UNIVERSITÀ DEGLI STUDI DI URBINO CARLO BO

Department of Economics, Society, Politics (DESP)

PhD Programme in Global Studies. Economy, Society and Law

Thematic Area: International Economic Policy, Business and Governance

Cycle XXXIII

Title

THREE ESSAYS ON INCOME DISTRIBUTION AND ECONOMIC GROWTH

Scientific Disciplinary Sector: SECS-P/02

Supervisor
Prof. Giuseppe Travaglini

Phd Candidate
Alessandro Bellocchi

Co-supervisor
Prof. Giovanni Marin

Academic Year 2019/2020

A DISSERTATION

SUBMITTED TO THE DEPARTMENT OF ECONOMICS, SOCIETY AND POLITICS (DESP)

AND THE COMMITTEE ON GRADUATE STUDIES

OF THE PHD IN GLOBAL STUDIES

IN PARTIAL FULLFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DECLARATION

I certify that the thesis I have presented for examination for the PhD degree of the University of Urbino Carlo Bo is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I declare that my thesis consists of approximately 92.000 words, excluding graphs, tables and appendices.

Chapter	Pages	Words	Characters (without spaces)	Characters
Introduction	42	17,282	90,742	107,964
Chapter 2	64	24,539	128,012	152,468
Chapter 3	48	23,555	125,546	149,075
Chapter 4	68	26,718	144,515	171,205
Total	222	92,094	488,815	580,712

*Including text boxes, footnotes and closing notes.

Introduction	42	14,477	75,104	89,522
Chapter 2	64	20,778	107,428	128,121
Chapter 3	48	18,768	99,843	118,575
Chapter 4	68	23,157	125,220	148,346
Total	222	77,180	407,595	484,564

*Without text boxes, footnotes and closing notes.

STATEMENT OF CONJOINT WORK

I confirm that Chapter 3 - "Market power, capital-output ratios, and technological change the firm-level determinants of labor share" - was jointly co-authored with Giovanni Marin and Giuseppe Travaglini, and I contributed to 50% of this work.

ACKNOWLEDGEMENTS

This project has enormously benefited from the help and support of several people. First and foremost, I am deeply indebted to my supervisor, Prof. Giuseppe Travaglini. He encouraged me to pursue a PhD after the end of my master's degree; he firstly introduced me to the main themes addressed with this thesis; and he invited me to work on a project that then became the third paper of it. But even more, I must thank him for his patient and invaluable guidance, since the encouragement and the advices he provided at each stage of the process and his continuous support throughout all the PhD, day in and day out have been essential. Much of the intellectual work of this thesis took place in conversations with him, and I can safely say that this work in its current form would not exist without his support. Therefore, I wish to express my deepest gratitude. Many others have helped me during the PhD. I am also very grateful to my co-supervisor (and coauthor) Giovanni Marin, for his generosity with his time and thoughts, for all the fruitful and insightful discussions we have had over these years and for the useful suggestions about the implications of the empirical part of my research. I have drawn extensively on those comments while drafting the final version of the thesis and even more importantly, his joy and enthusiasm for research have always been very contagious and motivational for me.

I must thank Gilles Saint-Paul for many reasons, firstly because one of his paper was of great inspiration for me in writing the third chapter of this thesis, but also for the fruitful discussions we had during his stay in Urbino in September 2019 and finally for his interesting lectures on globalization and economic growth.

Special thanks must also be given to Professor Libertad González for making it possible for me to visit the Department of Economics and Business of Universitat Pompeu Fabra (UPF) and Barcelona GSE and to the PhD students with whom I shared my office and from whom I received helpful comments during my stay in Barcelona: Christian Höynck and Yiru Wang.

During these years, I have also had the possibility to discuss my ideas with many colleagues and faculty members in Urbino. I owe them many thanks. I have benefitted from fruitful interactions either in terms of productive conversations, deep insights and generous advice with all the faculty of the Department of Economics, Society and Politics (DESP), in particular with members of the School of Economics: Gian Italo Bischi, Roberta Bocconcelli, Giorgio Calcagnini, Piera Campanella, Andrea Coveri, Ilario Favaretto, Laura Gardini, Germana Giombini, Alessandro Pagano, Elena Paglialunga, Tonino Pencarelli, Andrea Ricci, Rosalba Rombaldoni, Edgar J. Sánchez Carrera, Laerte

Sorini, Luciano Stefanini, Antonello Zanfei and many more. I thank them all from the bottom of my heart. The several discussions we have had constituted an essential ingredient of this thesis and have contributed to the improvement of its quality. I wish to express my gratitude to Francesco Bloise, Davide Castellani, Giovanni Dosi, Iuri Albert Kyril Kazepov, Michael Landesmann, Fabio Landini, Rajneesh Narula, Mario Pianta as well as many other participants at seminars and conferences of the PhD programme for the useful questions and comments provided. Notably, as a guest of the fourth edition of the PhD we also had the opportunity to attend the intervention of the Nobel Prize in Economics Joseph Stiglitz. His lecture on the economic consequences of the pandemic was very inspiring.

A special mention in this regard must go to the director of the PhD in Global Studies Antonello Zanfei for having strongly believed in the creation of this new and international doctorate and for all his constant efforts to improve it. But also, to Alba, Simona and Sofia for working so hard to make everything run smoothly and for never hesitating to help us with our technical issues and administrative formalities.

I am indebted to the many people and places in Urbino that have accompanied me during the doctoral years and beyond. These are too many to list. I must however at least mention the amazing group composed by PhD students of the XXXIII, XXXIV and XXV cycles which have been a source of friendships as well as good advice and collaboration. Elisa Carloni and Dalila Ribaudo have been either referees, editors or enthusiastic supporters as well as very good friends during these years. Rosa Fioravante has been my emotional anchor. Our endless philosophical and political discussions enriched my world outside of research, and through her energy we created a close-knit community of PhD students and researchers. They have all been a huge support and the PhD would definitively not have been the same without them.

My deepest gratitude goes to my parents and my family. Thank you for encouraging me to study and putting my education above everything else; thank you for supporting me while I was doing so; thank you for suggesting trying and go a bit further with my work. It has been a long way I suppose, but it was probably worth it - time will tell.

Finally, I cannot omit to thank the two anonymous referees for their careful review and insightful comments that have certainly helped to improve the quality as well as the overall consistency of the thesis.

Abstract

This thesis presents three papers on the determination of factor income shares and economic growth. The aim is to address a topical but often overlooked issue in economics, namely, the functional distribution of income, i.e., the division of national income amongst factors that concur to its creation (labor and capital). The relative stability of the labor share of income is a sound foundation in modern macroeconomic models. However, there is strong empirical evidence suggesting that the global labor share in advanced economies has remarkably declined since the early 80s, with a generalized fall taking place in most countries and sectors. Alongside this trend, recent research on the field stresses the macro-dimension of income distribution but no theory has emerged yet, thus relegating the topic as a secondary one. In the first part of the work, we make some technical and statistical considerations on the measurement and composition of labor share - since not all types of income in the national accounts can be easily attributed to either capital or labor. Once the issues related to the measurement of self-employment income have been considered, we will see that there are multiple forces which contribute to the observed fluctuations of the labor share, and among them there is a significant amount of self-reinforcement. However, what emerges is that, despite the number of insights one can gain from the empirical literature, these theories alone cannot provide a complete explanation of the current worsening of income distribution. It is precisely this reason that motivates our work. From a theoretical perspective - which is crucial to understand the cross-relationships between the economic variables involved - we further show that the cost of modifying existing models is in some cases low if compared to the benefits that can be obtained and is especially important in understanding the implications of this phenomenon on economic growth.

In the first paper we show that the CES production function presents at least two criticalities which are not compatible with the necessity to set up a modern theory of distribution. Therefore, we present a novel theory on how factor shares are determined at the aggregate level. By using AMECO data for a set of 20 industrialized countries over a 58-year period we provide empirical evidence against the CES and develop micro foundations for an aggregate production function that better fits the data and has the property of a variable elasticity of substitution. Then we relax the assumption of perfect competition by proposing a time-series calculation of the aggregate price mark-up and provide estimates of the elasticity of substitution under such a framework of imperfect competition in product markets. Finally, we test the prediction of the model by means of a numerical

simulation. We find that firms' rising markups along with biased technological change can account for a significant part of the labor shares' decline observed in the last 40 years. The results also suggest complementarity between labor and capital in most of the cases, with the elasticity of substitution σ that has been below unity on average, fluctuating around 0.7-1.16.

In the second paper the focus is shifted to heterogeneous sectors and firms and we study the micro-Level determinants of factor shares. Existing empirical analysis typically rely on industry or aggregate macro data, thus strongly downplaying the role of firm-level variables in the determination of wages. We analyze micro panel data from AMADEUS and seek to understand the dynamics of labor share in 19 broad sectors of the EU28. More specifically we explore the role of technological change, product and labor market imperfections. We build on insights from Bentolila and Saint-Paul (2003), Blanchard and Giavazzi (2003) Azmat et al. (2012), Karabarbounis and Neiman (2014) and econometric techniques from De Loecker and Warzynski (2012), to propose a model in which firms can be heterogeneous in terms of capital employed in production, market power and productivity. The core argument of our theoretical framework is the relationship between the labor share and the capital-output ratio. We show that this relationship holds also for firms and acknowledge the possible existence of relevant non-linearities. Labor share's movement turns out to be driven by a complex interplay of conditions for capital and labor, the nature of technological progress and imperfect market structures which can shift the curve but also - by creating a discrepancy between the marginal product of labor and the real wage - cause departures from it. Broadly confirming results from previous cross-country and industry-level studies, we find that the main factor decreasing labor shares are connected to capital deepening (a 1% increase in the capital-output reduce the labor share by -0.03 percentage points) in conjunction with capital-augmenting technical progress and labor substitution (-0.15). Although institutional factors play a significant role in some specific industries (like for instance Construction, Manufacturing and Transportation), they appear to be less important for the aggregate economy.

Finally, in the third and last paper we introduce new elements into a standard macroeconomic growth model and develop a post-Keynesian model which allow us to acquire valuable insights on the macroeconomic effects of changes in the aggregate distribution of income. We show, analytically, that: (i) income distribution matters mostly in the medium run; (ii) real wage restraint policies along with labor market deregulation can depress capital accumulation and growth; (iii) a decline in EPL may reduce the equilibrium unemployment. Then we test the predictions of the model by estimating the impact of a change in the labor share on economic

growth in a sample of 20 industrialized OECD countries. At the national level, a decrease in the labor share leads to lower growth in Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain and Sweden; whereas it stimulates growth in Australia, Canada, Ireland, United Kingdom and the United States. However, a simultaneous decline in the labor share in all these countries lead to a decline in global growth. Finally, we turn our attention to the long-run dynamics of the model by means of a structural vector autoregression (VAR). We focus on the relationship between effective demand, income distribution, labor market regulation, capital accumulation, labor productivity and unemployment. The VAR model is estimated for France, Germany, Italy, Spain, the UK and the USA. We find that employment is demand-led, and that income distribution may influence either demand or employment. Technological progress affects income distribution as well as employment. The policy conclusions of the paper shed light on the limits of international competitiveness strategies based on wage competition in a highly integrated global economy.

Keywords: Income distribution; Labor share; Technological progress; Economic growth.

Abstract in italiano

Questa tesi si compone di tre lavori sulla determinazione delle quote di reddito dei fattori produttivi e la crescita economica. La serie di paper proposti ha l'obiettivo di affrontare un tema estremamente attuale ma troppo spesso trascurato in economia, ovvero la distribuzione funzionale del reddito nazionale, e quindi la sua ripartizione tra i fattori che concorrono alla sua creazione (lavoro e capitale). La relativa stabilità della quota di reddito da lavoro (la c.d. *labor share*) costituisce una base solida nei moderni modelli macroeconomici. Tuttavia, vi sono forti evidenze empiriche che suggeriscono come la labor share nelle economie avanzate sia notevolmente diminuita a partire dai primi anni '80, con un calo generalizzato nella stragrande maggioranza dei paesi e dei settori. Accanto a questa tendenza, recenti studi applicati sottolineano l'importanza della dimensione macroeconomica del problema, ma non è ancora emersa alcuna teoria, facendo così passare l'argomento in secondo piano. Nella prima parte di questo lavoro si fanno alcune considerazioni tecniche e statistiche sulla misurazione e sulla composizione della labor share - poiché non tutti i tipi di reddito classificati nella contabilità nazionale possono essere facilmente attribuiti rispettivamente al capitale o al lavoro. Una volta considerate tutte le questioni relative alla misurazione del reddito da lavoro autonomo, vedremo che vi sono molteplici forze che contribuiscono alle fluttuazioni osservate, e fra queste vi è una quantità significativa di effetti auto-rinforzanti. Tuttavia, ciò che emerge è che, nonostante un elevato numero di ipotesi avanzate in letteratura sull'argomento, queste teorie da sole non possono fornire una spiegazione completa dell'attuale peggioramento osservato nella distribuzione dei redditi. È proprio quest'ultima motivazione che fornisce una solida giustificazione a questo lavoro. Da un punto di vista teorico - che è cruciale per comprendere le relazioni incrociate e quindi le causalità tra le variabili economiche coinvolte - dimostriamo che il costo di modifica dei modelli esistenti è relativamente basso se paragonato ai benefici che si possono ottenere, ed è particolarmente importante per comprendere le implicazioni di questo fenomeno sulla crescita economica.

Nel primo paper dimostriamo che le funzioni di produzione di tipo CES presentano almeno due criticità che non sono compatibili con la necessità di costituire una moderna teoria della distribuzione. Pertanto, presentiamo una nuova teoria su come vengono determinate le quote fattoriali a livello aggregato. Utilizzando i dati AMECO per un panel di 20 paesi industrializzati in un periodo di 58 anni, forniamo prove empiriche contro le CES e gettiamo le micro-basi per una funzione di produzione aggregata che si adatta meglio ai dati ed ha la proprietà di un'elasticità di

sostituzione variabile. Successivamente, allentiamo l'ipotesi di concorrenza perfetta nel mercato dei prodotti calcolando un markup dei prezzi aggregati e forniamo stime dell'elasticità di sostituzione in tale contesto. Infine, testiamo le previsioni del modello mediante una simulazione numerica. Quello che emerge è che i markup crescenti delle imprese, insieme al cambiamento tecnologico, possono spiegare una parte significativa del calo delle labor shares osservato negli ultimi 40 anni. I risultati suggeriscono anche una complementarità tra lavoro e capitale nella maggior parte dei casi, con l'elasticità di sostituzione σ che è stata in media inferiore all'unità, oscillando intorno a 0,7-1,16.

Nel secondo paper spostiamo l'attenzione sui settori e sulle imprese, studiando le micro-determinanti delle quote di reddito dei fattori. Le analisi empiriche esistenti sono largamente basate su dati macroeconomici aggregati, e minimizzano il ruolo delle variabili d'impresa nella determinazione dei salari. Pertanto, analizziamo un micro-panel con dati di bilancio AMADEUS e cerchiamo di comprendere le dinamiche della labor share in 19 settori dell'UE28. Più nello specifico esploriamo il ruolo del cambiamento tecnologico e delle imperfezioni sia nel mercato dei prodotti che in quello del lavoro. Ci basiamo sulle intuizioni di Bentolila e Saint-Paul (2003), Blanchard e Giavazzi (2003), Azmat et al. (2012), Karabarbounis e Neiman (2014) e sulle tecniche econometriche sviluppate da De Loecker e Warzynski (2012), per proporre un modello in cui le imprese sono eterogenee sia in termini di capitale impiegato nella produzione, che di potere di mercato e produttività. L'argomento al centro del nostro framework teorico è la relazione tra labor share e il rapporto capitale-prodotto. Dimostriamo che questa relazione vale anche per le imprese e riconosciamo la possibile esistenza di non linearità. Il movimento della labor share diventa quindi guidato da un complesso gioco di forze a favore rispettivamente di capitale e lavoro, nonché dalla natura del progresso tecnologico e da strutture di mercato imperfette che sono in grado di spostare la curva ma anche - creando una discrepanza tra il prodotto marginale del lavoro e il salario reale - causare deviazioni dalla stessa. Confermando i risultati di precedenti studi internazionali e di settore, troviamo che il principale fattore in grado di diminuire la labor share è legato all'intensità del capitale (un aumento dell'1% del rapporto capitale-prodotto riduce la labor share di -0,03 punti percentuali) in concomitanza con il progresso tecnologico e la sostituzione capitale-lavoro (-0,15). Sebbene i fattori istituzionali svolgano un ruolo significativo in alcuni settori specifici (come ad esempio l'edilizia, l'industria manifatturiera e i trasporti), essi sembrano essere meno importanti per l'economia aggregata.

Infine, nel terzo e ultimo lavoro introduciamo nuovi elementi in un modello standard di crescita macroeconomica e sviluppiamo un modello Post-Keynesiano che ci permette di acquisire

preziose informazioni sugli effetti macroeconomici dei cambiamenti nella distribuzione aggregata del reddito. In particolare, dimostriamo analiticamente che: (i) la distribuzione del reddito è importante soprattutto nel medio periodo; (ii) le politiche di contenimento dei salari reali insieme alla deregolamentazione del mercato del lavoro possono deprimere l'accumulazione di capitale e la crescita economica; (iii) un declino dell'EPL può ridurre la disoccupazione di equilibrio. Testiamo quindi le previsioni del modello stimando l'impatto di una variazione della labor share sulla crescita economica in un campione di 20 paesi industrializzati OCSE. A livello nazionale, una diminuzione della labor share porta ad una minore crescita in Austria, Belgio, Canada, Danimarca, Finlandia, Francia, Germania, Grecia, Irlanda, Italia, Giappone, Lussemburgo, Norvegia, Paesi Bassi, Portogallo, Spagna e Svezia; mentre stimola la crescita in Australia, Canada, Irlanda, Regno Unito e Stati Uniti. Tuttavia, un contemporaneo calo della labor share in tutti questi paesi porta ad un calo della crescita globale. Infine, rivolgiamo la nostra attenzione alle dinamiche di lungo periodo del modello attraverso un'autoregressione vettoriale (VAR). In particolare, ci concentriamo sul rapporto tra domanda effettiva, distribuzione del reddito, regolamentazione del mercato del lavoro, accumulazione di capitale, produttività del lavoro e disoccupazione. Il modello VAR è stimato per Francia, Germania, Italia, Spagna, Regno Unito e Stati Uniti. Troviamo che l'occupazione è guidata dalla domanda e che la distribuzione del reddito può avere un effetto sia sulla domanda che sull'occupazione. Il progresso tecnologico influisce sulla distribuzione del reddito e sull'occupazione. Le conclusioni fanno luce sui limiti delle strategie di competitività internazionale basate sulla concorrenza salariale in un'economia globale altamente integrata.

Keywords: Distribuzione del reddito; Labor share; Progresso tecnologico; Crescita economica.

This page is intentionally left blank.

Of the tendencies that are harmful to sound economics, the most seductive, and in my opinion the most poisonous, is to focus on questions of distribution. [...] Of the vast increase in the well-being of hundreds of millions of people that has occurred in the 200-year course of the industrial revolution to date, virtually none of it can be attributed to the direct redistribution of resources from rich to poor. The potential for improving the lives of poor people by finding different ways of distributing current production is nothing compared to the apparently limitless potential of increasing production.

Robert Lucas Jr. (2002)

SUMMARY

CHAPTER 3: MARKET POWER, CAPITAL-OUTPUT RATIOS, AND TECHNOLOGICAL CHANGE: THE FIRM-LEVEL DETERMINANTS OF LABOR SHARE 187

CHAPTER 4: MACROECONOMIC IMPLICATIONS OF A CHANGING INCOME DISTRIBUTION 302

This page is intentionally left blank.

Chapter 1: Introduction[1]

1.1 What do we know about the labor share?

The aim of this thesis is that of contributing to the existing literature by shedding light on one of the most challenging (and probably neglected) issues in economics: the functional distribution of national income. With this latter sentence, we refer, from a macroeconomic point of view to the slice of the economic cake (i.e., the aggregate production) that goes to each factor involved in the production process, as a reward for its contribution to the generation of economic value. National income is the sum of all income available to the residents of a country each year. Since we are considering the aggregate factor shares in output, we are talking of "functional distribution" of income between different groups or classes of people, whose roots are traditionally linked to macroeconomic analysis. Accordingly, functional distribution must not be confused with "personal distribution", which on the other hand studies the distribution of income across individuals or households and has traditionally been at the center of a microeconomic approach. However, as we will see in the next paragraphs and chapters of this theses which is composed of this extensive introduction and three separates but well-connected papers on the subject, it would be a mistake to consider the two kinds of distribution as independent of each other. Indeed, the same underlying drivers are shaping both the functional and the personal distribution of income. From an historical perspective, the question of income distribution is not recent at all and can be classified as one of the oldest questions ever addressed by economists. Theories, writings and essays on the distribution of income between single individual and social classes have been put forward in the economic literature since before Adam Smith to present day (Dobb and Dobb, 1975; Atkinson and Bourguignon, 2014; Sandmo, 2015). Nevertheless, even if Ricardo (1891) in the preface of his most famous work elevated the question on the determination of the laws of distribution to the "principal problem of political economy", this research field has many times been relegated to a modest existence, at the periphery of mainstream economic research. After Ricardo, the attention of economists for the topic has always been cyclical (Solow, 1958). The golden age was under the Classics (including the works of Marx), the early 20th century with the advent of modern statistical

[1] This Chapter is an extended version of a working paper which has published in the WP series of the University of Urbino. Full reference: Alessandro Bellocchi, 2020. Labor share is falling down, but which one?. Working Papers 20-01, University of Urbino Carlo Bo, Department of Economics, Society & Politics - Scientific Committee - L. Stefanini & G. Travaglini, revised 2020.

surveys, as well as the 50s and 60s. Then the whole matter has been sidelined following the marginal revolution and its aftermath as well as in the 30-40s, 70s and 80s; to get back on the front line only in the 1990s in its most visible form at the time, i.e., a tremendous growth in personal inequalities (Giovannoni, 2014). Finally, with the advent of the new millennium and the deterioration of functional distribution in the United States and worldwide, there has been also an increase in the research to investigate the macro roots of the problem. An interest reinforced after the global financial crisis of 2008, reflecting to some extent the impact of authors such as Piketty (2014), Atkinson (2015) and Milanovic (2016) which supported their works with long-term historical data. One of the main reasons why the problem of distribution has been forgotten for such a long period of time lies in the fact that factor shares have been roughly stable until 40 years ago. And this relative constancy was alternatively considered a "bit of a miracle" by Keynes (1939), a "stylized fact" of economic growth by Kaldor (1961)[2] or even a law[3] by the English economist Arthur Bowley (Samuelson, 1964). However, it is now certain that it is no longer possible to consider the labor share constant. The effective stability of income distribution has been questioned since the early 80s when aggregate productivity growth in most countries has decoupled from real median compensation growth, leading the labor share to track downward (see Figures 1 and 2). From this moment forward, raising productivity was no longer sufficient to raise the real wage of a typical worker.

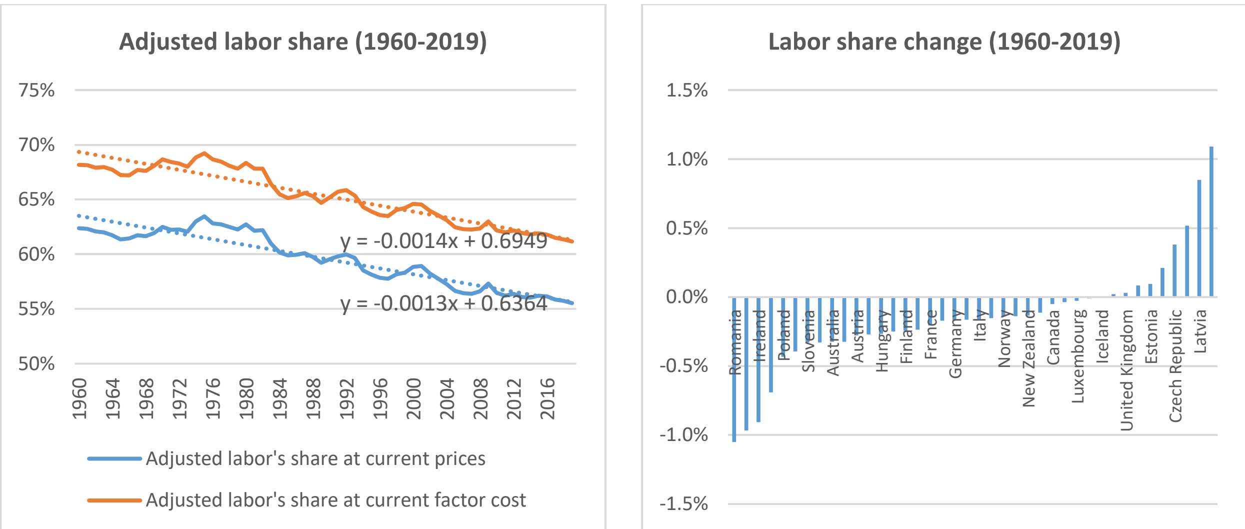


Figure 1 - Adjusted labor share as % of GDP at current prices and current factor cost (panel a) and average annual change of the labor share at current factor cost (panel b).[4] *Note:* The labor share is calculated as a weighted average of year-on-year labor shares. *Source:* Author's calculation on AMECO data.

---

[2] For Kaldor, the economy was at its natural level: real wage growth matched productivity gains and the share of labor was constant.

[3] This terminology was introduced by Samuelson (1964) referring to the work of the British economist and statistician Arthur Bowley.

[4] The starting year for Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom and the United States is 1980; New Zealand

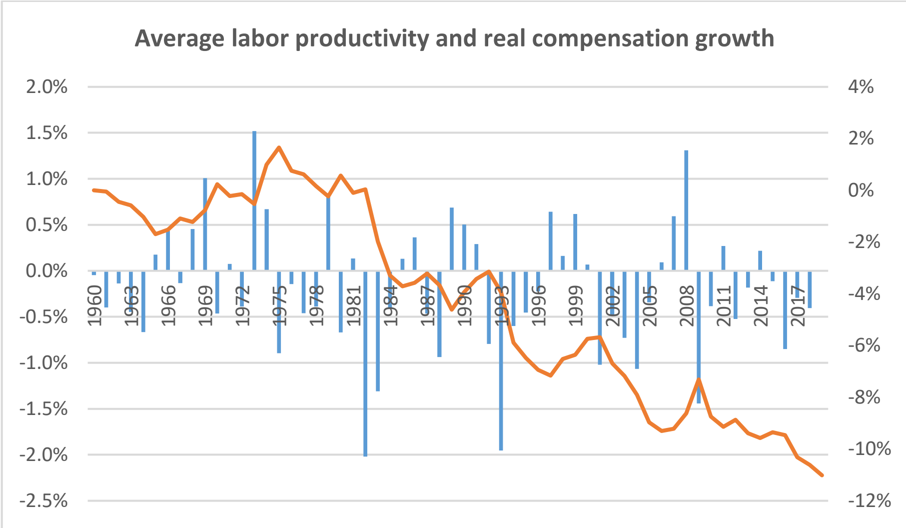


Figure 2 - Difference between annual growth rates of real compensation and labor productivity on the main axis and cumulative curve of the difference on the secondary one.

Note: Labor productivity and real compensation growth are calculated as weighted averages of year-on-year growth in respectively annual real compensation per employee (deflator GDP) and annual GDP at 2015 reference levels per person employed. The countries included are the same as in Figure 1. *Source:* Author's calculation on AMECO data.

Favorable economic conditions along with the low unemployment rates of the 90s produced a small improvement in the general development of the labor share, but they were far from being able to overturn the trend. With the beginning of the new millennium, the downward long run trend finally won, and the labor share has been falling since then, bringing the puzzle on its relative stability (i.e., instability) back to the forefront of economic research. Finally, consistently with the fact that the labor share is countercyclical in advanced economies, the financial crisis and the related Great Recession of 2008 barely produced an increase.[5] However, even after this recent (and somehow indirect) revival of interest in the functional distribution of income, the importance of the topic is a long way off that it used to have with the Classicals, and six decades after Kaldor (1961), almost all the economists are still considering factor shares constant, thus overshadowing the problem. For instance, Lucas (2002) states that: "Of the tendencies that are harmful to sound economics, the most seductive, and in my opinion the most poisonous, is to focus on questions of distribution". Feldstein (2008) confirms his view and adds that: "The share of national income going to employees is approximately the same level now as it was in 1970", relegating the misunderstanding to some

starts in 1986, Turkey in 1988, Romania in 1990, Switzerland in 1991, Latvia and Poland in 1992, Czech Republic, Estonia and Lithuania in 1993, Bulgaria, Croatia, Cyprus, Hungary, Malta, Mexico, Slovakia and Slovenia in 1995, Macedonia FYR in 1997.

[5] The adjusted global labor income share presents a clear countercyclical behavior during the financial crisis and in its aftermath (see for instance the IMF, 2012 for a complete review of the studies which employ aggregate data). However, these results are also confirmed by the adjusted micro-data with the labor share showing a clear downward trend between 2004 and 2017, only interrupted in the years of the financial crisis (Gomis, 2019).

measurement errors which have led analysts to conclude that the rise in labor income has not kept up with the growth in productivity. But the list goes on. Mankiw (2017), author of one of the most popular textbooks of undergraduate Macroeconomics, start his introduction by arguing that: "More recent US data are also consistent with the Cobb-Douglas production function. […] Despite the many changes in the economy over the past four decades, this ratio has remained about 0.7. This division of income is easily explained by a Cobb-Douglas production function in which the parameter is about 0.3. According to this parameter, capital receives 30 percent of income, and labor receives 70 percent". However, we should never forget that Solow itself, just after introducing the use of aggregate Cobb-Douglas (CD) production functions in macroeconomic modelling, recommended extreme caution with their employment in empirical works because the stability of factor shares was apparently "partially a mirage" (Solow 1958). Nowadays, the use of the CD production functions[6] is very common, and its diffusion has not been even partly hampered by the possibility that factor shares may not be constant and the consequences of this eventuality on the hypotheses underlying economic models. In the last 60 years, our theoretical knowledge and use of production functions has not changed that much. In other words, it is almost as if the issue of distribution has been largely separated from that of production. Now, thanks to the greater availability of data and statistics on distribution for either developed or developing countries things are starting to change with the revolution rising from the empirical side. There is a large amount of empirical evidence and applied studies that all tell us the same story: we are witnessing to a worldwide fall in labor shares since the early 80s (see Karabarbounis and Neiman, 2014 for a complete survey of these studies). Further, the tendency seems to have accelerated its pace over the past decade. This thriving literature identify the reasons for the decline of the labor share on structural factors such as biased technological progress (through capital deepening, capital-labor substitution, and the automation of the production processes), international trade (with offshoring and the reduction of labor bargaining power), the phasing-out of the welfare state, liberalization and deregulation (which lead to an increase industry concentration, rising market power and with consequent emergence of rents) and, more than all, financialization (OECD, 2012). Curiously, the revolution did not come from academia, and most of the work is the result of independent research efforts by international

[6] Paul Douglas noted that the division of national income between capital and labor in the US was roughly constant over a long period of time. In other words, as the economy developed over time, the total income of workers and the total income of capitalists grew exactly at the same rate. This observation made him develop, along with the mathematician Charles Cobb a production function that would originate constant factor shares. In this context, they developed a simple production function with this property: $F(K,L) = A\,K^{\alpha}L^{\alpha-1}$, where $(1-\alpha)$ is the labor share of output. This function became famous in economic applications as the Cobb-Douglas (CD) production function.

organizations and government or intergovernmental agencies (e.g. the International Labor Organization - ILO, the United Nations - UN, the International Monetary Fund - IMF, the Federal Reserve - FED, the European Central Bank - ECD, the European Commission - EC, the Organization for Economic Co-operation and Development - OECD, to name but a few).[7] For instance, the OECD (2012) has estimated that, over the period from 1991 to 2010 the share of labor compensation in national income fell in 26 out of 30 advanced economies for which data is available, with the median adjusted labor share that declined from roughly 66% to 61% (on average 0.23 percentage points a year). More recently, they have revised this calculation upwards and found that the adjusted labor share in G20 countries decreased by about 0.30% each year between the early 80s and the late 2000s. Similar results have been confirmed by other international agencies (EC, 2009; BOI, 2016; IMF, 2017; ECB, 2019; ILO, 2019; McKinsey, 2019). However, these long-run patterns and even more the countercyclical behavior seem to be less robust outside the developed world. Indeed, in the case of developing countries the evidence is more mixed and, in some cases, ambiguous. For instance, Asia presents an important decline, with a countercyclical peak in 2008-2009, mainly due to the behavior of the labor share in India. Africa, on the other hand has decoupled from the global declines, and since 2010 its labor income share is steadily increasing (even if it was starting from the lowest level of the considered regions). It is important to highlight that in these regions data availability is scarce, and hence the regional figures present a large degree of uncertainty (ILO, 2019).

Understanding why the labor share has been falling while it used to be constant and investigating the macroeconomic consequences of this shift is exactly the puzzle that we want to address with this collection of papers. Specifically, we start by reviewing recent trends in labor income shares to provide an updated global picture for what concerns the most advanced OECD countries and discuss the possible causes of the observed tendencies (both from a macro and micro point of view to account for the observed heterogeneity which is present in the data). Then we explore the linkages between the labor share and the main components of aggregate demand. Other critical and related aspects such as the impact of shifts in the labor share on growth and employment as well as the consequence in terms of policy implications are finally analyzed. However, before diving into the exposition and presenting the individual papers we believe it is

[7] See for instance Lübker (2007), Lavoie and Stockhammer (2013) and Gomis (2019) for the ILO; Guscina (2006), Rodriguez and Jayadev (2010), Dao et al. (2017), Abdih and Danninger (2017), Lian (2019) and Dimova (2019) for the IMF; Elsby et al. (2013) and Orak (2017) for the FED; Lawless and Whelan (2011) and McAdam et al. (2019) for the ECB; Arpaia et al. (2009) for the EC; OECD (2012), Bassanini and Manfredi (2014) and Schwellnus et al. (2018) for the OECD.

worth opening a brief parenthesis around all the aspects concerning the calculation of the share itself, its measurement and related technical issues. Indeed, as we will see, statistical agencies (in accordance with the System of National Accounts[8]) usually report aggregates of income such as wages, benefits, mixed income, net interest, rents and corporate profits, thus making impossible to distinguish in a simple straightforward way between wages, profits and rents as we are used to have in the dichotomies of economic models. On the practical level this means that not all types of income can be easily allocated to either capital and labor and some authors have recently wondered whether this apparent decline in factor shares may be due to measurement problems, or the way in which indirect taxation and capital depreciation are considered (Bernanke and Gürkaynak 2001; Rognlie 2015; Bridgman 2017). Therefore, we will spend some time explaining what the possibilities are to make these choices more effective.[9] Secondly, when it comes to the functional distribution of income, it is of crucial importance to define the terms as accurately as possible. Sometimes there is a certain confusion in the exposition - such as referring to the "wage share" having in mind what is more properly a “labor share” - which we believe should be addressed from the beginning.

The work is organized as follows. In *Chapter 1* (i.e., the introduction/methodological note) we start by crossing various existent datasets to derive several high frequency measures of labor share in the United States. Actually, at least since the work of Gollin (2002) it has been clear that its measurement is not straightforward and hence we will discuss all the strategies that are frequently used by international organization and independent researchers to adjust the labor share. We then compare alternative data sources to check for the robustness of the estimation and ultimately place the results in the international context. What emerges from the analysis is that contrary to some recent findings that long run changes in factor shares must be attributed to the lack of adequate adjustment for self-employment income, indirect taxes and capital depreciation, these factors determine only the extent of a clear downward trend. Finally, we conclude with a rapid survey of the expanding empirical literature on the determinants of functional distribution in order to identify the factors that have been found by the literature to have an impact on the labor share. Aside from structural reasons and reasons related to economic policy we will see that a key role has been played by technological change, international trade and financialization, with the latter two referring to the so-called “bargaining power hypothesis” which attributes the decline of the labor share to a decline

[8] The System of National Accounts (SNA) is the internationally agreed standard on how to compile and measures economic activity.

[9] As pointed out by Krueger (1999), calculation used to determine factor income shares inevitably force income into two “artificial” categories: earned income and non-work income. However, there are many different kinds of work and “labor and capital no longer divide so neatly into mutually exclusive categories” since each economic agent derives its income from a number of different sources.

in the bargaining power of labor.[10] Each of these variables and its relationship with the labor share is then studied, and its effect quantified in the three papers at the heart of this work.

Chapter 2 presents the first paper - *Variable Elasticity of Substitution, imperfect competition and the decline of the labor shares* - where we contribute to the literature by showing and documenting an average drop of the global labor share in the order of 8 percentage points for 20 industrialized countries between 1960 and 2019. Speculating on the form of the production function, we reexamined the dynamics of the labor share and investigate theoretically and empirically two of its driving forces: technological progress and the presence of frictions in labor and product markets. By means of a variance decomposition analysis we find - in contrast with part of the existent literature - that technological change is indeed a key driver of the behavior of factor shares and accounts on average for roughly 43% of the total movement. However, also the other factors, such as real wages dynamics and capital deepening (46%), the markups (11%) and structural/institutional conditions of the economy (through a change in the parameters of the production function) have had a not negligible role. We further estimate the elasticity of substitution between capital and labor and, confirming the most recent empirical literature find elasticity to be larger than one in some countries (Austria, Canada, Finland, France, Ireland, Portugal, the UK and the USA) and lower than one in others (Belgium, Denmark, Germany, Greece, Italy, Japan, Luxembourg, Netherlands, Norway, Spain and Sweden). All the economies investigated have experienced different declining path of labor income shares and, at the same time, different trajectories in the evolution of capital deepening and real wages. In this sense our model is also able to reconcile these facts by unveiling the connection between these variables, the elasticity of substitution and technological progress.

In *Chapter 3* we present the second paper on *Market power, capital-output ratios, and technological change: the firm-level determinants of labor share*. Existing empirical analysis typically rely on industry or aggregate macro data, thus downplaying the importance of heterogeneity among firms. Therefore, in this part of the work, we analyze micro panel data from AMADEUS and seek to understand the dynamics of the labor share in 19 broad sectors of the EU28. We start by documenting basic empirical regularities to give an interpretation of the fall in labor shares mainly

[10] (i) The technological change hypothesis argues that the labor share declined due to capital augmenting technological progress or an increase in capital intensity. (ii) The bargaining power hypothesis posits that the decline in the labor share has been due to a decline in the bargaining power of labor, induced by changes in government policy, labor market institutions, globalization or financialization. The relevance of these factors differs across countries: 1. Labor market institutions depends on the bargaining regime. 2. The effect of globalization depends on the prevalence of market or cost seeking activities, which differs by country or industries. 3. The effect of technological change depends on the production structure and varies across high- and low-skilled sectors.

based on firm level determinants. Then we explore the role of technological change, product and labor market imperfections. Broadly confirming results from previous cross-country and industry-level studies, we find that the main factor decreasing labor shares are connected to capital deepening (a 1% increase in the capital-output reduce the labor share by -0.03 percentage points) in conjunction with capital-augmenting technical progress and labor substitution (-0.15). Although institutional factors also play a significant role in specific industries (like for instance Construction, Manufacturing, Mining and Transportation), they appear to be less important for the aggregate economy. However, our most important result is to show that when non-linear terms for capital-output are included in the model the effect of capital accumulation on the labor share is no longer so trivial to interpret and gives rise to heterogeneous behavior in various industries.

Chapter 4 presents the last paper on the *Macroeconomic implications of a changing income distribution*. Here we introduce new elements into a standard macroeconomic growth model and develop a Post-Keynesian model which allow us to acquire precious insights on the macroeconomic effects of changes in the aggregate distribution of income. As a result, we find, analytically, that: (i) income distribution matters mostly in the medium run; (ii) real wage restraint policies along with labor market deregulation can depress capital accumulation and growth, slow down technological progress and productivity; (iii) fiscal and/or monetary policy can also have permanent effects on the natural rate of unemployment; (iv) the impact on equilibrium unemployment of an increase in labor protection legislation is ambiguous. Then we test the predictions of the model by estimating the impact of a change in the labor share on economic growth in a sample of 20 OECD countries. At the national level, a decrease in the labor share leads to lower growth in Australia, Austria, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Netherlands, Norway and Sweden, whereas it stimulates growth in Ireland, United Kingdom and the United States. However, a simultaneous decline in the labor share in all these countries lead to a decline in global growth. Finally, we turn our attention to the long-run dynamics of the model by means of a structural vector autoregression (VAR). We focus on the relationship between effective demand, income distribution, labor market regulation, capital accumulation, labor productivity and unemployment. The VAR model composed as follows is estimated for France, Germany, Italy, Spain, the UK and the USA. We find that employment is demand-led, and that income distribution may influence either demand or employment. Technological progress affects income distribution as well as employment. The policy conclusions of the paper shed light on the limits of international competitiveness strategies based on wage competition in a highly integrated global economy.

1.2 Estimating the labor share: a methodological note

1.2.1 A couple of remarks before starting

Before getting into the topic, we need to provide some clarifications on several relevant points. The first of these is that national statistical offices or the departments of commerce of different states publish report which includes elements of aggregate income such as wages, benefits, proprietors' (or mixed) income,[11] interest, rents and corporate profits and therefore there is no such a clear separation between wages, profits and rents as we use to have in economic models.[12] Indeed, at least since Gollin (2002) and Gomme and Rupert (2004) has been clear that the measurement of the labor share from macro data is not as simple as one may think. This means that basically, not all the different types of income can be easily allocated to either capital or labor and a proper attribution is crucial to give an exact assessment of the shifts that took place in the distribution of income. Secondly, it is equally important to define the terms as accurately as possible. Indeed, there is often some confusion surrounding these concepts, such as for instance talking about a "wage share" while having in mind what is a "compensation share" or a "labor share" and we believe that, in order to avoid potential sources of misunderstanding these issues should be addressed from the beginning. Therefore, let us start by remembering that a share, in this case an income share, depends on both its numerator and its denominator. The denominator used is typically the GDP (Gross Domestic Product), GDI (Gross Domestic Income), NNI (Net National Income) or GVA (Gross Value Added).[13] In order to make a meaningful comparison, it is important that the shares are always expressed in the same aggregate. From this point forward (and in the econometric analysis of papers) - unless explicitly stated - we will always refer to the GDP at factor cost, which can be defined as "the sum of net value added by all the producers in the domestic territory of the country and consumption of fixed capital during an accounting year". According to Guerriero (2012) the latter measure is more meaningful in computing the labor share, since taxes do not represent - from an accounting

[11] From the Bureau of Economic Analysis (BEA) of the US Department of Commerce, the macroeconomic aggregate called "proprietors' income includes current-production income of sole proprietorships, partnerships, and tax-exempt cooperatives, while it excludes dividends, monetary interest received by nonfinancial business, and rental income received by persons not primarily engaged in the real estate business.

[12] They also publish data about secondary types of income, which constitute however small flows and used to be constant over time. These categories include incomes such as business current transfers and payments, taxes on production and imports, taxes on corporate profits, subsidies, and capital consumption. We will discuss how the income distribution account is structured here below.

[13] The standard definition of capital income implies the measurement net of capital consumption. Therefore, consumption of fixed capital should be subtracted from the measure of value added, to obtain a net measure (Kuznets, 1959). However, since data availability precludes us from being able to do so for all countries, we do this calculation only for the United States and rely on the gross version for international comparisons.

perspective - any kind of return to property or capital, and hence cannot be considered as a non-labor income. On the other hand, subsidies are instead retained (Glyn, 2009). Gross value added at factor cost is not a concept used explicitly in the system of national account (SNA, 2008).[14] Nonetheless, it can be easily derived from either the measures of gross value added (i.e. at basic current prices or at producer's prices) by subtracting the value of taxes on production of any kind, less subsidies on production - payable out of gross value added as defined.[15] Actually, the only taxes on production remaining to be paid out of gross value added at basic prices consist of "other taxes on production - D.29)" which are not charged per unit. These consist mostly of current taxes (or subsidies) on the labor or capital employed in the enterprise, such as payroll taxes or current taxes on vehicles or buildings.

$$GDP\ at\ Factor\ Cost\ = \sum of\ all\ GVA\ at\ factor\ cost =$$
$$GDP\ at\ market\ price - \ Taxes\ on\ products\ and\ production +\ Subsidies$$

Alternatively, another way of calculating the GDP at factor cost is by summing the total of compensation of employees' in an accounting year and depreciation of fixed capital (capital consumption). In this way we obtain the Gross Domestic Income - GDI (following the so-called income approach to GDP). Net Domestic Product (NDP) - which excluded depreciation[16] - is also called Net Domestic Income (NDI).

$$GDP\ at\ Factor\ Cost\ =$$
$$Net\ Domestic\ Product\ at\ factor\ cost + Indirect\ taxes\ minus\ subsidies +\ Depreciation$$

---

[14] The biggest difficulty in the construction of the GVA (or the GDP) at factor cost is that there is not a set of observable prices that can be employed in order to obtain it directly multiplying prices by the total quantities of production. By definition, other taxes or subsidies on production are not items like taxes or subsidies on products that can be removed from producer and input prices. Thus, despite its traditional name, GVA at factor cost is not strictly a measure of value added (output) but is essentially a measure of income. It represents the amount of income that remains to be distributed from GVA after payment of all taxes on production and receipt of all subsidies on production. In this sense it makes no difference which measure of GVA is used to derive this measure of income, since alternative measures differ only in the amounts of taxes or subsidies on production which remain to be paid on GVA (SNA2008).

[15] Taxes on products are proportional taxes to the quantity or value of goods and services produced, sold or imported by residents. They include (among others) the following items: value added tax, taxes on sales and purchases, taxes on services, taxes on exports and imports, etc. Subsidies are uncompensated (and unrequired) current payments due by the government to firms in strictly connection with their production activities.

[16] Depreciation is the loss of value of an ageing asset. It represents a deduction from income to account for the loss of capital value due to the use of capital goods in production. "Consumption of fixed assets" was used as a synonym for "Depreciation" in the SNA 1993. However, unlike "depreciation" in business accounting, CFC in national accounts is not a method of allocation for the costs of past expenses for fixed assets in subsequent accounting periods. Rather, it represents the decrease in future benefits from the assets due to their employment in the production process.

The income approach to GDP is based on the accounting reality that all expenditures within the boundaries of an economy should equal the total income generated by the production of all economic goods and services - i.e., every dollar of income must ultimately be earned either by the factors employed in production (capital and labor) or retained by government. Therefore, by adding all the sources of income together, a quick estimate can be made of the total productive value of economic activity over a certain period. Then, additional adjustments are necessary for taxes, depreciation, and foreign factor payments. Aggregate production is the result of the joint work of several factors involved in the production process. In exchange for their contribution, they receive a remuneration in the form of rent, wages, interest and profit. Total national income is exactly equal to the sum of all wages plus rents plus interest and profits.[17] These payments to factors are called production cost or factor cost. From the point of view of the company, they are costs and from the point of view of the factors, it is their income.

$$\boldsymbol{Gross\ value\ added\ (GVA)} = Compensation\ of\ employees + Gross\ operating\ surplus + Mixed\ income + Other\ taxes\ less\ subsidies\ on\ production$$

$$\boldsymbol{Gross\ value\ added\ (GVA)} = Compensation\ of\ Employees + Corporate\ Profits + Rental\ Income + Net\ Interest\ Income + Proprietor's\ income + Indirect\ taxes\ less\ subsidies + Depreciation$$

Whilst the concept of value added is initially found in the *Production account*[18] of the national accounts, it is the *Primary distribution of income account*[19] which shows how the gross value added

[17] All final goods and services are produced using factors of production, therefore, by adding the payments to the factors, it is possible to obtain the value of GDP: (i) Compensation of employees includes wages, salaries, fringe benefits, contributions to social security, health care and retirement plans. (ii) Rent is the income of the property owners. (iii) Interest is the income of the suppliers of money capital. (iv) Proprietor's Income is the income of incorporated business, sole proprietorships, and partnerships. (v) Corporate Profits is the income of the corporations' stockholders whether paid to stockholders or reinvested. Sum of the above items compose the National Income (NI). Then, two non-income adjustments have to be made in order to get the GDP: (i) indirect business taxes minus subsidies have to be added to transform factor cost into market prices. (ii) depreciation (or capital consumption) has to be added to transform the NDP into GDP.

[18] The Production account is explicitly built to show value added as one of the main balancing items of the system. As a consequence, it does not cover all the transactions connected with the production processes, but only the result of production (output) and consumption of goods and services when producing it (intermediate consumption). Intermediate consumption of goods does not include the progressive wear and tear of fixed capital which is recorded as a separate transaction (consumption of fixed capital) and constitute the difference between the gross and net balancing items. All the institutional sectors have a production account, however, in the production account of institutional sectors, output and intermediate consumption are not broken down by products.

[19] The process concerning the distribution of national income is so important that each of the steps is reported and shown separately in different accounts. Therefore, income distribution is decomposed into three main steps: primary distribution, secondary

generated in the economy is distributed back to labor, capital, government and, where necessary, flows to and from the rest of the world. Indeed, in compliance with the specifications of the SNA, the Primary distribution of income account is never presented as a single account but always as two sub-accounts. The first of these is the *Generation of Income Account* (Table 1) in which value added is distributed to labor (in the form of compensation of employees), capital and government (taxes on production and imports less subsidies as far as they are included in the evaluation of output). The distribution to capital appears in the balancing item as operating surplus or mixed income (1). On the other hand, the *Allocation of primary Income Account* (Table 2) shows the remaining part of the primary distribution of income. It contains operating surplus or mixed income as a resource and records, for each sector, property income receivable and payable, and compensation of employees and taxes, less subsidies, on production and imports receivable by households and government. Since transactions of this kind may appear in the Rest of the world account, these must be included as well. As can be seen, the balancing item of the Allocation of primary income account (and of the complete primary distribution of income account) is the balance of primary income (2).

Generation of income account	
Uses	*Resources*
Compensation of employees	Value added (VA)
Taxes on production and imports	
Subsidies (-)	
Operating surplus, net (1)	
Mixed income, net (1)	

Table 1 - The Generation of income account (Primary distribution of income) of the national accounts.

Source: The system of national accounts, 2008.

distribution and redistribution in kind. As long as all kinds of distributive transactions included in the system are effectively measured, the increase in the number of accounts adds very little to the work done but allows the introduction of balance sheet items that are significant concepts of income. The allocation of primary income account of the national accounts focuses on resident institutional units or sectors in their capacity as recipients of primary incomes.

Allocation of primary income account	
Uses	*Resources*
	Operating surplus, net
	Mixed income, net
	Compensation of employees
	Taxes on production and imports
	Subsidies (-)
Property income	Property income
Balance of primary income (2)	

Table 2 - The Allocation of primary income account (Primary distribution of income) of the national accounts

Source: The system of national accounts, 2008.

The *Secondary distribution of income account* (Table 3) deals with the redistribution of income through current transfers other than social transfers in kind made by government and other non-profit institutions serving households (NPISHs) to households. As resources, it records, in addition to the balance of primary incomes, current taxes on income, wealth, etc. and other current transfers except social transfers in kind. On the uses side, the same kinds of transfers are also recorded. Since these transfers are resources for some sectors and uses for others, their exact content varies from one sector to another. Although employers normally pay social contributions on behalf of their employees directly to the social insurance schemes, in the SNA these payments are treated as if they were made to employees who then make payments to social insurance schemes. In terms of the account, this means that they first appear as a component of compensation of employees in the use side of the Generation of income account of employers and the resource side of the Allocation of primary income account of households (adjusted for external flows in compensation of employees). They are then recorded as uses in the Secondary distribution of income account of households (and possibly of the rest of the world), and as resources of the sectors managing social insurance schemes.[20] The balancing item of the Secondary distribution of income account is disposable income (3). For households, this is the income that can be used for final consumption expenditure and saving. For non-financial and financial corporations, disposable income is income not distributed to owners of equity remaining after taxes on income are paid.

[20] This way of recording transactions in the accounts as if they followed another course is commonly called “rerouting”.

Secondary distribution of income account	
Uses	*Resources*
	Balance of primary incomes
Current transfers	Current transfers
Current taxes on income, wealth, etc.	Current taxes on income, wealth, etc.
Net social contributions	Net social contributions
Social benefits other than social transfers in kind	Social benefits other than social transfers in kind
Other current transfers	Other current transfers
Disposable income (3)	

Table 3 - The Secondary distribution of income account of the national accounts.

Source: The system of national accounts, 2008.

Finally, there is the *Redistribution of income in kind account* which, for the transactions concerned, is only for government, households and NPISHs. Social transfers in kind cover two more elements in representation of the redistribution process. The first of these is non-market production by government and NPISHs of individual services and the second is the purchase by government and NPISHs of goods and services for transfer to households free or at prices that are not economically significant. Redistribution of income in kind represents the tertiary distribution of income. The System of National Accounts (SNA2008) is the statistical framework that provides consistent and comparable macroeconomic accounts. It is produced by the joint action of the UN, the EC, the OECD, the IMF and the WB. It represents an update of the SNA 1993 and at the end of 2017 it was adopted by 180 member states (79 in its 2008 revision and 101 in the original version of 1993) (UNSD, 2018). The European system of national and regional accounts (ESA 2010) is consistent with the guidelines on national accounting set out in the SNA 2008.

Understanding how national accounts work and how different types of income are recorded within them turns out to be crucial in addressing another problem closely related to the calculation of the labor share, namely, estimating the impact of the self-employed. Usually, the labor share is calculated first, while the capital share as a residual. Therefore, although it is considered elementary to be determined from a theoretical perspective, some problems may emerge from its measurement.

For what concerns the numerator, we can distinguish between:

- The *wage share* (i.e., share of wages on a chosen measure of income);
- The *compensation share* (i.e., sum of wages and benefits on a chosen measure of income);
- The *labor share* (i.e., sum of wages, benefits and an estimate of the labor component of mixed income on a chosen measure of income).

Hence, depending on the choice of both numerator and denominator, a wide range of labor shares can be calculated, and they do not necessarily tell the same story. This is the reason why with this introduction we would like to provide evidence from different angles. The first two measure are generally easy to obtain; the labor share is trickier. Likewise, we should pay attention to what we mean when referring to the complement to unity of the labor share. “Capital share” may be an equally misleading term in applied research, and the term "profit share" refers only to corporate profits. According to national accounting practices, the complement to unity of the labor share can be simply called "non-labor share of income”. Figure 1 - panel a (page 2), which should now be familiar, presented the official AMECO data for the adjusted labor share. The latter is the ratio the ratio of labor compensation and GDP at factor cost at each time t:

$$LS_t = \frac{W_t}{Y_t} = \frac{w_t L_t}{P_t Y_t} = \frac{w_t}{P_t}\frac{Y_t}{L_t} \quad (1)$$

So that,

$$LS_t = \frac{w^r{}_t}{y_t} \quad (2)$$

Where:

- LS_t is the labor share for the aggregate economy;
- W_t is total labor income (total compensation of employees);
- Y_t is the GDP at factor cost;
- w_t is the nominal rate of labor income (the nominal wage rate or nominal compensation);
- L_t is the level of employment (persons employed);
- P_t is the overall price level;
- $w^r{}_t$ is real labor income;
- y_t is the productivity of labor.

The hourly basis for compensation and labor productivity is practical because it directly accounts for every change in the duration of work.[21] However the availability of data is in some cases limited. The compensation share is calculated from the national accounts by dividing the total compensation in the economy by aggregate GDP (either at basic prices or factor cost as in the version we employed) and sometimes is also called *unadjusted labor share*. The measure of compensation is generally considered a better measure than the simple "wages and salaries", because it takes also into account of some other forms of non-wage compensation - such as for instance bonuses, family allowances, employers' contributions to social security, health and other pension schemes. The definition of the US Bureau of Economic Analysis in compiling these data includes for instance realized stock options and all the taxable fringe benefits which are not part of the pay package of a typical worker (Krueger, 1999). In contrast to the unadjusted labor share, the *adjusted labor share* (Figure 3 - panel a, page. 2) increases the unadjusted labor share to correct this latter for the level of self-employment since, as explained in Krueger (1999) and Gollin (2002), this indicator has very strong limits. By including only payments to workers, we are implicitly classifying all the income of the self-employed as capital income, hence underestimating the real labor share and potentially introducing a bias in international comparisons.[22] Published and unpublished data have been employed by the literature and different organizations to derive an adjusted version of the measure. Data on the compensation of employees is usually readily available for the US, EU member states and advanced economies of the world.[23] However, data on labor income of the self-employed must be estimated since the national accounts record labor income of self-employed together with capital income of corporations and quasi-corporations. Given the limitations in both measuring mixed income as well as allocating a "fair" share of it to labor, in order to obtain comparable series for several countries, AMECO overcome this problem by means of another correction which does not rely on mixed income data. The adjusted labor share is calculated by AMECO as:

$$LS^{adj}{}_t = \frac{\frac{\text{Compensation of employees}}{\text{Number of employosss}} \cdot \text{Total employment}}{\text{Gross domestic product at factor cost}} \text{x } 100 \qquad (3)$$

[21] Employment (persons) includes all the persons involved in the production activities. Employment (hours worked) refers to number of hours worked, whether paid or not. However, data on hours worked have been incorporated into national accounts only recently for many countries. Actually, the integration of labor accounts into national accounts has turned out to be a long and complicated process. Where available, employment data in NA cover employees and self-employed persons working in domestic production units. The methodology is thus consistent with other NA's variables but differs from the employment estimates published by the LFS.

[22] The income earned by the self-employed represents both returns to work and returns to capital. Especially in developing countries, the self-employed and the people working in family firms account for a very consistent share of the total workforce.

[23] Compensation of employees shall include wages and salaries both in cash and in kind, paid to workers in return for their labor and the social contributions paid by employers, which comprises pension contributions and non-pension contributions.

The resulting measure is readily available in the Commission's AMECO database as variable ALCD2.[24] However, it is worth noting that that such an adjustment is implicitly based on the assumption that the composition of self-employed remains constant over time, and that the self-employed earn the same as employees. However, this is not necessary the case. For instance, it is plausible that in the 1960s a higher percentage of self-employed workers worked in the agricultural sector than today where most of the self-employed are employed in the liberal professions and services (e.g., lawyers, consultants, doctors, etc.). Data on self-employment collected by the BLS as part of the Current Population Survey (CPS) for the US show that while in 1960 33.5% of all the self-employed were working in agriculture (2.776.000), in 2019, with 741.000 people, agricultural workers represented only 7.8% percent of the total (Figure 3).[25] On the basis of these data, the US labor share in domestic income has remained virtually constant from around 1960 to 1983 and has decreased since then (Figure 4).

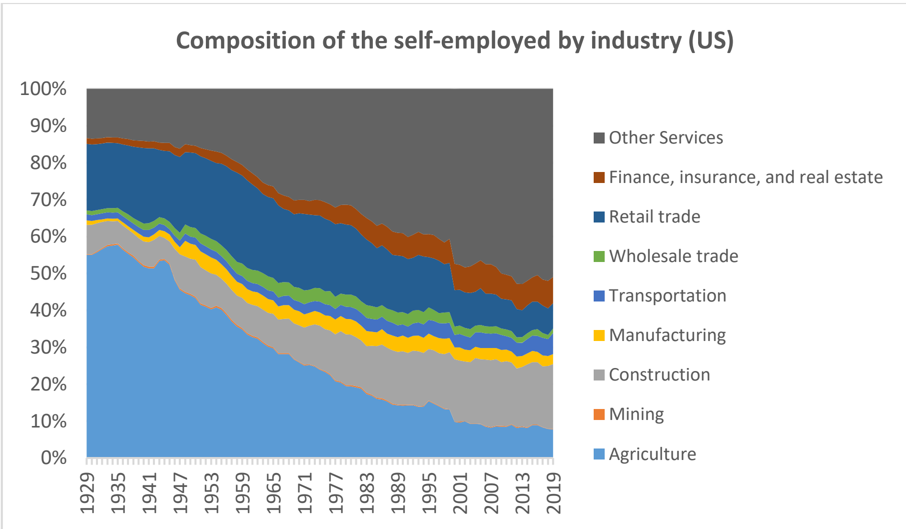


Figure 3 - Composition of the self-employed by industry in the US (1929-2019).

Source: Author's calculation on BEA data.

[24] This measure of the labor share will be an unbiased indicator of the labor income share as long as, on average, the self-employed earn the same labor compensation as employees.

[25] Bureau of Economic Analysis (BEA). National Income and Product Accounts - Table 2.1 Employment by Major Industry Sector. Self-employed consists of proprietors or partners who devote the majority of their working hours to their unincorporated businesses.

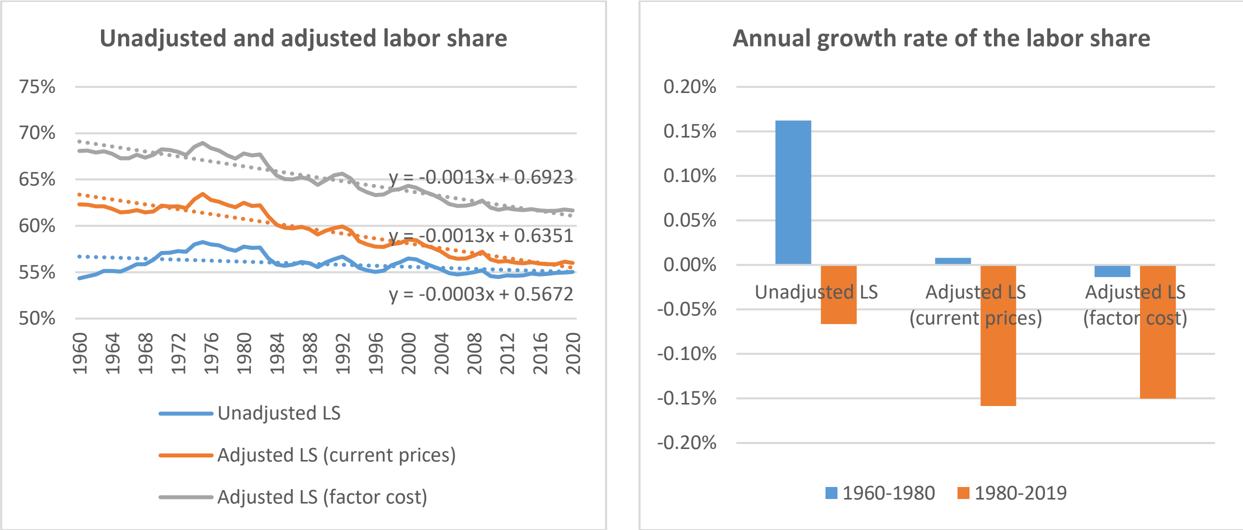


Figure 4 - Unadjusted and adjusted (global) labor share of income and average annual growth rate.

Note: Weighted average for developed countries.[26] Author's calculation on AMECO data.

Nevertheless, in most cases, one measure is barely sufficient for a generalization and there is a wealth of information that can be obtained from a deeper investigation. At first glance, since compensation of employees is unequivocally labor income and corporate profits, rental income, net interests and depreciation are unequivocally capital income, deriving respectively the labor and capital shares seems to be an easy and straightforward exercise. The total income earned by factors can be split into what is earned from working activities into wages, salaries and benefits, and what is earned from the employment of capital into profits and interest payments. However, the dividing line between these categories may be rather opaque; for instance, should the income earned by someone who runs his own business be counted as "labor income" received for the hours worked, or as "capital income" received from ownership of the business itself, or some combination of both? As mentioned earlier, we should be very careful when calculating the labor share, as there is a problem concerning the allocation of proprietors' income - the so-called apportionment of proprietors' (or mixed) income problem.[27] In addition, the more one deepens his knowledge of the National income and product accounts (NIPA), the more he becomes aware that simple calculation

[26] The countries included are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom and the United States. Weighted average by using Gross domestic product at current factor cost (Mrd PPS).

[27] From the glossary of the US Bureau of Economic Analysis (BEA): Proprietors' income = current production income of sole proprietorships, partnerships, and tax-exempt cooperatives. It excludes dividends, monetary interest received by nonfinancial business, and rental income received by persons not primarily engaged in the real estate. Some other countries call proprietor's income "mixed income", as it includes both effort of the proprietor as a worker and indirect income through the ownership. http://www.bea.gov/glossary/glossary_p.htm.

are often inappropriate. Hence, even if a detailed review of the techniques and methodologies used to estimate the labor share is not exactly the purpose of the theses, we believe - also considering the doubts raised by the literature - that some important considerations should be done in order to have clear in mind all the different biases that could affect our measurement of the labor share:

(i) *Consideration n.1:* How should the allocation of proprietors' (or mixed) income between labor and capital be done? Since proprietors' income has components of both labor and capital income, it should (ideally) be allocated between labor and capital. As we will see, there are different techniques to do that and the choice of a method rather than another necessary leaves room for a certain arbitrariness.

(ii) *Consideration n.2:* How should the public sector's lack of capital income be address? In the government sector, there is no capital income and all the value added generated is composed of wage and salary plus consumption of fixed capital. Therefore, including the public sector is likely to bias the measured labor share upward.[28]

(iii) *Consideration n.3:* How should the housing sector's lack of labor income be addressed? The national income account imputes rents as capital income to owner-occupied housing but does not impute any labor income. This omission in the labor income component of owners-opposed housing is expected to bias the estimated labor share downward.

(iv) *Consideration n.4:* How should indirect taxes less subsidies be addressed? If government is excluded from the measurement of national income, as discussed above, for logical consistency indirect taxes less subsides should be apportioned to both capital and labor.

(v) *Consideration n.5:* Should income be measured on a gross or a net basis? In other words, should depreciation be included or excluded from the measurement of output? Usually, in macroeconomic applications, gross value added is preferred because it measures the total production of a sector. However, the latter has the advantage of avoiding allocating amortization across the different shares of capital income, and hence may be preferable for analysis on the capital side.

[28] Compensation of employees is the only form of income in the government sector. There are no interest, rents, proprietors' income or profits reported for this part of the economy which constitutes 20% of the total VA. In the system of national accounts, the labor share of the public sector is, by definition, 100%, since public production is valued at its labor input. As a consequence, an expansion of the size of the state in the economy including it in the calculation always raises the labor share. Nevertheless, what emerges by focusing on the private sector is similar to the results obtained for the whole economy (Heintz, 2013; ILO and OECD, 2015).

In the following pages, we will show that all these decisions regarding the use of gross rather than net value added (i.e., the denominator) as well as the choice of what sectors include in the calculation and the methods used to apportion mixed incomes (i.e., the numerator) affect in a significant and not trivial way the level of the estimated labor share of income. As already stated, some measures of the labor share consider only the non-farm business sector of the economy - thus excluding the general government, non-profit institutions, paid employees of private households, and the rental value of homes occupied by the owners). According to BLS data (2019), together, all these items excluded from the calculation are worth approximately 23% of national income in the United States. Similarly, by looking at Eurostat data, agriculture and the public administration together account for about 20,5% of the total GVA in Europe.[29] One the reasons for the exclusion of these sectors lies in the abovementioned difficulty of measuring their value added, however, since the latter consist mostly of compensation, including them in the calculation is likely to affect the labor share positively. Measures of the labor share published by different statistical agencies differ principally with regards to decisions made on these items, and the lack of transparency behind the methodology followed is made worst by the fact that in many cases publications consist of highly aggregated data. The lack of information makes extremely hard to break down the time series and understand how they are constructed, as well as under what assumptions. As we will see, even if the available data does not allow the addressment of all the aspects we have discussed - especially in order to have comparable data for many countries - it is still possible to disentangle and, in many ways, improve the basic measures of the labor share provided by international statistical agencies.

1.2.2 Alternative data sources

There are several reasons why it is important to derive and compare alternative series for the labor share. Recently, three datasets have been made available to the public by respectively the Organization for Economic Co-operation and Development (OECD), the European Commission (EC) and the United Nations (UN), increasing the availability of data for international comparisons:

- *AMECO:* The Annual Macro-ECOnomic (AMECO) database of the European Commission's, offers data on the adjusted labor share on an annual basis for 40 advanced OECD economies. The starting date of the series varies but most of them start in 1960. The labor share of

[29] BLS: Table B-1. Employees on nonfarm payrolls by industry sector and selected industry detail; Eurostat: Gross value added and income by A*10 industry breakdowns [nama_10_a10].

income share is computed as the compensation of employees over the GDP multiplied by total employment.

- *OECD:* The system of unit labor costs Indicators of the Organization for Economic Cooperation and Development (OECD) provides annual data on the labor share for 46 countries and different economic areas. These are developed by the OECD and data is extracted from the system of national accounts of members countries with some harmonization in order to increase the international comparability.

- *UNSNA:* The United Nations System of National Accounts (USNA) presents a detailed collection of data on national accounts of participating countries and adjust them in order to make the series comparable. More exactly these are part of the UN national accounts statistics, a database prepared by the statistics division of the department for economic and social affairs and consisting of analytical tables for 178 countries from 1946 onwards. For most of the countries, it provides yearly data on the main national aggregates, which were collected using the SNA 1993 and later updated following the SNA 2008. It is maintained and updated based on annual collections and supplemented with estimates for those years and countries with incomplete information.[30]

- *ILO:* The International Labor Organization (ILO) publishes both an adjusted and an unadjusted measure of the labor share, each of which is produced starting from national accounts data of the UN. The period covered by the series is shorter than the one in AMECO, however the sample is larger.

Only for the US the most accurate raw data come from primary sources, i.e., the National Income and Product Accounts (NIPA) and are then elaborated by the Bureau of Labor Statistics BLS to extract the labor share.

- The National Income and Product Accounts (NIPA), produced by the Bureau of economic analysis (Department of commerce). Data are available on a quarterly basis since 1947 and on an annual basis from 1929. This incredible availability of long-term, high-frequency data makes the United States the country with the best data coverage in the world.

[30] However, some comparability issues are still present in the data (see Hartwig, 2006).

- The Bureau of Labor Statistics (BLS) of the Department of labor, calculates a labor share of income in two of its databases: one relative to “labor productivity and costs” (from 1947, quarterly) and one relative to “multifactor productivity” (from 1987, annually). In both cases the series include the private nonfarm business and manufacturing sectors.

For our purposes, in order to ensure international comparability, in each of the papers presented here we employ as a reference measure for the analysis the adjusted wage share for the total economy as percentage of GDP at current factor cost developed by AMECO (ALCD2). However, we think it is worthwhile dedicating at least a couple of paragraphs to the large availability of disaggregated data present in the NIPA accounts for the United States to understand how the different choices affect the calculation of the labor share and how different labor shares compare with the one calculated by AMECO.

1.2.3 Shares of gross domestic income (GDI)

Macroeconomists usually calculate factor shares not by relying on firm-level data but starting from economic aggregates.[31] Indeed, a broadly used strategy is to estimate the labor share of income at starting from the share of employee’s compensation in GDP. Such aggregates are available for many advanced countries. For instance, UN data on the allocation of primary income account (gross operating surplus, gross mixed income, compensation of employees and property income) are available for several advanced countries of the world, including the United States, France, Italy, the United Kingdom, Germany and Spain.[32] However, outside the US the covered time period is variable and, in many cases, limited, with the first observation respectively in 1950, 1980, 1987, 1991 and 1995. Nevertheless, for some of them, like for instance the US, the great availability of highly disaggregated macro data for a longer time period allows us to do an in-depth analysis. Table 1.11 of the National Income and Product Accounts (NIPA) and BEA Table 1.10, present a detailed

[31] A few studies have recently proposed some methods for the estimation of the labor share using micro-level data. The methodology consists on using repeated cross-sectional household survey data representative at the national level which contain an exhaustive classification of income by source. They then estimate the labor share using different estimators. The result is that there are large differences in the factor’s share obtained using NIPA’s data and those obtained using household survey data (Garcıa-Verdú, 2005; Adler and Schmid, 2012; Wolff and Zacharias, 2013; Steffen, 2013; Schlenker and Schmid, 2014; Tansever, 2017). However, they also mention some limitations of these approaches.

[32] The complete list of countries consists of: Australia (1959-2017), Austria (1995-2017), Belgium (1985-2017), Canada (1970-2017), Denmark (1981-2018), Finland (1975-2017), France (1950-2017), Germany (1991-2017), Greece (1995-2017), Hungary (1995-2017), Iceland (1995-2014), Italy (1980-2017), Japan (1980-2017), Latvia (1995-2017), Liechtenstein (1998-2016), Luxembourg (1995-2017), Mexico (1993-2017), Netherlands (1980-2017), New Zealand (1986-2016), Norway (1978-2018), Poland (1991-2017), Portugal (1995-2018), Republic of Korea (1975-2017), Slovakia (1992-2017), Spain (1995-2017), Sweden (1993-2018), Switzerland (1990-2017), Turkey (2009-2015), United Kingdom (1987-2017), United States (1970-2017).

decomposition of all the percentage shares that make up the aggregate Gross Domestic Income (with yearly observations from 1929 to 2018).

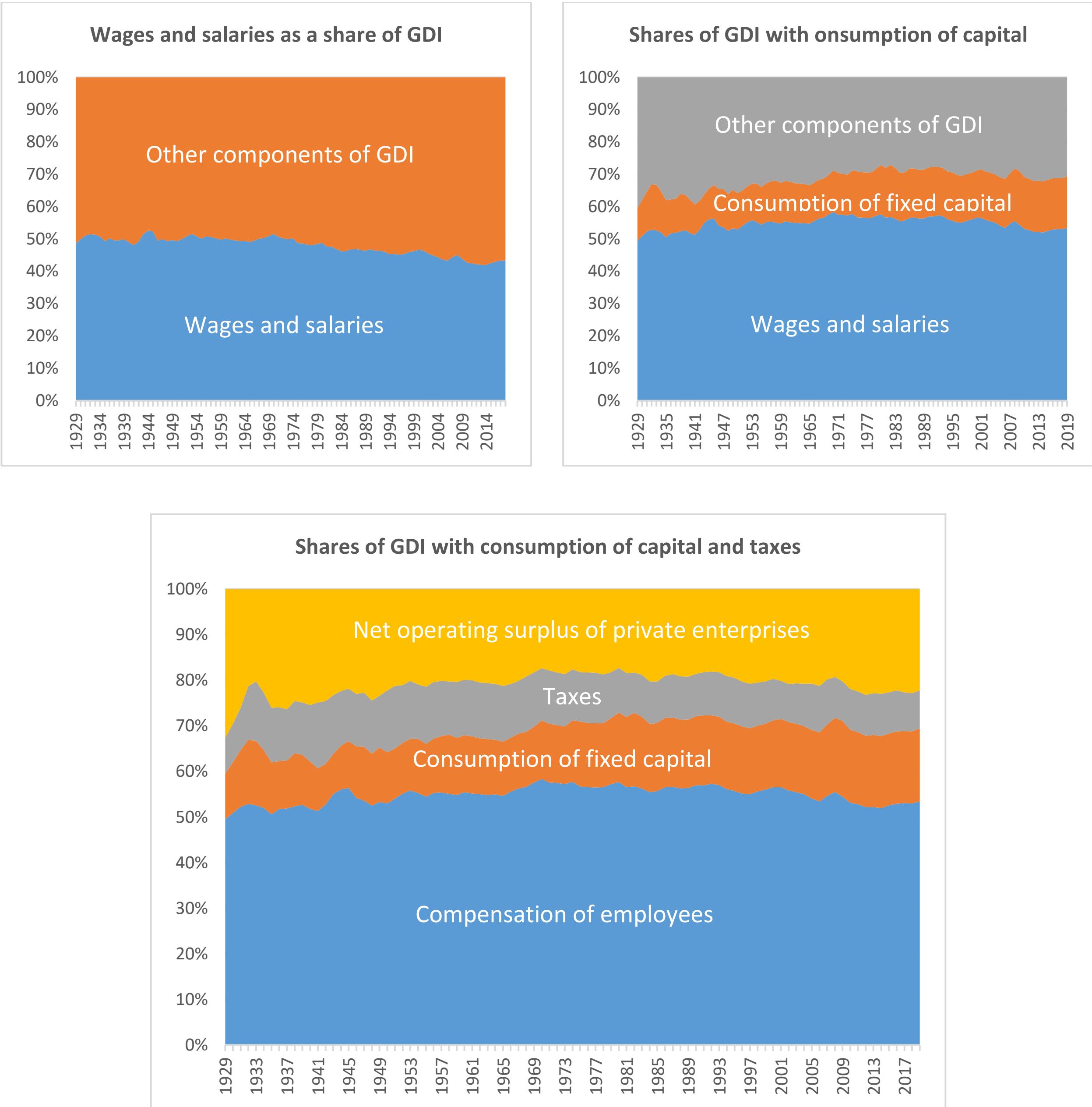


Figure 5 - Wages and salaries, consumption of fixed capital and taxes as shares of GDI (1929-2018).

Source: Author's calculation on data from NIPA Table 1.11.

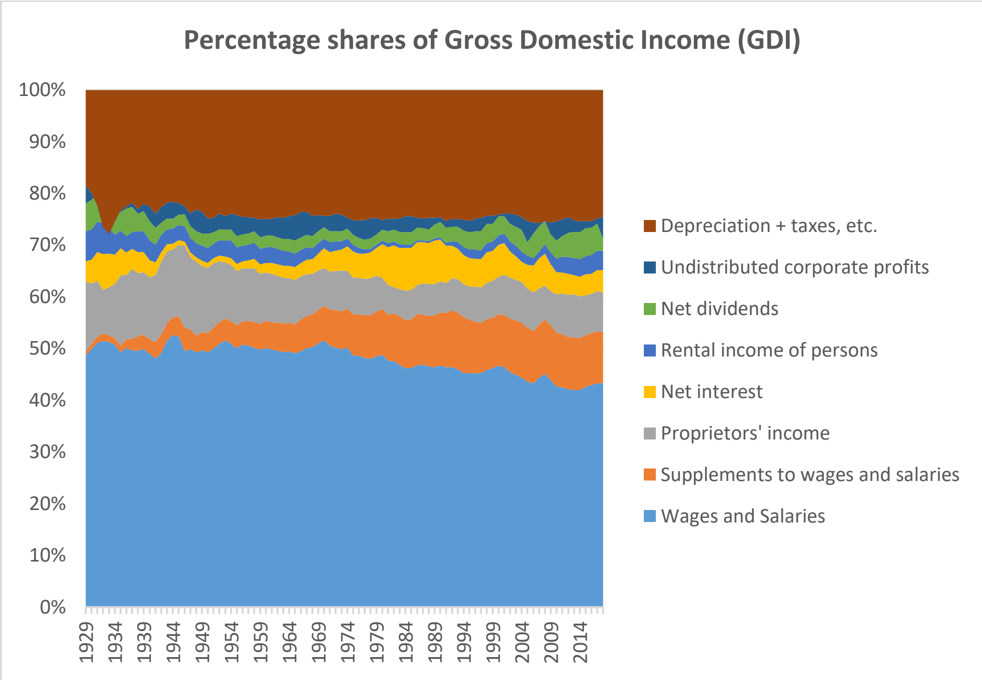


Figure 6 - Percentage shares of Gross Domestic Income (1929-2018).

Source: Author's calculation on data from NIPA Table 1.11.

While the GDP measures what is purchased, GDI measures who is paid. Figure 5 shows all the incomes realized in the United States since 1929. Instead of showing the overall increase in wages and salaries (from 50 billion of dollars in 1929 to 9.3 trillion in 2019), the graph shows wages and salaries as a share of the total. This result - in scale - is like an analysis of personal income as reported on tax records.[33] What emerges is that the largest component of GDI in the US (similarly to almost all the other advanced countries) is represented by wages and salaries. Historically, about half of all national income goes to workers in this form. Figure 5 - panel a, highlights the well-known secular trend: wages and salaries are decreasing as a share of total income. After remaining stable at around 50% before 1970, the wage share has now dropped to 43% in 2018. We can take a step forward by decomposing all the components of the GDI, as shown in Figure 6. What immediately stands out from Figure 6 is that the share of depreciation, taxes, business current transfer payments and subsidies did not change much over the last 90 years (between 1930 and 2018) and hence it is as if changes in tax have been perfectly matched by changes in the depreciation charges (with machinery depreciating faster - see the capital consumption share in Figure 5, panel b). Indeed, this latter increased from roughly 10% of GDI in 1929 to 16% nowadays (Bridgman, 2018). Further, given the

[33] Wages and salaries are also the largest form of taxable income (Cole, 2015).

virtual stability of this share in GDI, it is possible exclude it from the total. For this reason, it is not uncommon to talk about relative labor share in Net National Income (NNI). Indeed, in some cases the net labor share - where consumption of fixed capital is subtracted from the operating surplus of both corporations and unincorporated enterprises, in both the numerator and the denominator - may be more important, because depreciation is not consumed (Blanchet and Chancel, 2016; Rognlie, 2016).[34] Similarly, Figure 5 - panel c separates the effects of both depreciation and public administration and show that the share of taxes charged on enterprises (obtained by clustering together taxes on production and imports with taxes on corporate income)[35] has decreased over time from 13.7% of GDI in 1950 to 8.3% of GDI in 2019, remaining however constant in the last 30 years. The residual part of income is income that private company distributes to individuals. Most of this income is composed of labor compensation (at the bottom of the graph), but a minority of it is constituted by other types of income, clustered together as the net operating surplus of private companies (represented at the top). At this point one may wonder why the part of income consisting of individual taxes on wages, salaries and investments has been excluded from the analysis. The problem with including this share is that taxes affect different types of income in different ways and what we observe is just the aggregate result of a complex taxation process. Therefore, it is impossible to distribute individual income taxes in an accurate way. Instead, we focus on the part income that people receive from businesses before paying tax on these different types of individual income. This amount is approximated by the combination of labor compensation and net operating surplus in Figure 5 - panel c (above).

In Figure 7, we subtract both depreciation and taxes and apply a simple allocation technique for mixed income. For instance, Bridgeman (2018) of the BEA concluded that once depreciation and production taxes are subtracted, "recent net labor share is within its historical range whereas gross share is at its lowest level." In other words, he argues that the historic low in labor share can be attributed to taxes and depreciation.[36]

[34] Part of national income do not accrue to either individuals, firms or even the government. Some income is just lost as goods wear and tear out. Machines, plants and building break down, while computers and software becomes obsolete. These things require replacement, which costs money. In this sense, depreciation represents the income that individuals, businesses and governments set aside to replace capital.

[35] The former category (i.e. taxes on production and imports) comprises state and local taxes that businesses pay, as well as federal excise duties. The latter (i.e. taxes on corporate income) is the sum of all corporate income taxes paid. These two categories do not include taxes on personal income of individuals, but just those out of business profits.

[36] Bridgeman excluded production taxes and depreciation from net income, but not corporate income taxes. He includes proprietors' income in the capital share, while acknowledging that some of that income was actually labor income.

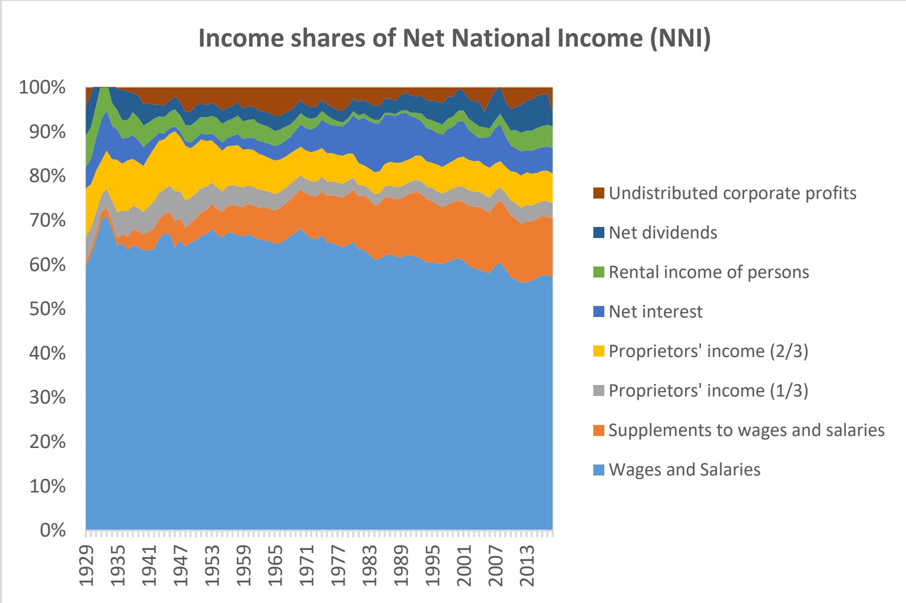


Figure 7 - Percentage shares of Net National Income (NNI).

Source: Author's calculation on data from NIPA Table 1.11.

Figure 7 reveals an important composition effect. While the compensation share (i.e., wages and salaries plus supplements) has remained roughly constant from the early 70s (oscillating between 69 and 77% of NDI), as already noticed the share of wages has been falling since then (-10 percentage points, or a total loss for labor of roughly 0.002% a year). Therefore, the overall stability of the compensation share has been obtained thanks to an opposite and equal increase in the part of compensation that does not take the form of wages or salaries. This consists mainly of pension contributions (including Social Security - with Medicare and Medicaid[37] in 1966 or COLAs[38]) and insurance premiums (such as health insurance) paid by employers following the expansion of the welfare state (see Figure 8 below where we decompose this specific invoice). From an economic point of view, they are costs for firms, while, on the other hand represent a compensation for workers. However, it should be noted that given the mixed nature of the benefits, this part of income it is not as flexible as wages and salaries are. The "non-labor" share of compensation has grown dramatically in the last century. It was a negligible part of net national income in 1929 (around 1%), it now exceeds 13% of NNI. There are several reasons that can explain the marked

[37] Medicare and Medicaid are two different, government-run programs. They are operated and funded by different parts of the government and serve different groups. (i) Medicare is a federal program that provides health coverage if you are 65+ or under 65 and have a disability, no matter your income; (ii) Medicaid is a state and federal program that provides health coverage if you have a very low income.

[38] Legislation enacted in 1973 provides for cost-of-living adjustments, or COLAs. With COLAs, Social Security and Supplemental Security Income (SSI) benefits keep pace with inflation.

increase of this component over the years and probably a leading role has been played by the growth of the health sector. Quality of healthcare has improved at an incredible rate over the last century, but the cost of employing qualified doctors has led to higher insurance costs. In the United States, insurance premiums are often paid by employers on behalf of workers, so they have become an increasingly large part of standard compensation packages. Another factor driving the growth of wage and salary supplements is the increase in payroll taxes to finance social security and healthcare. Indeed, as in other advanced economies, the costs of these programs have increased following the aging of US population. Both these phenomena, which go in the direction of lowering the GDI and NDI's wage and salary shares, are the result of specific policies that excludes insurance premiums from taxable income to encourage companies to offer benefit-compensation packages instead of wages and salaries (Forman, 1992). Therefore, while employers' compensation has remained relatively stable as a share of national income, an increasing share of workers' earnings is being redirected to benefits rather than wages and salaries - NIPA Table 7.8.

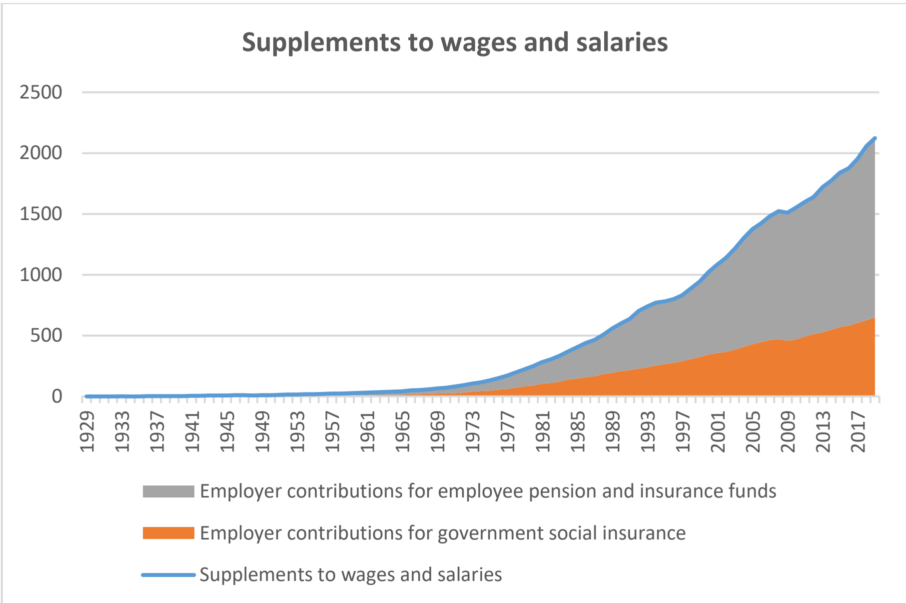


Figure 8 - Supplements to wages and salaries (decomposition).

Source: Author's calculation on data from NIPA Table 7.8.

There are mainly four different types of non-compensation income after firm-level taxes and depreciation are subtracted from GDI and hence the result of the productive activity of businesses is distributed to individuals - before the payment of individual taxes. (i) The first of these categories is rental income, i.e., the added value generated by homes to the owners after accounting for the money needed for their maintenance and the payment of interests. It includes all houses, whether they are rented or not and reflects some actual income received by the owners, but also measures the advantage of having a place to live. This amounted to roughly 4.8% of NDI in 2019. (ii) (ii) Then there are net corporate profits (after-tax) of corporations. These can take the form of either capital gains, dividends, but also pension funds or retirement accounts. Corporate profits were about 10.5% of NDI in 2019. (iii) The third one represents net interests, which represents money paid to stockholders by companies and was approximately 5% of NDI in 2019. [39] (iv) Finally, there is proprietors' income (i.e., net income of unincorporated businesses) generated by the activity of partnerships and sole proprietorships. Noncorporate businesses are becoming increasingly popular, in part because of tax policies, and in 2019 accounted for 10% of the NDI (Pomerleau, 2015).

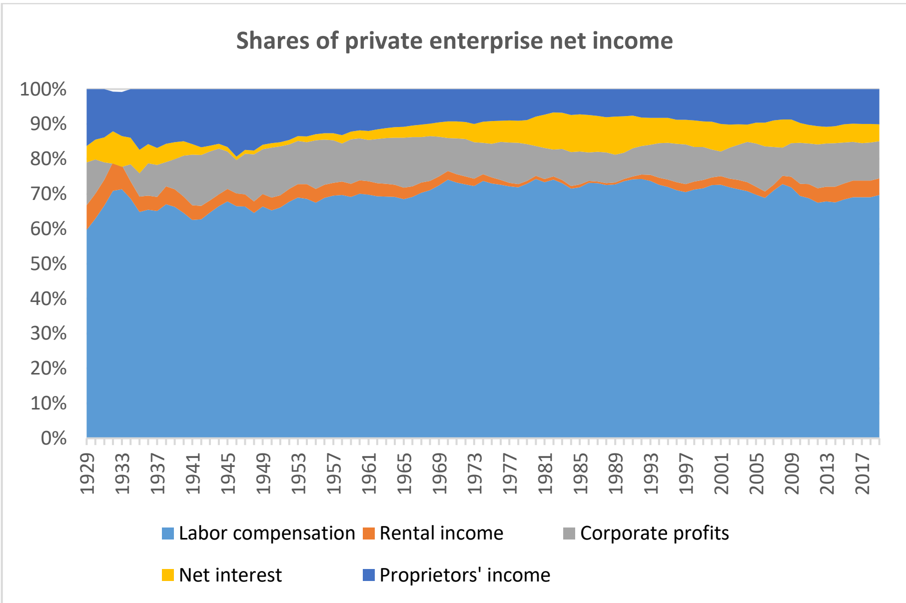


Figure 9 - Shares of private enterprise net income.

Source: Author's calculation on data from BEA Table 1.10.

[39] Interest on mortgages is included. Since enterprises can either receive interests or pay them, the BEA reports a net value.

Figure 9 shows the shares of national income excluding depreciation and government taxes - i.e., the shares of NDI. The labor compensation share is the same as in previous charts, while the remaining shares are the individual components of the net operating surplus of private enterprises in Figure 5. Figure 9 is useful as it removes extraneous parts of NDI, hence focusing on income received by individuals. The labor share of income includes compensation of employees and a portion of proprietor's income, similarly the capital share of income includes rental income, profits, interest, and a portion of proprietor's income. As anticipated in the previous paragraph, one issue strictly connected with proprietorships and partnerships is that the split between labor and capital cannot be determined, since the owner (or the partner) is compensated for both his work and investment in the activity.[40] Therefore, the exact value of the labor and capital share depends on the extent to which proprietors' income accounts to labor or capital. A common convention since the work of Johnson (1954) has been to allocate 2/3 of the proprietors' income to labor earnings, and 1/3 to capital (Figure 10). With this method, as we have already seen also in Figure 7, the labor share of income in the US has remained virtually stable. Nevertheless, Johnson is not the only way to apportion mixed incomes and a greater number of methodologies (as well as their implications) will be discussed in the following section.

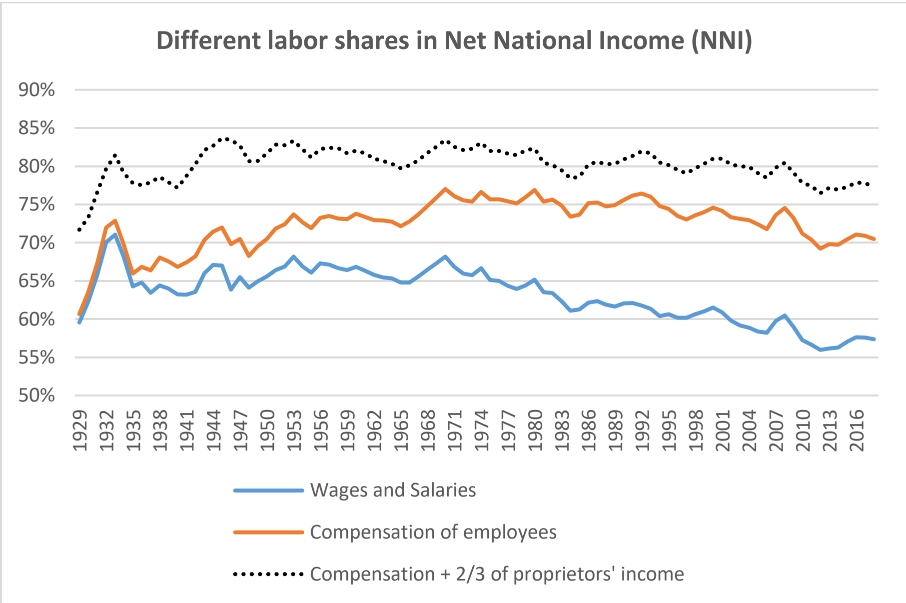


Figure 10 - Different labor shares in Net National Income (NNI).

Source: Author's calculation on NIPA data.

[40] This issue is also present when one works with individual tax record and has to attribute "business income" to labor or investment.

1.2.4 Alternative methods for the allocation of mixed income

Given that the compensation of employees as registered in the system of national accounts ignores the self-employed, the unadjusted labor income share will be a downwards-biased estimation of the effective one.[41] The reason is that GDP (and other related measures) include income of the self-employed. As discussed above, part of the income generated by self-employed individuals is likely to be labor income, while the rest accrues to capital. Therefore, if there is a positive share of self-employed income that accrues to labor the unadjusted labor income share lies below the real labor share. This circumstance is very relevant at the empirical level and the necessity to adjust this biased measure is widely recognized in the literature (Gollin, 2002; Guerriero, 2019). A necessity which turns out to be even more important in low- and middle-income countries. These two facts should not surprise, according to the ILO (2019) the average global prevalence of self-employment during the last 20 years is close to 50% and in low-income countries, around 80% of the workforce is self-employed. On the other hand, in high income countries the same rate is approximately 10% (see Figure 11 below). Thus, the calculation of the labor share and its distribution gets more complicated, requiring data on the labor income of the self-employed. From a theoretical point of view, income of the self-employed contains both labor and capital income. From an empirical one, however, there is not a completely satisfactory way to estimate it, which has led to multiple proxy approaches in the literature. Many studies follow the strategy of estimating a fair share of self-employment labor income based on the mixed income aggregate of the national accounts system. According to the United Nations Statistics Division (UNSD), mixed income is the magnitude accrued from production of noncorporate businesses owned by households. As such, it implicitly contains unpaid labor inputs provided by the owner or other family members. Indeed, the SNA framework recognizes that the remuneration of labor may dominate the overall value of mixed income. Unfortunately, there is no easy way to fix the problem. For almost all the countries analyzed, with the notable exception of the US and a couple of other advanced countries in the world there is no data on the total income produced by self-employed workers, and even less information can be retrieved on how to allocate this income between labor and capital. What we know is just that the rate of self-employment differs greatly across countries. Nevertheless, even if the recent changing patterns that are taking

[41] The definition of self-employed varies among different offices for labor statistics, however the category of self-employed generally include independent contractors, sole proprietors and partnerships. They are not standard employees and this means that, in accordance with the UN System of National Accounts, adopted by all the UN member states since 1953, the income produced by the self-employed must not be accounted as "compensation of employees" in the income account (Gollin, 2001). This kind of income, which is usually composed by a mix of labor and capital income, is actually treated as a form of business income.

place in modern economies led to a reduction in the number of the self-employed in almost all the countries considered (except the UK and France - see Figure 11), the share of self-employed in total employment is still consistent, especially in Italy, Spain and the UK thus making the allocation of this part of income very important (Gindling and Newhouse, 2012).

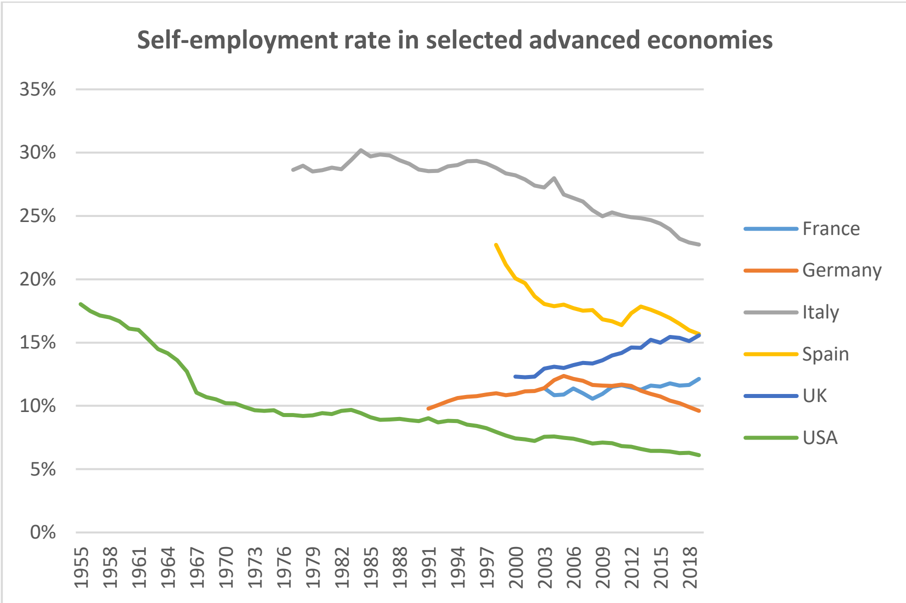


Figure 11 - Self-employment rate (% of total employment), 1955-2019 [42] [43]

Source: Author's calculation on OECD data.

However, even where a sustained increase in the share of self-employment has characterized the dynamics of the labor market in recent years (for instance the UK or France) and hence income of the self-employment has increased as well, this increase in relation to the growth in compensation of employees (which constitute the largest share of total household income), was rather modest. This means that since compensation of employees are growing faster than mixed income, their share on total household income is still increasing (Sidhu and Dunn, 2018).

How should we treat mixed income if it accrues to both labor and capital? We employ detailed data on multiple levels of income in the US (mainly from the NIPA and the BLS) to assess the impact of self-employment in estimating the labor share. We discuss 8 alternative approaches

[42] Self-employed people are not paid since they lack a formal contract to receive a fixed amount of income at regular intervals. Unpaid family workers are particularly important in industries like farming and retail trade. All persons who work in corporate enterprises, including company directors, are considered employees. Employed people are those aged 15 or more who report that they have worked for at least one hour in the previous week or who had a job but were absent from work during the reference week.

[43] Data for the USA start in 1955, Italy in 1977, Germany in 1991, Spain in 1998, the UK in 2000 and France in 2003.

used for the apportionment of mixed income. Then we compare the obtained measure with the one estimated by AMECO (ALCD2) and finally undertake an international comparison. The dotted line in Figure 10 shows the labor share from raw data adjusted with the Johnson's method, while the blue one is the labor share at current prices by AMECO.

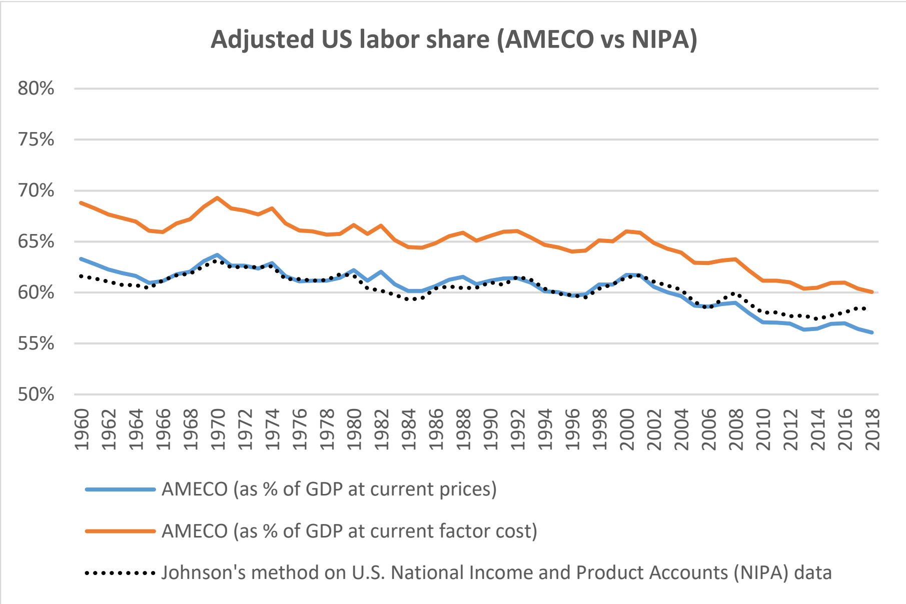


Figure 12 - US labor share, adjusted for mixed income (AMECO vs NIPA).

Source: AMECO and author's calculation on NIPA data.

AMECO adjust the wage share in the way we have seen in paragraph 1.2.1 (i.e., by employing the Gollin's method) which roughly correspond to the measure obtained by apportioning 2/3 of proprietor's income to labor compensation (dotted line in Figure 12). Short-term movements in the labor share are driven by the business cycle. While wages and salaries paid to workers usually tend to be more stable and adjust slowly in response to changes in the level of economic activity, on the other hand, the returns to capital tend to be more volatile. This is well known to the literature and makes the labor share highly countercyclical (OECD, 2015) Further, in addition to these short-term movements, there are visible longer-term trends even after adjustments are made. In the US, where the national labor share appears - from a first analysis - to be rather stable, we can say that it started to fall between the late-70s and the mid-90s. Then recovered a little in the late-90s and early 2000 to decrease again since then. A last and barely noticeable increase (following the abovementioned countercyclical properties of the latter) occurred during the years of the great recession. The data suggest that, between the late-70s and the late-90s, in the US the share of national income accruing to workers fell from around 62% to roughly 58% of the NDI (for a total loss of 4 percentage points) or from 82.5 to 77% of GDI (-5.5 percentage points). This means that in recent years, a smaller and smaller fraction of the fruits of economic growth has been returned to labor.

Figure 13 - Proprietor's (or mixed) income as % of GDI and self-employment rate in the US and the UK.

Source: Author's calculation on NIPA and ONS data.[44]

[44] As we have already seen BEA is the US Bureau of Economic Analysis, while ONS is the UK's Bureau of National Statistics.

The breakdown of the total income produced by the self-employed into a labor and capital component is a complex process, and most of the difficulties are due to lack of data.[45] This is why, to avoid the difficulty of matching micro-data records at national levels, usually, macroeconomic studies concentrate their research efforts on the compensation share (Karabarbounis and Neinman, 2014; Rognlie, 2016; Cho et al., 2017). There are several different ways used to apportion this part of "entrepreneurial income" and here we will explore seven of the most widely employed by the literature:

(i) *LS1.* The first method presented by Johnson (1954) is called the "2/3rds rule". This is a fixed-weight rule of thumb which solve the problem by allocating two-thirds of proprietor's income as a return to labor and a third as a return to capital. The labor share adjusted in this way presents a change in its level, but the overall trend remains unchanged and is driven by changes in compensation of employees, which represents the biggest share on overall income. The method is therefore relatively simple, however, given that the division of income is constant over time, it ignores potential drivers which may shift the mixed income labor and capital shares over time.

$$LS_1 = \frac{Compensation\ of\ Employees\ +\ 2/3\ \cdot\ Mixed\ Income\ GDP}{Net\ National\ Income\ (NNI)} \quad (4)$$

(ii) *LS2.* Kravis (1959) proposed the attribution of all mixed income as a return to labor. His justification refers to the fact that in developing countries the share of income produced by the self-employed is mainly related to the supply of labor. However, in more advanced and industrialized economies things are likely to be different, as the self-employed are known to also employ capital (either human and intellectual) in the production of goods and services.

$$LS_2 = \frac{Compensation\ of\ Employees\ +\ Mixed\ Income\ GDP}{Net\ National\ Income\ (NNI)} \quad (5)$$

(iii) *LS3.* Following Atkinson (1975), another strategy is that of considering income produced by the self-employed as composed of the same combination of labor and capital present in the

[45] The SNA 1993 breaks down value added into: compensation of employees, operating surplus (from rent and capital) and mixed income from the self-employed. The U.N. National Accounts Statistics provide information on mixed income for a large number of countries. See the discussion in Paragraph 3.

rest of the economy. In this case, the labor share can be increased by a factor that considers the self-employed, to whom a salary equal to the average salary of the employees is attributed:

$$LS_3 = \frac{\text{Compensation of Employees}}{Net\ National\ Income\ (NNI) - \text{Mixed income}} \tag{6}$$

This adjustment implicitly assumes that the distribution of income is roughly the same in unincorporated private businesses and large corporation. However, these different types of business usually operate in sectors that are very different from each other, in terms of size of firms, market structure and labor intensity. Further, there are also strong differences from one country to another. However, even taking these problems into account, this technique is more reasonable than the previous one, because it allows the self-employed to generate part of the capital income. Moreover, being quite simple to implement, it has already been widely employed in literature (Harrison, 2005).

The main problem with these three methods (LS1, LS2 and LS3) is that they require specific data on self-employment income. As mentioned above, these tables are available as part of the UN national account statistics and show the value of "mixed income" or gross operating surplus of private unincorporated businesses. Unfortunately, these aggregates are not available for many countries and, more importantly, sufficiently backwards in time.

(iv) *LS4.* More recently, Gollin (2002) presented an alternative method which does not require data on mixed incomes. In fact, it is very likely that even when we do not have such income information, we may still obtain data on the composition of the workforce. Therefore, he assumes that the self-employed earn the same wage of an average employee and therefore assigns the average wage to each worker independently from his status (i.e., employee or self-employed).

$$LS_4 = \frac{\text{ompensation of Employees} \cdot \left(\frac{Total\ workforce}{Numer\ of\ employees}\right)}{Net\ National\ Income\ (NNI)} \tag{7}$$

The labor share obtained in this way is likely to be a lower bound of the real one, for the presence among the self-employed of professionals such as doctors, lawyers, consultants and entrepreneurs whose income is more likely to be above the market average than below. However, it is also true that tax records show that in most countries the average self-employed usually earn a lower income than his employed counterpart, consistently with a lot of studies which have shown how the self-employed tend to underreport their income (Hurst et al., 2010). This method has been widely employed in the literature and is the one applied by the OECD and the EC in their calculations.

(v) *LS5.* One problem of Gollin is that it tends to overestimate the labor share. Thus, it is possible that considering the workforce net of employers is a better choice. Indeed, employers receive an amount of labor income which is not comparable to what earned by the employees or other self-employed. Therefore, Guerriero (2012) proposed an alternative measurement which completely removes the income earned by the "employers" from the adjusted numerator and hence attributes the average wage of employees to all those workers who are self-employed but not "employers".

$$LS_5 = \frac{\frac{\text{Compensation of Employees}}{Numer\ of\ employees} \cdot (Total\ workforce - Employers)}{Net\ National\ Income\ (NNI)} \qquad (8)$$

(vi) *LS6.* Another method to apportion ambiguous income between capital and labor is that developed by Gomme and Rupert (2004). They start by recognizing that there are some incomes which are either unequivocal labor (i.e., compensation of employees) or capital (i.e., corporate profits, rental income, net interest and depreciation). Then, they assume that the labor share within all the "not clearly defined" forms of income (i.e., proprietors' income and indirect taxes less subsidies) is the same as in the rest of the economy. The labor share can thus be obtained in the following way:

$$Y_{TL} = Y_{UL} + \alpha Y_D \qquad (9)$$

$$\textit{and} \quad LS = \alpha = \frac{Y_{TL}}{Y} \qquad (10)$$

Where:

- Y_{TL} is total labor income;
- Y_{UL} are the compensation of employees (unequivocal labor income);
- Y_{UK} are corporate profits, rental income, net interest and depreciation (unequivocal capital income);
- Y_D are proprietors' income plus indirect taxes less subsidies (i.e. dubious income).

Since Y_{TL} is also:

$$Y_{TL} = \alpha Y = \alpha(Y_{UL} + Y_{UK} + Y_D) \tag{11}$$

Putting the two equations together and solving for the labor share we get:

$$LS_6 = \frac{Y_{UL}}{Y_{UL} + Y_{UK}} \tag{12}$$

(vii) *LS7.* Following the line of Giovannoni (2014), an original technique to split mixed income consists in employing cluster analysis. Since at each and any point in time a certain amount of income for each category is generated by the production activities of an economy, it is plausible to think that there exists a hidden relationship between mixed income and other types of income, i.e., it may consist of a certain amount of profits, a certain amount of interest, a certain amount of rental income and a certain amount of wages. In this perspective, cluster analysis can be applied to the data in order to discover the connection between variables. The procedure considers the rate of change of each variable since each variable is $I(1)$, and standardizes them to avoid affinity by standard deviation.

(viii) *LS7.* Finally, a standard regression of mixed income on other types of incomes can also be run. We did the exercise for the US and there is no significant breaking point in the data. Therefore, there is no reason to expect the 75-25% percentage to have changed much throughout the sample. The regression states that mixed income is much more related to compensation, with a highly significant and large coefficient (0.70, t-stat 2.85), whereas the property coefficient is small (0.19, t-stat 1.30). Results from the regression confirm those of the literature which attribute a greater share of proprietors' income to labor.

While Johnson (1954) and Kravis (1959) are based on fixed-weight rules (i.e., they assume that the division of income remains constant over time), Gollin (2002), Guerriero (2012), Gomme and Rupert (2004) and the cluster analysis are variable-weights methods. In other words, fixed factor shares methods adjust the labor share for mixed income without considering the changing composition of the economy over time. Finally, it must be said that also other approaches have been suggested by the literature. However, they are usually very data demanding, requiring detailed information on the structure of income which are very difficult to obtain for many countries. Glyn (2009), for instance, proposed to assign the average agricultural wage to the labor income component of self-employment. The logic behind all this lies in the fact that in developing countries the self-employed are mainly concentrated in agriculture, where average wages are very low with respect to the national average. A natural extension of this approach has been that of assessing the value of labor and capital services based on the prevailing returns in each sector of the economy (instead of considering the economy as a whole like in Gollin). In this way one would allocate to labor the average income that the self-employed would have received by working as paid employees in the same industry. This would also capture in a most effective way potential variations of the labor share across industries which, as documented by literature, can become also considerable. Young (1995), on the other hand, with a more micro-matching approach constructed his estimates of the labor shares by assigning an implicit wage to the self-employed and unpaid workers based on their occupation, gender, age and education, hence if they earn an implicit wage equal to the hourly wage of employees (with similar characteristics) in the same industry. This approach, which has recently been used in the literature is extremely accurate, however unfortunately also highly demanding in terms of data. Finally, some scholars have tried to work around the problem of self-employment by excluding agriculture and focusing only on the manufacturing sector, where there are fewer self-employed workers (Elsby et al., 2013; Armenter, 2015; Giandrea and Sprague, 2017; Grossman et al., 2017). Nevertheless, this approach does not address the problem and can be especially problematic in those countries with a high rate of self-employed workers in agriculture or other sectors characterized by low wages. Indeed, depending on the structural characteristics of the economy and its workforce, these different measures of labor share will be more or less similar to its real value.

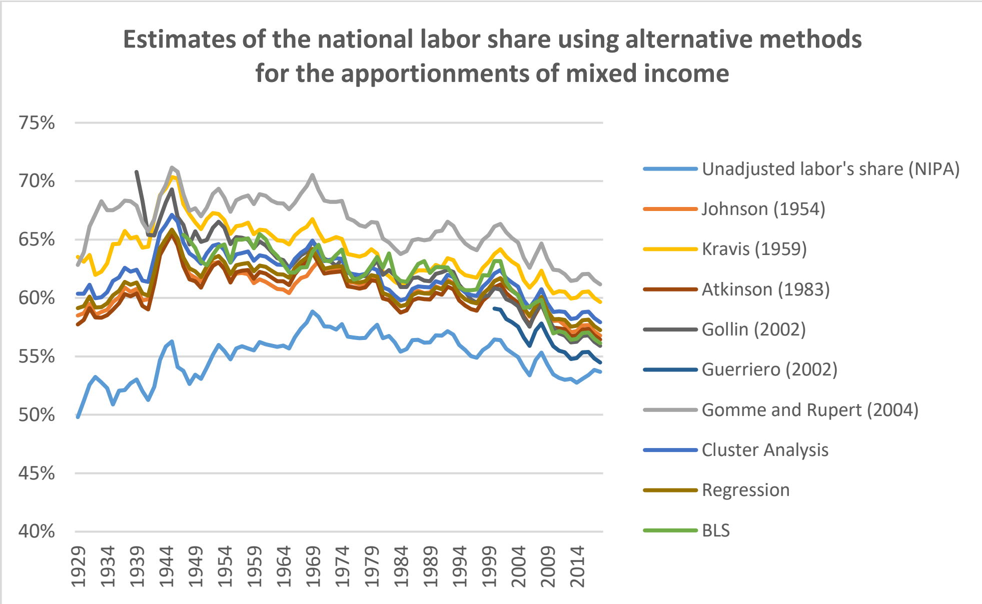


Figure 14 - US national labor share estimates using alternative methods for the allocation of mixed incomes. [46]

Source: author's calculation on NIPA data.

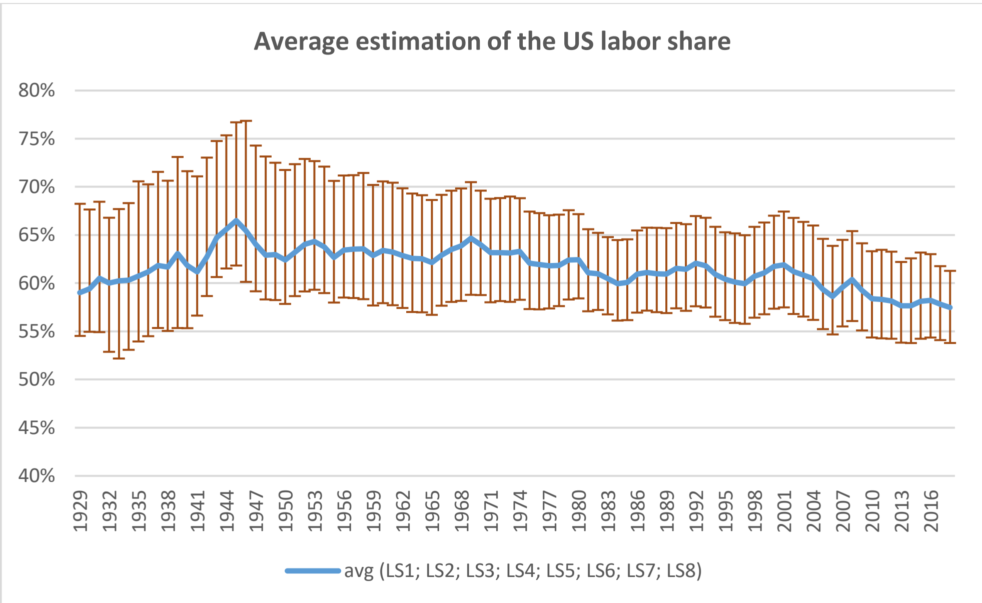


Figure 15 - Average estimation of the US labor share based on NIPA's data (1929-2018).

Source: Author's calculation on NIPA data.

[46] Guerriero (2012) starts in 2000 due the availability of data on "employers" as classified by the UN following the International Classification of Status in Employment ICSE-1993. Status in employment - ILO modelled estimates from ILOSTAT.

Figure 14 summarize all the different estimations of the labor share following the alternative methods for the allocation of mixed income described above and Figure 15 presents the average value and the bands with maximums and minimums obtained by using different apportionment techniques. As it is possible to see, consistently with the fact that the part of mixed income to be redistributed has been decreasing over time (see Figure 13 - panel a, page 33), the bands are larger at the beginning of the series and then decrease over time. While there were up to 9 percentage points of difference depending on the method employed in 1929, in 2018 this difference does not exceed 3.8 points. Further while some methods like for instance Gomme and Rupert, Kravis, the Cluster analysis and Gollin tend to systematically overestimate the labor share others (i.e., Johnson, Regression, Guerriero and Atkinson) compute values with on average fall below its real value.

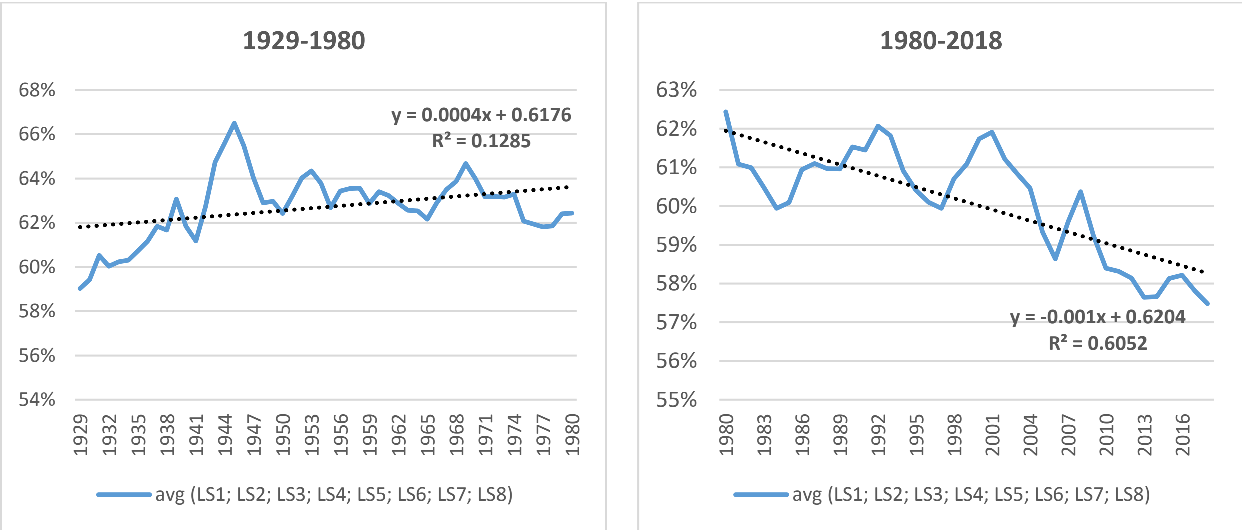


Figure 16 - The labor share of income in the United States before and after 1980.

Note: Average of LS1-LS8. *Source:* author's calculation on NIPA data.

Figure 16 portrays a labor share of income that has increased before 1940, been remarkably constant at about 63 of GDP in the period between 1940 and 1980 and declining since then, with a total loss for labor, of about 6 percentage points (roughly 0.0016% a year). Our measure of the labor share as an average of LS1-LS8 reports a value which for 2018 is about 57.4% of the GDP, while it was 63.4% in 1980. At the end of this extensive introduction, we have developed concepts and notions that will be essential for the development of the papers presented in the following pages. The analysis and decomposition of US national incomes allow us to draw some important preliminary conclusions. (i) The most important of these is that the study of functional income distribution should remain closely focused on employee's compensation. However, it should be remembered that inequality on the wage side - which is the single largest source of income - is the most important factor contributing to overall income inequality. Further, as we have seen, when wages decrease their share in national income, this is due to the increase in other types of income that are favored by their tax codes - such as for instance contributions to assistance programs, employer-sponsored health insurance, and returns on owner-occupied housing. It should therefore be reconsidered if these policies - that have been widely employed over the last 40 years – can sustain a stable economic growth. (ii) Secondly, as it will be understood, in order to calculate the labor share is crucial the attribution of a "fair share" of mixed income to labor. The results of our analysis offer an argument on the importance of a correct measurement and provide additional evidence against the assumption of stable labor shares (Kaldor 1961). Contrary to some recent findings that long run changes in factor shares must be attributed to the lack of adequate adjustment for self-employment income, indirect taxes and capital depreciation, we show that these factors determine (at most) only the strength of a significant downward trend. Actually, the labor share in the United States has constantly decreased over time starting from the 1980s. In addition, the overall negative effect has been mitigated by a strong growth in the share of supplements to wages and salaries. (iii) Finally, considering what has been observed so far, the recent inconstancy of the relative factor shares seems to make less valid the use of Cobb-Douglas production functions, which for years have been the basis of modern macroeconomic models. In terms of levels, the rule of thumb in the choice of the exponent for the "labor" input (2/3 or 3/4) seems that need to be revised as well.

Have we always been right, after all, that nothing has happened since Kaldor (1961)? As we will see in the second paper of the theses - where we undertake a detailed and meticulous shift share analysis either within sectors or firms over time - our argument is that not only something has happened in terms of aggregate movements in the labor share, but even that some changes took place in its composition.

1.2.5 Robustness check and international comparison

In recent years, the distribution of national income between labor and capital has gained a level of attention higher than ever before. This was also due to overwhelming empirical evidence of a persistent long run decline in labor shares common to all the world's most developed economies. Hence, international comparability between data turns out to be a factor of first order importance to correctly understand the different economic reasons behind this secular fall. Ideally, this requires a coherent logical framework and a rigorous methodology to be followed in each country to ensure a certain degree of comparability and eliminate as much as possible discretion in the choices that are made to obtain this indicator. However, as we have seen there are significant (and often not not easily reconcilable) differences in the way income of the self-employed workers is recorded in national accounts. More specifically, the treatment of unincorporated businesses in the household or business sector can differ greatly from one country to another. So far, our investigation has been conducted with a focus on the US economy. Now we place our findings for the US into the international context and compare the results with alternative data sources for robustness. To provide a meaningful comparison we will use the AMECO dataset, which allows us to have a precise measure of the labor share for many developed countries.

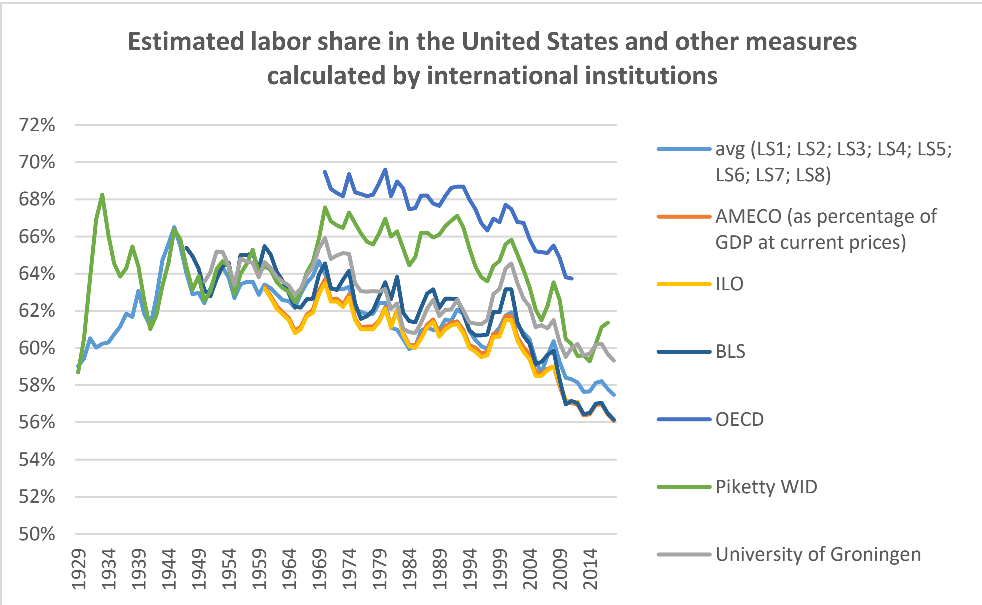


Figure 17 - Comparison of alternative data sources for the US labor share.

Source: Author’s calculation on NIPA, BLS, AMECO, OECD, ILO and the University of Groningen data.

Figure 17 presents a comparison between our estimate of the US labor share (average of Johnson, Gollin, Gomme and Rupert, Kravis, Guerriero, Atkinson, Cluster analysis and Regression), and the ones provided respectively by the BLS, AMECO, OECD, ILO, Piketty WID and the University of Groningen (Penn World Tables). For the period where the two series are comparable (from 1960 onwards) our measure is in line with all the other measures in terms of the form that in terms of general trend. The resulting share is a composition of fixed-weight and flexible-weight methods and represents our baseline estimate for the labor share. Hence, the unadjusted labor share tends to be lower than that calculated with any other method, as it deliberately excludes the mixed income received by the self-employed. By apportioning all the mixed income as a return to labor (Kravis), the labor share is, on average, 9 percentage points higher than the unadjusted one, and 3.2 percentage points higher than the adjusted labor share using Johnsons. Gollin closely tracks the labor share estimated using Kravis between 1980 and 1990. While Gomme and Rupert is the most similar to the adjusted labor share estimated by AMECO. As we have seen in Figure 15, the difference between the various measures is maximum at the beginning of the series, with a band oscillating up to 9% before 1960 and then decreasing with the reduction of the mixed income share. In 2018 the difference between the various methods is less than 3.5%. All the shares are in percentage of the GDP at current factor cost and all the different approaches give very similar results (on average the difference between the max and the min estimated value is of 5.5%).

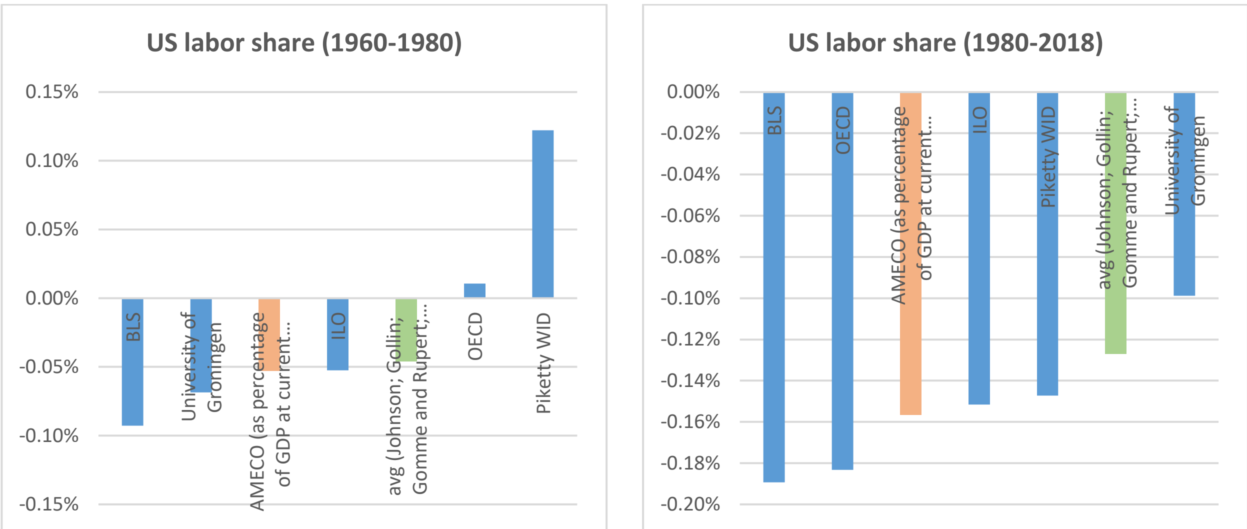


Figure 18 - Average annual growth rate of the US labor share before and after 1980. [47]

Source: Author's calculation based on NIPA, BLS, AMECO, OECD, ILO and the University of Groningen data.

[47] The periods for which data is available and the labor share is estimated vary: AMECO: 1960-2018, Penn World Table - University of Groningen: 1950-2018, ILO: 1960-2012, OECD: 1970-2011, Piketty WID: 1929-2017, BLS: 1947-2018.

Figure 18 confirms the picture and shows that the most similar measure to our estimate is the one provided by AMECO, with an average difference of just 0.63 percentage points over the period in which they are comparable. It follows the ILO's labor share, which on average tends to overestimate the labor share by 0.65 percentage points. Each of these series has been available starting from the 1960. Then we have the labor income shares calculated by respectively the BLS and the University of Groningen, with the former which starts in 1947 and differs (downwards) with our average of LS1-8 by only 0.40 percentage points and the latter which starts in 1950 but tend to underestimate the measure by about 1.26%. Finally, there is the measure from the WID database of Piketty which - especially after the 1970 - underestimates the labor share by roughly 2.6 percentage points and the OECD which is only available between 1970 and 2012 and has an average difference above 6%. However, what is more interesting to note from our point of view is that all the series tell the same story of a not-constant labor share, declining between of 2.7 and 9.2 percentage points over the last 60 years (Figure 18 - panel b). The correlation between our estimate and alternative existing datasets (over the period 1929-2018, except for the one with AMECO for which available data start in 1960, the BLS from the 1947, the University of Groningen from the 1950 and the OECD with the first observation in 1970) is very high, ranging from the 0.83 with OECD, to 0.95 with AMECO (as reported in Table 4 below).

Measure	**Corr.**
avg (LS1; LS2; LS3; LS4; LS5; LS6; LS7; LS8)	1.000
AMECO (as percentage of GDP at current factor cost)	0.953
University of Groningen	0.948
ILO	0.929
BLS	0.879
OECD	0.844
Piketty WID	0.512

Table 4 - Matrix of correlations between different measure of the US labor share.

Source: Author's calculation on NIPA, BLS, AMECO, OECD, ILO and the University of Groningen data.

The measure of the labor share that we have calculated for the United States has several advantages over existing measures. (i) Firstly, it provides a greater coverage compared to any other available measure. It starts in 1929 with annual frequency and from 1947 can be calculated also with quarterly frequency. In this sense it is worth pointing out that there is no quarterly data available in addition to our own, except for the BLS measurement, which however is valid only for the private sector and available from 1947. (ii) Secondly, our measure provides a solid methodological basis as it is derived from an average of eight alternative methods of mixed income distribution, while alternative sources for the labor share usually rely only on one method, generally assuming an identical wage rates at all levels. For more recent and variable time periods, depending on the sample, it is possible to replicate the approach also for some other advanced economies and, in recent years (after 1995) for most of the OECD countries. (iii) Thirdly, in this way the measurement of the labor share is made transparent, since all the details for its derivation have been widely discussed in this introduction. (iv) Thanks to this transparency, this way of measuring the labor share also makes it easily decomposable, thus eliminating the fuzziness in the definition and, finally, making it easier to understand its complement to the unit, the "non-labor share”. All in all, our labor share measure has very desirable properties and is strongly correlated with existing data. However, for the purposes of the thesis and to have internationally comparable data - that are essential for the development of a detailed global analysis - we have shown that it is possible to employ the labor share at factor cost calculated by AMECO with a good approximation. As a final step of this introductive part, it is therefore worth seeing how the compensation of employee as percentage of GDP at factor cost per person employed (i.e., the adjusted wage share) has behaved internationally.

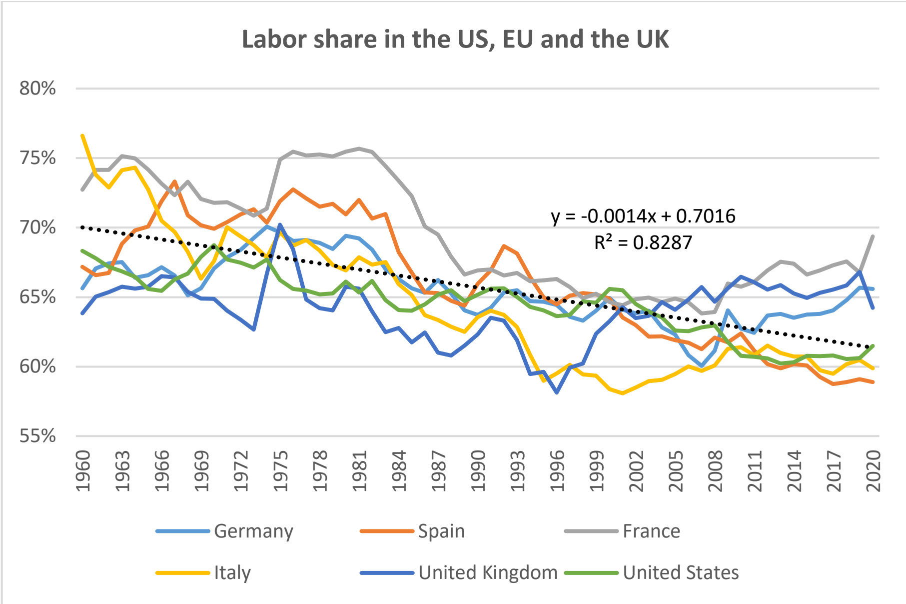


Figure 19 - Adjusted labor share (% of GDP at factor cost) for selected EU countries, the US and the UK.[48]

Source: Author's calculation on AMECO data.

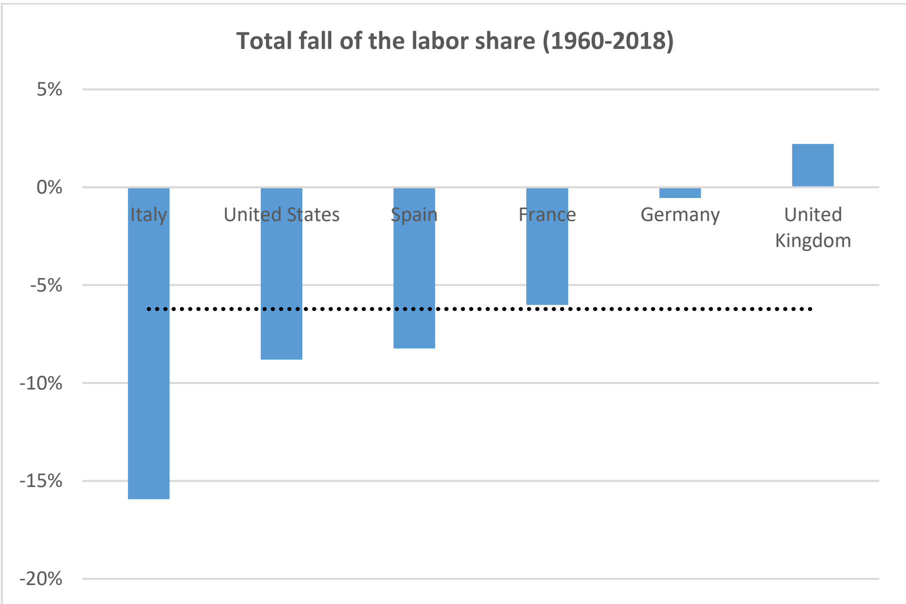


Figure 20 - Total fall of the labor share (% of GDP at factor cost) in selected EU countries, the US and the UK.

Source: Author's calculation on AMECO data.

[48] The regression line is based on the average labor share calculated as a weighted average of year-on-year labor shares and each observation is weighted by GDP (PPP) at 2015 constant prices.

Figures 19 and 20 report a comparison between the labor income shares in the United States and major European countries (i.e., Germany, France, Italy and Spain) plus the UK. Among all of them, the UK is the one which presents the smoothest evolution and the greatest stability in the long run, with its labor share remaining (even if with some fluctuations) almost stable for the whole period of analysis. While most of the countries experienced a rise in their labor shares following the oil shocks and the growth slowdown of the early 70s (Spain, Germany and France), the American and the British labor shares remained remarkably constant and the Italian one had already begun its remarkable decline. Between 1965 and 1975 (exception made for Italy), all the countries have reached their historical maximum, while between 2001 and 2017 (except for the UK - 1995) the minimum level recorded in the whole series. Then, with a similar dynamic, the downward trend that seems to have started partly as compensation for the previous increase, won and the fall went further and continued throughout the 80's and part of the 90's. Finally, the Great Recession of 2008, somehow, produced an increase in European labor shares, again by means of the same mechanism that used to operate in the 70s, with the national output falling faster than real wages. Now, in 2018, with the exclusion of the UK, the labor shares are on average 6.5 points below their 1960 levels, 6.8 points below their 1970 levels and 7.5 points below their 1980 levels (Figure 20). After all the discussions we made on the relative instability of the labor share, one could be led to conclude that overall, the labor share is subjected to substantial changes over time, especially if we are talking of billions of dollars instead of percentage points. However, it must be specified that the labor shares are generally not unstable. They historically tend to fluctuate within a range of 4.5 to 6.5 points of the GDP, and just exceptionally more. An alternative but interesting way to look at the data consist in comparing the US to EU and the UK as separate blocs. This can be achieved by calculating a weighted average of the European labor shares on data from the AMECO database, as we do in Figure 21 - panels a and b. Again, the labor share in the UK stands out as the most stable in the long run, although with some important movements in shorter periods of time. However, it has been demonstrated that if one subtracts the highest part of labor income (for instance the top 1% of the income distribution) from the UK's labor share, the evolution of the labor share for the 99 lowest percentiles becomes very similar to that observed in Europe and the United States (Giovannoni, 2014). On the other hand, the evolution of labor income shares in these countries is quite similar. Overall, the labor share in the US, and that of the EU have fallen by respectively 5.7 and 7.5 percentage points of GDP in the period 1960-2007 and 8.2%, 5.4% considering the whole sample (1960-2018).

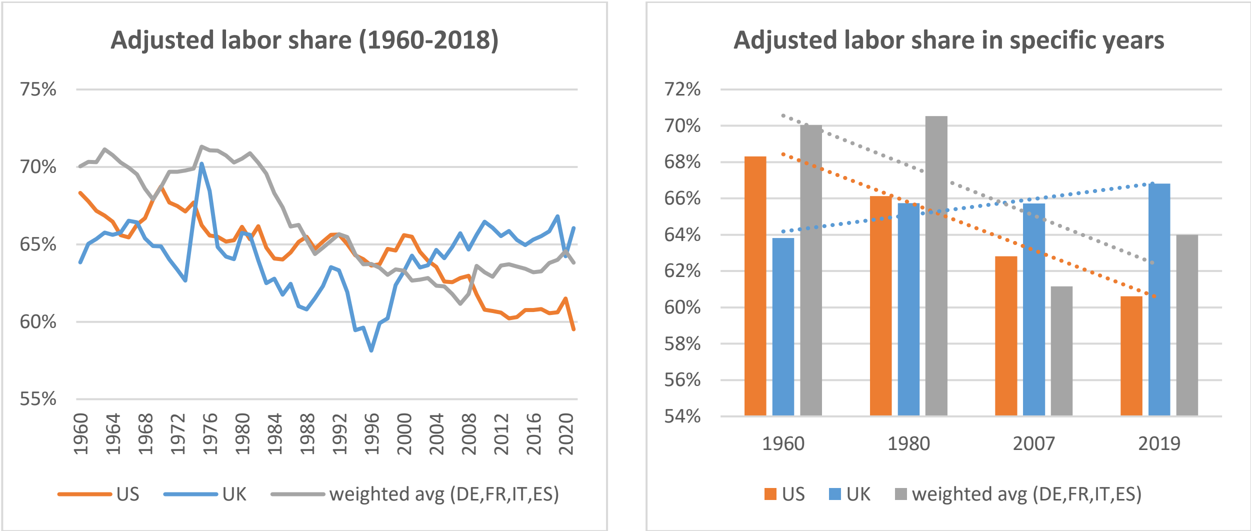


Figure 21 - Adjusted labor share in the US, EU and the UK as separate blocs (historical data and specific years).

Source: Author's calculation on AMECO data.

Some of the credit for the renewed interest in factor shares should be attributed to the publication of the dataset by the European Commission's Directorate General for Economic and Financial Affair (AMECO), which shows a declining labor share of income over the last 40 years (see Figures 22-23 below) for the major industrialized economies of the world. AMECO offers data on the adjusted labor share on an annual basis for 11 G20 countries and 29 OECD economies.[49] The starting year of the series varies but most of them starts in 1960. AMECO's time series will constitute the main source of data for the present study. From the two published time series (i.e., the adjusted wage share at market prices and at current factor costs)[50] - the long-term downward trend in labor income is evident, as can be seen in Figures 22 and 23 - panels a and b. When GDP is measured at factor cost, the average labor share for the 4 major European countries (DE, FR, IT, ES) declined from an average of roughly 69 per cent in 1960 to about 63 per cent in the most recent year (the total decrease is on average in the order of 6 percentage points); from 68,5% to 60,5 in the USA (-8%) and apparently increased from 64 to 66,5 in the UK (+2,5%), Figures 22 and 23 - panel a. When

[49] The complete list includes: Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Macedonia FYR, Malta, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States.

[50] AMECO estimates this adjusted measure of the labor share with either GDP at market prices or GDP at current factor cost (i.e. minus taxes and plus subsidies). However, according to Guerriero (2012) this latter is more meaningful, since - from an accounting perspective - taxes do not represent any kind of return to capital or land. The name for the two series is respectively: (i) adjusted wage share: total economy: as percentage of GDP at current prices (Compensation per employee as percentage of GDP at market prices per person employed); (ii) adjusted wage share: total economy: as percentage of GDP at current factor cost (Compensation per employee as percentage of GDP at factor cost per person employed).

measured at market prices, the labor share declined from an average of 62 per cent to 56 per cent in Continental Europe (the total decrease is also in the order of 6 percentage points); from 63% to 56,5 in the USA (-6,50%) and from 64 to 58.5 in the UK (-5,5), Figures 22 and 23 - panel b**.**

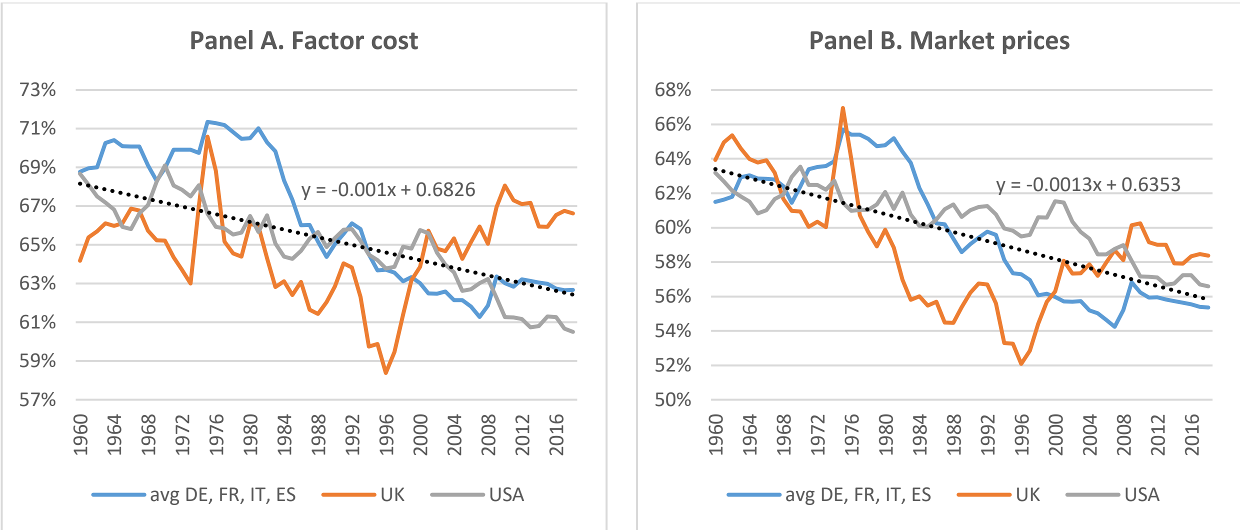


Figure 22 - The adjusted labor income shares in Continental Europe, the UK and USA

Source: Author's calculation on AMECO data.

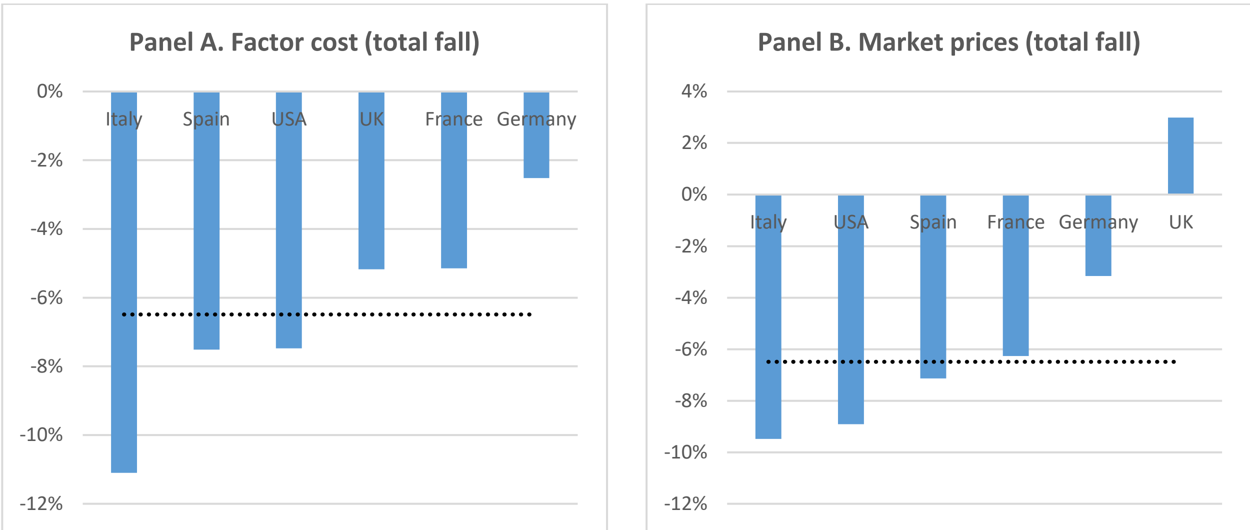


Figure 23 - Total fall in the adjusted labor income share in Continental Europe, the UK and USA (1960-2019).

Source: Author's calculation on AMECO data.

Both the panels of Figure 22 show that during the years of the global economic recession the long downward trends stopped or even reversed to start declining again after 2009. This is consistent with empirical evidence that wages are relatively less volatile than profits in adverse economic cycle phases.[51] Indeed, it is well documented that in advanced countries the labor share tends to increase in the initial years after an economic downturn to resume its negative trend afterwards with a countercyclical behavior (Jaumotte, 2012). In Europe, the behavior of the labor share during the most recent recovery – with a strong growth in profits compared to labor income - does not seem so different with respect to what observed during other recoveries between 1980 and 2007. In contrast, the case of the United States appears rather unusual from a historical perspective - and is characterized by a stronger rebound in profits relative to labor income. One explanation is that the fear of workers for long-run unemployment has led to lower wages with respect to labor productivity growth during the recent recovery. Apart from these specific peculiarities, however, at the country level, data from different sources and calculated in different ways, even with some differences in terms of magnitude, show the same long-term trends in the evolution of the labor share, with a generalized decline in almost all the economies.

Are factor income shares stable over the very long run? One might wonder whether the downward spikes in the labor share as observed today corresponds to an historical minimum over the entire century. To address the question, we employ historical data that goes sufficiently far back in time to capture the long-term fluctuations of the labor share. Using Piketty (2013) and Piketty and Zucman (2014) data we can track back the evolution of the labor share of income for France (1896-2010), the United Kingdom (1856-2010) and the United States (1929-2010).[52] Figure 24 shows the labor share for the countries considered together with the long-term trend captured by means of a third-degree polynomial. As it is possible to see the series are made of short- and medium-term fluctuations along longer cycles. Let us focus on the long-term component. In the United States, there are two peaks in 1940 and 1980 and two minimums in 1917 and 1955. The labor share displays three long-term cycles in the United Kingdom and two and a half cycles in France and the US. In the UK, peaks can be dated back to the years 1888, 1927 and 1975 and minimums in 1906 and 1949. In France, the peaks occurred in 1948 and 1980, and the minimums 1925, 1964 and 2000. Looking at the series in their entirety we can say that the labor share in France has reached its historical

[51] During recessions, profits were the component that contribute most to the decline in income, which caused the labor share to increase. Following the recovery, even if all components of GDP increased, profits rebounded strongly in most economies, leading to a decline in the labor share.

[52] Note: Data for France is taken from Piketty and Zucman (2014). The US data are also taken from Piketty and Zucman (2014) over the sample 1929-2010; prior to 1929 the labor share is extrapolated using the database by Groth and Madsen (2016).

minimum since the WWII and now is back to its 1856 level. Likewise, in the UK, the labor share is now reaching a level not different from the one recorded before WWII. Finally, also in the US, the labor share shows a decline over the past 40 years, pushing it down to a level not far from the one reached in the 30s.

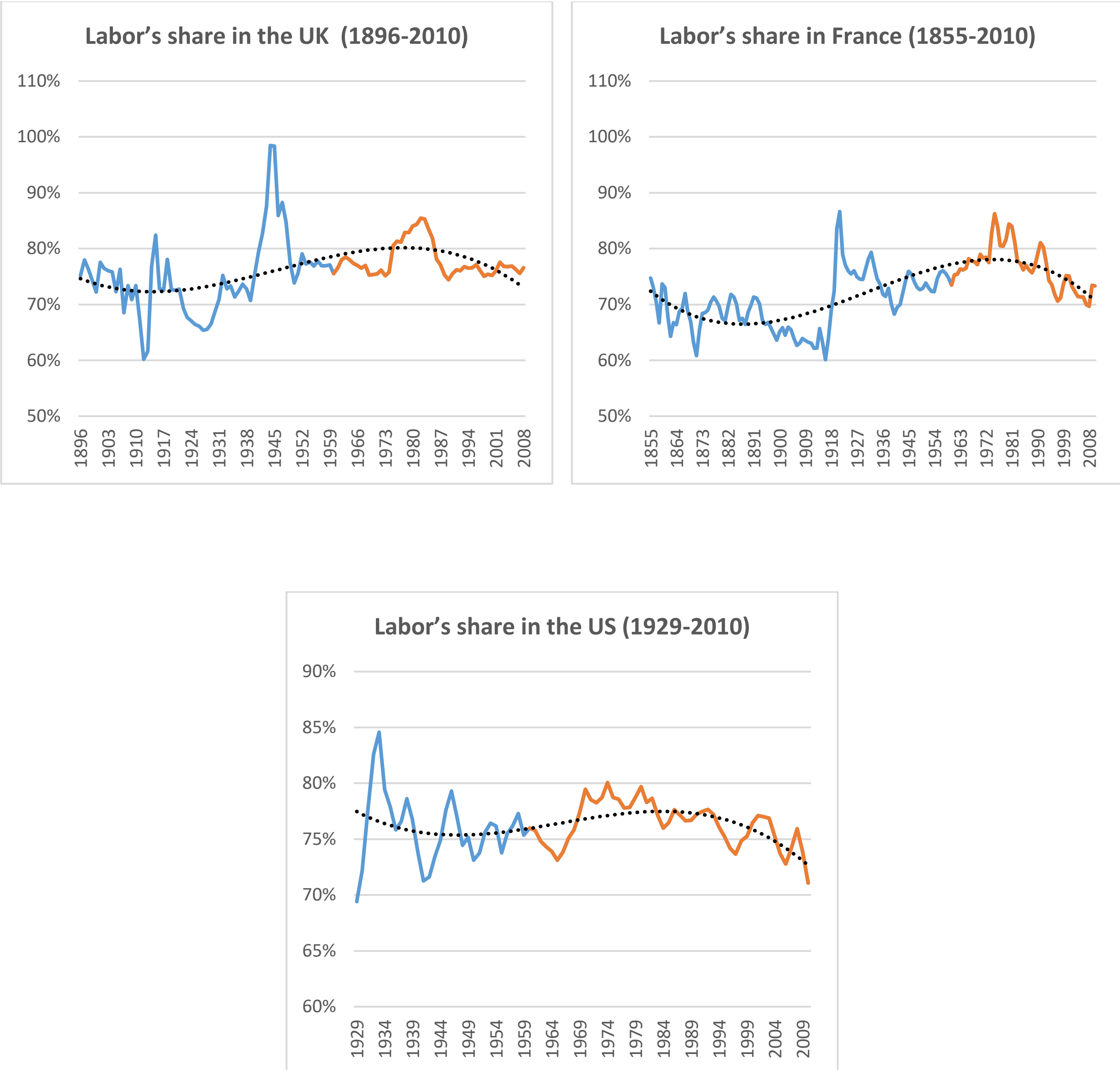


Figure 24 - The labor share in the very long-run.

Note: in orange the series from 1960 onwards. *Source:* Author's own elaboration on Piketty WID data.

References

Abdih, M. Y., and Danninger, S. (2017). What Explains the Decline of the US Labor Share of Income? An Analysis of State and Industry Level Data. *International Monetary Fund (IMF)*.

Adler, M., and Schmid, K. (2012). Factor Shares and Income Inequality - Empirical Evidence from Germany 2002-2008.

Armenter, R. (2015). A bit of a miracle no more: the decline of the labor share. *Business Review Q3* , 1-9.

Arpaia, A., Pérez, E., and Pichelmann, K. (2009). Understanding labour income share dynamics in Europe. *European Commission Economic Papers 379 | May*.

Atkinson, A. B. (1975). *The economics of inequality*. Oxford: Clarendon Press.

Atkinson, A. B. (2009). Factor shares: principal problem of political economy? *Oxford review of economic policy*, 3-16.

Atkinson, A. B., and Bourguignon, F. (2014). Handbook of income distribution. *Vol. 2. Elsevier.*

Bassanini, A., and Manfredi, T. (2014). Capital's grabbing hand? A cross-industry analysis of The decline of the labor share in OECD countries. *Eurasian Business Review 4.1*, 3-30.

Bellocchi, A., 2020. Labor share is falling down, but which one?. *Working Papers 20-01, University of Urbino Carlo Bo, Department of Economics, Society & Politics* - Scientific Committee - L. Stefanini & G. Travaglini, revised 2020.

Bernanke, B. S., and Gürkaynak, R. S. (2001). Is growth exogenous? taking mankiw, romer, and weil seriously. *NBER macroeconomics annual 16*: 11-57.

Blanchet, T., and Chancel, L. (2016). *National Accounts Series Methodology*.

Bridgman, B. (2018). Is labor's loss capital's gain? Gross versus net labor shares. *Macroeconomic Dynamics 22.8*: 2070-2087.

Cho, T., Hwang, S., and Schreyer, P. (2017). Has the labour share declined?: It depends.

Cole, A. (2015). Sources of Personal Income, Update. *Economist 492*.

Dao, M. C., et al., e. (2017). Why is labor receiving a smaller share of global income? Theory and empirical evidence. *International Monetary Fund (IMF)*.

Dimova, D. (2019). The Structural Determinants of the Labor Share in Europe. *International Monetary Fund*.

Dobb, M., and Dobb, M. H. (1975). Theories of value and distribution since Adam Smith: Ideology and economic theory. *Cambridge University Press.*

Elsby, M. W., Hobijn, B., and Şahin, A. (2013). The decline of the US labor share. *Brookings Papers on Economic Activity 2013.2*, 1-63.

Feldstein, M. (2008). Did wages reflect growth in productivity?. *Journal of policy modeling 30.4,* 591-594.

Garcıa-Verdú, R. (2005). Factor shares from household survey data. *Banco de México, Working Paper 5*.

Giandrea, M. D., and Sprague, S. A. (2017). Estimating the US labor share. Monthly Labor Review.

Gindling, T. H., and Newhouse, D. (2012). Self-employment in the developing world. *The World Bank*.

Giovannoni, O. (2014). What do we know about the labor share and the profit share? Part I: Theories. *Working Paper No. 803 - Levy Economics Institute of Bard College*.

Glyn, A. (2009). Functional distribution and inequality. *The Oxford handbook of economic inequality.*

Gollin, D. (2002). Getting income shares right. *Journal of political Economy 110.2*.

Gomis, R. (2019). The global labour income share and distribution. *ILO Department of Statistics, Methodological description - Geneva, ILO*.

Gomme, P., and Rupert, P. (2004). Measuring labor's share of income. *FRB of Cleveland Policy Discussion Paper 7.*

Grossman, G. M., et al. (2017). The productivity slowdown and the declining labor share: A neoclassical exploration. No. w23853. *National Bureau of Economic Research*.

Groth, C., and Madsen, J. B. (2016). Medium-term fluctuations and the "Great Ratios" of economic growth. *Journal of Macroeconomics 49*, 149-176.

Guerriero, M. (2019). The Labour Share of Income around the World. *ADBI Working Paper Series*.

Guerriero, M., and Sen, K. (2012). What determines the share of labour in national income? A cross-country analysis. *IZA Discussion Papers 6643. Institute for the Study of Labor (IZA).*

Guscina, A. (2006). Effects of globalization on labor's share in national income*. International Monetary Fund (IMF).*

Harrison, A. (2005). Has Globalization Eroded Labor's Share? Some Cross-Country Evidence. *Munich Personal RePEc Archive*.

Hartwig, J. (2006). On spurious differences in growth performance and on the misuse of National Accounts data for governance purposes. *Review of International Political Economy 13.4*, 535-558.

Heintz, J. (2013). *Unpacking the US labor share. Capitalism on Trial.* Edward Elgar Publishing.

Hurst, E., Li, G., and Pugsley, B. (2010). Are household surveys like tax forms. Evidence from income underreporting of the self-employed. *Cambridge, Mass.: National Bureau of Economic Research*.

ILO. (2019). The Global Labor Income Share and Distribution. *Data Production and Analysis Unit, ILO Department of Statistics*.

ILO, and OECD. (2015). The labour share in G20 economies. *Report prepared for the G20 Employment Working Group, Antalya*.

IIMF. (2017). Why is Labor Receiving a Smaller Share of Global Income? Theory and Empirical Evidence. *IMF Working Paper*.

Inter-Secretariat Working Group on National Accounts, and Commission of the European Communities. (1993). *System of national accounts 1993*. Vol. 2. IMF.

Jaumotte, F. (2012). Is Labour Compensation Still Falling in Advanced Economies? *IMF Survey Magazine*.

Johnson, D. G. (1954). The functional distribution of income in the United States, 1850-1952. *The Review of Economics and Statistics*, 175-182.

Kaldor, N. (1957). A model of economic growth. *Economic Journal 67(268)*, 591-624.

Kaldor, N. (1961). *Capital accumulation and economic growth. The theory of capital.* Palgrave Macmillan, London, 177-222.

Karabarbounis, L., and Neiman, B. (2014). The global decline of the labor share. *The Quarterly journal of economics 129.1*, 61-103.

Keynes, J. M. (1939). Relative movements of real wages and output. *The Economic Journal 49.193, 34-51.*

Kravis, I. B. (1959). Relative income shares in fact and theory. *The American Economic Review 49.5*, 917-949.

Krueger, A. B. (1999). Measuring labor's share. *American Economic Review 89.2*, 45-51.

Kuznets, S. (1959). Quantitative aspects of the economic growth of nations: IV. Distribution of national income by factor shares. *Economic Development and Cultural Change 7.3, Part 2*, 1-100.

Lavoie, M., and Stockhammer, E. (2013). *Wage-led growth: Concept, theories and policies*. Palgrave Macmillan, London, 13-39.

Lawless, M., and Whelan, K. T. (2011). Understanding the dynamics of labor shares and inflation. *Journal of Macroeconomics 33.2*, 121-136.

Lian, W. (2019). Technological Changes, Offshoring, and the Labor Share. *International Monetary Fund (IMF)*.

Lübker, M. (2007). Labour Shares: Technical Brief No. 01. *Policy Brief, Policy Integration Department, ILO: International Labour Organization*.

Lucas, R. E. (2002). Lectures on economic growth. Harvard University Press.

Mankiw, N. G., and Taylor, M. P. (2017). *Macroeconomics, 4th edition*. Andover: Cengage.

McAdam, P., Bridji, S., and Charpe, M. (2019). Labor share and growth in the long run. *ECB working paper series No. 2251*.

McKinsey Global Institute. (2019). A new look at the declining labor share of income in the United States. *Discussion paper May 2019*.

OECD. (2012). The Labour Share in G20 Economies. *OECD Employment Outlook*.

Orak, M. (2017). Capital-task complementarity and the decline of the US labor share of income. *FRB International Finance Discussion Paper 1200.*

Ostry, J. D., Berg, A., and Tsangarides, C. G. (2014). Redistribution, inequality, and growth. *International Monetary Fund (IMF)*.

Piketty, T. (2013). *Capital in the Twenty-first Century*. Harvard University Press.

Piketty, T., and Zucman, G. (2014). Capital is back: Wealth-income ratios in rich countries 1700-2010. *The Quarterly Journal of Economics 129.3*, 1255-1310.

Pomerleau, K. (2015). An Overview of Pass-through Businesses in the United States. *Economist* 227.

Ricardo, D. (1891). *Principles of political economy and taxation*. G. Bell and sons.

Rodriguez, F., and Jayadev, A. (2010). The declining labor share of income. *Journal of Globalization and Development 3.2*, 1-18.

Rognlie, M. (2016). Deciphering the fall and rise in the net capital share: accumulation or scarcity? *Brookings papers on economic activity 2015.1*, 1-69.

Samuelson, P. (1964). *Economics: An Introductory Textbook*. New York: McGraw-Hill.

Sandmo, A. (2015). The principal problem in political economy: income distribution in the history of economic thought. *Handbook of income distribution. Vol. 2. Elsevier*, 3-65.

Schlenker, E., and Schmid, K.D. (2014). Capital income shares and income inequality in the European Union. *No. 80-2013. FZID Discussion Paper.*

Schwellnus, C., et al., e. (2018). Labour share developments over the past two decades: The role of technological progress, globalisation and “winner-takes-most” dynamics.

Sidhu, S., and Dunn, M. (2018). Estimating the impact of the self-employed in the labour share.

Solow, R. M. (1958). A skeptical note on the constancy of relative shares. *The American Economic Review,* 618-631.

Steffen, P. EJ. (2013). The Real Income Shares of Labor, Human and Physical Capital from Micro-and Macro-Data. *No. 9/2013. DEP (Socioeconomics) Discussion Papers, Macroeconomics and Finance Series.*

Tansever, S.S. (2017). Labor income share consequences of global financial crisis: Evidence from Turkey. *International Journal of Business and Economic Sciences Applied Research (IJBESAR) 10.2*: 73-84.

Torrini, R. (2016). Labour, profit and housing rent shares in Italian GDP: long-run trends and recent patterns. *Bank of Italy Occasional Paper* 318.

United Nations. (2009). System of national accounts 2008. *European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development*.

Wolff, E. N., and Zachari, A. (2013). Class structure and economic inequality. *Cambridge Journal of Economics 37.6*, 1381-1406.

Young, A. (1995). The tyranny of numbers: confronting the statistical realities of the East Asian growth experience. *The Quarterly Journal of Economics 110.3:* 641-680*.*

Chapter 2: Variable elasticity of substitution, imperfect competition and declining labor shares

Alessandro Bellocchi[1]

Abstract

Both the recent literature and a considerable body of empirical works on the functional distribution of income assume that the underlying production function is either Cobb-Douglas or CES. In the former case the labor income share is constant under the additional assumption of perfect competition. On the other hand, with a CES production function, the magnitude of the elasticity of substitution is crucial for the immediate impact of factor accumulation on factor shares. However, as we will show, the CES presents at least two criticality which are not compatible with the necessity to set up a modern theory of distribution: (i) the assumption of independence in the relationship between labor productivity and real wages from the stock of capital; (ii) the restriction for the value of the elasticity of substitution to be constant, although different from unity. This paper presents a novel theory on how factor shares are determined. Using AMECO data for a set of 20 industrialized countries over a 58-year period we provide empirical evidence against the CES and develop microfoundations for an aggregate production function that better fits the data and has the property of a Variable Elasticity of Substitution (VES) between factors. Then we relax the assumption of perfect competition by proposing a time-series calculation of the aggregate price mark-up and provide estimates of the elasticity of substitution under such a framework of imperfect product markets. Finally, we test the prediction of the model by means of a numerical simulation. We find that firms' rising markups along with biased technological change can account for a significant part of the labor shares' decline observed in the last 40 years. The results also suggest complementarity between labor and capital in most of the cases, with the elasticity of substitution that has been below unity on average, fluctuating around 0.7-1.16. Our contribute to the literature is twofold. On the one hand we provide new estimates of the elasticity of substitution at an aggregate level which indicate that the latter could be lower or higher than that indicated in previous studies and may in some cases differ significantly from one. On the other hand, our paper reconciles all these facts by unveiling the connection between the elasticity of substitution, capital deepening, technological progress and the trajectory of the labor shares with an alternative explanation for their decline who carries with it significantly and interesting implications.

Keywords: Labor share, Capital-deepening, Elasticity of substitution, Technical change, Price markups.

[1] Department of Economics, Society and Politics (DESP); University of Urbino Carlo Bo, Italy. e-mail: alessandro.bellocchi@uniurb.it.
This paper was presented at the PhD students' Seminar Session held in Urbino on May 29-30, 2019 receiving the best paper award.

1. Introduction

The labor share of national income[2] is falling everywhere. Wages, especially in advanced economies are growing less than productivity, or, alternatively, labor productivity, is falling by more than wages do. The common result is that a growing fraction of productivity gains is going to capital owners. In other words, the historical distributional conflict between workers and capitalists is now back at the center of the economic debate and more relevant than ever. Given that the propensity to consume of workers is higher compared to that of capitalist, in the long run a lower labor share can lead to a decrease in aggregate demand with adverse effects on economic growth (Lavoie and Stockhammer, 2013; Sherman, 2014; O'Mahony et al., 2015; Bellocchi, 2020).

The functional distribution of income used to be a relevant topic for economists a century ago when Ricardo referred to it as "the principal problem of political economy" (Ricardo, 1891). During the 1930s, 40s and 50s the topic was frequently debated in academia (Giovannoni, 2014). This relevance lasted at least until the pioneering work of Kaldor's (1961) with its "stylized facts" of economic growth that became widely accepted among economists. For Kaldor, which based his conclusion on an economic model with a steady state stable at near full employment, real wages would always end up matching labor productivity gains, with the result that in the long run, the resulting labor share cannot but be constant. From this moment forward, for at least three decades, the stability of the labor share of income has been a fundamental feature of standard macroeconomic models and the issues regarding its determination were marginalized. It is not surprising that in times of large-scale shared gains and economic well-being, the focus of the economists shifted from distribution to growth. Indeed, for at least 50 years, the labor share in industrialized countries never ventured far from 68% of national income, remaining relatively stable through expansions, recessions, high and low inflation, and the long transition from an economic model based on manufacturing to one centered on services.[3] Therefore, in these years factor shares

[2] There are basically two forms of household income: (i) labor income, which includes wages, salaries, and other work-related forms of compensation (such as pension and insurance benefits and incentive-based compensation), and (ii) capital income, which includes interest, dividends, and other realized investment returns (such as capital gains). The labor share is defined as the part of national income allocated to wages (labor). From this perspective, one explanation used to account for the decline of the labor share involves alterations in how the statistics for labor and capital income are calculated over time. Indeed, a number of issues within these definitions arise. The most decisive factor seems to be a change in the way self-employed workers' income is treated.

[3] Economists have not found conclusive evidence for the mechanism behind the decline of the labor share. Some studies have proposed as an alternative explanation the transition of the economy from a composition mainly based on manufacturing to one based on services. Indeed, manufacturing is characterized by a higher labor share than services, so it seems natural that with a change in the composition of industry shifting from manufacturing to services, the labor share would decrease. However, this transition does not coincide with the timing of the observed decrease in the share of labor in national income. For instance, in the US, most of the transition from manufacturing to services happened before the 1980s (which as we will see represents the breaking point after which the labor share started to decline). See Armenter (2015).

used to be considered as trivial constant and this led to a substantial reduction of the role that the distribution of income used to have in academic discussions and economic textbooks (Atkinson, 2009).[4] The relative stability of the labor share was the result of large forces that pulling it in opposite directions canceled each other out (Armenter, 2015). Nevertheless, Keynes referred to this as "a bit of a miracle" (Keynes, 1939). The distributional conflict among classes so dear to Marx seemed, after a long time to be over.

However, the recent striking and worldwide decline in the labor income shares as well as rising inequalities on the personal side of the distribution brought new and fresh blood to this research field. Finally, the interest in the area has risen again after the crisis of 2008, when we have witnessed to the dissipation of net wealth combined with a fall in aggregate demand. From a social perspective, this phenomenon generates even more concerns in an economic system characterized by high wage inequalities. Indeed, if there is a gap with wages at the top end of the distribution rising more than the average wage, then a declining labor share of income also implies that the average worker's share of national income is decreasing at a higher rate with respect to the total picture.

It is no coincidence that the revolution started on the empirical side. Olivier Blanchard (1997) was one of the first to note a decline in labor share in several European countries. Subsequently, Karabarbounis and Neiman (2014) documented that the global labor share has declined significantly since the early 1980s, with the decline occurring within most countries and industries. Rodriguez and Jayadev (2010) used two separate panel datasets and showed that over the past three decades the labor shares have decreased both in manufacturing and at the economy-wide level. Elsby et al. (2013) provides compelling evidence of a declining trend for the US. Finally, Piketty and Zucman (2014) showed, for a set of advanced economies, a decreasing (increasing) trend of the labor (capital) income shares since the late 1970s. According to Gordon (2012), the economic growth rates seen for much of the past century in developed countries may be over because their drivers (i.e., the large gains from public education, increasing participation of women in the labor force, infrastructural investments, etc.), have been fully exploited. If this is the case, and the cake is no longer growing at the pace we have been used to for more than a century, then its division will become even more contested.

[4] For instance, most business cycle research is still performed using the notion that factor shares of national income (capital and labor) are constant.

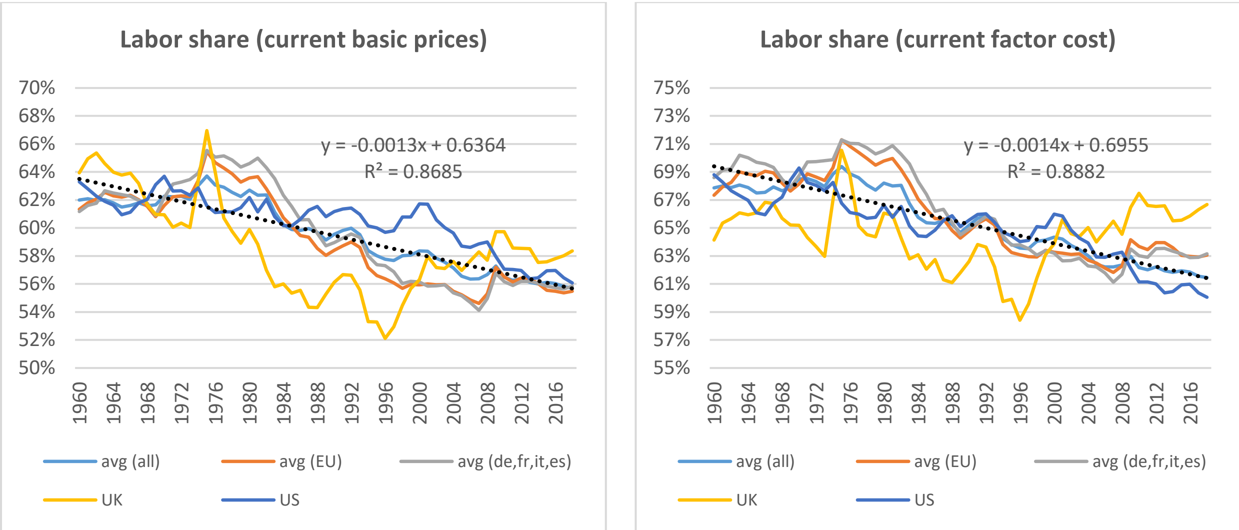


Figure 1 - Labor share trends (as % of GDP at current basic prices/factor cost).[5]

Note: The average labor share (avg) for either the whole sample or sub-aggregates of countries is calculated as a weighted average (GDP at constant 2010 prices) of year-on-year labor shares. See Footnote 9 for the full list of countries included in the sample. *Source:* Author's own calculation on AMECO data.

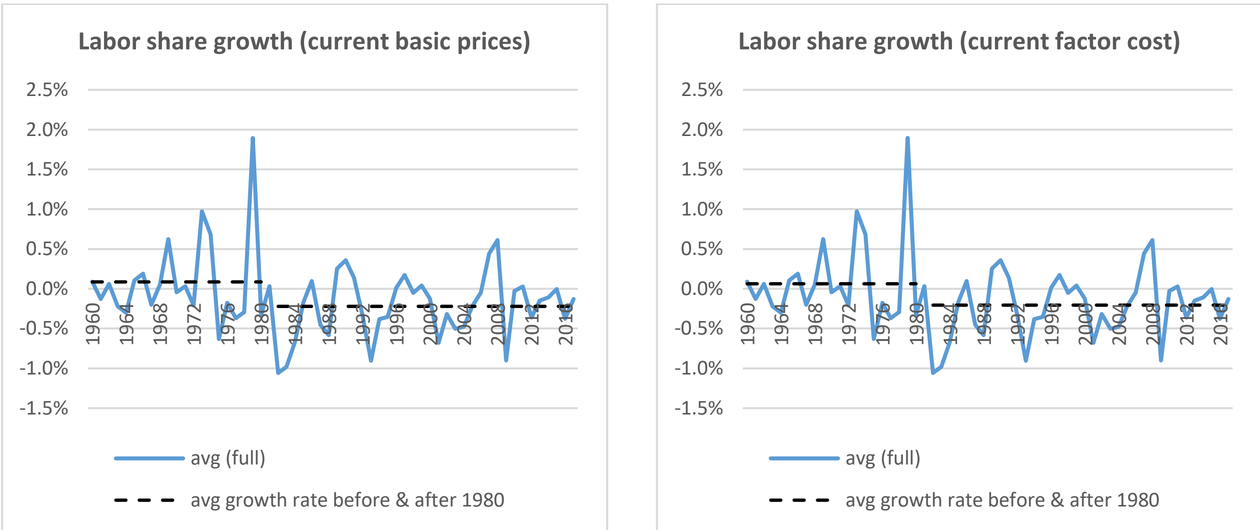


Figure 2 - Average labor share's growth rate (as % of GDP at current prices and at current factor cost).[5]

Note: The average labor share growth rates (avg) for either the whole sample or sub-aggregates of countries is calculated as a weighted average (GDP at constant 2010 prices) of year-on-year labor shares. See Footnote 9 for the full list of countries included in the sample. *Source:* Author's own calculation on AMECO data.

[5] Labor compensation includes wages and salaries of employees plus employers' contributions for social insurance and private benefit plans, and all other fringe benefits. An estimate of the wages, salaries, and supplemental payments of the self-employed is included.

We do not intend to enter the debate on timing or magnitude, which already reflects a large amount of accurate empirical data. But to prepare the ground for our next discussion, we describe the evolution of the labor share. Figure 1 and Figure 2 are the figures of concern.[6] They show the evolution of the share of labor compensation including wages, salaries and employer-contributed benefits[7] (either calculated at current basic prices or current factor cost)[8] in the non-farm business sector according to our data for a selection of advanced industrialized OECD economies.[9] Of course, it is difficult to identify a precise starting point for any decline, but the figure clearly shows that the labor share has fallen significantly since the early 80s.[10] Taking this year as a reference point, what we observe is that the global labor shares have exhibited a clear downward trend only interrupted by a sudden and short rise in the early 90s. Then they reached their lowest level of the past half century just before the global financial crisis of 2008. However, this sudden stop of the long-term dynamic during the depths of the global economic crisis was only temporary, and the labor shares started to decline again after 2009. This reflects the fact that wages tend to be less volatile than profits during economic downturns (ILO and OECD, 2015). The countercyclical behavior of labor shares in advanced economies has been well documented by the literature (IMF, 2012). If we normalize 1980 to equal its weighted average value (69.40% when measured at factor cost), the average labor share reaches a level of roughly 61.60% at the end of the sample, implying an actual decline of 7.80 percentage points during the period considered (Table 1, panel a). This means that now, on average, the labor shares are much lower than they were in 1970 and implies an actual annual declining rate of 0.2 percentage points per year between 1980 and the late 2017. Similar downward trends have been observed by international institutions (IMF, 2017; OECD, 2018; ILO, 2018). The decline has affected to a greater or lesser extent all the countries considered. As we can observe, over the period from 1960 to 2018 the share of labor compensation in national income

[6] Additional tables and graphs are available in Appendix B (we refer to Figures A1-2 and Table A12).

[7] The measure shown in the graphs includes an imputed labor remuneration for the self-employed based on the average wage. Mixed income is apportioned by assigning the same average wage to each worker regardless of him/her being an employee or self-employed (Gollin, 2002). Regressions are weighted by GDP at constant 2010 prices.

[8] The annual macroeconomic database (AMECO) of the European Commission's Directorate General for Economic and Financial Affairs) provides data based on National Accounts on the adjusted labor shares for over 40 OECD countries in the world. The labor income share is calculated as the compensation of employees over total economy GDP multiplied by total employment. Two series are published series: with GDP at market prices as well as with GDP at current factor cost (i.e. minus taxes and plus subsidies). According to Guerriero (2012) the latter is more meaningful, since taxes do not represent any kind of return to capital or land.

[9] The 20 countries considered are the following: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Swede, United Kingdom, United States.

[10] To check whether the labor shares in the countries under investigation can be treated as stationary or not we use the Augmented Dickey-Fuller (ADF), the Philipp-Perron (PP) and the Kwiatkowski - Phillips - Schmidt - Shin (KPSS) tests. We obtain consistent results (which are available in Appendix B - Unit root tests): according to the ADF and the PP test the null of a unit root cannot rejected; according to the KPSS the null of stationarity is rejected. We conclude that during our sample period these series have not evolved around a constant value.

declined in 15 out of 20 of the advanced countries for which data are available, with the notable exceptions of Belgium, Denmark, Luxembourg, Netherlands and the UK. When current basic prices are used, the results obtained are similar and the labor share declined from an average of 64 per cent in 1980 to 55.60% in 2018 (Table 1, panel b).[11] Further, as highlighted by Bentolila and Saint Paul (2003), it is surprising to see that there are great differences between countries in the behavior of labor shares and even more so that the latter also exist between countries that are relatively similar from a technological point of view. As shown in Table 1, the UK is the country with the closest approximation to a constant labor share (the stylized fact observed by Kaldor), as it seems to fluctuate in the medium run around a stable level. Here, over the full sample the total increase has been of 2.55 percentage points (1.95% before 1980 and 0.60% after 1980). In contrast, the US are experiencing substantial short-run fluctuations around a mild downward trend of 8.75 percentage points (-2.20% before 1980 and -6.55% after 1980). The same downward trend appears to be even more visible in the case of Japan (-13.60 percentage points since 1980). In Continental Europe, country experiences are highly heterogeneous, with the biggest declines taking place in Ireland (-37.35%) and Greece (-24.80%). Italy lost a total of 9.25 percentage points since 1960, Spain 7.45 and France 5.30. On the other hand, Germany (-3.08%) and Sweden (-2.63%) are relatively more stable. Further, while in Belgium, Denmark and France the labor share reached its peak in the early 1980s (between 1980 and 1981), in Austria, Germany, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden it did so in the mid-1970s (between 1974 and 1977) and in Finland, Italy, Spain in the mid-1960s (between 1964 and 1967).

[11] Of course, the figures we obtain may differ to some extent with those obtained by other studies since different methodologies are employed for their calculation, however, the overall trend is the same. For example, the AMECO database uses GDP (gross including depreciation in the denominator) and this is known to reduces the labor share.

	LS at current basic prices			LS at current factor cost		
	1960-1980	1980-2018	**1960-2018**	1960-1980	1980-2018	**1960-2018**
Australia	6.52%	-15.36%	-8.83%	7.90%	-12.04%	-4.14%
Austria	0.01%	-9.56%	-9.55%	0.25%	-10.87%	-10.62%
Belgium	10.23%	-6.74%	3.49%	10.19%	-6.09%	4.10%
Canada	-3.29%	-3.88%	-7.17%	-5.29%	-1.95%	-7.24%
Denmark	3.98%	-5.18%	-1.20%	7.15%	-6.16%	0.99%
Finland	-4.23%	-9.91%	-14.13%	-5.16%	-9.13%	-14.29%
France	3.57%	-7.60%	-4.03%	2.74%	-8.03%	-5.29%
Germany	4.95%	-7.47%	-2.52%	3.78%	-6.86%	-3.08%
Greece	-22.43%	-3.62%	-26.05%	-25.65%	0.87%	-24.78%
Ireland	2.08%	-33.15%	-31.07%	-0.67%	-36.66%	-37.34%
Italy	-0.43%	-10.49%	-10.92%	-3.40%	-5.86%	-9.25%
Japan	NA	-14.74%	-14.74%	NA	-13.62%	-13.62%
Luxembourg	11.07%	-5.03%	6.04%	12.86%	-2.20%	10.66%
Netherlands	10.56%	-11.55%	-0.99%	11.75%	-10.25%	1.49%
Norway	-3.44%	-4.87%	-8.31%	-3.14%	-4.97%	-8.11%
Portugal	3.17%	-15.37%	-12.20%	3.35%	-10.15%	-6.80%
Spain	5.05%	-12.73%	-7.68%	3.79%	-11.23%	-7.45%
Sweden	3.22%	-6.45%	-3.24%	2.60%	-5.24%	-2.63%
United Kingdom	-4.05%	-1.52%	-5.58%	1.93%	0.61%	2.54%
United States	-1.11%	-6.11%	-7.22%	-2.17%	-6.57%	-8.75%
Mean	2.14%	-8.50%	-6.36%	1.52%	-7.80%	-6.28%
Standard Deviation	0.075	0.069	0.088	0.085	0.078	0.104

Table 1 - Evolution of the labor shares for the total economy from 1960 to 2018.

Source: Author's own calculation (based on raw data from AMECO).

From Table 1 emerges also another interesting feature of this spectacular decline. If we take a measure to quantify the amount of variation among countries' values, we find that the standard deviation in the growth rates of labor shares has not changed. Since the initial situations in levels were very different it follows that the labor shares have not converged among the countries considered. There was a sort of convergence until 2008 when the labor shares began again to diverge quite sharply. Nowadays, some countries like France and the UK show labor shares around 67% of their GDP, while others like Norway, Greece and Australia have more modest values around 57%. Finally, the labor share of Ireland is as low as 36%. To sum up, in contrast with the traditional belief of economists, there have been significant movements in the labor shares over a relatively short period of time and the debate is far from being solved. For these reasons, we believe that it is important to investigate its dynamics, which is exactly the purpose of this paper.

2. Literature review

The reasons for the decline of the labor shares are complex. Several attempts have been made by literature to explain the non-constancy of the labor share of income in the medium run. Recently, two previously standard assumptions of neoclassical economics have been questioned, namely the assumption behind the technology of production usually assumed to take the Cobb-Douglas (CD) functional form and the one on the perfect competitiveness of the markets. These assumptions underlying the neoclassical growth model imply that the equilibrium labor share would always be constant over time.[12] Since this is not the case and a declining trend is observed, the new models proposed generally shift away from the Cobb-Douglas and employ a more general Constant Elasticity of Substitution production function (CES) that allows an elasticity of substitution different from one. If firms produce with a CES technology, even if markets are perfectly competitive, the labor share can be expressed as a function of the capital-output ratio and eventually, evolve over time. The capital (labor) share is either an increasing or decreasing function of the capital-output ratio depending on the elasticity of substitution. In other words, the parameter σ (following the standard notation) links the capital-output ratio to the capital (labor) share. It is this latter which determines how much the rate of return falls when the capital-output ratio rises, and consequently

[12] Assume for instance the following functional form: $Y = F(K, L) = K^{\alpha}L^{1-\alpha}$. Then for any interest rate r and wage rate w, $Y_K = \alpha Y$ and $Y_L = (1-\alpha)Y$. With a Cobb-Douglas production function, the capital and labor shares are entirely determined by technology. Either labor supply or saving elasticities does not matter. Note however that the assumption of competitive markets - firms maximizing profits by taking prices as given - does matter.

if the capital share is an increasing or a decreasing function of K/Y.[13] Starting from this relationship between labor share and the capital-output ratio, this strand of literature emphasizes the role of the capital stock in the economy as a main determinant of labor share.

This first set of hypotheses put forward to explain the decline in the labor share is also known as the *technological change explanation* and posits that this negative trend has been due to factor biased technological change and/or an increase in capital intensity (Guschanski and Onaran, 2018). Recently, technological change has become increasingly capital-augmenting, and this has made production activities more capital intensive. Here, the work of Bentolila and Saint-Paul (2003) represents a milestone. The value of their contribution lies mainly in their theoretical model, which, for the first time derived and generalized the above-mentioned relationship, now well established in the literature. The resulting share-capital schedule (as they refer to it) is not altered by changes in real wages, capital accumulation, or labor-augmenting technical progress, which are all encompassed within the curve. This means that shocks in capital-augmenting technical progress, as well as factors that generate a gap between the marginal product of labor and real wages are the main candidates to explain shifts of the schedule. However, when everything is constant, labor share dynamics can only arise if the economy is outside of its balanced growth path, meaning that capital and output are not growing at the same rate. In this case, the positive correlation between the capital-output ratio and the labor share is the other side of a negative correlation between capital productivity and the labor share (Sala and Trivín, 2014). Under these conditions, an increase in the productivity of capital is accompanied by a situation in which the productivity of labor grows more (or fall less) than wages, thus decreasing the labor share according to the following relationship:

$$LS = \frac{wL}{Y} = \frac{\frac{W}{L}}{\frac{Y}{L}} = \frac{avg\ W}{Labor\ productivity} \tag{1}$$

As is well known, over the past four decades, aggregate labor productivity growth in most OECD countries has decoupled from real median compensation growth, implying that rising productivity is no longer enough to raise real wages for the average worker (Figure 3).

[13] In the CES framework, the elasticity of substitution is crucial for either long-run growth or short-run fluctuations. Ever since de La Grandville (1989) used a CES production function to demonstrate that a country with a higher elasticity of substitution could achieve a higher rate of economic growth and a higher value of income per capita in its steady state, there has been a considerable increase in the volume of research - both theoretical and empirical - on this theme. An elasticity of substitution above unity can be perceived as an engine of long-run growth (Palivos and Karagiannis, 2010). If capital and labor are gross substitutes and neither of them is essential for production, physical capital accumulation alone can drive an endless growth. See also Klump and De La Grandville, 2000; Karagiannis et al., 2005; Miyagiwa and Papageorgiou, 2007; Mallick, 2012).

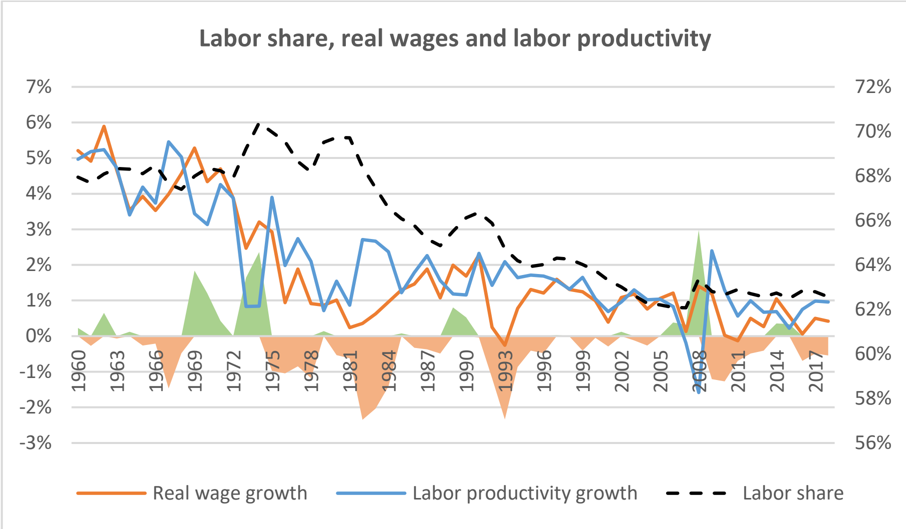


Figure 3 - Labor share, real wages and labor productivity (1960-2018).

Source: Author's calculation on AMECO data.

Among subsequent studies which have followed the lead of Bentolila and Saint-Paul on the role of capital intensity, it is worth mentioning the analysis by Piketty (2014) and Piketty and Zucman (2014) which suggest that the global decline in the labor share has been due to capital accumulation and an elasticity of substitution greater than one[14] and that of Karabarbounis and Neiman (2014) which focused more on the role of relative prices (i.e. the ratio between investment and consumption prices), estimating likewise an elasticity greater than one and hence attributing to it the worldwide deterioration in income distribution.[15] This is fully in line with the neoclassical view.[16] A fall in the relative price of investment goods, such as computer equipment, has induced firms to replace workers with machines. New capital goods have not only become cheaper, but they have been increasingly able to substitute workers' in their routine activities. Both these studies rely on the abovementioned relationship with the capital-output ratio. In response to a higher capital accumulation, and due to low diminishing returns, the return to capital has not adjusted sufficiently downwards and this has led to an increase in the capital share. Note that to make this explanation effective it is necessary that the aggregate elasticity of substitution between capital and labor is

[14] Piketty (2014) observed that historically the capital share was lower when the capital-output ratio was lower. This empirical evidence suggested to him that the elasticity of substitution must be above 1. Indeed, this is the only way to explain a simultaneously rising capital income ratio and profit share that he observes in his dataset.

[15] Note that since Bentolila and SaintPaul (2003) control for the capital-output ratio they implicitly also control investment and labor prices and hence the main findings of Karabarbounis and Neiman (2014) are hence enclosed.

[16] This hypothesis, which dates to Hicks (1932), highlights the role of capital-labor substitutability and capital deepening in the determination of income shares.

slightly above one, because otherwise, the mechanism proposed would work in the opposite direction and there would be no negative effect of capital augmenting technological change and capital intensity on the labor share.[17] Koh et al. (2016) demonstrate that capital-augmenting technical progress can be interpreted as a form of intellectual property products capital deepening and that this leads to a decline in the labor share - which is otherwise constant for traditional capital (i.e., buildings and equipment). However, there is also a consistent body of empirical literature that traditionally has estimated the elasticity to be slightly below one, thus implying a far greater degree of complementarity between capital and labor. In the context of the current debate, these economists convincingly argue that the secular decline in the labor share of income cannot be explained by the decrease in the relative price of investment, or by any other mechanism that increases the capital-output ratio.

In opposition to this first strand, another consistent part of the literature has stressed the role of labor and product market imperfections as potential explanatory variables for the global decline of the labor share. This latter is known as the *bargaining/market power hypothesis*. Indeed, even when the technology of production is assumed to behave as a standard Cobb-Douglas, movements in factor shares can be the result of changes in the bargaining power of workers induced by changes in government policy, labor market institutions, financialization and/or the monopoly power of firms. If it is not possible to establish an equality between workers' wages and the marginal productivity of labor, the extent to which emerging rents accrue to either capital or labor depends largely on the institutional framework and hence the bargaining power of workers. For instance, Blanchard and Giavazzi (2003) argue that weakening the employment protection legislation (EPL) has contributed to the decline of labor share in some OECD countries. From this perspective, the existing literature has emphasized particularly the role of product market competition (Azmat et al., 2012; Barkai, 2020; Autor et al., 2020) and labor market institutions (Bentolila and Saint-Paul, 2003; European Commission, 2007; Bental and Demougin, 2010; OECD, 2011). Azmat, Manning and Van Reenen (2012) have shown how softening product market competition and lowering employment protection policies has depressed the labor shares in European industries. Barkai (2020), focusing on the United States, found a negative industry-level relationship between changes in the labor share and changes in market concentration. Autor et al. (2020), using US firm level data, show that

[17] Only when capital and labor are, in the technological sense, substitutes enough, capital can be accumulated without decreasing too much its rate of return. Therefore, while capital-augmenting technology shocks can contribute to the decline of the labor share in some countries, they can, at the same time exert upward pressure on the labor share in others. The difference in the effects of capital-augmenting technology shocks on the labor share is due to the difference in the elasticity of substitution.

market concentration tends to rise as industries become increasingly dominated by superstar firms with high profits and a low share of labor in firm value-added and, consequently, the aggregate labor share tends to fall.

As extensively discussed, when we refer to marginal productivity theories a crucial role is played by the magnitude of the elasticity of substitution between labor and capital (σ). Macroeconomic models investigating the aggregate distribution of income have been found to deliver substantially different implications depending on specific values of this parameter. From an empirical point of view, the identification and estimation of the elasticity of substitution between labor and capital has challenged and intrigued many researchers. Identifying the true value of the elasticity of substitution is a notoriously difficult task. Arrow et al. (1961) over the period that runs from 1909 to 1949, as well as a voluminous academic literature exploiting time-series and cross-firm variation for more recent years (Antràs, 2004; Chirinko, 2008; Klump et al., 2007/2012; Young, 2013; Oberfield and Raval, 2014; Cantore et al., 2015) found that the elasticity of substitution is slightly below unity ($\sigma \approx 0.6 - 0.7$) in the US, documenting a gross complementarity between labor and capital. However, more recently, numerous studies exploiting cross-country variation in factor shares (Duffy and Papageorgiou, 2000; Karabarbounis and Neiman, 2014; Piketty and Zucman, 2014; Piketty, 2014) provided empirical evidence for a σ of about 1.25 ($\sigma \approx 1.2 - 1.3$) which tends to imply gross substitutability. This leaves some puzzle which seems to be unresolved and means that probably, σ is non-unitary and change over time (Pereira, 2003).

It is therefore highly questionable to believe that the elasticity of substitution is a technological constant, unchanged by relative factor accumulation and factor-augmenting technological change (Kaz and Papageorgiou, 2007). Probably the main weakness of existing models is that they have ignored factors which can potentially play an important role in explaining variations in the elasticity of substitution between capital and labor and hence the behavior of the relative factor shares. Intuitively speaking we can expect that as we move along a given isoquant, the elasticity of substitution increases (decreases) as the relevant input ratio goes from zero to infinity (and vice versa), since the magnitude of σ is an indication of the ease with which a certain level of output can be maintained by substituting capital for labor. In this regard a special reference should be made to the pioneering works of Lu and Fletcher (1968), Revankar (1971) and Sato and Hoffman (1968) who have developed a new class of production functions characterized the property of a

Variable Elasticity of Substitution (VES).[18] The general approach of these studies has been the assumption that the elasticity of substitution is a function of the ratio of two inputs and then to integrate the resulting differential equation to arrive at the implied production function. Nevertheless, to our knowledge, probably because of the complications that arise in such a framework, the consequences of an elasticity of substitution changing over time passed quite unnoticed to most of the economists and has not been adequately incorporated in their models - or at least not for the purpose of explaining changes in the relative factor shares. This is exactly the theoretical gap that this study wants to fill. The standard Solow growth model under the assumption of a CES production function cannot provide an adequate explanation for the dynamics of income distribution as it is unable to consider the endogeneity in the elasticity which remains static over time and input combinations. Therefore, we believe that there is a strong need to consider more flexible, alternative forms of production functions.

In this paper, despite we acknowledge the documented importance of globalization and financialization, we try to focus more on the structural/technological explanation and hence we follow the footsteps of the extensive mainstream literature that has investigated fluctuations and trends in labor share dating back to the first half of the 20th century. However, in the last part, we also detach from the assumption of perfect competition in the product market. Our aim is to extend this literature a step further by proposing a mechanism where the elasticity of substitution can vary over time. This is achieved by employing a specific VES in the form developed by Lu and Fletcher (1968). A VES is an appealing alternative to standard production functions considered by the literature, given that it is more general and nests several technological structures as special cases (such as the CES or the Cobb Douglas).[19] We believe that such a class of functions, even if presents difficult nonlinearities has the potential to yield further insights on income distribution with respect to existing studies. The basic assumption of the model is that the elasticity of substitution varies as a non-linear function of the capital-labor ratio which is consistent with our empirical study where the null hypothesis of the CES specification is robustly rejected. Depending on the value of certain parameters, the elasticity could depend positively or negatively on the ratio between capital and

[18] Obviously, we are not the first to move on this framework. There is a great number of theoretical papers, proposing various production functions with variable elasticity of substitution which were published in the late 1960s and early 1970s. Next, after a three decade-long break, the topic re-emerged around 2000, with a much more empirical focus, also fueled by the progress associated with production function normalization.

[19] Existing theoretical studies which rely on the VES, such as Karagiannis et al. (2005) consider Cobb-Douglas generalization. CES generalizations of the VES production function de exist (see, for instance, Kadiyala, 1972; Lu and Fletcher, 1968), although they have remained in the dark in both the theoretical and empirical spheres, probably due to their complicated nature.

labor. Analytically, the result is that σ takes different values at different points on the same isoquant. As we will see, this gives rise to a complex behavior of the relative factor shares which depend upon several different factors, such as the parameters of the production function, the rate of changes in the capital-labor ratio, the growth of wage rates, and the rate of technical change.

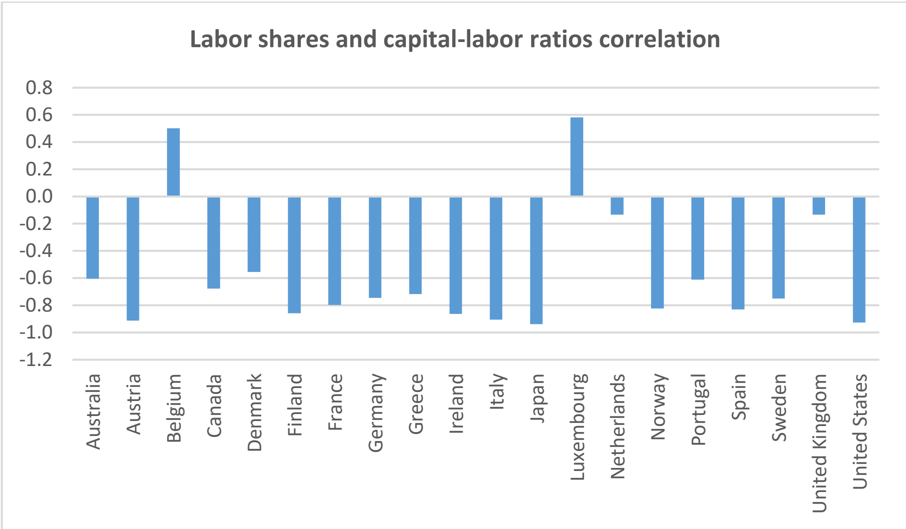


Figure 4 - Correlation coefficients between labor shares and capital-labor ratios (1960-2018).

Source: Author's calculation on AMECO data.

Our choice is motivated by the crucial stylized fact highlighted in Figure 4. Situations where the proportion of the capital stock to the number of hours worked is increasing in the economy, which seems to be the case worldwide in recent decades, are associated with situations in which the labor share suffers. This holds in almost all the economies investigated. Movements in the capital-labor ratio are closely tied to movements in labor productivity. An increase in capital per hour worked (or capital deepening) leads to an increase in labor productivity, but since these efficiency gains do not end up translated into higher wages, overall, the labor share decreases.

In this context, the objective of this paper is twofold. First, to provide new estimates of the elasticity of substitution between inputs at an aggregate level with an analysis which is free from the canonical restriction of perfect competition in the product market.[20] Second, to develop an alternative (and more comprehensive) explanation for the decline of the national labor share by

[20] Departures from perfect competition in the product market are explored, among others, in Bentolila and Saint-Paul (2003), Raurich, Sala, and Sorolla (2012) and Grenestam and Probst (2014), who also assess the dynamics of the labor income share when price markup is not constant.

reappraising the relationship between the labor share and the capital-labor ratio in a framework in which some crucial determinants are conditioned by each other. This latter is the most ambitious goal of the paper and requires unveiling the connection between the elasticity of substitution, capital deepening, technological progress and the trajectory of the labor share.

The rest of the paper is organized as follows. In the next section (Section 3) we lay the empirical foundation for a relationship between labor productivity, real wage and the capital-labor ratio. Then in Section 4 we introduce a specific VES production function and discusses its properties, with a focus on those relevant for the determination of the elasticity of substitution and eventually the relative factor shares. In view of the interesting features and empirical relevance of the VES production function, one of the aims of this paper is to explore its properties in greater depth. In Section 5 we discuss the data, the estimation techniques and finally estimate the key parameters of the VES for the 20 OECD countries analyzed. The value of these parameters is used to estimate the elasticity of substitution and finally this latter is compared with that obtained under a standard CES framework. In Section 6 we derive the behavior of the relative factor shares and use the estimated parameters to make predictions about its trend. In Section 7 we compute an aggregate price markup index, which we employ as a proxy of the degree of imperfect competition in product markets and re-estimate the elasticity of substitution under such product markets' imperfections. This allows us to revisit the dynamics of the relative factor shares when the canonical assumption of perfect competition does not hold. Finally, Section 8 concludes.

3. Empirical specification

To explain the behavior of relative factor shares within a neoclassical framework based on marginal productivity it is necessary to specify the form of the production function. There are many algebraic forms that can be used to represent aggregate production. Traditionally, income distribution theories have relied on the CES production function developed by Arrow et al. (1961). This latter is based on the good fit of a linear logarithmic function of the following type to observations on value added per hour worked and the wage rate:

$$\ln y = \beta_1 + \beta_2 \ln w + e \qquad (2)$$

Where:

- y is the productivity of labor;
- w is the real wage rate;
- β_1 is a constant;
- β_2 is a parameter;
- e is a random variable.

The CES is a generalization of the popular Cobb-Douglas and allows for any (non-negative) elasticity of substitution. However, despite their numerous insights, non-unitary elasticity of substitution production functions like the CES are also subject to the restriction (and hence the limitation) that the value of the elasticity of substitution is constant, although not necessarily unity. [21] In principle, however, the elasticity of substitution can be variable and take any value between 0 and ∞ and, eventually, change over time. If this is the case, the assumption of a constant σ may result in a specification bias. Kazi (1980) has shown that the CES production function overestimates the elasticity parameter and underestimates the efficiency parameter.[22] He argued that estimates of the elasticity of substitution from the CES production relationship give the gross elasticity, that is, it also includes part of variation connected with the capital-labor ratio in the average product. Indeed, as shown by Lu and Fletcher (1968), the crucial assumption that Arrow et al. made in deriving the CES is that the partial regression coefficient of $ln\, k$ is equal to zero. If this assumption does not hold, the regression coefficient of $ln\, w$ obtained by fitting equation (2) may not represent the true elasticity of substitution and the following model would be more appropriate:

$$\ln y = \beta_1 + \beta_2 \ln w + \beta_3 \ln k \ + e \qquad (3)$$

Where:

- k is the capital-labor ratio.

[21] The CES production function includes the Cobb-Douglas as a special case. As σ tends to unity (i.e. ρ tends to zero), the CES function becomes a standard Cobb-Douglas. In the case of the Cobb-Douglas, σ is equal to unity. In the case of a CES, σ is equal to a constant determined by the data.

[22] Using data on Indian manufacturing industries, Kazi (1980) demonstrated that the elasticity of factor substitution varies between industries, and that assuming a CES production function leads to an upward bias in the estimation of the latter, and hence concludes that the VES production function is the correct functional specification to account for these variations in factor substitutability.

A VES production function based on (3) explicitly permits the capital-labor ratio to be an explanatory variable of productivity. From an empirical point of view this link between labor productivity and the capital-labor ratio find its justification in the positive long-run relationship that seems to exist between the latter and productivity/TFP growth (as uncovered respectively in Figure 5 - panels a and b). In the first group of countries which includes all the biggest economies of continental Europe (Austria, Belgium, France, Germany, Greece, Italy, Netherlands, Spain) and Japan the relationship is quite noticeable and strong. In the second group of countries which includes the UK and the US is still positive, even though less strong. If we consider the TFP which is the increment of total output not attributable to the factors of production, and therefore should be cleaned up from any effect due to the variation in the capital-labor, we still find (albeit weaker) a positive correlation, suggesting that at least part of the change in TFP levels could be induced by a greater capital stock in the economy.

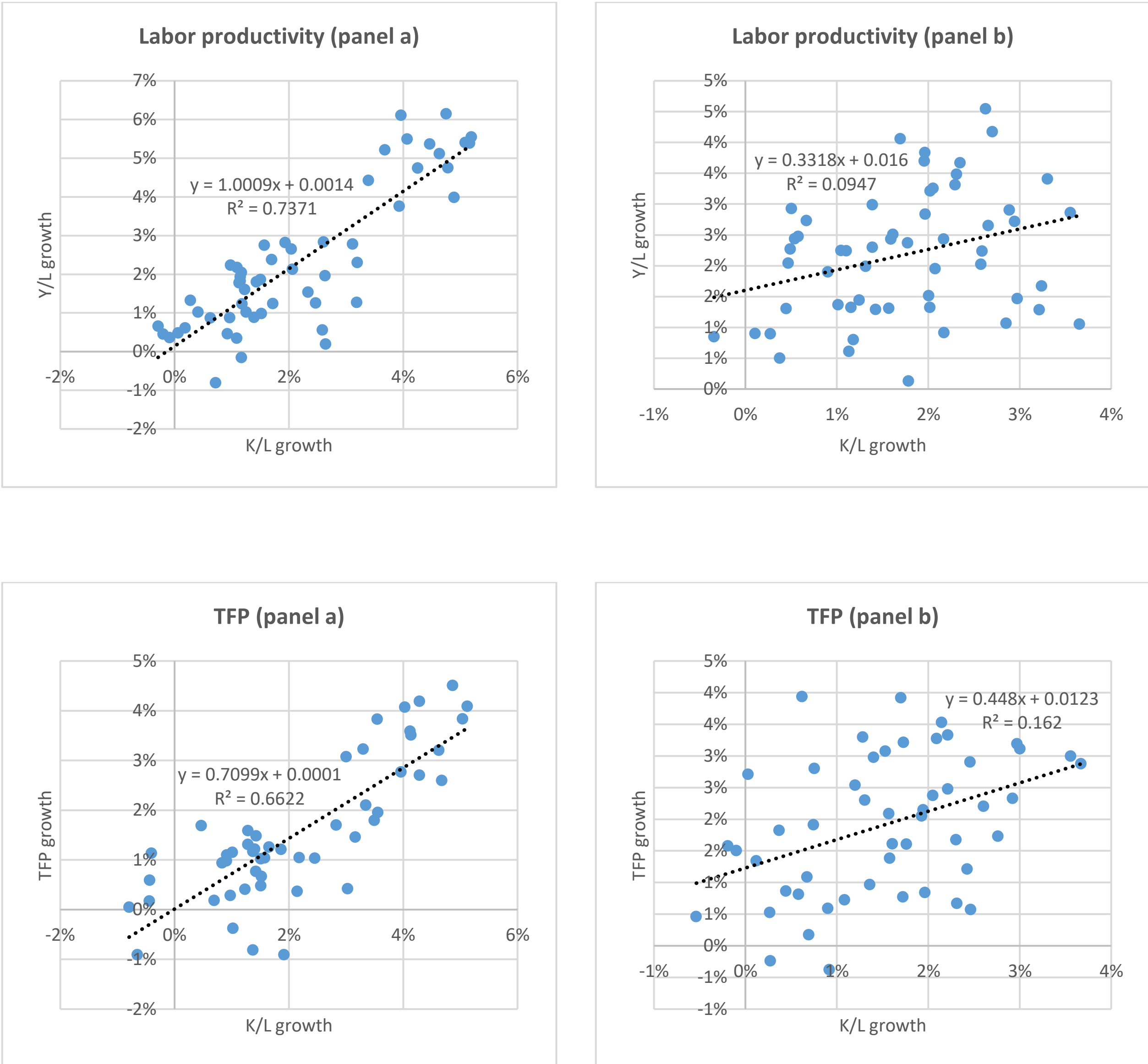


Figure 5 - Relationship between the capital-labor ratio and the labor productivity/TFP growth (1960-2018).[23]

Source: Author's own calculation on AMECO data.

[23] Panel A includes Austria, Belgium, France, Germany, Greece, Italy, Japan, Netherland, Norway and Spain. Panel B includes Australia, Canada, Denmark, Finland, Ireland, Luxembourg, Portugal, Sweden, the UK and the US.

This is also consistent with a long tradition of literature on endogenous growth which finds its most ancient roots in the intuitions of Schumpeter or even before in the Smithian and Ricardian models with technical change arising from profit-squeezes or, in the case of Smith, arising because of previous technical conditions.[24] Here, exactly like in the work of Nicholas Kaldor which posited the existence of a "technical progress" function we have a direct relationship between per capita investment (and hence the capital stock) and per capita output (see Kaldor 1957, 1961 and Kaldor and Mirrlees, 1962). In Kaldor, the direction of technical change is in part determined by the rate of capital deepening (Schlicht, 2016). The same result is at the core of other studies which attempt to relate labor productivity or technical progress to learning-by-doing in some specific production processes (see the review of the literature by Bairam, 1987). This part of the literature follows the footsteps of Arrow's (1962) seminar paper where for the first time the concept of learning-by-doing was incorporated into a macroeconomic model. In a growth model *a la* Arrow's, at least part of the technical change process does not depend on the passage of time as such but develops out of experience gained within the production process itself (Bairam, 1987). More exactly, the notion of learning-by-doing is embedded in the assumption that a labor efficiency index associated with workers of a particular vintage is a strictly increasing function of cumulative output or gross investment (i.e., capital accumulation). Such a relationship can be expressed as:

$$A_t = A_0 {L_t}^{\vartheta}$$

Where:

- A_t is the level of technology at time t;
- A_0 is the initial level of technology;
- L_t is the index of learning;
- $\vartheta > 0$ is the learning coefficient (i.e., the elasticity of A_t with respect to the index L_t).[25]

The more the capital-labor ratio increases, the more labor productivity increases, but even without any such capital deepening, labor productivity will increase somewhat, because, as Kaldor (1957) put it, “some increases in productivity would take place even if capital per man remained constant

[24] Kaldor’s technical progress function is a component of Kaldor’s growth theory. It has fallen into oblivion and is partly neglected in modern exhibitions. Leading modern textbooks such as Blanchard and Fischer (1989) or Romer (2012) do not mention it.

[25] Arrow (1962) chose cumulative gross investment as the index of experience ($L_t = \sum I_t$) while other studies favored cumulative output as an index ($L_t = \sum Q_t$). Arrow argued that the appearance of new machines provides more stimulation to innovation while cumulative output is less inspiring to innovation.

over time, since there are always some innovations (for instance improvements in factory layout and organization) which enable production to be increased without additional investment".[26] If, however, technical progress, is not assumed to be wholly the result of learning-by-doing, it is more appropriate to specify A_t as:

$$A_t = A_0 e^{\lambda t} {L_t}^{\theta}$$

Where λ is the Hicks-neutral rate of exogenous technical progress which is a function of time (see Sections 6 and 7 for more details).

Note that (2) and (3) are identical under the assumption that the partial regression coefficient of $\ln k$ is equal to zero.[27] Only in this case, the elasticity of substitution as estimated with a production function based on (2), like for instance a CES and the elasticity of substitution of a VES based on (3) would be identical. Whether or not the aggregate production technology is more a CES or a VES is ultimately an empirical matter. Therefore, to test the null hypothesis that $\beta_3 = 0$, we run a battery of regressions with AMECO data from 1960 to 2018 on our set of 20 advanced OECD economies, considering both the variables in levels and in first differences. We did the exercise for either the full sample and two subsamples of respectively 20 and 38 years, according to the breakpoint identified in Section 1. The following variables concerning gross domestic product, employment, and net fixed capital formation were used to fit the regression in eq. (3) for each of the 20 countries under investigation: [28]

- Gross domestic product at 2010 reference levels per person employed (y);
- Net capital stock at 2010 prices per person employed (k);
- Real compensation per employee, deflator GDP (w).

As a preliminary step, in order to avoid "spurious regression", we ran a number of unit-root tests (whose results are reported in Tables A4-11 in Appendix B, section unit-root tests): the classic ADF test; the Phillips-Perron (1988) test and the DF-GLS test by Elliott et al. (1996).[29] From the tests it is

[26] A model of economic growth, Kaldor (1957) - p. 596.

[27] Given the assumption of the VES production function, it follows that a test of the hypothesis that the production function has constant elasticity of substitution is obtained by a t-test on the least-squares estimator for the coefficient of the logarithm of the capital-labor ratio.

[28] All the variable included are referred to the aggregate economy. Following the nomenclature of AMECO, they are respectively: (i) Gross domestic product at constant market prices (OVGD); (ii) Net capital stock at constant prices per person employed (RKNDE); (iii) Real compensation per employee, deflator GDP (RWCDV).

[29] The number of lags for the ADF and PP tests was chosen using AIC and SC criterion, while for the DFGLS lag is chosen by looking jointly at the Schwarz criterion, the modified AIC method and the sequential-t method.

evident that the three variables are non-stationary on their levels and this result is justified by both including or not a trend terms. The Dickey-Fuller test based on the 10%, 5% and 1% critical values support the hypothesis that all series contain a unit root. Although, employing the Phillips-Perron test gives different results when an intercept and a trend are included, and lowers the level of significance, the main conclusion is qualitatively the same as reported by the Dickey-Fuller tests. Both tests are in favor of the unit root hypothesis in all the time series for most of the countries. The combined results of them suggest that the series appear to be $I(1)$ processes, hence integrated of order one. Since the data appears to be integrated of order one and stationary in first differences, from here on out we will employ these latter. It should be noted however that while it is safe to characterize the differences of y and w as stationary processes, the evidence before 1980 for k is more mixed. Under the assumption that the error term has a normal distribution, the null hypothesis that the coefficient of the regression of $dln\ k$ equals zero can be tested using the t-statistics. In the regressions of (3) before 1980, 12 out of 20 β_3 values are significantly different from zero. Further, 9 of them with a significance level of 1% and just in 3 cases they are significant at the 10% level. The results are even more clear when we regress the data after 1980, when 15 out of 20 β_3 values are significantly different from zero. 14 of them at the 1% level. If the full sample is taken into consideration, we have that for 19 times out of 20 the partial regression coefficient of β_3 is significant, 18 of them at 1%. These tests strongly suggest that the samples were probably not taken from a population in which the β_3 value is zero. Hence, the null hypothesis that $\beta_3 = 0$ is rejected, and we conclude that β_3 is not equal to zero.

Since the assumption at the basis of the CES does not hold, the regression coefficient of $dln\ w$ in equation (2) probably do not represent the real value of the elasticity of substitution and the value of the elasticity as estimated with a traditional CES is likely to suffer of an omitted variable bias. A good basis to derive a theoretical model is by relying upon the goodness of fit of an empirical one, such es the one highlighted by (3). Therefore, in this study we propose a theoretical, as well as empirical analysis taking as reference a specific functional form for the production function based on (3) and developed by Lu and Fletcher (1968). This choice is also strengthened by an increasing number of studies that found the elasticity of substitution between capital and labor to vary, usually inversely and often significantly, as capital deepening occurs (Lovell, 1973; Growiec and Muck, 2015).

4. The theoretical model

In this section we provide a detailed discussion of the properties of the production function based on the empirical relationship uncovered in Section 3. Then we move on to discuss the dynamics created by the VES for what concerns the determination of the elasticity of substitution and, eventually, the relative factor shares. We assume that overall, economies under investigation operate in a standard, competitive environment. Capital and labor are assumed to be homogeneous and producers are assumed to take the price of inputs as given. Similarly, the price of output is taken as given by the producers and all of them possess the same technology of production. Thus, we employ the standard notation to denote a general production technology as $Y = F(K, L)$, where Y, K, and L stand for output and the two inputs: capital and labor, respectively. The production function (see Appendix A - Section 1 for its derivation) has the following form:

$$Y_t = A[\delta K_t{}^{-v\rho} + (1-\delta)\eta L_t{}^{-v\rho} k_t{}^{-\frac{c(v+\rho)}{v}}]^{-\frac{v}{\rho}} \tag{4}$$

Where:

- Y_t is the aggregate production;
- K_t is the stock of capital;
- L_t is the total employment;
- v is the returns to scale parameter;
- $\rho = \frac{1}{b} - 1$ is the substitution parameter of the CES function; [30]
- $\eta = \frac{1-b}{1-b-c}$ is a composite parameter;
- A, δ, b, c are all parameters connected with technological change and whose role will be detailed hereunder.

We assume, without loss of generality, that $v = 1$, which is equal to say that (4) is homogeneous of degree one in its inputs (i.e., it displays Constant Returns to Scale - CRS).[31] Since any CRS production function F of two inputs, K and L, can be rewritten in its intensive form $y = f(k, 1)$, we can rewrite (4) in the following way:

[30] The parameter b of the VES determines the parameter ρ which in the standard CES determines the value of the (constant) elasticity of substitution and must lie in the range $1 < \rho < 0 \cup 0 < \rho < \infty$.

[31] For any $c \geq 0$, $F(cK, cL) = cF(K, L)$. For a formal demonstration that the production function has the property of first-degree homogeneity see Section 2 in Appendix A.

$$y_t = A[\delta k_t^{-\rho} + (1-\delta)\eta k_t^{-c(1+\rho)}]^{-\frac{1}{\rho}} \quad (5)$$

Where:

- $y = Y/L$
- $k = K/L$

Technical change, which is defined by Solow as shifts in the aggregate production function (i.e., it enables a firm to produce a given level of output with less inputs or to produce a greater level of output with a given set of inputs) can be seen as a variation of the parameters of the function itself. There are four parameters which can change in the VES production function (i.e., A, δ, b, c) and not all of them alter (if they do) the marginal rate of technical substitution of labor for capital in the same way. More specifically:

- $A > 0$ is an efficiency parameter which captures *Hicks-neutral* technological change[32] so that the larger the value of A the greater the level of output for a given K/L ratio.

On the other hand, for a given K/L ratio the $MRTS$ varies with changes in δ, b, c. Indeed, a change in the value of these parameters affects the MP_L and MP_K differently. They alter the shape (i.e., the slope) of isoquants at each input bundle, with b and c also changing the elasticity of substitution:

- $0 \leq \delta \leq 1$ capture *labor-saving* technical change. In the standard CES it is usually called distribution parameter or capital intensity factor as it is concerned with the relative factor shares in total output. In other words, it governs how much capital contributes to output relative to labor and hence determines the optimal distribution of inputs.

- b and/or c also captures *labor-saving* technical change if $ln\ k$ is greater than zero and, in the second case, if b is less than unity. If these condition hold, a higher value of b and c is always associated with a lower MP_L but a higher MP_K (see Section 3 on Technical change in Appendix A).[33]

[32] I.e. it augments output but does not alter the MRTS of labor for capital. In other words, a change in this parameter does not affect the shapes of isoquants, only their scale. It just shifts the production function up or down, causing the marginal products of the inputs at any input bundle to increase in proportion to one another. It is graphically represented by the movement of successive production functions toward the origin (Figure 6 - panel d).

[33] The reasoning behind this proposition is the following: an increase in the parameters b and c means a rise in the elasticity of substitution. As a consequence of this, it is easier to substitute K for L for a given K/L ratio. If the growth of capital is higher with respect to that of labor, capital will be substituted for labor at the margin, i.e. the innovation is labor-saving.

The effect of an increase in the value of the parameters A, b, c and δ on the $MRTS_{K,L}$ is shown in Figure 6.

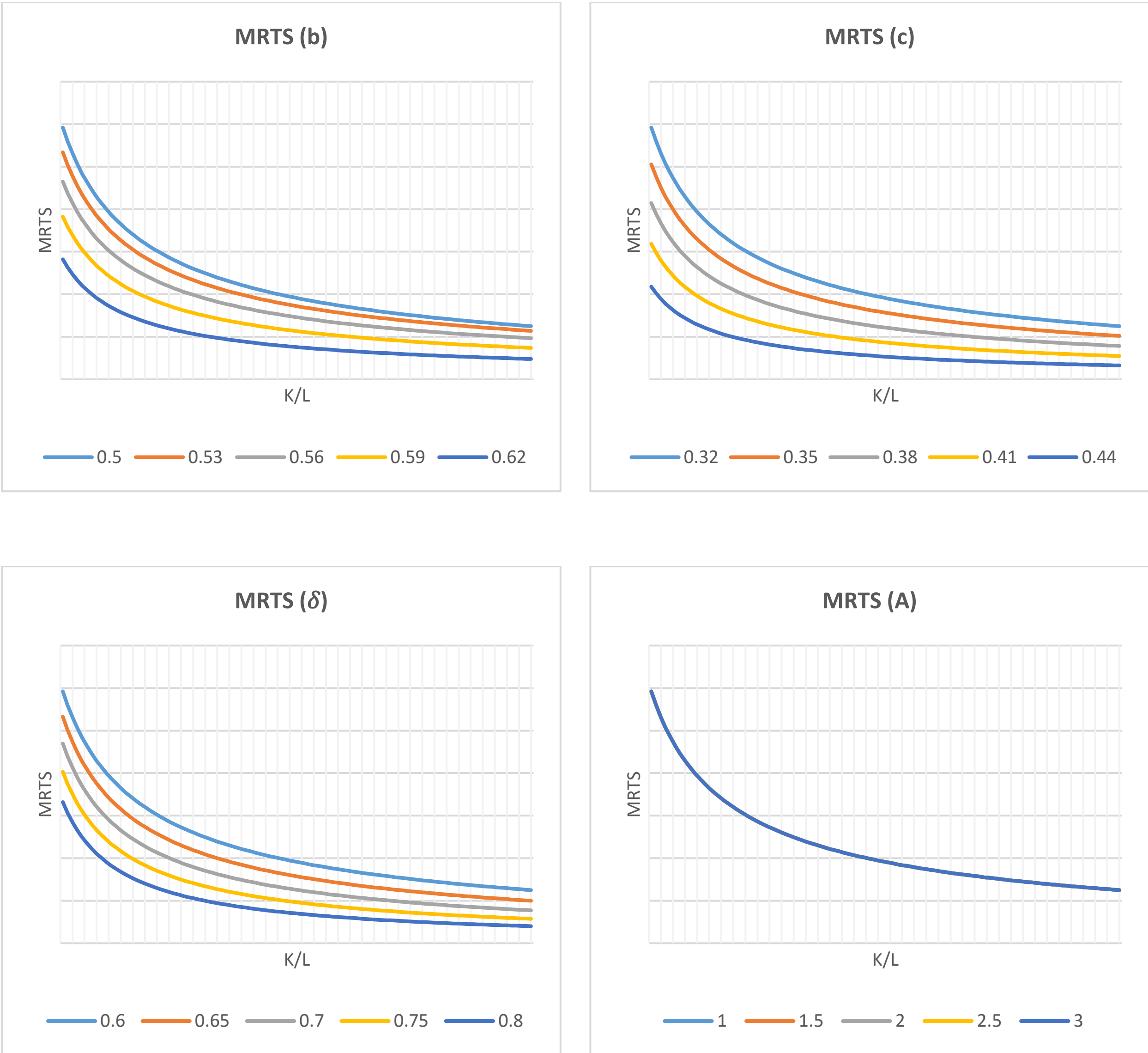


Figure 6 - Marginal Rate of Technical Substitution (MRTS) for different values of the parameters A, δ, b, c.

Source: Author's own elaboration.

A change in the parameters δ, b, c is a source of biased technical change. Specifically, a higher value of b and c causes the MP of capital to rise, while the MP of labor falls concurrently, and consequently the $MRTS_{K,L}$ shifts downward (respectively Figure 6 - panels a, b and c). On the other hand, a change in the parameter A does not affect the ratio between the marginal productivities of the two factors of production (Figure 6 - panel d). Given that these parameters are key determinants of several characteristics of the economy they are interpreted as important structural parameters. A higher value of b and c essentially represents a technology that enables greater factor substitution. But note that is just the value of c which determines, by being equal to 0 whether the production function behave like a standard CES or not. When we are in the VES world (i.e., when c is different from 0), a direct relationship between the capital-labor ratio and productivity arises. All together, these movements result in greater bias in production, which in turn influences the elasticity of factor substitution. This latter statement is crucial, since as we well see later, in the VES the effects of k on the elasticity of substitution run through the marginal rate of technical substitution. Here the $MRTS_{K,L}$ is a function of k, δ, b and c.

$$MRTS_{K,L} = -\frac{dK}{dL} = \frac{MP_L}{MP_K} = \frac{k}{\frac{\delta}{(1-\delta)}k^A - B} \tag{6}$$

Where:

- $A = \frac{b+c-1}{b}$
- $B = \frac{c}{b+c-1}$

Note that when $c = 0$, eq. (6) collapse to: [34]

$$MRTS_{K,L} = \frac{(1-\delta)}{\delta}k^{1+\rho} = \frac{(1-\delta)}{\delta}k^{\frac{1}{\sigma}} \tag{7}$$

[34] A two-factor production function is called "neoclassical" if satisfies the following properties (Hritonenko and Yatsenko, 1999): (i) F is homogeneous of degree 1. Formally, for any $c \geq 0$, $F(cK, cL) = cF(K, L)$. In other words, production exhibits constant returns to scale. (ii) Both factors are necessary, i.e., $F(0, L) = F(K, 0) = 0$, for any K, L. (iii) Positive marginal products (i.e. both factors contribute to output) - $\partial F(K, L)/\partial K > 0$ and $\partial F(K, L)/\partial L > 0$; (iv) downward sloping marginal product curves (i.e. the firm has decreasing returns in each product) - $\partial^2 F(K, L)/\partial K^2 < 0$ and $\partial^2 F(K, L)/\partial L^2 < 0$. Note however that as we will show later the "Inada conditions" does not hold as at least one of them is violated.

Which is the $MRTS_{K,L}$ of the CES production function.[35] Eq. (6) states that for a given K/L ratio, the marginal rate of technical substitution varies with δ, b and c . Therefore, non-neutral technological progress is associated with changes in the value of these variables. What determines if a change is neutral, capital or labor-saving is the partial derivative of $MRTS_{K,L}$ with respect to that variable. Indeed, it is the sign of this latter which, by being greater, equal to, or less than zero determines if the net effect of a specific change is such that the MRTS falls, remains constant, or rises, determining the nature of technological progress (see Appendix A - Section 3 for the relative cases). The production function in Eq. (4) is convenient for (at least) three reasons: (i) It satisfies all the requirements of a standard neoclassical production function; (ii) it includes the CES production functions and the Cobb-Douglas as special cases, (iii) it has the property of variable elasticity of substitution (VES). At this point, before taking any steps forward, it is worth analyzing more in detail each of these three statements.

- Note that $f(0) = 0$, $f'(k) > 0$ and $f''(k) < 0$ are the standard properties of the intensive form of a production function (Romer, 2012). Therefore, in order to verify the validity of (i) and hence to ensure that the VES works as a normal production function we evaluate the following first and second order partial derivatives:

$$f'(k) = -\frac{y^{\rho+1}}{\rho}\left[\frac{-\rho\delta k_t{}^{-\rho} - c(1+\rho)(1-\delta)\eta k_t{}^{-c(1+\rho)}}{k}\right] \tag{8}$$

$$f''(k) = -\frac{y^{\rho+1}}{\rho}\left\{\begin{matrix}\left(\frac{1}{\rho}+1\right)G^2 y^{\rho} \\ +(1+\rho)\left[\frac{\rho\delta k^{-\rho} + (c^2 + c^2\rho + c)(1-\delta)\eta k^{-c(1+\rho)}}{k}\right]\end{matrix}\right\} \tag{9}$$

Where:

- $G = \left[-\rho\delta k^{-\rho-1} - c(1+\rho)(1-\delta)\eta k^{-c(1+\rho)-1}\right]^2$

It is straightforward to show that $f'(k)$ is the MP of capital: since $F(K, AL) = ALf(K,/L)$, $\partial F(K/AL)/\partial K = ALf'(K/AL)(1/AL) = f'(k)$. From (8) and (9) above, we can see that the

[35] The Cobb-Douglas function has a linearly declining MRTS. The CES function, in turn, has an isoelastic MRTS. In both cases, MRTS unambiguously declines from 0 when $k = 0$ to $-\infty$ when $k \to \infty$.

standard properties of a production function are satisfied $\forall k > 0$ [36] if $0 < b < 1$, $0 \leq c < 1$ and $b + c < 1$. On the other hand, when $b + c > 1$ we have that $b > 1$ in order to have a positive first order derivative and a negative second order derivative. Therefore, $F(K, L)$ has continuous first- and second-order partial derivatives and the production function displays continuous substitution possibilities between K and L with the marginal productivities which are positive but diminishing in own factor. In other words, the graph of the intensive production function is increasing at a decreasing rate. By differentiating (8) with respect to L, we get the marginal product of labor (MP_L) which is:

$$MP_L = \frac{\partial Y}{\partial L} = (1 - \delta)A^{-\rho}\mathrm{k}^{-c(\rho+1)}\mathrm{y}^{\rho+1} \tag{10}$$

Note that when $c = 0$, eq (10) collapse to:

$$MP_L = (1 - \delta)\left(\frac{Y}{L}\right)^{1+\rho} \tag{11}$$

Which is the MP_L of the CES production function. From (10) we can also rewrite the marginal productivity of capital in terms of that of labor. As shown by Arrow (1961), when the production function is written in its intensive form, the marginal product of labor is equal to $MP_L = y - kf'(k)$, while that of capital is equal to $f'(k)$. Therefore, we can write MP_K in function of MP_L as:

$$MP_K = \frac{MP_L - y}{k}$$

Obtaining the following result:

$$MP_K = \frac{\partial Y}{\partial K} = \frac{\partial y}{\partial k} = \frac{1}{K}(Y - MP_L \cdot L) \tag{12}$$

Eq. (10) and (12) states that the value of b and c affects the marginal products of labor and capital differently. Indeed, an increase in their value is always associated with a lower marginal product of labor and a higher marginal product of capital. As we will see, much of the properties and dynamics associated with the VES production function are determined by the technology parameter that we

[36] The capital stock in any given period must be real and positive.

have labelled with the letter b. The value of this parameter has important implications for several key features of the economy such as capital intensity, the direction of technical change, and the relative share of labor in output. Through the technical change that it generates along with c, these parameters also relate the elasticity of substitution between labor and capital - with a nonlinear relationship - to the capital stock per worker.[37] Since MP_K is rising in b/c and MP_L is falling in b/c, a higher value of these parameters is associated with a steeper isoquant. From the intensive form of the VES production function given in equation (4) it is evident that output is increasing in the value of b/c. This implies that a higher value of b/c enables the firm to produce a particular level of output with less inputs, resulting in an inwards shift as these parameters rise. This movement of the isoquant resulting from a higher elasticity of substitution is a characteristic that the VES and the CES production functions share. Further, in a competitive market, the price of each factor will be equal to its marginal product. Thus, $MPL = w$ and $MPK = r$, where w and r are the wage and interest rates, respectively. Therefore, a higher elasticity of substitution, caused by a higher value of b/c means a lower reward for labor and a higher reward for capital. Nevertheless, just like a CES, the limiting properties of (5) are such that production function is not strictly neoclassical because the Inada conditions[38] are violated for some values of the parameters.[39] Indeed, when capital and labor are gross substitutes (i.e., $\rho < 0$, or in VES terms $b + c < 1$), the marginal product of capital never declines to zero, and the Inada condition in infinity does not hold. This means that at a low degree of substitution $\sigma < 1$, the graph of the production function has a horizontal asymptote (see the violet curve in Figure 7). However, here, in contrast with the VES of Karagiannis et al. (2005) where capital is the essential input of production (meaning that when $b > 0$ a positive level of output can be produced if a positive quantity of capital is employed in production) which also cause one Inada condition to be violated, both the inputs are essential. As established by Irmen and Maußner (2014) the fact that both inputs in the production function are essential is a necessary but not sufficient prerequisite.

---

[37] Thus, the elasticity of substitution is endogenous, since it is driven by the parameters b, c and the economy's capital-labor ratio. Differences in the value of this parameter may therefore provide a potential explanation for the empirically observed differences in the elasticity of factor substitution between countries and industries.

[38] The Inada conditions which have been introduced by Hirofumi Uzawa are assumptions about the shape of a production function that guarantee the stability of an economic growth path in a Neoclassical growth model. They imply that production increases quickly if the production inputs are low and, on the contrary, increases slowly if the production inputs are already high. (i.e. $\lim_{K\to 0} \partial F(K,L)/\partial K = \infty$, $\lim_{K\to\infty} \partial F(K,L)/\partial K = 0$, $\lim_{K\to 0} \partial F(K,L)/\partial L = \infty$, $\lim_{K\to\infty} \partial F(K,L)/\partial L = 0$).

[39] The definition of neoclassical production function that we have given is quite common in macroeconomic papers and convenient for its flexibility. There are textbooks on economic growth that define a neoclassical production function in a more restrictive way, including Inada conditions as a requirement to define the neoclassical production function. The general purpose of Inada's conditions is its strength and at the same time its weakness in excluding one of the most common production functions used, i.e. the CES production function.

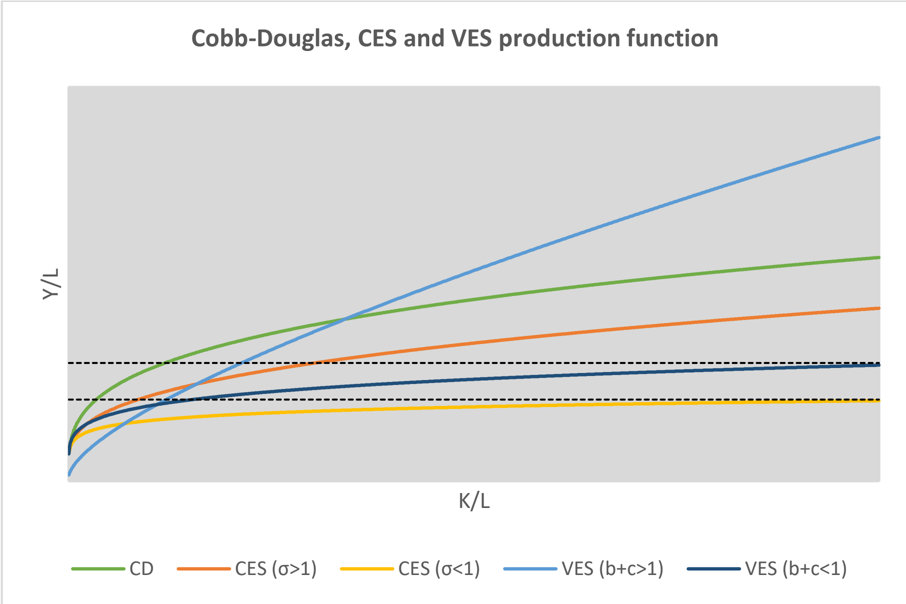


Figure 7 - The main types of production functions in per capita form: two-factor Cobb-Douglas (green curve), two-factor CES with $\sigma > 1$ (orange curve), two-factor CES with $\sigma < 1$ (yellow curve), two-factor VES with $b + c > 1$ (blue curve), two-factor VES with $b + c < 1$ (violet curve). *Source:* Author's own elaboration.

- From (ii) we have seen that when $c = 0$ the VES production function collapse into a CES. Since the CES production function includes three special cases (i.e., for $\rho \to 0$, σ approaches 1 and the CES turns to the Cobb-Douglas form; for very large ρ, σ approaches 0 and the CES turns to the Leontief production function; and for $\rho \to -1$, σ approaches infinity and the CES turns to a linear function under the CRS hypothesis), this means that also the VES include them. In particular, the Cobb Douglas case arise when b approaches 1, the Leontief behavior emerge when b approaches 0 and eventually, the linear function takes form when b approaches -1.[40]

- The implications of (iii) are explained in greater details in the next section.

[40] The fact that this particular form of the VES production function is a CES generalization adds to its analytical tractability and is one of its most appealing properties.

5. Estimation of the PF and the elasticity of substitution

The elasticity of substitution has been first introduced by Hicks (1932) as a tool for analyzing capital and labor income shares in a growing economy with a CRS technology and neutral technological change. Technically, it represents the curvature of an isoquant and thus, the substitutability between inputs, i.e., how easy it is to substitute one input with the other. The standard textbook definition of elasticity of substitution is the following:

$$\sigma = \frac{dln(k)}{dln\left(MRTS_{L,K}\right)} = \frac{dln(k)}{dln\left(\frac{MP_L}{MP_K}\right)} = \frac{d(k)}{k} / \frac{d\left(\frac{MP_L}{MP_K}\right)}{\frac{MP_L}{MP_K}} \tag{13}$$

Where:

- k is the capital-output ratio;
- MP_L and MP_K are the marginal products of inputs;
- $MRTS_{K,L}$ is the marginal rate of technical substitution.

This means that under perfect competitive markets, with the standard assumption of a firm which is cost minimizing facing constant factor prices for both labor and capital, the elasticity of substitution also governs how the relative expenditure on factor inputs adjusts to changes in factor prices. To see this, let denote with $S_{K,L}$ the expenditure on capital relative to that on labor.

$$S_{K,L} = \frac{r}{w} \cdot k \tag{14}$$

Where:

- r is the rental rate of capital;
- w is the wage rate.

Eq. (14) tell us that as the relative prices r and w changes, relative expenditure changes in the following way:

$$\frac{dS_{K,L}}{d\left(\frac{r}{w}\right)} = \frac{K}{L} + \frac{r}{w} \cdot \frac{d\left(\frac{K}{L}\right)}{d\left(\frac{r}{w}\right)} = \frac{K}{L}\left[1 + \frac{d\left(\frac{K}{L}\right)}{d\left(\frac{r}{w}\right)} \cdot \frac{\frac{r}{w}}{\frac{K}{L}}\right] = k(1-\sigma) \tag{15}$$

With a CES production function if an increase in the relative price of capital leads to an increase or a decrease in the relative expenditure on capital (for a given capital-output ratio) depends on whether the elasticity of substitution is less or greater than one. The direct effect of a rise in the relative price of capital is to increase expenditure on capital, since a given quantity of capital is costlier. On the other hand, a rise in the relative price of capital leads to a fall in relative demand for capital, so that the quantity of capital purchased falls, thus reducing the total expenditure on capital. Which of these effects dominates depends on the magnitude of the elasticity of substitution. When $\sigma < 1$, the first effect dominates: relative demand for capital falls, but by proportionally less than the rise in its relative price, so that relative expenditure rises. Under gross complements, accumulation of capital relative to labor increases the labor share of output. When $\sigma > 1$, the second effect dominates: the reduction in relative quantity exceeds the increase in relative price, so that relative expenditure on capital falls. Under gross substitutes, accumulation of capital relative to labor increases the capital share of output. When $\sigma = 1$ (as in the Cobb–Douglas case), expenditure on capital relative to Labor is independent of the relative prices. Most of the existing estimates of σ are obtained using a CES specification. In the case of a CES production function, obtaining the elasticity of substitution between labor and capital is straightforward. The latter is exactly equal to the partial regression coefficient β_2 implied by eq. (2). On the other hand, in the case of a VES things are more complicated. It has been shown by Allen (1938) that when the production function is linear and homogeneous, the elasticity of substitution σ can be rewritten in the following form:

$$\sigma = \frac{\frac{\partial Y}{\partial K}\frac{\partial Y}{\partial L}}{Y\frac{\partial^2 Y}{\partial K \partial L}} \tag{16}$$

Where the elasticity of substitution is inversely proportional to the cross second-order partial derivative of the (linear and homogeneous) production function. By using (16) we can derive the elasticity of substitution of the VES in eq. (4) with the following result:

$$\sigma = f(k) = \frac{b}{1 - c\left(1 + \frac{MRTS_{K,L}}{k}\right)} \tag{17}$$

Or

$$\sigma = \frac{b}{1 - c\left(1 + \frac{1}{\frac{\delta}{1-\delta}k^A - B}\right)} \tag{18}$$

From equation (6) we have that $\left(1/\frac{\delta}{1-\delta}k^A - B\right) > 0$, i.e., the marginal rate of technical substitution is positive for a given K/L ratio. Here we add that, in order to ensure that $\sigma \geq 0$, the condition $c < \left(1/1 + \frac{MRTS_{K,L}}{k}\right)$ must also be satisfied (given positive values for b and c). Note that since $MRTS_{K,L}$ is a function of K/L, moving along an isoquant, the elasticity of substitution varies non-linearly with the K/L ratio. Therefore, the elasticity of substitution is not a constant, but a function of the capital-labor ratio. Indeed, in the VES production function, the value of σ changes along a given isoquant. This feature contrasts with the CES production function in which σ remains constant at all points on an isoquant map. On the other hand, in the VES the capital-labor ratio is constant along a particular curve from the origin drawn through a map of isoquants (Revankar, 1971). As mentioned in the Introduction, in contrast to the CES literature, where the discussions are generally centered around the elasticity of substitution σ, in this study, we shift our attention to the parameters b and c. The limiting properties of (18) are such that:

- If $b + c > 1$, then $A = \frac{b+c-1}{b} > 0$, and consequently, k^A increases, with $k^A \to \infty$ as $k \to \infty$. This means that $\left(\frac{\delta}{1-\delta}k^A - B\right)^{-1}$ decreses to 0 and eventually, σ decreases to:

$$\lim_{k \to \infty} \frac{b}{1 - c\left[1 + \left(\frac{\delta}{1-\delta}k^A - B\right)^{-1}\right]} = \frac{b}{1 - c(1+0)} = \frac{b}{1-c}$$

- If $b + c < 1$, then $A = \frac{b+c-1}{b} < 0$, and consequently, k^A decreases, with $k^A \to 0$ as $k \to \infty$. Further, $\left(\frac{\delta}{1-\delta}k^A - B\right) = \left(\frac{\delta}{1-\delta}k^A + \frac{c}{1-b-c)}\right)$decreses to $\frac{c}{1-b-c}$ from where we can conclude that $\left(\frac{\delta}{1-\delta}k^A - B\right)^{-1}$ increases to $\frac{1-b-c}{c}$. Putting the information together, σ increases from the value:

$$\lim_{k \to 0^+} \sigma(k) = \lim_{k \to 0^+} \frac{b}{1 - c\left[1 + \left(\frac{\delta}{1-\delta} k^A - B\right)^{-1}\right]} = \frac{b}{1 - c(1 + 0)}$$
$$= \frac{b}{1 - c}$$

to

$$\lim_{k \to \infty} \sigma(k) = \lim_{k \to \infty} \frac{b}{1 - c\left[1 + \left(\frac{\delta}{1-\delta} k^A - B\right)^{-1}\right]}$$
$$= \frac{b}{1 - c(1 + \frac{1 - b - c}{c})} = 1$$

This means that the value of σ rises with the capital-to-labor ratio if $b + c < 1$ and falls if $b + c > 1$. In the first case, the value of σ declines with increased k and tends to $\frac{b}{1-c}$ which is greater than unity, as k increases to infinity. In the second case, the value of σ increases from $\frac{b}{1-c}$ which is less than unity, to unity as k increases from zero to infinity (Figure 8). However, given some values for the parameters, in any case the elasticity of substitution can cross the unity value. This strict monotonicity in the behavior of σ with respect to capital intensity is a shortcoming of the VES production function (Bairam, 1989).[41] It is clear from (17) that when $c = 0$ (i.e., the CES case), $\sigma = b$, which is equal to say:

$$\sigma = \frac{1}{1 + \rho} \tag{19}$$

And if $b = 1$ (i.e., the Cobb-Douglass case) we have that:

$$\sigma = 1 \tag{20}$$

[41] Contrary to the hypothesis formulated in the Introduction, capital and labor are either always gross substitutes or always gross complements here. Due to the strict monotonicity of the relative factor shares with respect to k, the elasticity of substitution $\sigma(k)$ cannot cross unity.

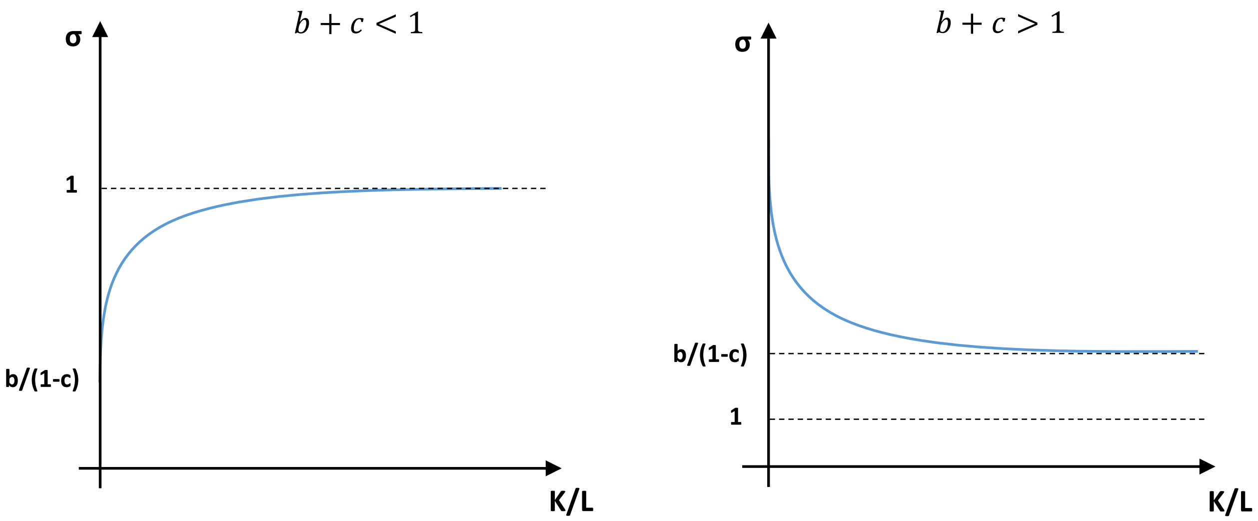


Figure 8 - Elasticity of substitution as a function of the K/L ratio.

Source: Author's own elaboration.

Many of the existent studies assume that the elasticity of substitution is an exogenous determinant of technical change in the economy (Mallick, 2012), and only a few of them, such as Miyagiwa and Papageorgiou (2007) and R.W. Jones (2008), have explored the issue of endogeneity in the elasticity of factor substitution. The VES production function connects with the latter view, as the elasticity of substitution is a result of directed technical change created by the value of the parameters b and c. Further to this point, it often contended that distinguishing between the impacts associated with the elasticity of substitution and those resulting from non-neutral technical change may be difficult, particularly when the elasticity of substitution is different from 1 (see León-Ledesma et al.,2010 and references therein). However, assuming that the economy is characterized by a VES production function removes part of this fuzziness by presenting a clear and direct cause and effect relationship between non-neutral/biased technical change and the elasticity of substitution, as the capital biased technical change originating from a higher value of b and c leads to a rise in the elasticity of substitution in this instance. The connection between capital deepening, the elasticity of substitution, and the share of labor created by the parameters b and c is of empirical relevance. For instance, several studies in the growth literature try to attribute capital deepening and a simultaneous rise of the share of capital over the decades of fast economic growth (and hence a decline in that of labor) to either the higher elasticity of substitution between labor and capital or labor-saving technical progress. However, such observations are typically made under the assumption that the underlying production function takes the CES form, which, as mentioned in the

Introduction, cannot capture the endogeneity and variability of the elasticity of substitution highlighted in many studies. If, according to authors like Kazi (1980) or Bairam (1989), the VES form is indeed the correct functional specification of the production function, the argument of the CES literature that capital deepening and a higher (lower) capital (labor) share are consequences of a higher elasticity of substitution may be spurious and therefore should be viewed with caution. The alternative interpretation provided by the VES production function is that capital deepening, a higher share of capital in output, as well as a higher value of the elasticity of substitution are all the results of a higher value of the parameters b and c. Having seen that b is an important technology parameter that determines the direction of technical change, the optimal capital-labor ratio and size of input shares, this discussion is still not complete without investigating what this parameter represent. Essentially, it can be considered an institutional parameter which incorporates several factors that might affect the direction of technical change in the economy.[42] In the case of the CES production function applied to an economy with more than one sector, the choice among various known production methods by reallocating factors both within and between sectors, as well as application of new production methods are influenced by technological progress, innovations, financial and other institutions, openness to trade or the degree of unionization (Klump and Preissler, 2000; Solow, 2005; La Grandville and Solow, 2009; Mallick, 2012). For what concerns this latter factor, if unions raise wages, the response of employers' in terms of substitution of capital for labor depends ultimately on the strength of labor unions (Maki and Meredith, 1987). In other words, a low value of σ is associated with the presence of a strong labor union. This is known as de La Grandville and Solow (2009) conjecture and states that a country that has strong customary and regulatory barriers to major changes in capital-labor ratios will have a lower σ than a country with fewer barriers or none. While the factors that that determine the value of σ in the CES production function are likely to be analogous to the characteristics the parameters b represents, the fact that this parameter affect factor shares, factor intensity, and the direction of technical change warrants some further discussion on this matter. For instance, C.I. Jones (2005) notes that a country can achieve a high elasticity of substitution only if it has access to the appropriate technology to support his choice. Hence, a higher value of b primarily captures a technology that enables greater

[42] When Hicks first introduced the concept of substitution elasticity in 1932, he was thinking at it as a pure technological parameter. Hicks pointed out the three possible ways in which substitution can take place: intra-sectoral substitution between known methods of production, inter-sectoral substitution of production, and substitution arising from new innovations. Capital can be more easily substituted for labor if demand shifts from labor-intensive to capital-intensive goods and services when there is a change in factor and commodity prices. This type of easiness in the substitution was seen also as a mechanism for fending off diminishing returns (Solow, 2005, p. 8). However, even if the σ is in principle a technological property of the production function, at an aggregate level it is can also be influenced by institutional settings.

substitution between capital and labor. However, as a higher value of this parameters leads to capital biased technical change, government policy relating to investment is likely to be also an important determinant of the value of b. Government policy could sometimes distort the direction of investment and create an artificial bias towards one factor.[43] Typically, the ideals of the ruling party may affect the value of b and thereby the direction of technical change in the economy. Usually, conservative political parties might encourage capital-biased technical change by encouraging investments that raise the relative price of capital, while more liberal political parties that favor equity are unlikely to advocate a decline in the labor share and would thereby discourage capital-biased technical change. Moreover, Macpherson (1990) shows that the size and density of trade unions is positively related to the share of labor. Powerful trade unions could exert pressure on governments and the private sector to maintain the share of labor in production at an artificially high level, preventing a decline in wages created by a falling share and marginal product of labor. In the context of the VES production function, this contributes goes through a reduction in the value of b. The elasticity of substitution at any point on an isoquant can be calculated using the formulas in eq. (17). Remember that the first-order condition for cost minimization under perfect competition implies that:

$$MRTS_{K,L} = \frac{MP_L}{MP_K} = \frac{w}{r} \tag{21}$$

Substituting the equilibrium value of $MRTS_{K,L}$ into (17) gives:

$$\sigma = \frac{b}{1 - c\left(1 + \frac{w}{r} \cdot \frac{L}{K}\right)} \tag{22}$$

In the case of a VES the empirical estimation of σ requires the estimation of the parameters and given the non-linearity of the function this is not an easy straightforward task. Indeed, the low popularity of the CES/VES functions in applied economics, is mostly related to the serious problems concerning their econometric estimation.[44] This is one of the biggest limitations of the analysis and the data. In the first place, we may note that the existing techniques for estimating elasticity of

[43] For instance, Yuhn (1991) points out that in the 1970s the South Korean government's fiscal policy led to massive capital investment, which in turn were reflected in an increase in capital per worker.

[44] This shortcoming has been filled only recently, when the CES function has gained importance also in econometric analysis, in particular in macroeconomics (e.g. Bentolila and Saint-Paul, 2003; Antràs, 2004) and growth theory (e.g. Caselli and Coleman, 2006; Klump and Papageorgiou, 2008), where it replaces the traditional Cobb-Douglas.

substitution suffer from several problems. Both the CES and VES production functions are non-linear, and as such cannot be estimated directly by linear regressions. Contrary to the CES, which are also nonlinear in parameters, as shown by Lu and Fletcher (1968) the VES function (because of the additional parameter c) cannot be linearized by logarithmic transformation or by using the Taylor-series approximation developed by Kmenta (1967).[45] Further, even in this eventuality, direct estimation after linearizing the function biases the estimates towards the value around which the function has been expanded. The only way to estimate all the parameters of the function without imposing additional restriction or condition on side relations[46] is by means of a non-linear least-squares regression. However, as is well known to the literature, the estimation of non-linear production function frequently performs poorly since the estimation techniques commonly employed to are essentially iterative, and very sensitive to the initial values of the parameters (Kemal, 1981). Nevertheless, in our case, at least some of the parameters can be retrieved from eq. (3) under the assumption of a neutral technical change which proceeds at a constant geometric rate (i.e., $A_t = A_0 e^{\lambda t}$).[47] In this case, eq. (3) can be rewritten in the following way:

$$ln\, y \;=\; \beta_0 + \beta_1 t + \beta_2\, ln\, w + \beta_3\, ln\, k + e \qquad (23)$$

Where:

$$\beta_2 = \hat{b}$$

$$\beta_3 = \hat{c}$$

$$\frac{\beta_1}{1-\beta_2} = \hat{\lambda}$$

Then, we can use the estimated value of the parameters b and the mean value of the observed $\left(\frac{w}{r}\cdot\frac{1}{k}\right)$ to compute the elasticity of substitution at any point on an isoquant for each country, as

---

[45] However, the applicability of the so-called Kmenta approximation is still limited, because it cannot be used to linearize CES functions with more than two inputs (Hoff, 2004). Further, it only returns reliable results if ρ is close to its point of approximation (i.e. zero). See Thursby and Lovell, 1978. In contrast, non-linear optimization algorithms very often face convergence problems or return varying, unreliable, or economically meaningless parameters' estimates (Henningsen et al., 2012).

[46] The weakness of this approach is that the specification of the side relations usually imposes additional assumptions.

[47] Another assumption under which the CES function can be estimated indirectly is that both product and factor markets are competitive. In our case, however, this would be an unrealistic assumption. The more the relative degree of imperfections in product and factor markets has changed over time, the higher is the bias in the estimates introduced by the indirect estimation. However, it is possible to reduce such a bias by postulating imperfect markets and then deriving an indirect estimation technique in which, in addition to wages, the relative degree of imperfections in product and factor markets is also an explanatory variable of labor productivity. This is exactly what we do in Section 7 where we estimate the VES production function under imperfect competition.

implied by eq. (22). In reviewing the previous estimates of eq. 2-3 and hence (23), two different and usually conflicting methods emerge, which, along with micro panels and nonlinear estimates have been widely employed by the literature. Studies based on cross-sectional data usually yield values for the elasticity of substitution which are overall not significantly different from unity, while time series studies, on average, give substantially lower estimates. Almost all these studies follow the original method of Arrow, Chenery, Minhas and Solow (ACMS), and hence estimates the elasticity of substitution from the regression of real wages on labor productivity or a related form. However, it is worth pointing out that the procedure rests on three questionable assumptions: (i) constant returns to scale; (ii) equality of the wage rate and the marginal product of labor; and (iii) exogeneity of the wage rate. The ready acceptance of the first two assumptions by ACMS and other scholars who have estimated CES production functions is rather surprising, for this reason in Section 7 we also detach from the condition of perfect competition. If there are IRS at the firm or industry level, the equality of the wage rate and the marginal product of labor is almost certainly invalid. Indeed, all factors cannot be paid the marginal product without over-exhausting the total value added. IRS are therefore compatible with a profit-maximization model only if there are imperfections in product or factor markets.

Alongside this problem, there is still the one raised by assumption (iii). Indeed, the regression of log (Y/L) on log W will be biased unless log Y/L and log W are totally uncorrelated, or $(\alpha = 1)$, or returns to scale are constant $(v = 1)$.[48] Thus, if the wage rate is not exogenous, the procedure yields a biased and inconsistent estimate of σ even if returns to scale are constant and the wage rate is equal to labor's marginal value product. Correct division of variables into exogenous and endogenous depends on the population from which the sample is extrapolated and the underlying model of market behavior. For instance, the exogeneity of W may be a more reasonable assumption for an international sample within an industry than for an aggregate time series within a single country. Moreover, without additional information, it is impossible to evaluate the bias and hence make an adequate allowance for the simultaneity problem which arise from the estimation of (23).

The usual solutions proposed by the literature to endogeneity is to rely on fixed effects models or instrumental variables. Unfortunately, in aggregative time series of this type, the available instrumental variables such as lagged labor are so highly correlated with the variable, they are replacing that there is almost no difference between the least squares and instrumental

[48] For instance, if the elasticity of substitution for the economy exceeds one, there are IRS, and wages are higher in the industries with larger value added, it is easy to assess that the estimated elasticity of substitution will be biased downward.

variables estimates of the major coefficients.[49] Lucas (1964) considered both the two sources of bias in the time series context - simultaneity and misspecification of the lag structure - and concluded that these latter do not bias the time series estimates, especially in some specific direction. The conclusion is supported by his findings that trying different lag schemes and a simultaneous equation model does not change his estimates by much. The idea is that in the absence of information, it is useful to obtain a variety of estimates based on different assumptions. If these are in close agreement with one another, an average value can be used in a policy context without severe discomfort. This way of proceeding is exactly what we will adopt in this paper.

The dataset is the same used in Section 3 and the results of the estimates for parameters b and c as well as the standard errors of the underlying regressions are shown in Table 2. The estimation problems discussed above are not limited just to our case. All the studies on production functions are confronted with similar problems. Nevertheless, even though we feel that the elasticity estimates are not going to be affected much by these assumptions, we should draw the policy implications by keeping these reservations in mind.

[49] Hildebrand and Liu (1965) and Griliches (1963) did the estimation using the same data and similar procedures. In none of the fifteen industries considered there is any significant difference between their least squares and two-stage least squares estimate of the production function coefficients.

	1960-1980			1980-2018			**1960-2018**		
	b	*c*	***b+c***	*b*	*c*	***b+c***	*b*	*c*	***b+c***
Australia	-0.1	-0.36	-0.46	0.65	-0.15	0.5	0.24	-0.16	0.09
	(0.1609)	(0.0149)**		(0.0027)***	(0.0739)*		(0.0214)**	(0.0901)*	
Austria	1.49	-0.43	1.06	-0.12	1.05	0.93	0.43	0.55	0.98
	(0.0017)***	(0.0112)**		(0.3463)	(0.0045)***		(0.0099)***	(0.0033)***	
Belgium	0.23	-0.92	-0.68	0.21	0.71	0.93	0.45	0.44	0.89
	(0.0458)**	(0.0269)**		(0.0062)***	(0.0005)***		(0.0255)**	(0.0015)***	
Canada	0.65	-1.01	-0.36	0.17	-0.34	-0.17	0.48	-0.12	0.36
	(0.0037)***	(0.0096)***		(0.1038)	(0.0954)*		(0.0031)***	(0.0881)*	
Denmark	0.78	0.39	1.17	1.2	-0.02	1.18	0.69	0.05	0.74
	(0.0099)***	(0.0354)**		(0.0048)***	(0.0152)**		(0.1006)	(0.0353)**	
Finland	-0.01	0.72	0.72	1.01	0	1.01	0.58	0.19	0.77
	(0.3325)	(0.0026)***		(0.0097)***	(0.0397)**		(0.0066)***	(0.0136)**	
France	0.95	0.32	1.28	-0.07	0.82	0.75	0.38	0.6	0.97
	(0.0042)***	(0.0397)**		(0.0124)**	(0.0054)***		(0.0017)***	(0.0056)***	
Germany	0.43	0.41	0.85	0.66	0.51	1.17	0.33	0.55	0.87
	(0.0062)***	(0.007)***		(0.0007)***	(0.0014)***		(0.0025)***	(0.0033)***	
Greece	0.59	1.14	1.73	0.46	-0.01	0.44	0.69	0.45	1.14
	(0.0012)***	(0.02)**		(0.0097)***	(0.035)**		(0.0393)**	(0.0006)***	
Ireland	0.17	0.7	0.87	-0.88	-0.16	-1.04	0.12	0.17	0.29
	(0.0687)*	(0.006)***		(0.0924)*	(0.0082)***		(0.0732)*	(0.0507)*	
Italy	0.29	0.83	1.13	-0.15	1.37	1.22	0.02	1.28	1.3
	(0.0263)**	(0.0266)**		(0.129)	(0.0071)***		(0.0087)***	(0.0015)***	
Japan	NA	NA	NA	0.97	0.02	0.99	0.97	0.02	0.99
	-	-		(0.0047)***	(0.0155)**		(0.0066)***	(0.0219)**	
Luxembourg	-0.68	0.11	-0.57	1.34	0.8	2.13	0.67	0.2	0.87
	(0.0098)***	(0.217)		(0.0016)***	(0.0068)***		(0.0051)***	(0.3167)	
Netherlands	0.49	0.59	1.08	-0.07	0.4	0.33	0.47	0.4	0.87
	(0.0024)***	(0.0092)***		(0.1618)	(0.0042)***		(0.0485)**	(0.0085)***	
Norway	0.05	1.05	1.1	0.74	-0.42	0.32	0.47	0.24	0.71
	(0.2739)	(0.0096)***		(0.0061)***	(0.054)*		(0.0002)***	(0.0908)*	
Portugal	0.26	-0.6	-0.34	0.52	0.07	0.59	0.65	0.16	0.82
	(0.0619)*	(0.0444)**		(0.0097)***	(0.0151)**		(0.0425)**	(0.0642)*	
Spain	0.71	-0.29	0.43	0.9	0.11	1	0.74	0.24	0.98
	(0.0059)***	(0.0219)**		(0.0013)***	(0.0521)*		(0.006)***	(0.0036)***	
Sweden	0.33	1.19	1.52	0.72	0.51	1.23	0.5	0.26	0.76
	(0.052)*	(0.0001)***		(0.0015)***	(0.0054)***		(0.0113)**	(0.0082)***	
United Kingdom	0.01	0.86	0.87	0.54	0.67	1.21	0.36	0.66	1.02
	(0.0178)**	(0.0023)***		(0.0034)***	(0.0027)***		(0.007)***	(0.0037)***	
United States	1.1	-0.05	1.05	0.61	0.2	0.81	0.76	0.29	1.05
	(0.0047)***	(0.0193)**		(0.0046)***	(0.0091)***		(0.0053)***	(0.0034)***	
Mean	0.41	0.25	0.65	0.47	0.31	0.78	0.5	0.32	0.82
Standard Deviation	0.489	0.688	0.753	0.540	0.483	0.639	0.228	0.320	0.289

P-values in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table 2 - Estimates of the parameters b and c of the VES production function under perfect competition.

b+c	1960-1980	1980-2018	**1960-2018**
>1	**9**	**8**	**4**
	Austria	Denmark	Greece
	Denmark	Finland	Italy
	France	Germany	United Kingdom
	Greece	Italy	United States
	Italy	Luxembourg	
	Netherlands	Spain	
	Norway	Sweden	
	Sweden	United Kingdom	
	United States		
<1	**10**	**12**	**16**
	Australia	Australia	Australia
	Belgium	Austria	Austria
	Canada	Belgium	Belgium
	Finland	Canada	Canada
	Germany	France	Denmark
	Ireland	Greece	Finland
	Luxembourg	Ireland	France
	Portugal	Japan	Germany
	Spain	Netherlands	Ireland
	United Kingdom	Norway	Japan
		Portugal	Luxembourg
		United States	Netherlands
			Norway
			Portugal
			Spain
			Sweden

Table 3 - Elasticity of substitution regimes.

Source: Author's own estimation.

What emerges from Tables 2 and 3 is that while in some countries the sum of the value of the parameters b and c is estimated to be greater than unity (9/19 before 1980, 8/20 after 1980 and 4 considering the full sample), meaning that an increase in the capital-labor ratios has a positive impact on the elasticity of substitution, in others the value of the same sum turns out to be lower than one, meaning that an increase in the capital-labor ratio has a negative impact on the elasticity of substitutions. Further, it is worth noting from Table 2 that while the average value of b was 0.41 and that of c 0.25 before 1980, then the latter have increased respectively to 0.47 and 0.31 after 1980 with a reduction of the standard deviation. On average, for the full sample we have estimated a value of b as high as 0.50 and a value of c as high as 0.32. The value of b has increased in half of the countries (i.e., Australia, Denmark, Finland, Germany, Luxembourg, Norway, Portugal, Spain, Sweden, UK) while that of c has increased in 11 countries (i.e., Australia, Austria, Belgium, Canada, France, Germany, Italy, Luxembourg, Portugal, Spain, USA) and decreased in 9. As a result of these movements, 11 countries have changed their regime (Table 3). 5 of them (UK, Germany, Finland, Spain and Luxembourg) have shift upwards, while 6 of them have shift downward (Greece, France, Norway, Netherlands, Austria, USA). The remaining 8 (excluding Japan for which we do not have consistent estimates for the period before 1980) have not changed their relative position with respect to unity. Sweden, Denmark and Italy have remained above one and Ireland, Portugal, Canada, Australia and Belgium below. However, for what concerns Italy, we should note a low significance in the value of the estimates with the p-value of the underlying regression always above 10%. The value of b which has important implications for the direction of technical change and the determination of the relative factor shares (as we will see in greater detail in Section 6) is currently above one in just three countries (Denmark, Finland and Luxembourg) and in none if we consider the full sample. Remember from the past section that while when $b + c < 1$ we have a convergence of the elasticity of substitution towards unity as k increase (with the starting value of σ determined by b and c), on the other hand, when the latter turns out to be greater than 1, the limit of σ for $k \rightarrow \infty$ is $\frac{b}{1-c}$, which is still greater than one. Starting and convergence values of σ are reported in Table 4, while an estimate of the elasticity of substitution, as well as a comparison of the latter and the one estimated with a standard CES is reported in Table 5 and shown in Figure 9. Estimates of the elasticity have also been obtained by fitting the CES production function even though our major emphasis is on the VES production function. CES estimates are useful in the present study for at least two reasons: (i) to understand the extent of bias in the elasticities of substitution across different industries due to CES production functions, and (ii) to compare our results with those of previous studies.

Country	1960-1980		1980-2018		**1960-2018**	
	b+c	b/(1-c)	b+c	b/(1-c)	b+c	b/(1-c)
Australia	-0.46	0.08	0.50	0.56	0.09	0.21
Austria	1.06	1.04	0.93	2.32	0.98	0.94
Belgium	-0.68	0.12	0.93	0.75	0.89	0.80
Canada	-0.36	0.32	-0.17	0.13	0.36	0.43
Denmark	1.17	1.28	1.18	1.18	0.74	0.73
Finland	0.72	0.02	1.01	1.00	0.77	0.71
France	1.28	1.41	0.75	0.35	0.97	0.94
Germany	0.85	0.74	1.17	1.34	0.87	0.72
Greece	1.73	4.20	0.44	0.45	1.14	1.25
Ireland	0.87	0.58	-1.04	0.75	0.29	0.14
Italy	1.13	1.76	1.22	0.40	1.30	0.05
Japan	NA	NA	0.99	0.99	0.99	0.99
Luxembourg	-0.57	0.76	2.13	6.61	0.87	0.84
Netherlands	1.08	1.19	0.33	0.12	0.87	0.78
Norway	1.10	0.98	0.32	0.52	0.71	0.62
Portugal	-0.34	0.16	0.59	0.56	0.82	0.78
Spain	0.43	0.56	1.00	1.00	0.98	0.97
Sweden	1.52	1.72	1.23	1.48	0.76	0.67
United Kingdom	0.87	0.06	1.21	1.64	1.02	1.04
United States	1.05	1.04	0.81	0.76	1.05	1.07
Mean	0.65	0.95	0.78	1.15	0.82	0.73
Standard Deviation	0.75	0.96	0.64	1.40	0.29	0.32

Table 4 - Starting/convergence values of the elasticity of substitution with the VES.

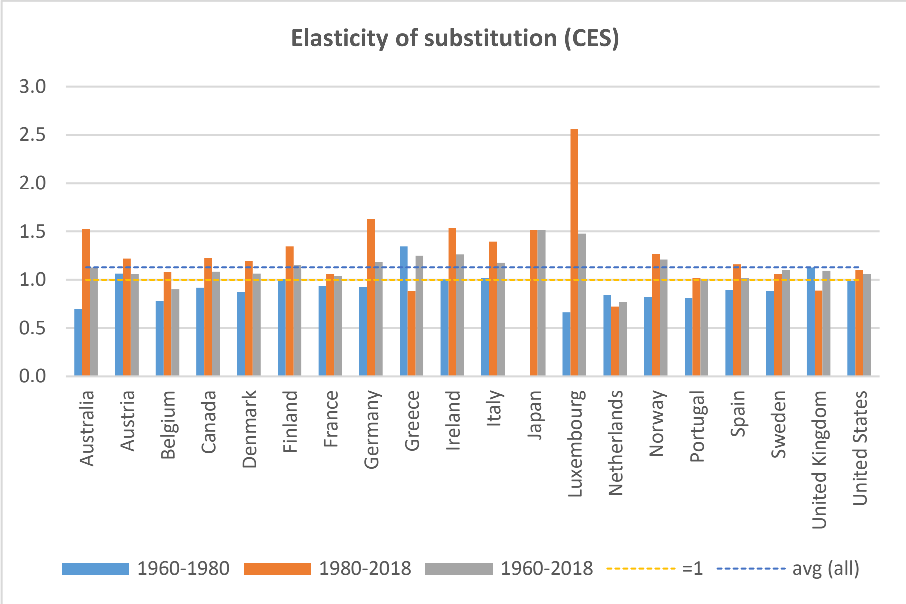
Source: Author's own estimation.

Country	1960-1980	CES 1980-2018	**1960-2018**	VES **1960-2018**
Australia	0.70	1.53	1.13	NA
Austria	1.07	1.22	1.06	1.00
Belgium	0.78	1.08	0.90	0.77
Canada	0.92	1.23	1.08	0.48
Denmark	0.88	1.20	1.07	0.71
Finland	1.01	1.35	1.15	0.97
France	0.94	1.06	1.04	1.34
Germany	0.92	1.63	1.19	0.95
Greece	1.35	0.88	1.25	1.47
Ireland	1.00	1.54	1.26	0.28
Italy	1.02	1.40	1.18	1.54
Japan	NA	1.52	1.52	1.14
Luxembourg	0.66	2.56	1.48	0.73
Netherlands	0.84	0.72	0.77	0.68
Norway	0.82	1.27	1.21	0.75
Portugal	0.81	1.02	1.01	0.75
Spain	0.89	1.16	1.02	0.94
Sweden	0.88	1.06	1.10	0.61
United Kingdom	1.13	0.89	1.10	1.13
United States	0.99	1.11	1.06	0.94
Mean	0.93	1.27	1.13	0.90
Standard Deviation	0.164	0.395	0.178	0.322

Table 5 - Estimates of the elasticity of substitution as implied by the CES and VES under perfect competition.[50]

Source: Author's own estimation.

[50] We estimated the elasticity of substitution also for the two subperiods. However, given the limited number of observations and the distortions due to the lack of data on the average return on capital and labor, in the case of the VES we decided to report only the estimates for the entire sample, leaving the others available in Appendix B.



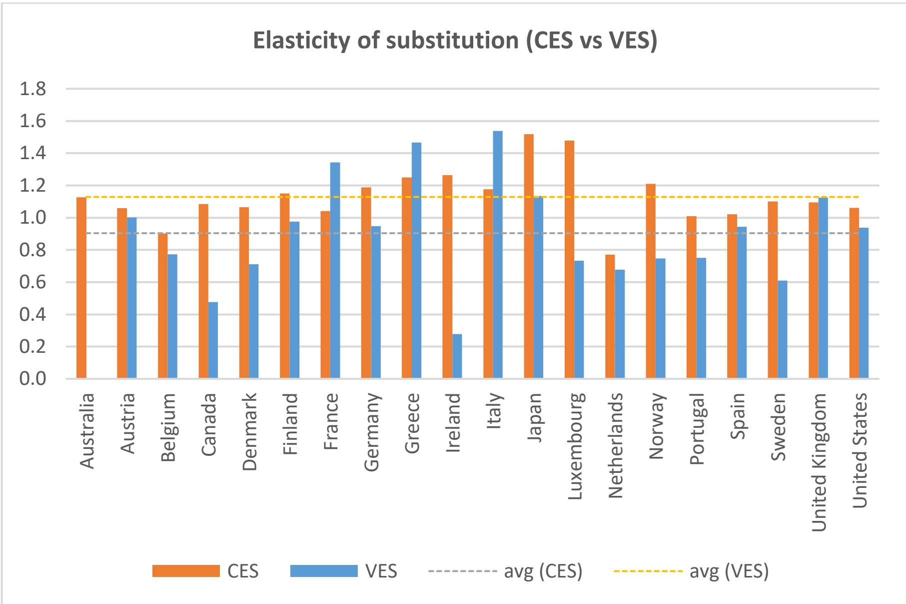


Figure 9 - Estimates of the elasticity of substitution as implied by the CES and VES under perfect competition.

Note: CES (panel a) is estimated from 1960 to 2018 and in the two relevant sub-periods with a break in 1980; While the VES (panel b) is estimated only over the full time period. *Source:* Author's own elaboration.

The estimates of σ obtained with the CES specification range from 0.66 in Luxembourg to 1.35 in Greece for the period before 1980 and from 0.72 in the Netherlands to 2.56 in Luxembourg after 1980. For the full sample, the lowest value is the 0.77 of Netherlands and the highest the 1.52 of Japan. From before to after 1980, the standard deviation has increased. In contrast, when a VES framework is applied and hence the specification allows σ to vary with the capital to labor ratio we have much more variation between the behavior of elasticity in single countries. Even if, due to the lack of data on the average return on capital we cannot obtain reliable estimations for the two subsamples (which are in any case reported for completeness in the Appendix B), we have that in the full sample our estimates of the elasticity now range from 0.28 in Ireland to 1.54 in Italy. The results clearly show that the elasticities of substitution estimated by the VES function are no longer confined to the neighborhood of unity as is true with the estimates obtained by means of the CES function. As it is possible to see from the increase in the standard deviation they vary over a wider range (0.32 against 0.17). It is also interesting to note that in 5 cases (Austria, France, Greece, Italy, Japan and the UK) we can confirm the results obtained with the CES of a substitution elasticity greater than unity and in 2 cases (Belgium and the Netherlands) those of an elasticity of substitution lower than unity. However, for the other 12 cases evidence is mixed. Further, the elasticities as estimated with the CES are usually overestimated. The values obtained with the latter specification are higher in 15 cases out of 19. With the VES we found a far lower degree of complementarity between capital and labor, which on average is equal to 0.90 against the CES estimates that revolve around a greater mean value of 1.13. As pointed out in the introduction, substitution elasticities are not generally invariant with respect to changes in the capital-labor ratios. We shall focus on the estimates obtained through the VES production function which allows for changes in the elasticities with respect to changes in the capital-labor ratios. Remember that to the extent the elasticities are affected by changes in capital intensity, estimates obtained through CES will be biased upwards and downwards. In this sense, results provide compelling evidence that, at least for some countries, σ is lower than reported in most recent studies and may be probably less than one, implying anyway a sharp rejection of the Cobb-Douglas specification. The substitution elasticities remain generally low. Furthermore, if we take a measure of how much on average the calculated values deviate from 1 (let say the Average Square Difference) we have an increase in its value, from 0.04 to 0.11. These findings are consistent with the hypothesis that ACMS production function overestimates the elasticity of substitution (Kazi, 1980)[51] since the value obtained also includes part of variation due

[51] Kazi (1980). "The Variable Elasticity of Substitution Production Function: A Case Study for Indian Manufacturing Industries", p. 235.

to K/L in the average product. Therefore, the elasticity of substitution as estimated with a CES production relationship should be regarded as a "gross elasticity". In addition, this result indicates that the value of σ does vary with the capital-labor ratio and that a specification which explicitly permits the capital-labor ratio to be an explanatory variable of productivity is more correct. Moreover, not only the magnitude, but also the significance of elasticity is affected. In this sense, the CES production function leads to a misspecification of the production function to the extent that the estimates are not only lower but also insignificant in the CES specification. These results show that if the CES production function is specified we shall erroneously conclude that in a number of countries, changes in relative prices of the factors are not going to influence the production techniques.

6. Relative factor shares in the VES framework

Under the standard assumption of perfect competition in the product market, the representative firm face the following long run profit maximization problem:

$$max_{\{L,K\}}\, pf(L,K) = PY - wL - rK$$

$$s.t. \qquad Y_t = \gamma[\delta K_t{}^{-\rho} + (1-\delta)\eta\left(\frac{K}{L}\right)_t^{-c(1+\rho)} L_t{}^{-\rho}]^{-\frac{1}{\rho}}$$

By assuming that the output price is equal to one we have the following system of partial derivatives which determines the equilibrium:

$$\begin{cases} MP_L(K_t, L_t) = w_t \\ MP_K(K_t, L_t) = r_t \end{cases} \qquad (24)$$

Where:

- w_t is the real wage per unit of labor;
- r_t is the cost of capital;
- MP_L is the marginal product of labor;
- MP_K is the marginal product of capital.

Combining equations (4) and (24), we obtain the following expression for the relative labor share of income:

$$RLS_{L.K} = \frac{MP_L}{MP_K}\frac{L}{K} = \frac{w}{r}\frac{L}{K} = \frac{MRTS_{K,L}}{\left(\frac{K}{L}\right)} = \frac{MRTS_{K,L}}{k} = \frac{1}{\left(\frac{\delta}{1-\delta}k^A - B\right)} \tag{25}$$

Eq. (25) give rise to 3 different cases:

- If $A > 0$ (i.e., $b > 0$ and $b + c > 1$):

$$\lim_{k\to\infty} RLS = \frac{1}{\infty} = 0^+$$

- If $A < 0$ (i.e., $b > 0$ and $b + c < 1$; this imply that also $B < 0$ under the condition that c is positive):

$$\lim_{k\to\infty} RLS = \frac{1}{0 - B} = -\frac{1}{B} = \left|\frac{1}{B}\right|$$

- If $A = 0$ (i.e., if $b + c = 1$):

$$\lim_{k\to\infty} RLS = \frac{1}{\left(\frac{\delta}{1-\delta} - B\right)}$$

When $c = 0$, eq. (25) collapse to:

$$RLS_{L.K} = \frac{1-\delta}{\delta}k^{\rho} = \frac{1-\delta}{\delta}k^{\frac{1-\sigma}{\sigma}} \tag{26}$$

Which states that with a CES production function the labor (capital) share is a decreasing (increasing) function of K/Y if and only if the elasticity of substitution is higher than one. On the other hand, when the elasticity is less than one, an increase in the capital stock relative to the output will result in an increase in the labor share relative to that of capital.[52] In contrast, as stands out from eq. (25), many factors affect changes in relative factor shares in a VES model. In fact, these depend on the value of the parameters of the production function, the relative supply of capital and workforce, the growth of real wages and technological progress. Eq. (25) states that given the technological

[52] For the CES production function, the ratio of factor shares increases with k, from 0 (when $k = 0$) to $+\infty$ as $k \to \infty$, if $\sigma > 1$. Conversely, if $\sigma < 1$ then the ratio gradually declines, from $+\infty$ to 0.

progress, an increase in the k ratio will raise the relative labor share in total output if $A < 0$. On the other hand, if $A > 0$, an increased k ratio will result in a declining labor share relative to that of capital. Only when $A = 0$ the relative labor share will hold constant following an increase in the k ratio. We know that an increase in k (the K/L ratio) will increase, hold constant, or decrease the elasticity of substitution, depending upon the parameters b and c (and more exactly from their sum). We can see the effect on the relative factor shares of changes in σ due to changes in k for given values of b and c by rewriting (22) in the following way:

$$\frac{wL}{rK} = \frac{MRTS_{K,L}}{k} = \left(\frac{1}{c} - 1\right) - \frac{b}{\sigma c} \tag{27}$$

The partial derivative of $\frac{MRTS_{K,L}}{k}$ with respect to σ gives:

$$\frac{\partial\left(\frac{MRTS_{K,L}}{k}\right)}{\partial\sigma} = \frac{b}{c}\sigma^2 \tag{28}$$

Which is positive under the condition that $b \cdot c$ is positive (i.e., b and c have the same sign). If this is true, an increase in the value of the elasticity of substitution will always raise the share of labor in national income. To sum up if $b + c$ is greater than one, σ also is greater than one and an increase in k will decrease the value of σ as well as the relative labor share of income. On the contrary, if $b + c$ is less than one, so is σ and an increase in k will increase the value of σ as well as the relative share of labor.

However, it is well known that the determination of factor shares is closely related to technical progress. Indeed, when technical progress take place, both the marginal products of labor and capital increase. Further, if the latter is biased (i.e., non-neutral) toward one factor such an increase does not affect both the marginal productivities in the same way. Therefore, technical progress may change the relative marginal products of factor inputs and consequently impact on the relative factor shares. The effects on factor shares of the relative supply of capital and labor, changes in the elasticity of substitution, and growth of the real wage rate can be seen starting from the equilibrium condition $MPL = W$,[53] which, under the usual assumption that technical change is neutral and proceeds at a constant geometric rate becomes:

$$ln\frac{wL}{Y} = [b\ln(1-\delta) + (b-1)\ln A_0] \\ +(1-b)\ln w + \lambda(b-1)t - c\ ln\ k \quad (29)$$

Or, by totally differentiating with respect to time:

$$\dot{LS} = (1-b)\dot{w} - c\dot{k} + \lambda(b-1) \quad (30)$$

Where LS refers to the labor share and a point on the variable indicates the derivative of such variable with respect to time. Eq. (30) states that the direction and rate of change of the labor share depend on the parameters of the production function b and c, the growth rate of real wages, the growth rate of k and the rate of technical progress. This latter can be obtained by taking the derivative of log A with respect to time ($i.e.\lambda$), and is shown in Table 6.[54] More specifically:

- If $b < 1$, $c > 0$ and $\lambda > 0$ (on average we have $b = 0.50$, $c = 0.32$, $\lambda = 0.02$), an increase in the real wage rate will raise the share of labor in national income, while an increase in the k ratio will reduce the labor share.

When technological progress is assumed to be constant (i.e., $\lambda = 0$), an increase in real wages and the K/L ratio will raise or reduce the labor income share, depending upon the result of the interaction of two conflicting forces: the labor share raising force, $(1-b)\dot{w}$, and the capital share raising force, $c\dot{k}$. Two different cases are possible:

- If $b + c < 1$, an increase in the real wage rate and the capital-labor ratio always raises the labor share.
- If $b + c > 1$, an increase in the real wage rate and the capital-labor ratio always decreases the labor share.

---

[53] Under perfect competition the profit maximization condition implies that the marginal product of labor is equal to the wage rate, i.e. $P\frac{\partial Y}{\partial L} = w$. Since the output is measured by value added, its price (P) is unity. Therefore, we have: $\frac{\partial Y}{\partial L} = \alpha k^{-\frac{c}{b}} y^{\frac{1}{b}} = w$. Solving for y, yields: $y = \alpha^{-b} w^b k^c$. By substituting $\alpha = (1-\delta)A^{-\rho}$ we can derive $\frac{wL}{Y} = (1-\delta)^b A^{-\rho} w^{1-b} k^{-c}$.

[54] We have assumed that technological progress is neutral and proceeds at a geometric rate such that $A = A_0 e^{\lambda t}$. Under this assumption the annual growth rate of technological progress is obtained by taking the derivative of $log\ y$ with respect to t ($\dot{A}/A$), which is equal to λ.

On the other hand, when technological progress occurs, (i.e., $\lambda > 0$), the increment of output attributable to it may be entirely allocated to labor or capital, depending on the parameters of the production function. Eq (30) tell us that the increment of output due to technological progress will be allocated entirely to labor if b is greater than unity (which is true in 2 cases before 1980 and 3 cases after 1980 with the parameters of the production function estimated under perfect competition). If b is less than unity, technical change will favor the capital share.

Country	1960-1980 λ	1960-1980 (1-b) λ	1960-1980 b>1	1980-2018 λ	1980-2018 (1-b) λ	1980-2018 b>1	**1960-2018** λ	**1960-2018** (1-b) λ	**1960-2018** b>1
Australia	2.18%	2.40%	NO	2.84%	1.00%	NO	1.85%	1.40%	NO
	(0.0788)*			(0.0137)**			(0.3257)		
Austria	-0.20%	0.10%	YES	-0.18%	-0.20%	NO	-0.17%	-0.10%	NO
	(0.0003)***			(0.0256)**			(0.0027)***		
Belgium	7.28%	5.60%	NO	0.25%	0.20%	NO	0.36%	0.20%	NO
	(0.0669)*			(0.0442)**			(0.0073)***		
Canada	0.86%	0.30%	NO	1.57%	1.30%	NO	1.35%	0.70%	NO
	(0.0267)**			(0.028)**			(0.0018)*		
Denmark	-2.27%	-0.50%	NO	0.00%	0.00%	YES	1.62%	0.50%	NO
	(0.0559)*			(0.099)*			(0.0031)***		
Finland	0.80%	0.80%	NO	-71.43%	0.50%	YES	1.91%	0.80%	NO
	(0.0278)**			(0.0091)***			(0.0279)**		
France	-30.43%	-1.40%	NO	0.19%	0.20%	NO	0.00%	0.00%	NO
	(0.0988)*			(0.0013)***			(0.0385)**		
Germany	0.70%	0.40%	NO	0.59%	0.20%	NO	0.59%	0.40%	NO
	(0.0069)***			(0.0179)**			(0.0055)***		
Greece	-10.44%	-4.30%	NO	1.28%	0.70%	NO	-0.97%	-0.30%	NO
	(0.0165)**			(0.1865)			(0.0267)**		
Ireland	0.12%	0.10%	NO	2.51%	4.70%	NO	2.84%	2.50%	NO
	(0.0483)**			(0.0346)**			(0.0383)*		
Italy	-0.28%	-0.20%	NO	-0.78%	-0.90%	NO	-0.81%	-0.80%	NO
	(0.0359)**			(0.001)***			(0.0056)***		
Japan	NA	NA	NA	19.23%	0.50%	NO	19.23%	0.50%	NO
	(0.2507)			(0.0332)**			(0.0053)***		
Luxembourg	2.45%	4.10%	NO	1.49%	-0.50%	YES	0.91%	0.30%	NO
	(0.0592)*			(0.0878)*			(0.0131)**		
Netherlands	-1.18%	-0.60%	NO	0.56%	0.60%	NO	0.19%	0.10%	NO
	(0.0788)*			(0.0071)***			(0.0044)***		
Norway	-0.42%	-0.40%	NO	4.53%	1.20%	NO	1.51%	0.80%	NO
	(0.0512)*			(0.3175)			(0.0156)**		
Portugal	7.47%	5.50%	NO	1.46%	0.70%	NO	1.44%	0.50%	NO
	(0.0148)**			(0.0853)*			(0.0295)**		
Spain	8.04%	2.30%	NO	0.00%	0.00%	NO	0.00%	0.00%	NO
	(0.0353)**			(0.0268)**			(0.0028)***		
Sweden	-3.73%	-2.50%	NO	-0.71%	-0.20%	NO	0.99%	0.50%	NO
	(0.0046)***			(0.0054)***			(0.0465)**		
United Kingdom	0.20%	0.20%	NO	-0.43%	-0.20%	NO	0.31%	0.20%	NO
	(0.0319)**			(0.0415)**			(0.0007)***		
United States	2.11%	-0.20%	YES	1.27%	0.50%	NO	0.41%	0.10%	NO
	(0.0233)**			(0.0055)***			(0.0012)***		
Average	0.33%	0.61%		0.79%	0.36%		0.83%	0.34%	
Standard Deviation	0.083	0.025		0.170	0.011		0.042	0.007	

P-values in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table 6 - Average annual growth rate of technological progress (λ).

Changes in the labor share relative to total output along with the growth rates of wages and capital-labor ratios of the 20 countries investigated over the period 1960 to 2018 are shown in Table 7, while a graphic representation can be seen in Figure 10.

	1960-1980			1980-2018			**1960-2018**		
	W	K/L	LS_fc	W	K/L	LS_fc	W	K/L	LS_fc
Australia	2.34%	0.79%	0.34%	0.61%	1.54%	-0.35%	1.23%	1.29%	-0.11%
Austria	3.83%	4.12%	0.01%	0.91%	1.66%	-0.26%	1.97%	2.48%	-0.17%
Belgium	4.55%	3.20%	0.49%	0.89%	1.23%	-0.16%	2.20%	1.85%	0.06%
Canada	1.53%	0.09%	-0.20%	0.79%	1.29%	-0.07%	1.06%	0.89%	-0.12%
Denmark	2.83%	2.11%	0.27%	1.07%	1.06%	-0.15%	1.74%	1.40%	0.00%
Finland	3.68%	4.45%	-0.22%	1.35%	1.58%	-0.24%	2.18%	2.57%	-0.24%
France	4.17%	3.92%	0.15%	0.94%	1.46%	-0.20%	2.11%	2.28%	-0.08%
Germany	3.67%	3.50%	0.21%	0.70%	0.77%	-0.18%	1.78%	1.69%	-0.05%
Greece	4.54%	6.94%	-1.14%	0.32%	1.04%	-0.04%	1.85%	3.01%	-0.43%
Ireland	4.00%	4.70%	0.03%	1.74%	1.91%	-0.90%	2.58%	2.82%	-0.58%
Italy	4.47%	3.94%	-0.09%	0.52%	1.37%	-0.21%	1.91%	2.23%	-0.17%
Japan	2.94%	5.45%	NA	0.98%	1.80%	-0.36%	0.98%	2.98%	-0.24%
Luxembourg	3.15%	1.72%	0.57%	0.91%	0.48%	-0.09%	1.72%	0.86%	0.14%
Netherlands	3.64%	3.22%	0.53%	0.81%	0.92%	-0.28%	1.89%	1.69%	0.00%
Norway	2.74%	3.28%	-0.16%	1.28%	1.26%	-0.13%	1.85%	1.95%	-0.14%
Portugal	5.43%	3.44%	0.16%	1.17%	2.60%	-0.33%	2.68%	2.84%	-0.16%
Spain	5.74%	4.82%	0.21%	0.69%	1.95%	-0.31%	2.48%	2.85%	-0.13%
Sweden	2.73%	3.35%	0.14%	1.37%	1.69%	-0.15%	1.91%	2.25%	-0.05%
United Kingdom	1.94%	2.54%	-0.05%	1.50%	1.27%	-0.01%	1.67%	1.67%	-0.03%
United States	1.53%	0.92%	-0.08%	1.27%	1.27%	-0.16%	1.39%	1.14%	-0.14%
Mean	3.47%	3.33%	0.06%	0.99%	1.41%	-0.23%	1.86%	2.04%	-0.13%
Standard Deviation	0.012	0.017	0.004	0.004	0.005	0.002	0.005	0.007	0.002

Table 7 - Average growth rates of real wages, capital-labor ratios and total change in the labor shares at factor cost.

Source: Author's own estimation.

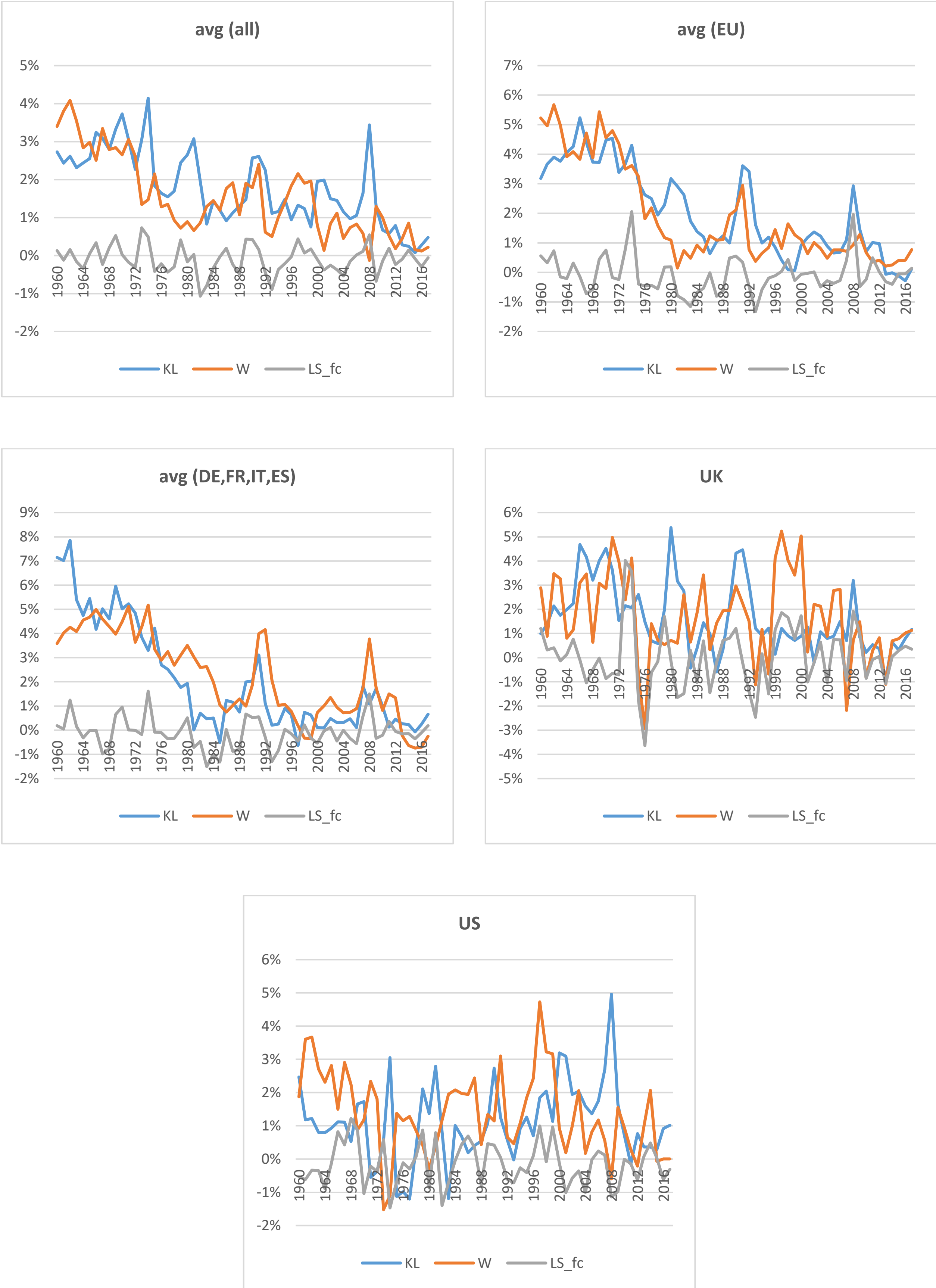


Figure 10 - Average growth rates of real wages, the capital-labor ratios and the labor shares at factor cost.

Source: Author's calculation on AMECO data.

In all countries included in the analysis, observed wage rates and capital-labor ratios have increased over time. The average annual growth rate for each variable is listed in the first two columns of each panel, and the growth rate of the labor share relative to total output is listed in the last column of Table 7. However, it should be noted (Figure10) that even if both the growth rates of real wages and that of the capital-labor ratio plummeted (except in the Anglo-Saxon countries), real wages have slowed down more than capital accumulation per worker. Indeed, while before 1980 the average growth rate of wages was higher than that of the capital-labor ratio, from 1980 onwards the growth of the labor capital ratio is on average higher than that of real wages. The biggest reduction in the growth rate of real wages took place in continental Europe where since 1980 real wages are growing at a rate which is 2.76 percentage points lower (2.40 considering the EU) than it was in the previous period and the UK (-1.27%), while in the US, the growth rate of real wages has increased (+0.48%). On the other hand, accumulation of capital per worker has slowed down everywhere, following the same pattern of wages with a more pronounced decline in Europe (-3.82% in Continental Europe and -2.84% in the EU) and a lighter one in Anglo-Saxon countries (-0.43% in the UK and -0.28% in the US). The labor share also moved accordingly (-0.32% in Continental Europe, -0.28% in the EU, -0.15% for the average of all the countries, -0.07% in the UK and -0.03% in the US).

After this first extensive qualitative analysis on the dynamics of the variables involved, we can examine model's predictions by asking the following question: "Through the lens of the model, can variations in real wages, capital-labor ratios and technological change explain the behavior of factor shares in the countries analyzed over the period 1960-2018?". To answer this question, we calibrate the model and use AMECO annual data on gross domestic product, employment, and net fixed capital formation[55] to predict movements in factor shares according to eq. (27). The model's predictions are then compared with data and the variance analyzed. We make use of the observed growth rate of the capital to labor ratio, wages and technological progress, as well as the estimated values of the coefficients of the production function to perform the simulation. In this way we can decompose the variation in the labor income share and examine how much of it can be explained by w and K/L and how much by the exogenous part of technological progress. As inputs of the simulation, we need the growth rates as reported in Table 7, and the value estimated for the parameters b and c. For what concerns the exogenous technological progress we assume, as we did in the previous section, that it grows at a constant rate. This rate is set at the sample period average growth rate, which is equal to λ. To obtain a close simulation we split the sample period into two

[55] A detailed description of the variables employed together with a summary of their statistical properties is available in Appendix B.

subsamples, exploiting the breakpoint that we have already used for the estimation of the parameters of the production function. This allows us to deal with the structural change in the value of the parameter (which account for the exogenous part of technological progress, as well as changes in the institutional settings) and hence the behavior of the labor share that seems to have happened after 1980. All this information is summarized in Tables 8, 9, 10 where LS_cp is the adjusted wage share as a percentage of GDP at current prices, LS_fc is the adjusted wage share as a percentage of GDP at current factor cost, LS_e1 is the labor share as estimated net of the technological progress and LS_e2 is the final estimate. Moreover, there is an important remark related to the restricted period for which the simulation is conducted. Indeed, when the whole sample is considered, the model fails to produce a good fit after 1980. We can thus confirm that some relevant determinants of the macroeconomic scene in the second part of the sample are not well captured by our stylized analysis if the parameters are estimated over the full sample. In contrast, the model performs reasonably well when explaining the evolution of the labor share when we split the sample and re-estimate the value of the coefficients for the second part. Table 11 evaluates these simulations through the RSS and R^2 (to check their global fit).

	1960-1980					
	W	K/L	LS_cp	LS_fc	LS_e1	LS_e2
Australia	2.34%	0.79%	0.31%	0.38%	2.86%	0.46%
Austria	3.83%	4.12%	0.00%	0.01%	-0.11%	-0.21%
Belgium	4.55%	3.20%	0.49%	0.49%	6.42%	0.82%
Canada	1.53%	0.09%	-0.16%	-0.25%	0.63%	0.33%
Denmark	2.83%	2.11%	0.19%	0.34%	-0.21%	0.29%
Finland	3.68%	4.45%	-0.20%	-0.25%	0.48%	-0.32%
France	4.17%	3.92%	0.17%	0.13%	-1.08%	0.32%
Germany	3.67%	3.50%	0.24%	0.18%	0.64%	0.24%
Greece	4.54%	6.94%	-1.07%	-1.22%	-6.04%	-1.74%
Ireland	4.00%	4.70%	0.10%	-0.03%	0.01%	-0.09%
Italy	4.47%	3.94%	-0.02%	-0.16%	-0.13%	0.07%
Japan	2.94%	5.45%	NA	NA	NA	NA
Luxembourg	3.15%	1.72%	0.53%	0.61%	5.09%	0.99%
Netherlands	3.64%	3.22%	0.50%	0.56%	-0.04%	0.56%
Norway	2.74%	3.28%	-0.16%	-0.15%	-0.85%	-0.45%
Portugal	5.43%	3.44%	0.15%	0.16%	6.07%	0.57%
Spain	5.74%	4.82%	0.24%	0.18%	3.02%	0.72%
Sweden	2.73%	3.35%	0.15%	0.12%	-2.16%	0.34%
United Kingdom	1.94%	2.54%	-0.19%	0.09%	-0.26%	-0.46%
United States	1.53%	0.92%	-0.05%	-0.10%	-0.10%	0.10%
Mean	3.47%	3.33%	0.06%	0.06%	0.75%	0.13%
Standard deviation	0.012	0.017	0.004	0.004	0.029	0.006

Table 8 - Labor shares predicted and observed values (1960-1980).

Source: Author’s own estimation.

	1980-2018					
	W	K/L	LS_cp	LS_fc	LS_e1	LS_e2
Australia	0.61%	1.54%	-0.39%	-0.31%	0.45%	-0.55%
Austria	0.91%	1.66%	-0.25%	-0.28%	-0.73%	-0.53%
Belgium	0.89%	1.23%	-0.17%	-0.16%	-0.18%	-0.38%
Canada	0.79%	1.29%	-0.10%	-0.05%	1.09%	-0.21%
Denmark	1.07%	1.06%	-0.13%	-0.16%	-0.19%	-0.19%
Finland	1.35%	1.58%	-0.25%	-0.23%	-0.01%	-0.51%
France	0.94%	1.46%	-0.19%	-0.21%	-0.19%	-0.39%
Germany	0.70%	0.77%	-0.19%	-0.18%	-0.15%	-0.35%
Greece	0.32%	1.04%	-0.09%	0.02%	0.19%	-0.51%
Ireland	1.74%	1.91%	-0.85%	-0.94%	3.56%	-1.14%
Italy	0.52%	1.37%	-0.27%	-0.15%	-1.26%	-0.36%
Japan	0.98%	1.80%	-0.38%	-0.35%	-0.01%	-0.51%
Luxembourg	0.91%	0.48%	-0.13%	-0.06%	-0.69%	-0.19%
Netherlands	0.81%	0.92%	-0.30%	-0.26%	0.50%	-0.10%
Norway	1.28%	1.26%	-0.12%	-0.13%	0.87%	-0.33%
Portugal	1.17%	2.60%	-0.39%	-0.26%	0.37%	-0.33%
Spain	0.69%	1.95%	-0.33%	-0.29%	-0.14%	-0.14%
Sweden	1.37%	1.69%	-0.17%	-0.13%	-0.48%	-0.28%
United Kingdom	1.50%	1.27%	-0.04%	0.02%	-0.16%	0.04%
United States	1.27%	1.27%	-0.16%	-0.17%	0.24%	-0.26%
Mean	0.99%	1.41%	-0.25%	-0.21%	0.15%	-0.36%
Standard deviation	0.004	0.005	0.002	0.002	0.01	0.002

Table 9 - Labor shares predicted and observed values (1980-2018).

Source: Author’s own estimation.

	1960-2018					
	W	K/L	LS_cp	LS_fc	LS_e1	LS_e2
Australia	1.23%	1.29%	-0.15%	-0.07%	1.13%	-0.27%
Austria	1.97%	2.48%	-0.16%	-0.18%	-0.23%	-0.13%
Belgium	2.20%	1.85%	0.06%	0.07%	0.39%	0.19%
Canada	1.06%	0.89%	-0.12%	-0.12%	0.65%	-0.05%
Denmark	1.74%	1.40%	-0.02%	0.02%	0.47%	-0.03%
Finland	2.18%	2.57%	-0.24%	-0.24%	0.44%	-0.36%
France	2.11%	2.28%	-0.07%	-0.09%	-0.05%	-0.05%
Germany	1.78%	1.69%	-0.04%	-0.05%	0.27%	-0.13%
Greece	1.85%	3.01%	-0.44%	-0.42%	-0.78%	-0.48%
Ireland	2.58%	2.82%	-0.53%	-0.63%	1.79%	-0.71%
Italy	1.91%	2.23%	-0.19%	-0.16%	-0.98%	-0.18%
Japan	0.98%	2.98%	-0.25%	-0.23%	-0.03%	-0.53%
Luxembourg	1.72%	0.86%	0.10%	0.18%	0.39%	0.09%
Netherlands	1.89%	1.69%	-0.02%	0.03%	0.33%	0.23%
Norway	1.85%	1.95%	-0.14%	-0.14%	0.52%	-0.28%
Portugal	2.68%	2.84%	-0.21%	-0.12%	0.47%	-0.03%
Spain	2.48%	2.85%	-0.13%	-0.13%	-0.03%	-0.03%
Sweden	1.91%	2.25%	-0.05%	-0.04%	0.37%	-0.13%
United Kingdom	1.67%	1.67%	-0.09%	0.04%	-0.03%	-0.23%
United States	1.39%	1.14%	-0.12%	-0.15%	0.01%	-0.09%
Mean	1.86%	2.04%	-0.14%	-0.12%	0.26%	-0.16%
Standard deviation	0.005	0.007	0.001	0.002	0.006	0.002

Table 10 - Labor share predicted and observed values (1960-2018).

Source: Author’s own estimation.

For instance, by looking at the full sample, on average, the values of the parameters of the production function are: $b = 0.50$, $c = 0.32$, and $\lambda = 0.017$. The annual growth rate of the capital-labor ratio is 2.04%, and that of the real wage rate is 1.86%. Since $b + c$ is lower than unity, the labor share raising force is greater than that of capital. Hence, labor's share would have increased at a rate of 0.3 percent a year if technical change had not occurred. Apparently, this is not true. The observed labor's share relative to total output, in fact, has declined at a rate of 0.13 percent a year. During this period technical change has taken place at an average rate of 1.7 percent a year. Since b is less than unity, changes in technique will depress labor's share relative to total output by an annual rate of $\lambda(1 - b) = 0.84$ percent and the net effect of the three forces is -0.16 percent. Therefore, we will expect that labor share relative to total output would decline slightly over time. This estimation is quite close to the observed rate of changes in labor's share relative to total output, which is -0.13 percent. The resulting time series (LS_e1), i.e., the one obtained splitting the sample in the 1980 provide the closest approximation to the actual labor share trajectories in all the economies with the lowest residual sum of squares (RSS) and the higher R^2 (Table 11).

	RSS		R^2	
	Split	Full	Split	Full
Australia	0.001	0.006	0.937	0.900
Austria	0.001	0.002	0.674	0.802
Belgium	0.003	0.007	0.782	0.780
Canada	0.001	0.002	0.608	0.561
Denmark	0.001	0.001	0.543	0.563
Finland	0.002	0.001	0.712	0.666
France	0.002	0.006	0.710	0.638
Germany	0.002	0.003	0.908	0.908
Greece	0.022	0.003	0.841	0.764
Ireland	0.003	0.003	0.864	0.886
Italy	0.002	0.004	0.834	0.870
Japan	0.000	0.000	0.892	0.892
Luxembourg	0.007	0.001	0.697	0.429
Netherlands	0.017	0.019	0.113	0.110
Norway	0.002	0.001	0.732	0.766
Portugal	0.010	0.012	0.534	0.542
Spain	0.015	0.004	0.001	0.841
Sweden	0.001	0.001	0.565	0.785
United Kingdom	0.003	0.011	0.535	0.369
United States	0.001	0.002	0.728	0.706
Mean	0.005	0.004	0.660	0.689

Table 11 - Simulated labor shares' fit.

Note: RSS = Residual sum of squares; the R^2 and the RSS are obtained from regressing the actual trend-component of the LS on a constant and the simulated LS in each scenario. *Source:* Author's own calculation.

In order to plot the path of the simulated labor income shares along with the observed one, we set the initial value of the simulated labor share to coincides with the actual observed value of the labor share at factor cost in the initial period. We distinguish two different simulation that combine: (i) the labor share net of the technological effect; and (ii) the labor share including the effect of technology. The results for the usual aggregates of countries are summarized in Figure 11.

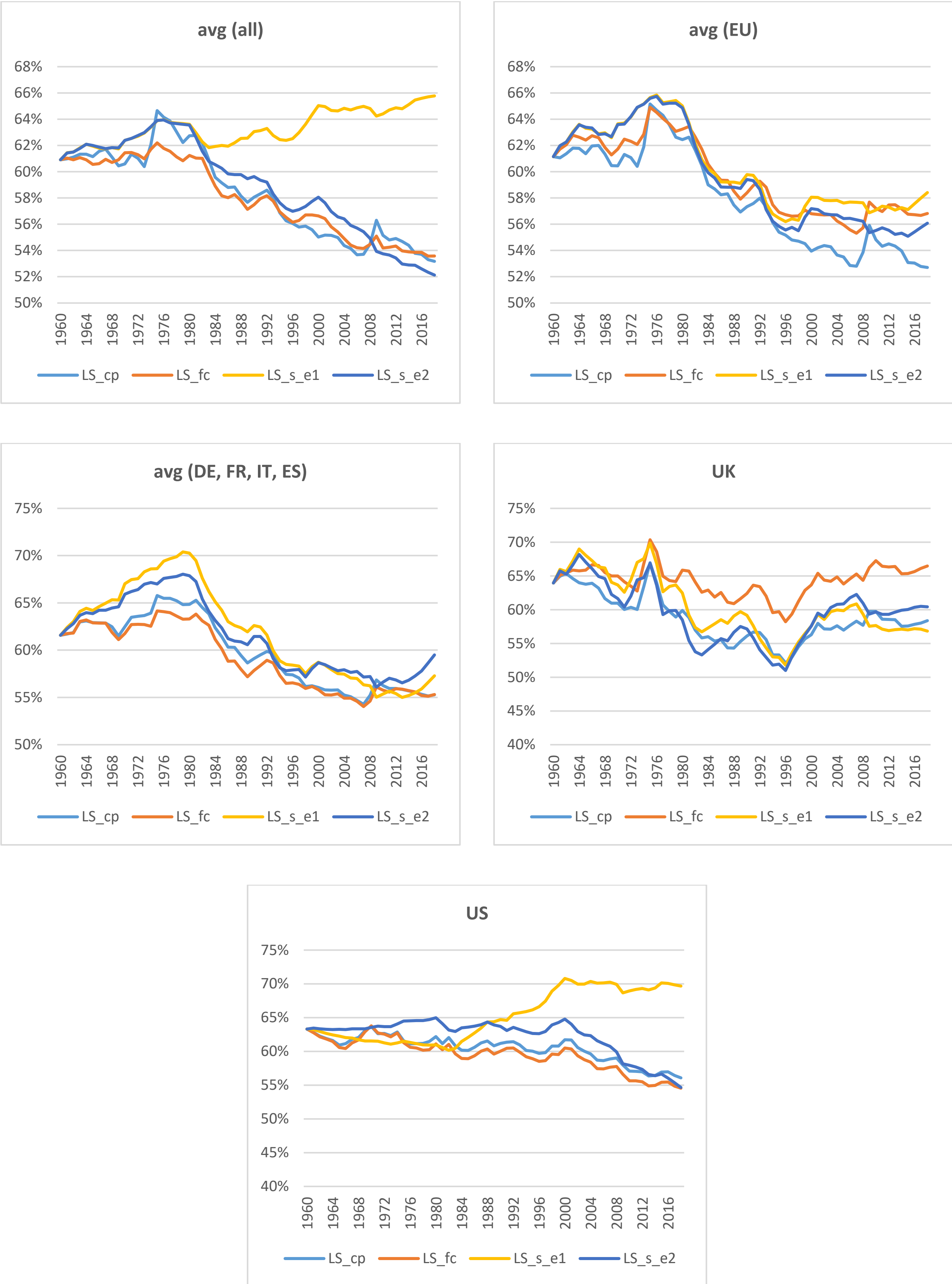
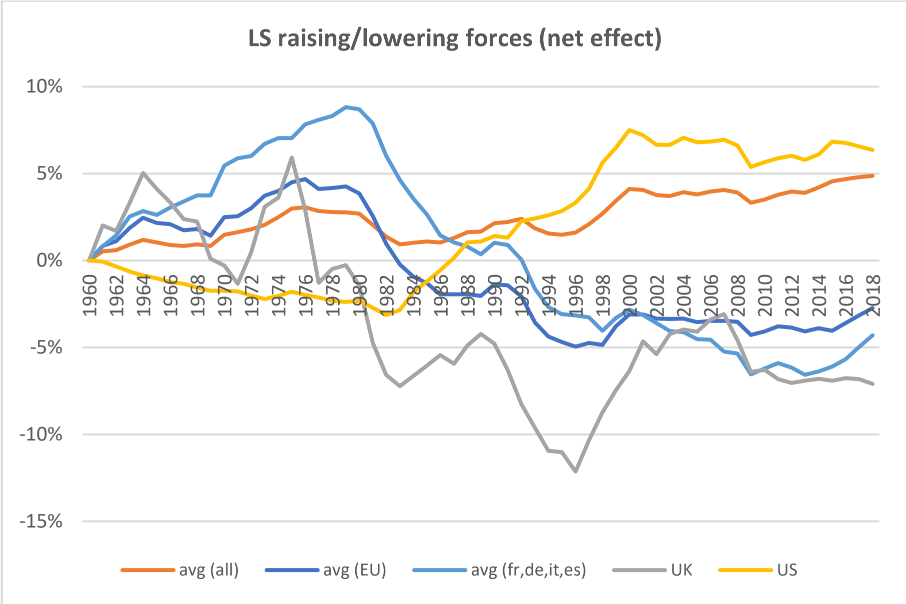


Figure 11 - Simulated labor shares under perfect competition.

Note: LS_cp is the observed adjusted wage share as a percentage of GDP at current prices, LS_fc is the observed adjusted wage share as a percentage of GDP at current factor cost, LS_e1 is the labor share as estimated net of the technological progress and LS_e2 is the final estimation. *Source:* Author's own simulation.



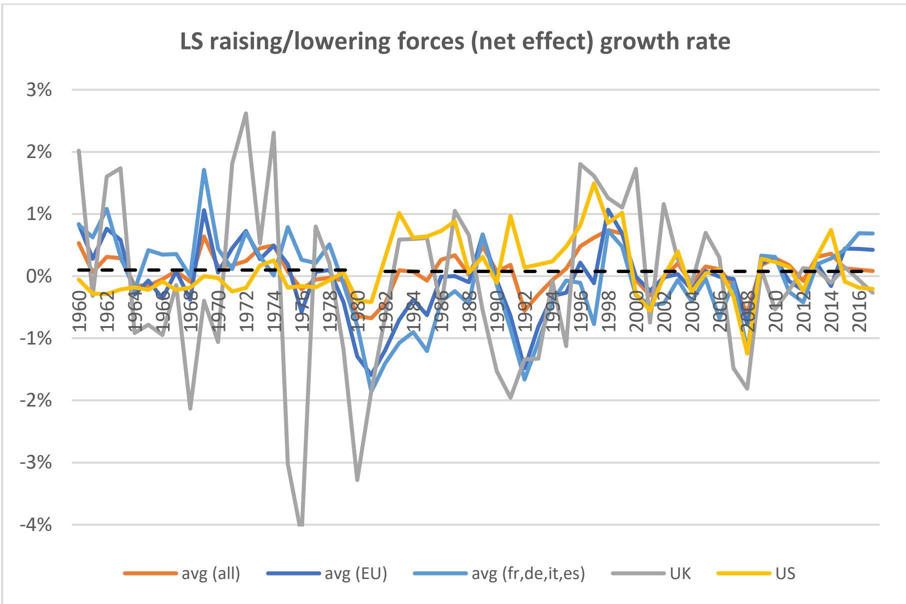


Figure 12 - Labor Shares rising/lowering forces net effect and growth rates of the net effect.

Source: Author's own simulation.

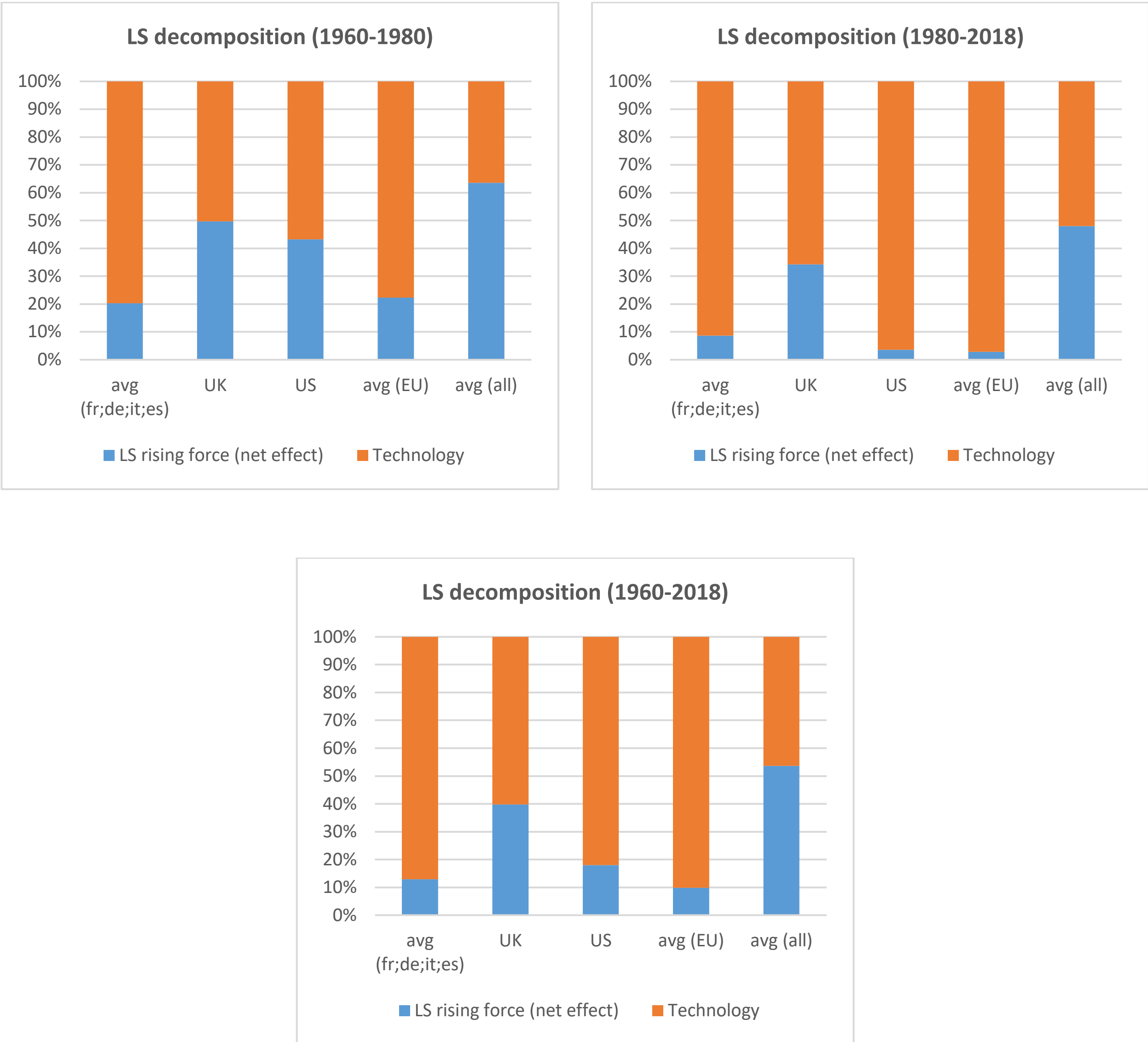


Figure 13 - Labor Shares' variance decomposition.

Source: Author's own simulation.

	1960-1980				
	avg (DE,FR,IT,ES)	UK	US	avg (EU)	avg (all)
LS rising force (net effect)	20.28%	49.70%	43.26%	22.31%	63.61%
Technology	79.72%	50.30%	56.74%	77.69%	36.39%
	1980-2018				
	avg (DE,FR,IT,ES)	UK	US	avg (EU)	avg (all)
LS rising force (net effect)	8.68%	34.21%	3.59%	2.81%	47.99%
Technology	91.32%	65.79%	96.41%	97.19%	52.01%
	1960-2018				
	avg (DE,FR,IT,ES)	UK	US	avg (EU)	avg (all)
LS rising force (net effect)	12.88%	39.82%	17.95%	9.87%	53.65%
Technology	87.12%	60.18%	82.05%	90.13%	46.35%

Table 12 - Labor Shares' variance decomposition.

Source: Author's own estimation.

As we can see from Figure 11, the estimated labor shares net of technological progress (yellow lines) has remained in line with the overall labor shares until 1980 to begin to diverge strongly since then- Indeed, until this moment, the effect of technological progress was more or less neutral if we look at all country average or the EU, pro-labor in the US and slightly against work in the UK and continental Europe (France, Germany, Italy and Spain). From this moment forward, on the contrary, technological progress has started to play significantly against work in the US and in the EU and considerably in favor of work in the UK and continental EU. As for Europe and continental EU, the total effect on the labor share has remained contained, although positive in the first case and negative in the second. On the contrary, for the United States and the average of all countries the effect was much stronger. These dynamics generated by technological progress clash with those determined by the joint action of wages and capital accumulation per worker and together determines the labor share. The net effect of this interaction between wages and capital was positive in every country until the early 80s (slightly negative in the US and the UK) and, made exception for the US (where the trend has turned upside down) has become negative since then, especially in Continental Europe and the UK (Figure 12). However, if we look at the average of all the countries, we do not notice any big difference in the growth rate of the labor share rising force from before to after 1980 (which has decreased from an average annual growth rate of 0.10% a year to one of 0.08%). To see how much each of the two relative forces (i.e., the net effect of the labor shares rising force and that of technology) have contributed to the total movement observed in the labor shares we decompose the total variance. The results are shown in Figure 13 and reported in Table 12.[56] We find technological progress to account on average for the 82% of the total movement in the labor share estimated for the US while the residual 18% is due to the joint game created by the dynamics of wages and capital. Similarly, when we do the same exercise on the economies of Continental Europe (i.e., France, Germany, Italy and Spain) we find respectively values of 13% and 87%. On the other hand, when all the countries are considered, the contribution of wages and that of the K/L ratio appear to be higher (around 54%). Finally, in the UK the role of technology has been relatively lower (40%). It is also worth noting that the relative importance of technological progress has grown everywhere after 1980, especially in the US (+40%) and the EU (+20%). This growth in the importance of technology in explaining the dynamics of labor shares is mainly due to two factors that both occurred in the 1980s: (i) a change in the type/speed of technological progress. Indeed, according to our model it is not just the levels of technology parameters themselves that determine the labor share, but also the pace of technical progress. We have had an increase in the rate of technical change itself (represented by a rise in the parameter λ). Further, recent technologies, with automation and the introduction of ICT have become increasingly capital using, leading to more capital-intensive production activities. In terms of the model this means an increase in b which combined with an increase in c and the pattern of capital-deepening has amplified firms' incentives to substitute labor for capital. As already noted by previous literature this trend has been facilitated by a decrease in the price of capital goods, leading to higher substitution of labor with capital (Bentolila and Saint-Paul 2003, Karabarbounis and Neiman 2014). Investments in information and communication technologies (ICT), automation and artificial intelligence are gradually replacing tasks previously performed by workers (Acemoglu and Restrepo 2018, Aghion et al. 2017), changing the structure of the workplace and further reducing the demand for workers, particularly those with low skills. (ii) on the other hand, in many cases, we have witnessed to a simultaneous slowdown in the net effect of labor shares rising forces. In other words, as we have seen, both real wages and accumulation of capital per worker have slowed down, however, the slowdown in the former has been higher than in the latter - look at the cumulative curve of the growth rates of the variables in Figure 15. Recently, in advanced countries, even when the economies grow and the unemployment

[56] The graphs for the whole period are available in Appendix B.

rate is low, the average wage growth remains disappointingly low. Wages are growing much more slowly than in the past. This is the familiar "wage puzzle", a phenomenon well documented by international organizations and that has been the subject of much speculation by economist. One explanation for this could be low productivity growth. Real wage growth and productivity growth, measured by growth in total factor productivity (TFP), tend to move together (the correlation between the two is on average 0.976) with the mediation of the unemployment rate (Figure 14).

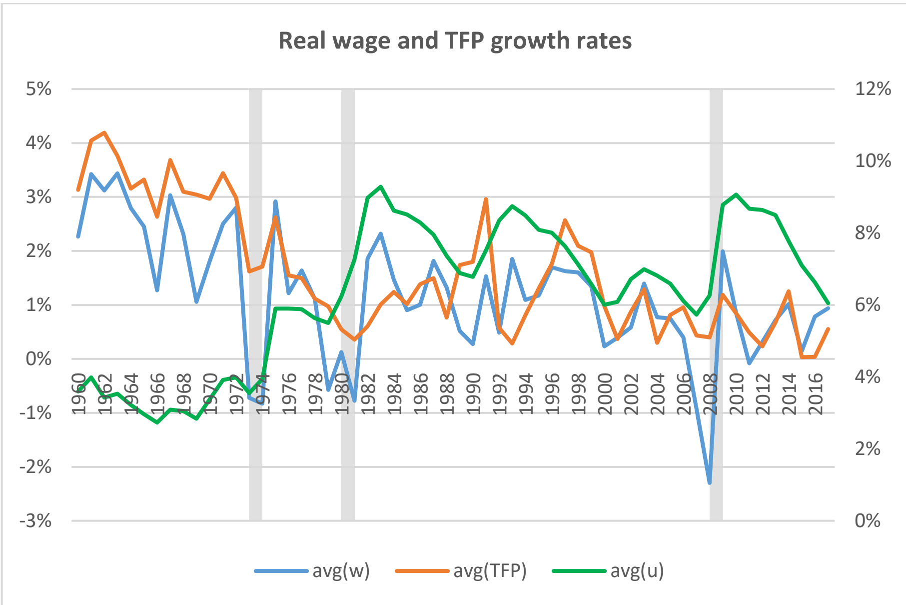


Figure 14 - Real wage growth, productivity growth and the unemployment rate. Year-over-year percent change.

Note: Gray bars denote recessions. *Source:* Author's calculation on AMECO data.

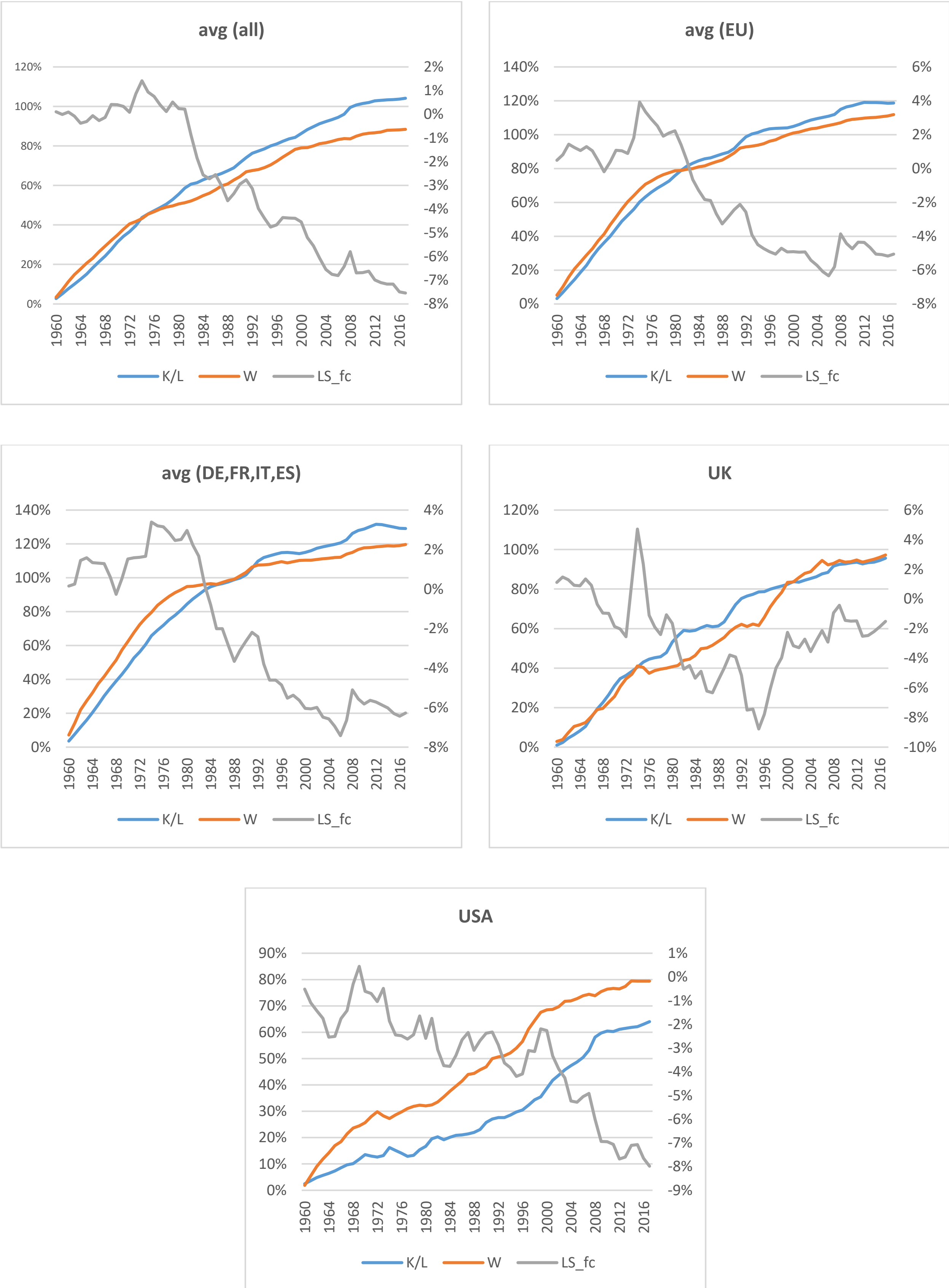


Figure 15 - Cumulative effect of the labor share rising and lowering forces and the observed labor share.

Source: Author’s calculation on AMECO data.

7. Relative factor shares under imperfect competition

So far, all discussions were conducted under the assumption of perfect competition. Under perfect market competition, wage is equal to the marginal product of labor, interest is equal to the marginal product of capital and the price of goods is equal to their marginal production cost. However, in a context of imperfect competition, the price of a company's product may be different from its marginal cost - i.e., it includes a mark-up.[57] Recent empirical research suggests that there is an increasing concentration of economic activity and a decrease in the intensity of competition across industries, with markups that have risen dramatically since 1980. (Foster et al., 2011; Weche and Wambach, 2018; Van Reenen, 2018).[58] [59] Further it seems that that this increase in the market power of firms has been more pronounced in the US than in Europe.[60] However, despite the vital importance of market power in economics, surprisingly little is known about its patterns for the aggregate economy. The potential reasons for an indicated intersectoral decline in the intensity of competition are not well identified. Some of the explanations that are currently under debate include an increasing role of scale economies against the background of a globalized world economy, crowding-out effects and increasing entry barriers through selective technological progress (Andrews et al., 2015; Grullon et al., 2018); external growth strategies of companies (CEA, 2016; Grullon et al., 2018) combined with an underenforcement of competition authorities (Furman, 2016; Motta, 2017; Gutierrez and Philippon, 2018; De Loecker and Eeckhout, 2020). Measured trends in markups and profit rates are consistent with this story. In this section we discuss the role of imperfect competition and its impact on the relative factor shares. Kalecki's seminal studies (1938, 1954)[61] were among the first ones to analyze the labor income share considering an

[57] Pressures from competitors and new entrants lead companies to set prices that reflect their costs, which benefits the customer. In the absence of competition, companies gain market power and can charge high prices.

[58] Even though Lynn and Longman (2010) and Foster et al. (2011) specify some negative aspects of increasing monopolization, such as for instance a reduction in the bargaining power of workers, they do not directly link it to the fall of the labor share of income.

[59] Recently, several papers have employed various alternative methods to measure markups. For example, Grullon et al. (2018) examined publicly traded companies in the US and find that concentration increased in 75% of all industries since 2000 and that the number of publicly traded firms in the United States shrank by almost 50% during the last two decades. De Loecker and Eeckhout (2020) use the inverse of the cost of goods sold to revenue and find astronomical increases in the markup in the US, rising from 1.2 in 1980 to 1.6 now.

[60] The divergent results between Europe and the United States may suggest that different factors were at play. It can be assumed that globalization has increased competitive pressure in general and has therefore had a similar impact on mark-ups on both sides of the Atlantic, but it is likely that this general trend has been stronger in Europe due to the European integration process. By contrast, the many new internet-based companies, which in some cases have strong market power due to network effects, may have played an important role in the US. Finally, the prolonged economic crisis also had a negative impact on the profit margins of companies in Europe.

[61] Kalecki (1943) developed a theory in which firms in industries characterized by imperfect competition set the product price as a markup over costs, more specifically the average variable cost. This approach to pricing has - since then - been adopted by many economists concerned with pricing in imperfectly competitive markets and has been subjected to a great deal of empirical analysis.

imperfectly competitive market. In the context of our setup, changing the markup has an immediate implication for the labor share. Indeed, we can see this by assuming a linear homogeneous production function with CRS in the following form:

$$Y = f(K, L) = Kf\left(1, \frac{L}{K}\right) = Kf(l) \tag{31}$$

In this case, the firm maximizing condition implies that: $\pi = pKf(l) - wKl - rk$ and goods market clear when $\frac{w}{p} = f'(l)$. This prompts us to write the labor income share as:

$$LS = \frac{wL}{pY} = \frac{lf'(l)}{f(l)} \tag{32}$$

A price mark-up (that following the traditional nomenclature we indicate with the Greek letter μ) can enter the profit maximization condition in an imperfectly competitive market as $\mu\frac{w}{p} = f'(l)$, hence resulting in a slightly different expression for the labor income share (eq. 32) and suggesting a pro-cyclical movement if movements in the mark-up are counter-cyclical. In other words when this is the relevant framework, profit maximization by individual firms implies that the labor share is inversely proportional to the markup. Therefore, as the markup increases, we expect to see a decrease in the labor share.

$$LS = \frac{wL}{pY} = \mu^{-1}\frac{lf'(l)}{f(l)} \tag{33}$$

When markets are not perfectly competitive, the extent to which emerging rents belong to either labor or capital becomes crucial in explaining the dynamics of factor income shares. (Blanchard and Giavazzi 2003). A recent strand of literature on labor share emphasizes the role of increasing concentration and markups. Institutional settings shape rent-sharing patterns: if price markups are larger than wage markups, a lower degree of competition is expected to decrease the labor share (Autor et al. 2020; Barkai 2020). Measuring the market power of firms at the industry or aggregate level is notoriously a difficult task.[62] In this section, we derive the equation of the labor share of

[62] Rognlie (2015) shows that capital share is higher because higher markups came alongside increased globalization. Another recent study by Grullon et al. (2018) uses firm-level data to document that most US industries became more concentrated over time because the most successful firms made large profits and realized outstanding stock returns as well as profitable mergers and acquisitions. Barkai (2020) using industry level data shows that markups have grown over time, lowering down the labor and capital shares.

income when there is non-perfect competition, and the aggregate technology is characterized by the following VES production function in eq. (4). If we assume that the output price is equal to one, under imperfect competition in the product market, profit maximization implies:

$$\mu_t w_t = MP_L(K_t, L_t) \tag{34}$$

Where:

- μ_t measures the price markup;
- $w_t = \frac{W_t}{p_t}$ is the real wage per unit of labor;
- MP_L is the marginal product of labor.

Combining equations (34) and (4), we obtain the following expression for the relative labor share:

$$RLS_{L.K} = \frac{\mu^{-1}}{\left(\frac{\delta}{1-\delta}k^A - B\right)} \tag{35}$$

Under imperfect competition and the usual assumption that labor efficiency increases at a constant geometric rate, the equilibrium condition $MPL = w$ can be rewritten in the following way: [63]

$$\begin{aligned} ln\frac{wL}{Y} = {} & [b\ln(1-\delta) + (b-1)\ln A_0] \\ & +(1-b)\ln w + \lambda(b-1)t - c\,ln\,k - b\ln\mu \end{aligned} \tag{36}$$

Or:

$$ln\left(\frac{wL}{Y}\right) = \beta_0 + \beta_1 \ln w + \beta_2 t + \beta_3\,ln\,k + \beta_4 \ln\mu \tag{37}$$

By totally differentiating with respect to time:

$$\dot{LS} = (1-b)\dot{w} - c\dot{k} + \lambda(b-1) - b\dot{\mu} \tag{38}$$

Equations (35) and (38) shows that the LIS depends: (i) on the same elements identified before; (ii) on the time path of the price markup (always). From this perspective it is now easy to see the strong assumptions introduced in the literature when explaining the dynamics of the labor share of

[63] Following Antràs (2004) and Raurich (2012).

income. On the one hand, Bils (1987) and Galí (1995) assume $\sigma = 1$ (i.e., a Cobb-Douglas production function) so that these dynamics can only arise from the evolution of the price markup. On the other hand, under the assumption that $\mu = 1$ (i.e., perfect competitive markets), the price markup effect vanishes, and the dynamics of the labor share are explained just by capital deepening. The latter is the route followed by Antràs (2004), who assumes perfect competitive markets to estimate the US production function. In our analysis, which is free from these restrictions $(\sigma \neq 1,\ \mu > 1)$ we use the dynamics of the labor share to estimate the coefficient of the production function when the price markup is time-varying following the equality implied by eq (37). The main difficulty at this point lies in the calculation of the time-varying price markup. Measuring the degree of competition intensity in markets or the market power of individual firms is a challenging issue. We follow the approach developed by Raurich (2012) who extend the dual approach by Roeger (1995) and Diewert and Nakamura (2003) by computing a non-constant markup using Euler's Theorem and firms' first order condition.

$$\mu_t = \frac{Y_t}{w_t L_t + r_t K_t} \tag{39}$$

Where:

- r_t is the rental price of capital.

In this setting with CRS, μ may be greater than 1 only on account of price markups. Note however that if increasing returns to scale were allowed, the size of the increasing returns may also affect μ. From equation (39) we obtain:

$$\frac{\Delta\mu_t}{\mu_t} = \frac{\Delta Y_t}{Y_t} - \mu_t \emptyset_t \left(\frac{\Delta w_t}{w_t} + \frac{\Delta L_t}{L_t}\right) - (1 - \mu_t \emptyset_t)\left(\frac{\Delta r}{r_t} + \frac{\Delta K_t}{K_t}\right) \tag{40}$$

Equations (39) and (40) characterize the dual approach to compute the price markup. Since this is the amount of income that it is not labor nor capital income, this price markup computed in this way should be interpreted along the lines of the Solow residual. Note that the path of the markup can be characterized without any assumption on the aggregate production function. The only requirement is the availability of data on GDP, capital stock, employment, wages and the rental price of capital. The first three variables (i.e., quantities), are directly available through the AMECO database. The latter two - i.e., the prices - require some extra work. Wages need to be computed because the total compensation of dependent employees must be adjusted by the share of the pie corresponding to self-employment (Gollin, 2002). For this purpose, we employ the GDP at factor costs and compute self-employed income as effectively labor income. On this basis, w_t is defined as $\frac{LS_t Y_t}{L_t}$, where LS_t is the (adjusted) labor share of income at current factor cost. On the other hand, the rental price of capital, r_t, is computed from National Accounts data as the share of payments to capital in total income divided by the capital-output ratio. This measure is directly at hand since we have data on Y_t and K_t (in real terms), and we have just computed the (adjusted) labor share of income, LS_t. Relying on this data, we obtain a homogeneous and sufficiently long time series of price-marginal costs ratios (or markup ratios), for our whole set of 20 OECD countries. The markup indexes are estimated at the economy wide level per country over the period 1960-2018 and their growth rates for each subperiod are reported in Table 13 and plotted in Figure 16.

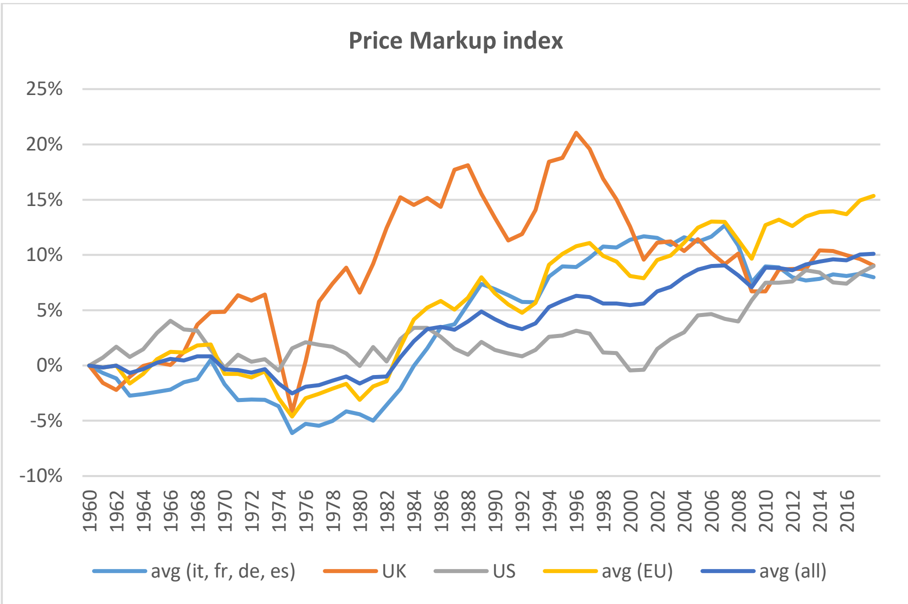


Figure 16 - The growth of the price markups in OECD economies (1960-2018).

Source: Author's calculation on AMECO data.

This price markup has some noteworthy characteristics. First, it follows a sort of U-shaped trajectory, with a downward path in the aftermath of the oil price crisis, which subsequently turns into a rise. The second characteristic is that overall, the cumulative effect of the series has been positive in all the countries analyzed except for Belgium, Denmark, Luxembourg and the Netherlands, increasing steadily between the 1980 and 2008. Further, in the case of European countries we can observe a relatively stable behavior during the years of economic integration and a strong rise in recent years with the persistence of economic crisis.[64] The third characteristic is a countercyclical behavior. In macroeconomics literature frictions are important sources of aggregate fluctuations. As stressed by Rotemberg and Woodford (1999), this countercyclical behavior is necessary to reconcile theory and empirical evidence on the procyclical behavior of wages.[65] To advance some intuition, it is well known that, in the simplest version of the New Keynesian model (see Galì, 2015), the labor share is equal to the inverse of the price markup (the marginal cost). This makes the labor share pro-cyclical if the price markup is counter-cyclical which is in line with the empirical evidence we find here.[66]

---

[64] In the European Union, access to what were previously single national markets was simplified with the single market. Similarly, there have been product market reforms, such as those suggested in the European Commission's country specific recommendations, often aimed at intensifying competition by taking down barriers to entry. This was also accompanied by the expectation that the scope of firms' market power would be reduced.

[65] We follow these authors and compute the correlation of our cyclical indicator of the price markup - the growth rate of the price markup - with the HP filtered GDP (HP stands for Hodrick-Prescott). We find the following correlation coefficients: -0.44; -0.48; -0.54; -0.45; -0.50; -0.57; -0.42; -0.56; -0.10; -0.59; -0.53; -0.51; -0.51; -0.42; -0.24; -0.27; -0.38; -0.52; -0.48; -0.30. In view of these results, we conclude that our price markup time series is counter-cyclical.

[66] For the correlation of our cyclical indicator of the labor share - the growth rate of the labor share at current basic prices/factor cost - with the HP filtered GDP (HP stands for Hodrick-Prescott). We find the following correlation coefficients: 0.39; 0.49; 0.64; 0.48; 0.63; 0.58; 0.46; 0.53; 0.13; 0.55; 0.49; 0.64 ;0.45; 0.44; 0.30; 0.28; 0.43; 0.50; 0.45; 0.34 and 0.33; 0.50; 0.63; 0.46; 0.55; 0.55; 0.40; 0.58; 0.07; 0.52; 0.47; 0.61; 0.42; 0.38; 0.25; 0.21; 0.26; 0.51; 0.39; 0.36. In view of these results, we conclude that our labor share is pro-cyclical.

	Markup growth rate		
	1960-1980	1980-2018	**1960-2018**
Australia	-0.51%	0.57%	0.15%
Austria	0.21%	0.18%	0.19%
Belgium	-0.78%	0.26%	-0.13%
Canada	-0.05%	0.18%	0.10%
Denmark	-0.52%	0.23%	-0.05%
Finland	0.15%	0.53%	0.41%
France	-0.37%	0.25%	0.02%
Germany	-0.27%	0.51%	0.22%
Greece	2.12%	0.27%	0.98%
Ireland	-0.12%	2.30%	1.43%
Italy	0.22%	0.17%	0.19%
Japan	NA	0.58%	0.58%
Luxembourg	-0.89%	0.24%	-0.18%
Netherlands	-0.73%	-0.18%	-0.35%
Norway	0.04%	0.28%	0.20%
Portugal	-0.36%	0.35%	0.09%
Spain	-0.56%	0.36%	0.02%
Sweden	-0.37%	0.33%	0.07%
United Kingdom	0.31%	0.05%	0.14%
United States	-0.01%	0.24%	0.16%
Mean	-0.13%	0.38%	0.21%
Standard deviation	0.007	0.005	0.004

Table 13 - Average annual growth rate of the price markup (in percentage points).

Source: Author's own estimation.

As it is possible to see from Table 13, starting from the 80s, the price markup has grown in all the countries (with the notable exception of the Netherlands), on average by 0.38 percentage points a year. This means that today's markets are on more imperfect than they were 40 years ago, and this result is consistent with some recent findings. For instance, Nekarda and Ramey (2013) show that an upward trend of the markup began in the early 1980s. The rise in the markup coincides with the more aggressive role of monetary policy in stabilizing inflation.[67] Other studies such as Alcala and Sancho (2000) and Raurich et al. (2012) have shown using various measures that the markup has risen since 1980. De Loecker and Eeckhout (2017), Autor et al. (2020) and Barkai (2020) document the same patterns for the US economy with a firm-level approach and found the latter to be consistent with several secular trends in the last four decades, including the decline in labor share. These studies find evidence of declining competition and increasing market concentration. A growing importance of large firms that dominate the market leads to higher concentration and possibly a decrease in labor share.

Therefore, we exploit the new side condition implied by eq. (37) to fit the VES production function and obtain the estimates of the coefficients under imperfect competition. We follow the methodology of Antràs (2004) and Raurich (2012) while however diverging in two important aspects with the former and one with the latter. This means that instead of assuming a CES technology we employ a VES and rather than assuming perfect competition, we consider the price markup as a relevant determinant of the relationships at work. From this perspective our contribution to the literature lies in the obtainment of new estimates of the elasticity of substitution under imperfect competition and with a VES production function characterizing the economic relationships. Table 14 presents the new estimates of the parameters b and c.

[67] This study employs the inverse of the labor share as a measure of markup, as this can be shown to be theoretically proportional to the average markup if the production function is Cobb-Douglas. They split the resulting time series into 1950-1980 and 1980-2007 and show an increase in the mean of the markup for the post-Volcker period (1980-2007), a period in which inflation was stabilized to a much greater extent.

	1960-1980			1980-2018			**1960-2018**		
	b	*c*	***b+c***	*b*	*c*	***b+c***	*b*	*c*	***b+c***
Australia	1.07	-0.08	0.99	0.64	-0.08	0.56	0.69	-0.08	0.62
	(0.1079)	(0.063)*		(0.0336)**	(0.0755)*		(0.0181)**	(0.0432)**	
Austria	1.04	-0.49	0.55	1.26	0.26	1.51	0.65	0.29	0.94
	(0.0151)**	(0.0364)**		(0.0442)**	(0.0839)*		(0.0075)***	(0.0145)**	
Belgium	1.1	-0.17	0.93	1.32	-0.48	0.84	1.13	-0.25	0.88
	(0.003)***	(0.008)***		(0.0068)***	(0.0064)***		(0.0031)***	(0.0048)***	
Canada	0.44	-0.1	0.34	1.01	0.19	1.2	0.93	-0.17	0.75
	(0.0286)**	(0.0558)*		(0.0235)**	(0.027)**		(0.0343)**	(0.0078)***	
Denmark	0.86	0.03	0.9	0.87	-0.33	0.54	0.94	-0.08	0.87
	(0.0878)*	(0.0313)**		(0.0872)*	(0.0428)**		(0.0822)*	(0.0396)**	
Finland	0.93	-0.38	0.55	1.13	0.09	1.23	1.2	-0.03	1.17
	(0.1289)	(0.0079)***		(0.0825)*	(0.0491)**		(0.0031)***	(0.0387)**	
France	1.26	0.04	1.29	1.34	-0.09	1.25	1.23	-0.2	1.03
	(0.0368)**	(0.0017)***		(0.003)***	(0.0059)***		(0.0139)**	(0.001)***	
Germany	1.08	0.03	1.11	0.67	-0.04	0.63	0.87	0.09	0.96
	(0.0408)**	(0.0031)***		(0.0031)***	(0.0015)***		(0.0231)**	(0.0033)***	
Greece	0.85	0.03	0.88	1.2	-0.26	0.94	1.13	0.01	1.14
	(0.0369)**	(0.1528)		(0.0031)***	(0.0304)**		(0.0074)***	(0.1845)	
Ireland	1.59	-0.86	0.73	1.14	-0.07	1.06	1.09	-0.1	0.99
	(0.0257)**	(0.0416)**		(0.2585)	(0.0457)**		(0.0421)**	(0.0072)***	
Italy	0.98	-0.01	0.97	0.69	0.07	0.76	1.06	-0.11	0.94
	(0.0011)***	(0.0049)***		(0.003)***	(0.2131)		(0.0084)***	(0.0351)**	
Japan	NA	NA	NA	1.06	0.06	1.12	1.06	0.06	1.12
	-	-		(0.0336)**	(0.0088)***		(0.0175)**	(0.0015)***	
Luxembourg	1.12	0.16	1.28	0.92	-0.1	0.81	0.91	-0.03	0.88
	(0.0879)*	(0.0031)***		(0.0353)**	(0.2741)		(0.0659)*	(0.0589)*	
Netherlands	1.1	-0.24	0.86	0.54	-0.36	0.18	0.83	-0.13	0.7
	(0.0498)**	(0.0428)**		(0.0332)**	(0.0068)***		(0.0454)**	(0.0018)***	
Norway	0.53	-0.19	0.34	0.92	0.05	0.98	1.01	0.09	1.09
	(0.1854)	(0.0581)*		(0.0764)*	(0.0263)**		(0.1341)	(0.0238)**	
Portugal	0.64	0.11	0.76	0.82	0.24	1.06	0.94	0.39	1.33
	(0.0018)***	(0.028)**		(0.0088)***	(0.0068)***		(0.0291)**	(0.0046)***	
Spain	0.81	-0.02	0.79	0.39	0.21	0.6	0.88	0.05	0.93
	(0.0058)***	(0.035)**		(0.0019)***	(0.0088)***		(0.0078)***	(0.0282)**	
Sweden	1.11	-0.73	0.38	0.99	-0.07	0.92	0.78	0.05	0.83
	(0.0961)*	(0.0076)***		(0.0105)**	(0.003)***		(0.0067)***	(0.0226)**	
United Kingdom	0.95	0.18	1.13	1.04	0.07	1.12	1.1	-0.19	0.91
	(0.0175)**	(0.0124)**		(0.0936)*	(0.0467)**		(0.0275)**	(0.006)***	
United States	0.87	-0.21	0.66	1.05	-0.03	1.02	0.94	-0.08	0.86
	(0.0045)***	(0.0497)**		(0.0497)**	(0.0056)***		(0.0191)**	(0.0035)***	
Mean	0.96	-0.15	0.81	0.95	-0.03	0.92	0.97	-0.02	0.95
Standard Deviation	0.264	0.286	0.291	0.262	0.203	0.309	0.159	0.158	0.168

P-values in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table 14 - Estimates of the parameters b and c of the VES production function under imperfect competition.

b+c	1960-1980	1980-2018	**1960-2018**
>1	**4**	**9**	**6**
	France	Austria	Finland
	Germany	Canada	France
	Luxembourg	Finland	Greece
	United Kingdom	France	Japan
		Ireland	Norway
		Japan	Portugal
		Portugal	
		United Kingdom	
		United States	
<1	**15**	**11**	**14**
	Australia	Australia	Australia
	Austria	Belgium	Austria
	Belgium	Denmark	Belgium
	Canada	Germany	Canada
	Denmark	Greece	Denmark
	Finland	Italy	Germany
	Greece	Luxembourg	Ireland
	Ireland	Netherlands	Italy
	Italy	Norway	Luxembourg
	Netherlands	Spain	Netherlands
	Norway	Sweden	Spain
	Portugal		Sweden
	Spain		United Kingdom
	Sweden		United States
	United States		

Table 15 - Elasticity of substitution regimes under imperfect competition.

Source: Author’s own estimation.

It is worth nothing (Table 14) that the coefficients obtained are different with respect to those obtained in a framework characterized by perfect competition. There are 4 major changes on which we should focus our attention. First, we observe an increase in the average value of b and a reduction in that of c, but overall, the movements are such that $b + c$ has grown compared to the estimates obtained with the previous framework. However, the sum of the two parameters is on average still less than 1. The increase in the value of b concerned 16 out of 20 countries in the periods before and after 1980 and all countries considering the full sample[68], while the reduction in that of c concerned 14 countries before 1980, 12 after 1980 and 17 in the full sample. [69] Secondly, the values of b are now close to the unit which is the critical value, after which technological progress begins to play in favor of labor in determining the labor share. More specifically, b is estimated to be above one in half of the countries before 1980 (Australia, Austria, Belgium, France, Germany, Ireland, Japan, Luxembourg, Netherlands, Sweden) and after 1980 (Austria, Belgium, Canada, Finland, France, Greece, Ireland, Japan, United Kingdom, United States), while in 9/20 considering the full sample (Belgium, Finland, France, Greece, Ireland, Italy, Japan, Norway, United Kingdom). Third, it should be noted that now the estimates between the different countries are much more similar among them than they were in the previous estimation and there is a strong reduction in the standard deviation. Finally, we should acknowledge also of have a reduction in the significance of the coefficients. Indeed, while under perfect competition the number of the countries where the estimates turned out to be significant were 11/13 respectively for b and c before 1980, 14/12 after 1980 and 18/16 over the full sample now the same number has decreased to 8/8, 13/13 and 15/14 for the relative subperiods. This led to some substantial changes also in the regimes identified in Table 15. When the possibility of imperfect competition is considered, we have an overall decrease in the number of countries where $b + c$ is estimated greater than unity. More exactly, before 1980 sum of b and c is now > 1 in just 4 countries (France, Luxembourg, United Kingdom and Germany) while it used to be in 9. On the other hand, the same number increased in the estimates after 1980 and for the full sample respectively to 9 (Austria, France, Finland, Canada, Japan, United Kingdom, Ireland, Portugal, United States) and 6 (Portugal, Finland, Greece, Japan,

68 Australia, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway Portugal, Spain, Sweden, United Kingdom before 1980; Austria, Belgium, Canada, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Sweden, United Kingdom, United States after 1980.

69 Austria, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Sweden, United Kingdom, United States before 1980; Austria, Belgium, Denmark, France, Germany, Greece, Italy, Luxembourg, Netherlands, Sweden, United Kingdom, United States after 1980; Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Spain, Sweden, United, Kingdom, United States for the full sample.

Norway, France), while it was 8 and 4. Further there are interesting movements also for what concerns the countries themselves. Indeed, before 1980 only France has not been affected in its position relative to unity, while after 1980 Finland and the UK are the only two countries that have not changed group. On the other hand, as a result of the changes in the value of b and in that of c, 9 countries have changed their regime. 5 of them (Austria, Canada, Finland, Ireland, Japan, Portugal and the US) have shift upwards, while 2 have shift downward (Germany and Luxembourg). The remaining 10 (excluding Japan for which we do not have consistent estimates for the period before 1980) have not change their position to unity. France and the UK have remained above one and Austria, Belgium, Denmark, Greece, Italy, Netherlands, Norway, Spain and Sweden below. The updated starting and convergence values of σ are reported in Table 16, while the new estimate of the elasticity of substitution under imperfect competition[70], as well as a comparison of the latter and the one estimated under perfect competition are reported in Table 17.

[70] As in the previous Section, to estimate the value of the elasticity of substitution empirically, we employed the equations (22) and (35) along with the mean observed value for $(w/r) * (L/K)$.

	1960-1980		1980-2018		**1960-2018**	
	b+c	b/(1-c)	b+c	b/(1-c)	b+c	b/(1-c)
Australia	0.99	0.99	0.56	0.59	0.62	0.64
Austria	0.55	0.70	1.51	1.69	0.94	0.91
Belgium	0.93	0.94	0.84	0.89	0.88	0.90
Canada	0.34	0.40	1.20	1.25	0.75	0.79
Denmark	0.90	0.89	0.54	0.66	0.87	0.88
Finland	0.55	0.68	1.23	1.25	1.17	1.16
France	1.29	1.30	1.25	1.23	1.03	1.02
Germany	1.11	1.11	0.63	0.64	0.96	0.96
Greece	0.88	0.87	0.94	0.95	1.14	1.14
Ireland	0.73	0.85	1.06	1.06	0.99	0.99
Italy	0.97	0.97	0.76	0.74	0.94	0.95
Japan	NA	NA	1.12	1.13	1.12	1.13
Luxembourg	1.28	1.33	0.81	0.83	0.88	0.88
Netherlands	0.86	0.89	0.18	0.40	0.70	0.74
Norway	0.34	0.44	0.98	0.97	1.09	1.10
Portugal	0.76	0.72	1.06	1.08	1.33	1.53
Spain	0.79	0.79	0.60	0.50	0.93	0.92
Sweden	0.38	0.64	0.92	0.93	0.83	0.82
United Kingdom	1.13	1.15	1.12	1.13	0.91	0.93
United States	0.66	0.72	1.02	1.02	0.86	0.87
Average	0.81	0.86	0.92	0.95	0.95	0.96
Standard Deviation	0.29	0.25	0.31	0.31	0.17	0.19

Table 16 - Starting/Convergence values of the Elasticity of Substitution under imperfect competition.

Source: Author's own estimation.

Country	1960-2018 CES	VES (perfect)	VES (imperfect)
Australia	1.13	NA	NA
Austria	1.06	1.00	1.00
Belgium	0.90	0.77	0.87
Canada	1.08	0.48	0.77
Denmark	1.07	0.71	0.88
Finland	1.15	0.97	1.16
France	1.04	1.34	0.97
Germany	1.19	0.95	0.98
Greece	1.25	1.47	1.14
Ireland	1.26	0.28	0.98
Italy	1.18	1.54	0.93
Japan	1.52	1.14	1.13
Luxembourg	1.48	0.73	0.88
Netherlands	0.77	0.68	0.73
Norway	1.21	0.75	1.10
Portugal	1.01	0.75	1.72
Spain	1.02	0.94	0.94
Sweden	1.10	0.61	0.82
United Kingdom	1.10	1.13	0.88
United States	1.06	0.94	0.85
Mean	1.13	0.90	0.99
Median	1.10	0.94	0.94
Standard Deviation	0.17	0.32	0.22

Table 17 - Estimates of the Elasticity of Substitution 1960-2018 (perfect vs imperfect competition).

Source: Author's own estimation.

Figure 17 - The elasticity of substitution estimated with the VES (perfect vs imperfect competition).

Note: Estimation period 1960-2018 for both CES and VES specifications. *Source:* Author’s own elaboration.

What emerges from Table 14 and Figure 17 is that the elasticity of substitution as estimated when markets are characterized by imperfect competition and firms charge a markup over unit labor cost seems to be higher with respect to that estimated in the previous section with the hypothesis of perfect competition. The elasticity, again, is statistically different from the Cobb-Douglas assumption of 1, but the estimated values are now very close to unity. On average we found an elasticity of substitution slightly lower than 1 on the period 1960-2018 (0.99), while it used to be 0.90 on the same period when perfect competition was considered. However, this difference is mostly given by the magnitude of the bias introduced in some countries (namely Portugal and Ireland) whose respective values are now higher respectively of 0.97 and 0.7 points. Indeed, if we look at the median value, we obtain almost the same value using one framework or the other (0.936 under perfect competition against 0.937 under imperfect competition). Further, just like what happens for the coefficients of the production function we observe a decrease in the dispersion between individual results which now fluctuate more compactly around the unity value, with a standard deviation of roughly 0.22 in contrast with the 0.32 obtained under perfect competition. Elasticity of substitution turns out to be above one in Portugal, Finland, Greece, Japan, Norway and Austria (respectively 1.72, 1.16, 1.14, 1.13, 1.10 and 1.00) while it was in Italy, Greece, France, Japan, United Kingdom and Austria (respectively 1.54, 1.47, 1.34, 1.14, 1.13 and 1.00). Furthermore, 5 times out of 19 the additional hypothesis of imperfect competition cause the elasticity to shift away from one (Austria, Finland, Portugal, Spain and the United States) while in the other cases (Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Sweden and the UK) the distance between the estimated value and the unity is reduced. Indeed, if we look at the absolute mean value of the deviation with respect to unity, this latter specification is the most similar to a standard Cobb Douglass, with an average deviation of 0.15 points, against 0.16 obtained with the CES and 0.27 with the VES under perfect competition. Consistently with the recent results of Karagiannis et al. (2005)[71], such values suggest that in the case of richer countries the Cobb-Douglas assumptions are close enough to reality for many purposes. We can draw two important conclusions from this empirical analysis: (i) On the one hand, some countries are very likely to have an elasticity of substitution above 1 as these results have been confirmed also in this framework. This is the case of Greece, Japan and Austria, which we

[71] Karagiannis et al. (2005) tested whether the elasticity of substitution varies continuously with capital intensity. They estimated a variable elasticity of substitution production function which allows the elasticity to change with the capital-labor ratio. The elasticity was statistically different from the Cobb-Douglas assumption of 1.0, but the estimated values were very nearly unity; Japan's ranged from 1.006 to 1.024 and the American values were 1.008 to 1.031, depending on the specification.

place respectively at 1.14, 1.13 and 1; On the other hand, for the same reason, some others are very likely to have an elasticity of substitution below 1. This is the case of Belgium, and the Netherlands which we place respectively at 0.87 and 0.73. Finally, there is also a consistent number of countries where the evidence is mixed. (ii) Omitting the degree of imperfect competition produces a significant bias. This latter is towards a unit elasticity of substitution between capital and labor in some countries (including Spain and the US, which is in line with the results of Raurich et al., 2012), therefore providing spurious support to the Cobb-Douglas specification in these cases and away from unity in others. Further, the extent of this bias seems to be correlated to the magnitude of the elasticity of substitution in that countries (if we compute the correlation between the increase in the absolute differences from a unitary elasticity and the growth rate of markup, we find a value of 0.62). In other words, the assumption of perfect competition introduces a bias on the estimates of the elasticity which differs depending on the estimated value. To conclude we replicate the exercise of simulation that we did in the last section by considering the variation of the labor share explained by the trajectory of the price markup. To address this issue, we relied on equation (38) to simulate the path of the labor share of income. The variables used as inputs are the same of the previous simulation (with the updated estimates of the coefficients of the production function) plus our measure of the price markup. Exactly as we did in the last section, the value of the LS is set so that the simulated labor share coincides with actual labor share of income at basic factor cost in the initial period. Before proceeding we need to update the estimates of the constant growth rate of the technological progress which are shown in Table 18.

	1960-1980			1980-2018			**1960-2018**		
Country	λ	(1-b) λ	b>1	λ	(1-b) λ	b>1	λ	(1-b) λ	b>1
Australia	2.82%	-0.20%	YES	1.92%	0.70%	NO	1.63%	0.50%	NO
	(0.2257)			(0.0396)**			(0.0583)*		
Austria	-40.91%	1.80%	YES	1.18%	-0.30%	YES	0.85%	0.30%	NO
	(0.0301)**			(0.0044)***			(0.0087)***		
Belgium	-1.03%	0.10%	YES	-0.62%	0.20%	YES	-1.56%	0.20%	YES
	(0.0779)*			(0.0386)**			(0.0213)**		
Canada	2.33%	1.30%	NO	30.00%	-0.30%	YES	5.41%	0.40%	NO
	(0.0263)**			(0.0079)***			(0.0089)***		
Denmark	0.00%	0.00%	NO	3.88%	0.50%	NO	3.51%	0.20%	NO
	(0.0725)*			(0.01)**			(0.0013)***		
Finland	31.88%	2.20%	NO	3.73%	-0.50%	YES	1.54%	-0.30%	YES
	(0.0034)***			(0.0028)***			(0.0091)***		
France	3.50%	-0.90%	YES	0.59%	-0.20%	YES	-0.44%	0.10%	YES
	(0.0216)**			(0.003)***			(0.034)**		
Germany	5.13%	-0.40%	YES	0.61%	0.20%	NO	0.00%	0.00%	NO
	(0.022)**			(0.0018)***			(0.0054)***		
Greece	4.00%	0.60%	NO	0.49%	-0.10%	YES	2.34%	-0.30%	YES
	(0.0167)**			(0.1109)			(0.0333)**		
Ireland	-3.21%	1.90%	YES	-1.48%	0.20%	YES	-3.37%	0.30%	YES
	(0.0223)**			(0.0405)**			(0.0092)***		
Italy	11.11%	0.20%	NO	0.64%	0.20%	NO	-5.17%	0.30%	YES
	(0.0045)***			(0.004)***			(0.0244)**		
Japan	NA	NA	YES	3.45%	-0.20%	YES	3.45%	-0.20%	YES
	-	-		(0.2923)			(0.0876)**		
Luxembourg	5.88%	-0.70%	YES	0.00%	0.00%	NO	0.00%	0.00%	NO
	(0.0855)*			(0.3146)			(0.0981)*		
Netherlands	-4.12%	0.40%	YES	2.17%	1.00%	NO	4.22%	0.70%	NO
	(0.048)**			(0.0422)**			(0.0058)***		
Norway	4.43%	2.10%	NO	0.00%	0.00%	NO	16.67%	-0.10%	YES
	(0.0587)*			(0.0257)**			(0.0056)***		
Portugal	4.49%	1.60%	NO	-1.09%	-0.20%	NO	-13.11%	-0.80%	NO
	(0.0133)**			(0.092)*			(0.045)**		
Spain	6.70%	1.30%	NO	0.66%	0.40%	NO	2.42%	0.30%	NO
	(0.0406)**			(0.0418)**			(0.0425)**		
Sweden	-20.95%	2.20%	YES	12.50%	0.10%	NO	1.78%	0.40%	NO
	(0.0737)*			(0.0048)***			(0.0007)***		
United Kingdom	-14.00%	-0.70%	NO	4.76%	-0.20%	YES	0.00%	0.00%	YES
	(0.0388)**			(0.0289)**			(0.0008)***		
United States	3.82%	0.50%	NO	0.00%	0.00%	YES	4.84%	0.30%	NO
	(0.0151)**			(0.0279)**			(0.0008)***		
Mean	0.64%	0.71%		1.47%	0.04%		1.33%	0.14%	
Standard Deviation	0.143	0.011		0.070	0.004		0.055	0.003	

P-values in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table 18 - Average annual growth rate of technological progress (λ) under imperfect competition.

Table 18 tell us that on average the estimated growth rate of technical change under imperfect competition is higher by 0.09 percentage points a year before 1980, and lower by 0.32 percentage points a year after 1980. When the whole period is considered the reduction amount to a total of 0.21 percentage points. It should also be noted that there is now a sharp decrease in the rate of technological progress estimated before and after 1980 (from 0.7% a year to 0.08%). For what concerns the significance of the new estimates we have (excluding the period after 1980) an increase in the number of countries where the coefficients are likely to be different from 0 (from 7 to 13 before 1980 and from 14 to 16 over the full sample). With the updated coefficients and by including the markup in the simulation, just like we did before, we can infer to what extent the price markup plays a dominant role in explaining the actual trajectories of the labor share in the countries analyzed. The new simulations are plotted in Figure 18 and their fit is evaluated in Table 19. The resulting time series provide the closest approximation to the actual labor share trajectories in all the economies considered.

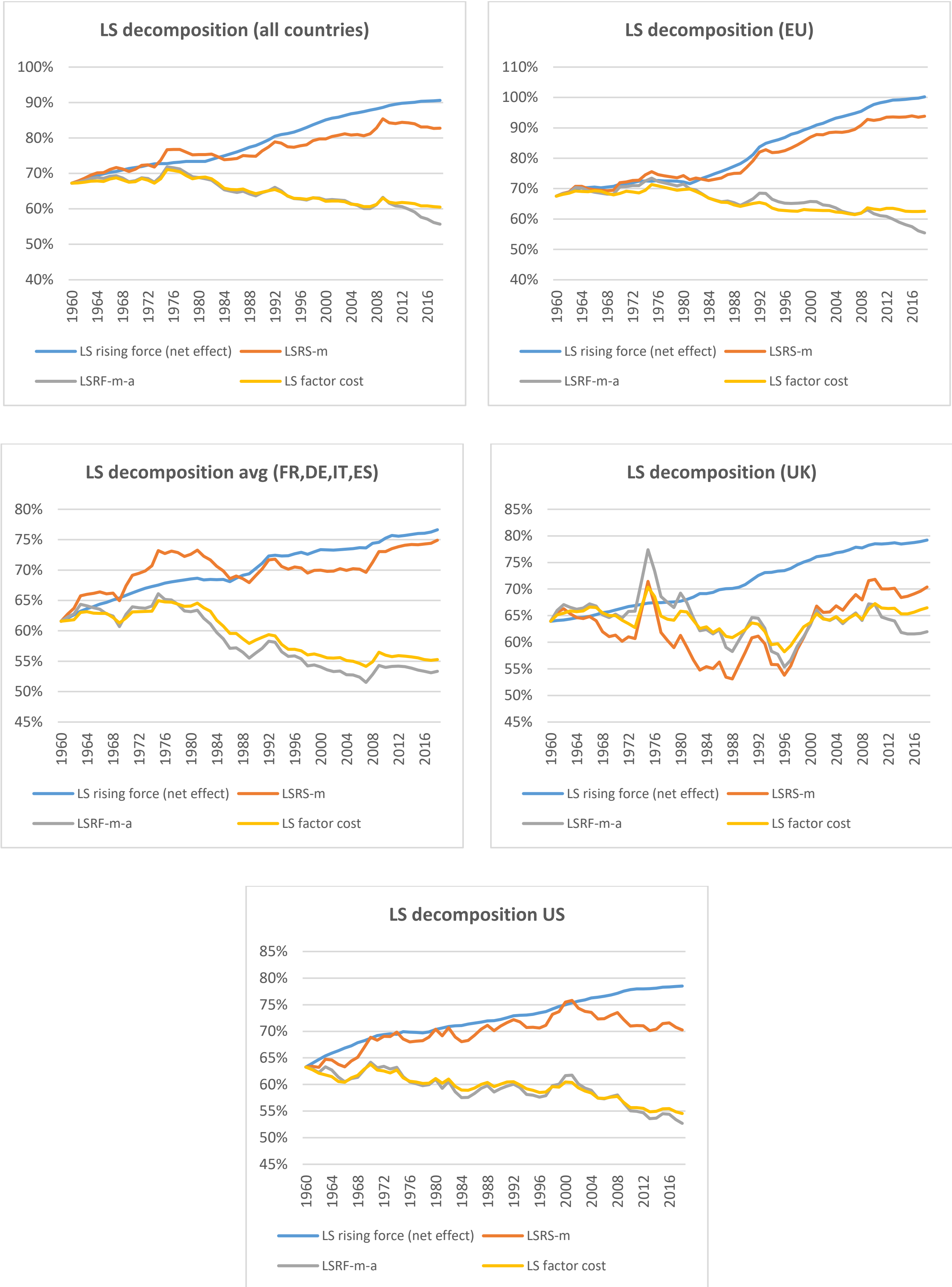


Figure 18 - Simulated labor shares under imperfect competition.

Note: $LS\ rising\ force$ is the net effect of the labor share rising forces, $LSRS-m$ is the net effect of the labor share rising forces less the effect of Markup, $LSRS-m-a$ is the net effect of the labor share rising forces less the effect of Markup and technology, and finally, LS_fc is the observed adjusted wage share as a percentage of GDP at current factor cost. *Source:* Author's own simulation.

	RSS		R^2	
	Split	Full	Split	Full
Australia	0.01	0.012	0.965	0.974
Austria	0.004	0.005	0.829	0.865
Belgium	0.002	0.003	0.977	0.972
Canada	0.008	0.008	0.82	0.824
Denmark	0.004	0.001	0.743	0.79
Finland	0.009	0.012	0.968	0.962
France	0.002	0.002	0.988	0.988
Germany	0.000	0.002	0.969	0.956
Greece	0.004	0.05	0.956	0.957
Ireland	0.033	0.027	0.973	0.972
Italy	0.003	0.009	0.98	0.979
Japan	0.002	0.002	0.996	0.996
Luxembourg	0.001	0.003	0.947	0.936
Netherlands	0.002	0.008	0.754	0.574
Norway	0.004	0.006	0.984	0.971
Portugal	0.001	0.003	0.957	0.936
Spain	0.001	0.002	0.985	0.924
Sweden	0.001	0.002	0.938	0.909
United Kingdom	0.001	0.003	0.908	0.86
United States	0.000	0.001	0.985	0.978
Mean	0.005	0.008	0.931	0.916

Table 19 - Simulated labor shares' fit (imperfect competition).

Note: RSS = Residual sum of squares; the R^2 and the RSS are obtained from regressing the actual trend-component of the LS on a constant and the simulated LS in each scenario. *Source:* Author's own calculation.

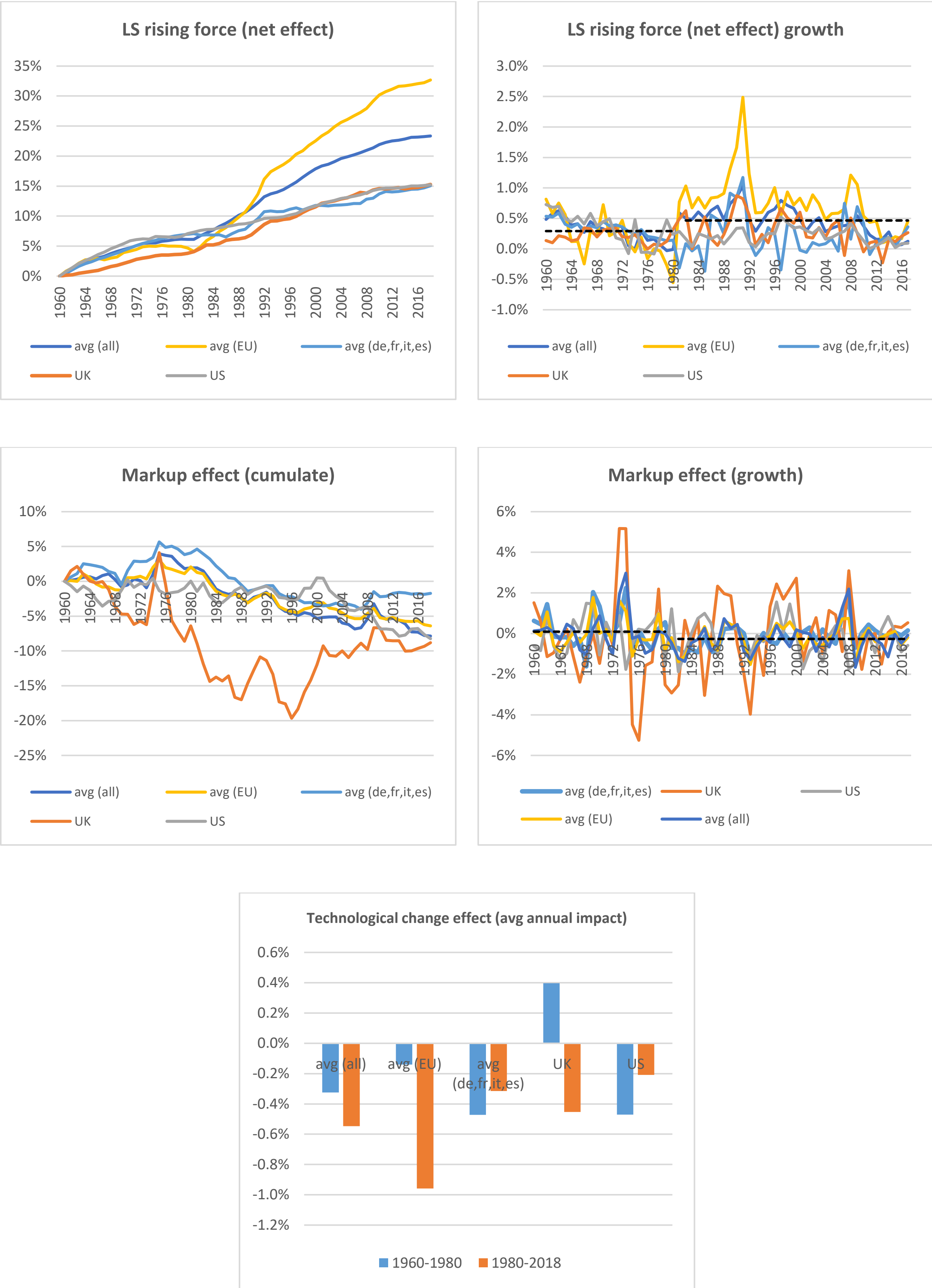


Figure 19 - Labor Shares rising/lowering forces net effect, markup and technological effects and growth rates.

Source: Author's own simulation.

As we can see from Figure 18 in all the countries considered the net effect of the labor shares rising forces has been largely positive over the period, and apart from an initial period (up to the mid-1990s) in the UK it would have been even net of the negative effect of the markup. In fact, even excluding the effects of this last factor, what we observe is a growth in the labor share, stronger in Europe (including continental) and weaker in Anglo-Saxon countries, but still positive (+ 6% in the UK and +7 % in the US). This latter factor has played in some cases in favor of labor before the early 80s (except for the Anglo-Saxon countries and with a more marked effect in France, Germany, Italy and Spain), while from this point forward it has always had a negative effect on the labor share (especially in the United Kingdom). Indeed, if we look at the average for all the countries in Figure 19, we have a slightly positive value before 1980 (to underline that in those years the dynamics related to the markup, have positively affected the labor share), which then becomes negative in the following years (-0.26% a year on average from 1980 onwards). However, even by considering the markup, most of the negative variation observed in the labor share must instead be attributed to technological progress. Technological change, except in the UK before 1980 and especially in European countries after 1980 has always disadvantaged (in a marked way) labor in the determination of the relative share (figure 19). Further, its negative effect became much stronger after 1980. Europe has been the one most affected by the adverse effect of technology, with technological change that has eaten 0.46 points of labor share every year starting from 1980 (0.36 in continental EU). On the other hand, this factor seems to have played a much smaller role in the United States, where the annual contribution to the decline of the labor share has been only of 0.09%. With the addition of markup into the story we have also a redefinition of the relative strength of factors in determining the overall movement of the labor share in value added and hence the amount of information each variable contributes to the labor share.

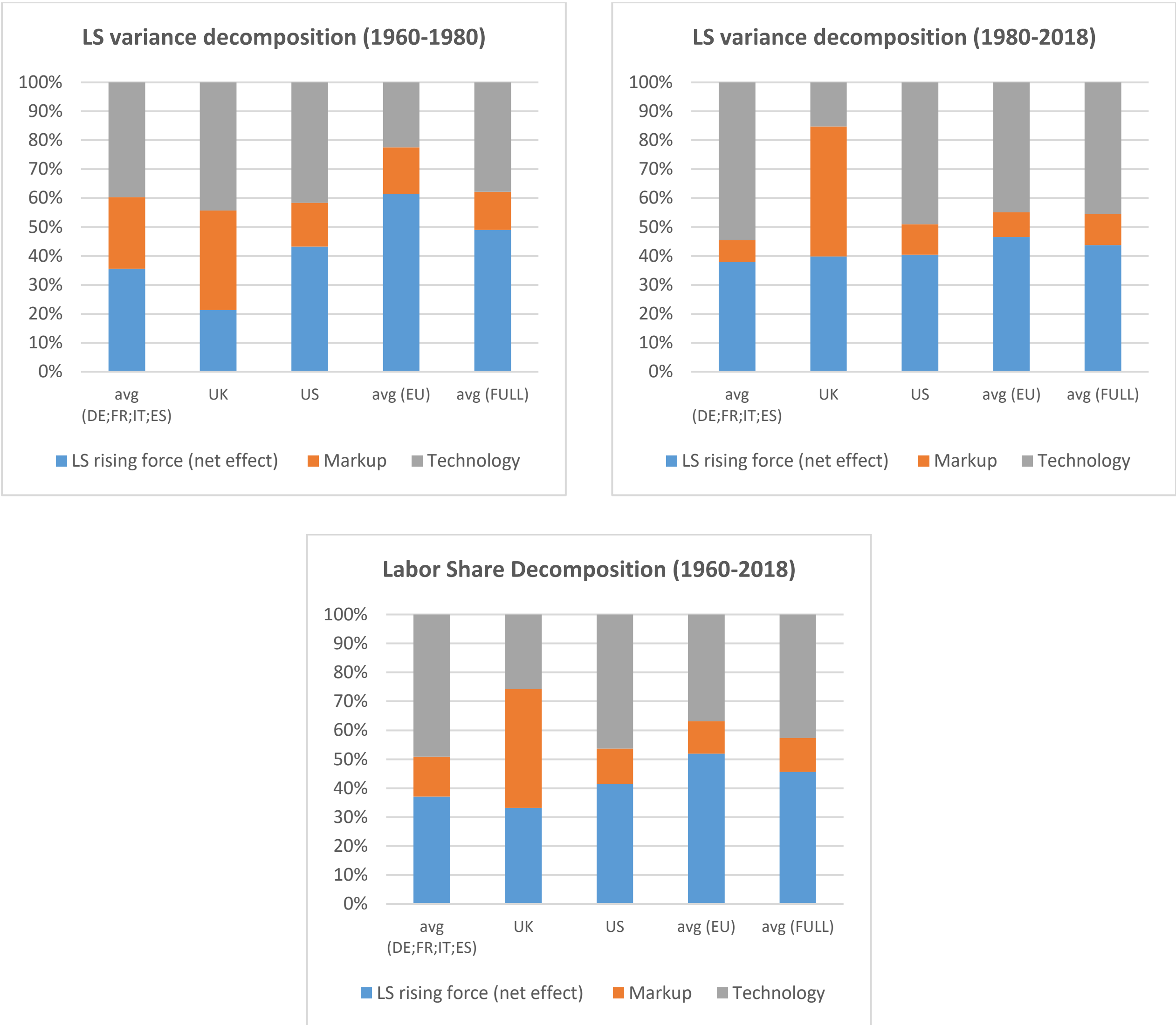


Figure 20 - Labor share variance decomposition under imperfect competition.

Source: Author's own simulation.

	1960-1980				
	avg (DE,FR,IT,ES)	UK	US	avg (EU)	avg (all)
LS rising force (net effect)	35.65%	21.31%	43.24%	61.52%	49.01%
Markup	24.68%	34.38%	15.10%	15.99%	13.23%
Technology	39.68%	44.31%	41.66%	22.49%	37.76%
	1980-2018				
	avg (DE,FR,IT,ES)	UK	US	avg (EU)	avg (all)
LS rising force (net effect)	37.96%	39.90%	40.42%	46.51%	43.77%
Markup	7.51%	44.86%	10.60%	8.54%	10.83%
Technology	54.53%	15.24%	48.98%	44.95%	45.40%
	1960-2018				
	avg (DE,FR,IT,ES)	UK	US	avg (EU)	avg (all)
LS rising force (net effect)	37.12%	33.17%	41.44%	51.94%	45.67%
Markup	13.72%	41.07%	12.23%	11.23%	11.70%
Technology	49.15%	25.76%	46.33%	36.82%	42.63%

Table 20 - Labor shares' variance decomposition.

Source: Author's own calculation.

Figure 20 and Table 20 show the relative contribution of each of these forces to the overall change in the labor share for the period considered. On average (all countries), before 1980 we found that roughly 49% of the movement in the labor share can be explained by the dynamics of wages and those of the K/L ratios (whose net interaction led the labor shares upwards), and around 38% can be attributed to by those of technology. The residual 13% is the contribution of Markup. These two factors have both lowered the labor share. In the same period the weight of technology and that of markup were above the average in the aggregate of countries that we have called Continental Europe (Germany, France, Italy, Spain, the UK and the US), with technology accounting for respectively 40%, 44% and 42% and the markup for respectively 25%, 34% and 15%. On the other hand, the interplay of wages and capital (what we have called the net effect of the labor share rising force) was particularly important in the EU where it explained around 62% of the total movement in the labor share. If we look at how the composition of the variance has changed in the transition from before to after 1980, we should notice how, except for the UK a small reduction in the role of the markup and in that of the labor share rising force which now account for respectively around 11% and 44% of the total variation. In contrast, the importance of technology is much higher everywhere, and now, alone, can explain around 45% of the decline the observed in the labor share. The conclusion we draw from this exercise is threefold. First, our model can proxy in an accurate way the path followed by the labor share of income in last decades in all the economies considered. Second, both the price markup, capital deepening and technology contribute to explain this path, although the role of technology is clearly more determinant. Third, the explanatory power of capital deepening is lower in continental Europe and higher in the US. This is consistent with the larger ratio of capital stock per employee in the US. These results confirm some recent findings of IMF (2017) which claims that in advanced economies, about half of the decline in labor shares can be traced to the impact of technology. As we have already discussed it has been shown by literature that the decline was driven by a combination of rapid progress in information and telecommunication technology (ICT), and a high share of occupations that could be easily automated. However, as we have already noted, when $b < 1$ and hence technological progress its bias toward one factor (in this case capital), the key to the decline of the labor share lies also in the speed of technological change which can accelerate or slow down the process. In other words, modern technology is very likely to be "capital-biased", namely it aims to replace labor by machines over time. As Krugman (2012) put it: "The effect of technological progress on wages depends on the bias of the progress; if it's capital-biased, workers won't share fully in productivity gains, and if it's strongly enough capital-biased, they can actually be made worse off." From this perspective, in line with traditional neoclassical explanation, when $b + c$ are greater than one, means that also the elasticity of substitution is greater than one and hence an increasing use of capital by firms does not diminish its return. Those with capital would increasingly gain (at the expense of labor) by investing their capital. This interpretation which is at the heart of Piketty's "Capital in the Twenty-First Century" is nothing new also in Marxist economic theory. Investments under capitalism occur only for profit, not to increase production or productivity as such. If profit cannot be increased sufficiently by means of more hours of work or by stepping up efforts, then the only way to increase labor productivity is through a better technology. Thus - in Marxist terms - the amount of capital (the ratio between machinery and equipment and the number of workers) will increase secularly. Workers can struggle to maintain most of the new value they have created as part of their compensation, but capitalism will invest for growth only if that share does not increase so much as to decrease profitability. So capitalist accumulation implies a decrease in the labor share over time.

8. Concluding remarks

What determines the relative income shares of workers and capital owners? This paper presents a novel (and alternative) theoretical framework that simultaneously provides micro-foundations for two key aspects of this question: production and distribution. The theory predicts that the behavior of factor income shares depends upon the parameters of the production function b and c which in turn reflect the combination of structural and institutional conditions of the economy, the growth rate of real wages, the growth rate of the capital-labor ratios, and the rate of technical progress. More specifically, we reexamined the dynamics of the labor share using a model based on a production function characterized by the property of variable elasticity of substitution (VES) in a context where product markets are considered imperfect.

In this sense, our contribute to the literature is twofold. (i) We provide updated time series to document the global decline of the labor share that started 38 years ago and set up a flexible framework to offer an alternative explanation for it. We believe that the most important contribution of the paper lies in the rationale behind the different values. All the economies investigated have experienced different declining path of the labor income shares and, at the same time, differ trajectories in the evolution of capital deepening and real wages. Hence the paper reconciles these facts by unveiling the connection between these variables, the elasticity of substitution and technological progress. As a result of this, we claim that our explanation carries with it significantly implications. We believe that this is an important result of the paper. (ii) We provide also new (and possibly unbiased) estimates of the elasticity of substitution between capital and labor. In accordance with some recent empirical literature, we found evidence for the elasticity to be currently larger than one in some countries (Austria, Canada, Finland, France, Ireland, Portugal, the UK and the USA) and lower than one in others (Belgium, Denmark, Germany, Greece, Italy, Japan, Luxembourg, Netherlands, Norway, Spain and Sweden). We observe that σ has been below unity on average, fluctuating around 0.3-1.5 and 0.7-1.7 depending on the specification. Further, our empirical results for the aggregate production function imply that this crucial parameter has been systematically positively related to the capital-labor ratio. In showing this, the paper also uncovers the bias that the assumption underlying the CES production function and that of perfect competition introduces in the estimates. This bias drive most of the existent estimated elasticity of substitution towards one regardless of whether the estimate is placed above or below. This is even more important if we consider that in standard macroeconomic models small differences in the value of this parameter have very strong implications for the relationship between the other aggregated variables. (iii) We provide a quantitative evaluation of the extent to which the trajectory of the labor share is explained by each of the factors identified with theory. This is obtained through a simulation exercise to examine quantitatively some of its basic predictions. Overall, the theory can explain much of the behavior of factor shares over a period of more than fifty years and the model yields predictions that are broadly consistent with the empirical data. The results confirm some of the findings of the previous literature and reveal new ones. Variance decompositions suggest that technological change is indeed a key driver of the behavior of factor shares and accounts on average for roughly 43% of the total movement of the labor share. However, also the other factors, such as real wages and capital deepening (46%), the markup (11%) and the structural/institutional conditions of the economy (through a change in the parameters of the production function) have had a not negligible weight in explaining the aggregate decline of the labor share. The empirical findings in this paper open some relevant issues and suggest several paths for future research. (i) The first one concerns the investigation of the causes behind these relevant different in terms of elasticity of substitution (and hence in the value of the structural/technological parameters) between the countries considered. This is crucial to have a clearer idea on the possibilities of intervention for the policy makers. Among others, some potential candidates are differences in the sectoral composition of GDP, in the composition of the labor force (skilled/unskilled), and in the institutional environment. (ii) The second one concerns the secular decline of the labor share which seems to suggest that non-unitary elasticities of substitution in production may be an important element to incorporate in growth models. Also, the fact that the elasticity of substitution between capital and labor change over time seems to be a real possibility to keep in mind. Standard macroeconomic models do not allow for long-term trends in labor shares, a strong prediction which we show to be violated in the data since the early 1980s. In this perspective we hope that our results can contribute to generate new frameworks and analyses useful to account for these new trends. (iii) The third one relates to the high correlation between capital deepening and the price markup. The explanation of this finding would obviously require considering models with endogenous markups. (iv) On the econometric level, extending our methodology to non-linear models, for example non-linear regression as in Karagiannis et al. (2005) also represents a new and interesting avenue for future research. Or more simply one could plan to examine the robustness of our OLS results by correcting for the fixed effects to capture country-specific characteristics (e.g., geography, political factors or culture), that might affect aggregate output and endogeneity problems usually cited in the literature.

Appendix A: mathematical appendix [72]

Here we present details of mathematical derivations of the results presented in the main text. The broad ideas and intuitions are discussed there; therefore, here we focus on the technical aspects.

(i) Derivation of the production function

Recall the empirical relationship of (3) in the main text:

$$ln\, y = \beta_1 + \beta_2\, ln\, w + \beta_3\, ln\, k + e \qquad \text{(A1)}$$

Where:

- y is the productivity of labor;
- k is the capital-labor ratio;
- w is the real wage rate;
- β_1 and β_2 are parameters;
- e is a random variable.

Assuming that the production function is homogeneous of degree (i.e., CRS) one we can rewrite the latter as: $y = F(k)$. If both the labor and product markets are competitive, then:

$$w = y - k\,\frac{dy}{dk} \qquad \text{(A2)}$$

By substituting A2 into A1, we get the following differential equation:

$$ln\; y = \beta_1 + \beta_2\, ln\left(y - k\,\frac{dy}{dk}\right) + \beta_3\, ln\, k \qquad \text{(A3)}$$

Solving for (dy/dk) results in:

$$\frac{dy}{dk} = \frac{y}{k} - \alpha k^{-\frac{c}{b}-1} y^{\frac{1}{b}} \qquad \text{(A4)}$$

Where $\alpha = a^{-\frac{1}{b}}$

[72] Note that the Appendix (both 1 and 2) follows a different numbering from the rest of the paper.

The differential equation obtained is non-linear. But note that being a Bernoulli differential equation in the form $y' = a(t)y + f(t)y^n$ with $n \neq 1$, it can be re-written in a more convenient standard linear form. By employing the substitution $z = y^{1-\frac{1}{b}}$ for the dependent variable we have a differential equation in x and z that is linear, and hence can be solved using the integrating factor method. If we define $\eta = \frac{(1-b)}{(1-b-c)}$, we can write z in a more compact form:

$$z = \alpha\eta k^{-\frac{c}{b}} + Ck^{1-\frac{1}{b}} \tag{A5}$$

Where $\eta = \frac{(1-b)}{(1-b-c)}$ and C is the constant of integration. By transforming z back to y, setting $\rho = (1-b)/b$, $\alpha = (1-\delta)\gamma^{-\rho}$ and $C = \delta\gamma^{-\rho}$ we obtain the following production function:

$$Y = \gamma\left(\delta K^{-\rho} + (1-\delta)\eta\left(\frac{K}{L}\right)^{-c(1+\rho)} L^{-\rho}\right)^{-\frac{1}{\rho}} \tag{A6}$$

Notice that this latter has the same form of a standard CES function except that $L^{-\rho}$ is multiplied by $\eta\left(\frac{K}{L}\right)^{-c(1+\sigma)}$. If $c = 0$, $\eta\left(\frac{K}{L}\right)^{-c(1+\sigma)} = 1$ and the VES of Lu and Fletcher (1968) reduces to the CES function.

(ii) Linear homogeneity (i.e., CRS)

It can be readily shown that the production function has the property of first-degree homogeneity such that $F(tK, tL) = tF(K, L)$ where t is a constant. When the production function $Y = F(K, L)$ is homogeneous of degree n, then $\frac{Y}{L^n} = F(\frac{K}{L}, 1)$. By setting $\frac{Y}{L^n} = y$ and $\frac{K}{L} = k$ the production function can be rewritten in the form of $y = f(k)$. If both product and labor markets are competitive, then $w = L^{n-1}(nf - kf')$. Setting $w^* = \frac{w}{L^{n-1}}$. Then we have $w^* = nf - kf'$ or $w^* = ny - k\frac{dy}{dk}$. In this case, the empirical relationship of $(A1)$ becomes:

$$ln\, y = \beta_1 + \beta_2\, ln\, w^* + \beta_3\, ln\, k \tag{A7}$$

Inserting the value of w^* into the above relationship results in the following nonlinear differential equation:

$$ln\, y = \beta_1 + \beta_2\, ln\left(ny - k\frac{dy}{dk}\right) + \beta_3\, ln\, k \qquad \text{(A8)}$$

Following the same procedure of before to solve the differential equation, we obtain:

$$Y = \gamma\left(\delta K^{-\rho^*} + (1-\delta)\eta^*\left(\frac{K}{L}\right)^{-\mu} L^{-\rho^*}\right)^{-\frac{n}{\rho^*}} \qquad \text{(A9)}$$

Where:

- $\eta^* = \frac{(1—b)}{n(1—b)-c}$
- $\rho^* = n\left(\frac{1}{b} - 1\right)$
- $\mu = \frac{c(\rho^*+n)}{n}$

It can be readily shown that this production function possesses the property of $n-th$ degree homogeneity such that $F(tK, tL) = t^n F(K, L)$. Since the degree of homogeneity is characterized by the parameter n, which can assume any value, the function may represent any degree of homogeneity. This function reduces to the production function of $(A6)$ when n is unity.

(iii) Technical change

Starting from the definition of the Marginal Rate of Technical Substitution (MRTS):

$$MRTS_{K,L} = -\frac{dK}{dL} = \frac{MP_L}{MP_K} = \frac{k}{\frac{\delta}{(1-\delta)}k^A - B} \qquad \text{(A10)}$$

We can calculate the following derivatives: $\frac{dMRTS_{K,L}}{dA}, \frac{dMRTS_{K,L}}{d\delta}, \frac{dMRTS_{K,L}}{db}, \frac{dMRTS_{K,L}}{dc}$.

- Since the parameter A does not appear in the marginal technical substitution we can infer that the latter is not influenced by a change in the value of that parameter.

- Since with a change in δ the MP of K rises relative to that of L, the change is labor-saving.

$$\frac{dMRTS_{K,L}}{d\delta} = \frac{\left(\frac{-k^{\frac{(c-1)}{b}}}{(1-\delta)^2}\right)}{D^2} = \frac{-k^{\frac{(c-1)}{b}}}{D^2(1-\delta)^2} \quad \text{(A11)}$$

- A change in b is greater than zero if $log\ k > 0$. If the capital stock grows faster than the labor force, the non-neutral technical change which increases the value of the parameter b is labor-saving. If $\log(k)$ is < 0 the change may or may not be capital-saving, depending upon the relative magnitude of the two terms in the bracket.

$$\frac{dMRTS_{K,L}}{db} = -\frac{1}{D^2}\left[\left(\frac{\delta}{(1-\delta)}k^{\frac{(c-1)}{b}}\, ln\, k\, \frac{(1-c)}{b^2}\right) + \left(\frac{c}{(1-b-c)^2 k}\right)\right] \quad \text{(A12)}$$

- A change in c is less than zero if $ln\ k > 0$ and $b < 1$. In this case, the non-neutral technical change which increases the value of c is labor-saving. If $ln\ k$ is less than zero and b is greater than unity, the change is capital-saving.

$$\frac{dMRTS_{K,L}}{dc} = -\frac{1}{D^2}\left[\left(\frac{\delta}{(1-\delta)}k^{\frac{(c-1)}{b}} \ln k \frac{1}{b}\right) + \left(\frac{(1-b)}{(1-b-c)^2 k}\right)\right] \quad \text{(A13)}$$

(iv) Inada conditions

If we consider a neoclassical production function, $Y = F(K, L)$; exhibiting CRS. Defining $k = K/L$; we can then write $Y = LF(k; 1) = \mathrm{Lf(k)}$; where $f(0) = 0$; $f' > 0$; and $f'' < 0$.

- **Essential inputs**

The upper Inada condition for MP_L together with CRS implies that without capital there will be no output:

$$F(0, L) = 0 \quad \text{for any} \quad L > 0 \tag{A14}$$

In other words: capital is an essential input. To prove this claim, let $K > 0$ be fixed and let $L \to \infty$: Then $k \to 0$; implying, that $MP_L = f(k) - f'(k)k \to f(0)$. But from the upper Inada condition for MP_L we also have that $L \to \infty$ implies $MP_L \to 0$. It follows that the upper Inada condition for MP_L implies $f(0) = 0$. Since under CRS for any $L > 0$, $F(0; L) = LF(0; 1) \equiv Lf(0)$, we have hereby shown our claim. Similarly, we can show that the upper Inada condition for MP_K together with CRS implies that labor is an essential input. Consider the output-capital ratio $x \equiv Y/K$. When F has CRS, we get $x = F(1, l) \equiv g(l)$, where $l \equiv l/K$, $g' > 0$ and $g'' < 0$. Thus, by symmetry with the previous argument, we find that under CRS, the upper Inada condition for MP_K implies:

$$F(K, 0) = 0 \quad \text{for any} \quad K > 0 \tag{A15}$$

That is, without labor, no output.

- **Sufficient conditions for output going to infinity when either input goes to infinity**

Here our first claim is that when F exhibits CRS and satisfies the upper Inada condition for MP_L and the lower Inada condition for MP_K, then:

$$\lim_{L \to \infty} F(K, L) = \infty \quad \textit{for any} \quad K > 0 \tag{A16}$$

To prove this, note that Y can be written $Y = Kf(k)/k$; since $K/k = L$. Here:

$$\lim_{k \to 0} f(k) = f(0) = 0 \tag{A17}$$

By continuity and remembering that the upper Inada condition for MP_L implies $f(0) = 0$), presupposing the upper Inada condition for MP_L. Thus, for any given $K > 0$;

$$\lim_{L \to \infty} F(K, L) = K \lim_{L \to \infty} \frac{f(k)}{k} = K \lim_{k \to 0} \frac{f(k) - f(0)}{k} = K \lim_{k \to 0} f'(k) = \infty \tag{A18}$$

by the lower Inada condition for MP_K. This verifies the claim. Our second claim is symmetric with this and says: when F exhibits CRS and satisfies the upper Inada condition for MP_K and the lower Inada condition for MP_L, then:

$$\lim_{K\to\infty} F(K,L) = \infty \quad for\, any \quad L > 0 \tag{A19}$$

The proof is analogue. So, in combination, the four Inada conditions imply, under CRS, that output has no upper bound when either input goes to infinity. Therefore, we compute the following limits for our production function. We have two possible cases. When $b + c$ are positive and their sum is < 1 (i.e., when the elasticity of substitution is lower than 1) we have that:

$$\lim_{k\to\infty} MP_K = 0 \; and \lim_{k\to\infty} y/k = 0 \tag{A20}$$

$$\lim_{K\to 0} MP_K =< \infty \; and \lim_{k\to\infty} y/k =< \infty \tag{A21}$$

Indeed, for low degree of substitutability ($\rho < 0$ for the CES and $b + c < 1$ for the VES which means in each case that $\sigma < 1$) either the CES or the VES fail to comply with the lower INADA condition for MP_K. Indeed, for $k \to 0$, both y/k and $\partial y/\partial k$ approach an upper bound which is $< \infty$ and, for $k \to \infty$, y approach an upper bound which is $< \infty$. On the other hand, for higher degree of substitutability ($\rho < 0$ for the CES and $b + c < 1$ for the VES which means in each case that $\sigma > 1$) we have that:

$$\lim_{k\to\infty} MP_K => 0 \; and \lim_{k\to\infty} y/k => 0 \tag{A22}$$

$$\lim_{K\to 0} MP_K = \infty \; and \lim_{k\to\infty} y/k = \infty \tag{A23}$$

In this case, when $k \to \infty$, wither with a CES or a VES, both y/k and $\partial y/\partial k$ approach a positive lower bound which is > 0, thus violating the upper INADA condition for MP_K. When instead $k \to 0$, y approaches a positive lower bound which is > 0. In other words, when $\sigma > 1$ we are in a situation where capital is not essential and a high value of σ, i.e., above unity, might be perceived as an engine of perpetual growth. At the same time $\partial y/\partial k \to \infty$ for $k \to 0$ (so the lower INADA condition for the marginal productivity of capital holds).

(v) Labor shares under perfect competition

Under perfect competition the profit maximization condition equates the value of the marginal product of labor with the wage rate, i.e.:

$$P\frac{\partial Y}{\partial L} = w \tag{A24}$$

Since the output is measured by value added, its price (P) is unity. From (10) in the main text, we have:

$$\frac{\partial Y}{\partial L} = \alpha k^{-\frac{c}{b}} y^{\frac{1}{b}} = w \tag{A25}$$

Solving for y yields:

$$y = \frac{w^b}{\alpha^b k^{-c}} = \alpha^{-b} w^b k^c \tag{A26}$$

By substituting $\alpha = (1-\delta)/\gamma^\rho$ we can derive:

$$w\frac{\mathrm{L}}{Y} = (1-\delta)^{b}\gamma^{-b\rho} w^{1-b} \mathrm{k}^{-c} \tag{A27}$$

If we further assume that technical change is neutral and proceeds at a constant geometric rate so that $\gamma(t) = \gamma_0 e^{\lambda t}$. Then, we can obtain:[73]

$$ln\left(w\frac{L}{Y}\right) = \underbrace{b\ ln(1-\delta) + (b-1) ln\,\gamma_0}_{\beta_0} + \underbrace{(1-b)}_{\beta_1} ln\,w + \underbrace{\lambda(b-1)}_{\beta_2} t - \underbrace{c}_{\beta_3}\ ln\,k \tag{A28}$$

Or

$$ln\left(w\frac{L}{Y}\right) = \beta_0 + \beta_1 ln\,w + \beta_2 t + \beta_3 \ln k \tag{A29}$$

[73] Remember that $\rho = (1-b)/b$.

The effects on the relative factor shares of the relative supply of K and L, changes in the elasticity of substitution, and growth of the wage rates can be seen by differentiating (32) totally with respect to time (t):

$$\frac{\dot{LS}}{LS} = (1-b)\frac{\dot{w}}{w} - c\frac{\dot{k}}{k} + \lambda(b-1) \qquad \text{(A30)}$$

Where LS refers to labor's share relative to total output and a dot on the variable denotes the derivative of that variable with respect to time.

(vi) Labor shares under imperfect competition

Under imperfect competition the profit maximization condition equates the value of the marginal product of labor with the wage rate, i.e.:

$$p\frac{\partial Y}{\partial L} = w\mu \qquad \text{(A31)}$$

Since the output is measured by value added, its price (p) is unity. From (10) we have:

$$\frac{\partial Y}{\partial L} = \alpha k^{-\frac{c}{b}} y^{\frac{1}{b}} = w\mu \qquad \text{(A32)}$$

Solving for y yields:

$$y = \alpha^{-b} w^{b} \mu^{b} k^{c} \qquad \text{(A33)}$$

By substituting $\alpha = (1-\delta)A^{-\rho}$ into (12) we can derive:

$$\frac{wL}{Y} = (1-\delta)^{b} A^{-\rho b} w^{1-b} \mu^{-b} k^{-c} \qquad \text{(A34)}$$

Assume that technical change is neutral and proceeds at a constant geometric rate so that $A_t = A_0 e^{\lambda t}$. Then, we can obtain:

$$ln\left(\frac{wL}{Y}\right) = [b\,ln(1-\delta) + (b-1)\,ln\,A_0] + (1-b)\,ln\,w + \lambda(b-1)t - c\,ln\,k - b\,ln\,\mu \qquad \text{(A35)}$$

Or

$$ln\left(\frac{wL}{Y}\right) = \beta_0 + \beta_1 \, ln \, w + \beta_2 t + \beta_3 \, ln \, k + \beta_4 \, ln \, \mu \tag{A36}$$

By totally differentiating with respect to time:

$$\dot{LS} = (1-b)\dot{w} - c\dot{k} + \lambda(b-1) - b\dot{\mu} \tag{A37}$$

Appendix B: data appendix

(i) Data sources and definitions of variables

The variables we use in the estimation are constructed from the annual macroeconomic database (AMECO) of the European Commission's Directorate General for Economic and Financial Affairs which provides data based on National Accounts on the adjusted labor shares for 11 of the G20 countries and Spain. It covers with disaggregated data on a sufficient scale for most variables for the period 1960-2018.

- *Labor share at current basic prices* (LS_cp)*:* 06 Adjusted wage share. Adjusted wage share: total economy: as percentage of GDP at current prices (Compensation per employee as percentage of GDP at market prices per person employed).

- *Labor share at current factor cost* (LS_fc)*:* 06 Adjusted wage share. Adjusted wage share: total economy: as percentage of GDP at current factor cost (Compensation per employee as percentage of GDP at factor cost per person employed).

- *Labor productivity* $(y = Y/L)$*:* 03 Gross domestic product per person employed. Gross domestic product at 2010 reference levels per person employed.

- *Capital-labor ratio* $(k = K/L)$*:* 01 Net capital stock at constant prices, total economy. Net capital stock at 2010 prices per person employed: total economy: Capital intensity.

- *Rate of return to capital* (r)*:* 01 Net capital stock at constant prices, total economy. Net returns on net capital stock: total economy.

- *Real wages* (w)*:* 05 Real compensation per employee, total economy. Real compensation per employee, deflator GDP: total economy.

The number of observations available for the econometric estimation, as well as a few basic summary statistics by country aggregates for either the two subsamples or the full sample are shown in Tables A1-3.

	Acronym, var	1960-1980			
		Mean	Median	St. Dev.	Nr. Obs
Real compensation per employee	w	82.164	83.069	8.064	20
Capital output ratio	k	84.212	83.971	11.137	20
Markup	m	48.454	40.152	11.514	20
Adjusted wage share (CP)	LS_CP	0.622	0.621	0.052	20
Adjusted wage share (FC)	LS_FC	0.681	0.679	0.058	20

*variables in level (normalized)

	Acronym, var	1960-1980			
		Mean	Median	St. Dev.	Nr. Obs
Real compensation per employee	w	0.0265	0.0303	0.0247	19
Capital output ratio	k	0.0217	0.0230	0.0217	19
Markup	m	0.0592	0.0574	0.0402	19
Adjusted wage share (CP)	LS_CP	0.0001	-0.0010	0.0151	19
Adjusted wage share (FC)	LS_FC	0.0000	-0.0014	0.0170	19

*growth rates

Table A1 - Summary Statistics (1960-1980).

Note: Real compensation per employee, deflator GDP (w). Net capital stock per unit of gross domestic product at constant prices: Capital output ratio (w). Price Markup index (m or μ - see section 7 for the methodology followed to derive the time series). Compensation per employee as percentage of GDP at current prices per person employed (LS_cp). Compensation per employee as percentage of GDP at factor cost per person employed (LS_fc). All the variables are for the total economy and normalized to 1980=100.

		1980-2018			
	Acronym, var	Mean	Median	St. Dev.	Nr. Obs
Real compensation per employee	w	126.268	129.292	11.746	38
Capital output ratio	k	135.307	135.720	19.119	38
Markup	m	310.088	319.007	240.690	38
Adjusted wage share (CP)	LS_CP	0.582	0.579	0.043	38
Adjusted wage share (FC)	LS_FC	0.639	0.638	0.044	38

*variables in level (normalized)

		1980-2018			
	Acronym, var	Mean	Median	St. Dev.	Nr. Obs
Real compensation per employee	w	0.0104	0.0091	0.0176	37
Capital output ratio	k	0.0123	0.0103	0.0154	37
Markup	m	0.0292	0.0250	0.0341	37
Adjusted wage share (CP)	LS_CP	-0.0018	-0.0017	0.0102	37
Adjusted wage share (FC)	LS_FC	-0.0016	-0.0016	0.0117	37

*growth rates

Table A2 - Summary Statistics (1980-2018).

Note: Real compensation per employee, deflator GDP (w). Net capital stock per unit of gross domestic product at constant prices: Capital output ratio (w). Price Markup index (m or μ - see section 7 for the methodology followed to derive the time series). Compensation per employee as percentage of GDP at current prices per person employed (LS_cp). Compensation per employee as percentage of GDP at factor cost per person employed (LS_fc). All the variables are for the total economy and normalized to 1980=100.

		1960-2018			
	Acronym, var	Mean	Median	St. Dev.	Nr. Obs
Real compensation per employee	w	111.015	109.664	10.635	58
Capital output ratio	k	117.719	115.883	16.602	58
Markup	m	220.525	207.353	163.199	58
Adjusted wage share (CP)	LS_CP	0.580	0.578	0.046	58
Adjusted wage share (FC)	LS_FC	0.653	0.653	0.049	58

*variables in level (normalized)

		1960-2018			
	Acronym, var	Mean	Median	St. Dev.	Nr. Obs
Real compensation per employee	w	0.0164	0.0131	0.0202	57
Capital output ratio	k	0.0155	0.0137	0.0176	57
Markup	m	0.0390	0.0302	0.0362	57
Adjusted wage share (CP)	LS_CP	-0.0011	-0.0013	0.0119	57
Adjusted wage share (FC)	LS_FC	-0.0010	-0.0015	0.0137	57

*growth rates

Table A3 - Summary Statistics (1960-2018).

Note: Real compensation per employee, deflator GDP (w). Net capital stock per unit of gross domestic product at constant prices: Capital output ratio (w). Price Markup index (m or μ - see section 7 for the methodology followed to derive the time series). Compensation per employee as percentage of GDP at current prices per person employed (LS_cp). Compensation per employee as percentage of GDP at factor cost per person employed (LS_fc). All the variables are for the total economy and normalized to 1960=100.

(ii) Unit Root tests

Tables A4-11 presents stationarity tests on the variables employed in the econometric analysis of sections 5, 6 and 7 of the paper. Unit root tests are conducted based on the methodology in Dickey and Fuller (1979, 1981) and that of Phillips-Perron (1988). The first 4 tables are for the variables in level and the last four for the first differences.

Labor share - ln(LS)

	1960-1980			1980-2018			1960-2018		
	t	ADF	PP	t	ADF	PP	t	ADF	PP
Australia	0.008***	0.7116	0.7310	-0.005***	0.8071	0.8804	-0.002***	0.7057	0.7416
	(0.001)	0.5045	0.4791	(0.000)	0.0402	0.0263	(0.000)	0.5760	0.6295
Austria	0.0010	0.0753	0.0675	-0.004***	0.4161	0.4247	-0.004***	0.8773	0.8803
	(0.001)	0.2559	0.2323	(0.000)	0.8514	0.7975	(0.000)	0.3777	0.3279
Belgium	0.009***	0.9811	0.9771	-0.001***	0.3901	0.3518	0.001***	0.3236	0.2744
	(0.001)	0.7308	0.6984	(0.000)	0.3781	0.2802	(0.000)	0.8635	0.8011
Canada	-0.003***	0.8908	0.9153	-0.002***	0.4909	0.4752	-0.002***	0.4337	0.4811
	(0.001)	0.4676	0.4081	(0.000)	0.4407	0.3948	(0.000)	0.1619	0.1375
Denmark	0.004***	0.3245	0.3171	-0.002***	0.0960	0.1033	-0.001***	0.3453	0.3479
	(0.001)	0.4388	0.4839	(0.000)	0.3828	0.4219	(0.000)	0.1294	0.1372
Finland	-0.003**	0.3986	0.3012	-0.004***	0.7367	0.6958	-0.004***	0.7000	0.7045
	(0.001)	0.4688	0.4002	(0.001)	0.8255	0.7447	(0.000)	0.4284	0.3683
France	0.0010	0.6355	0.5174	-0.003***	0.1159	0.1724	-0.003***	0.7765	0.7116
	(0.001)	0.8880	0.8231	(0.001)	0.9751	0.9691	(0.000)	0.9231	0.8033
Germany	0.003***	0.5720	0.5067	-0.003***	0.3357	0.3425	-0.002***	0.7561	0.7428
	(0.001)	0.6983	0.5731	(0.000)	0.6570	0.6783	(0.000)	0.3074	0.2586
Greece	-0.018***	0.2744	0.2851	0.0000	0.1674	0.1651	-0.003***	0.0026	0.0025
	(0.002)	0.7649	0.6931	(0.001)	0.4556	0.4538	(0.001)	0.1076	0.1077
Ireland	-0.003**	0.1437	0.1233	-0.014***	0.9915	0.9902	-0.010***	0.9960	0.9966
	(0.001)	0.2413	0.2396	(0.001)	0.9102	0.8094	(0.001)	0.9313	0.8992
Italy	-0.001**	0.1498	0.1238	-0.002***	0.3998	0.3887	-0.003***	0.6366	0.6420
	(0.001)	0.2651	0.2381	(0.000)	0.8794	0.8171	(0.000)	0.6359	0.5878
Japan	NA	NA	NA	-0.005***	0.3687	0.3761	-0.005***	0.3687	0.3761
	-	-	-	(0.000)	0.6743	0.5953	(0.000)	0.6743	0.5953
Luxembourg	0.011***	0.6728	0.7201	0.0000	0.0697	0.1039	0.002***	0.0822	0.1130
	(0.003)	0.5617	0.5862	(0.000)	0.2701	0.4029	(0.000)	0.1469	0.1761
Netherlands	0.008***	0.0815	0.0133	-0.003***	0.0627	0.0527	-0.002***	0.4987	0.4473
	(0.001)	0.1259	0.1505	(0.000)	0.1017	0.1085	(0.000)	0.0307	0.0279
Norway	0.0010	0.7593	0.5780	-0.004***	0.1947	0.2168	-0.005***	0.5774	0.6361
	(0.001)	0.9959	0.9958	(0.001)	0.3819	0.3732	(0.000)	0.2062	0.2027
Portugal	0.010***	0.5332	0.4260	-0.002***	0.2126	0.2040	-0.004***	0.6656	0.5481
	(0.003)	0.9793	0.9156	(0.001)	0.4820	0.4490	(0.001)	0.4639	0.3562
Spain	0.003***	0.2753	0.2816	-0.004***	0.5920	0.5700	-0.003***	0.9559	0.9233
	(0.001)	0.7337	0.7499	(0.000)	0.4129	0.2650	(0.000)	0.1948	0.1740
Sweden	0.003***	0.1536	0.1360	-0.001**	0.0051	0.0048	-0.002***	0.5133	0.4599
	(0.001)	0.5346	0.4515	(0.000)	0.0795	0.0816	(0.000)	0.3419	0.2503
United Kingdom	0.0000	0.1165	0.0849	0.002***	0.6273	0.4840	0.0000	0.2454	0.1780
	(0.001)	0.3742	0.2987	(0.000)	0.5993	0.5096	(0.000)	0.5703	0.4663
United States	-0.001*	0.3671	0.2809	-0.002***	0.9467	0.9505	-0.002***	0.8996	0.8794
	(0.001)	0.7531	0.6268	(0.000)	0.6272	0.5671	(0.000)	0.5528	0.3885

*MacKinnon p-value for Z(t). The first p-value is without t, the second one includes a linear t.

Table A4 - Augmented Dickey-Fuller and Phillips-Perron test on ln (LS).

Real Wages - ln(w)

	1960-1980			1980-2018			1960-2018		
	t	ADF	PP	t	ADF	PP	t	ADF	PP
Australia	0.026***	0.7601	0.7588	0.008***	0.4237	0.4652	0.012***	0.0056	0.0160
	(0.001)	0.8277	0.7367	(0.000)	0.9840	0.8811	(0.001)	0.9448	0.9153
Austria	0.042***	0.1367	0.2458	0.010***	0.0789	0.2165	0.018***	0.0000	0.0000
	(0.001)	1.0000	1.0000	(0.000)	0.9941	0.9885	(0.001)	0.1248	0.3646
Belgium	0.048***	0.9401	0.9385	0.010***	0.0512	0.0651	0.020***	0.0000	0.0000
	(0.001)	0.7732	0.6191	(0.000)	0.8692	0.7967	(0.001)	0.8369	0.8652
Canada	0.017***	0.2251	0.2566	0.008***	0.8865	0.8938	0.009***	0.0489	0.0353
	(0.001)	0.9772	0.9561	(0.000)	0.1183	0.0925	(0.000)	0.1312	0.1286
Denmark	0.029***	0.0464	0.0022	0.012***	0.6340	0.5245	0.015***	0.0000	0.0000
	(0.001)	0.8344	0.8706	(0.000)	0.9661	0.9848	(0.000)	0.0087	0.0013
Finland	0.038***	0.7373	0.7427	0.015***	0.0039	0.0189	0.022***	0.0000	0.0000
	(0.001)	0.7511	0.6325	(0.001)	0.9961	0.9950	(0.001)	0.9796	0.9797
France	0.042***	0.0001	0.0005	0.010***	0.9158	0.9148	0.017***	0.0000	0.0000
	(0.001)	0.9421	0.9256	(0.000)	0.5187	0.2681	(0.001)	0.0000	0.0001
Germany	0.040***	0.1008	0.1435	0.007***	0.8634	0.8602	0.014***	0.0000	0.0000
	(0.001)	0.9968	0.9968	(0.000)	0.8519	0.7863	(0.001)	0.0098	0.0589
Greece	0.049***	0.4758	0.5349	0.007***	0.7987	0.6790	0.015***	0.0001	0.0032
	(0.002)	0.9702	0.9426	(0.001)	0.9363	0.8155	(0.001)	0.6056	0.6215
Ireland	0.041***	0.9647	0.9672	0.018***	0.3128	0.3663	0.025***	0.0015	0.0018
	(0.001)	0.4468	0.4300	(0.001)	0.9539	0.8992	(0.001)	0.9737	0.9733
Italy	0.045***	0.0004	0.0000	0.005***	0.1655	0.1510	0.015***	0.0000	0.0000
	(0.002)	0.9941	0.9962	(0.000)	0.9161	0.9158	(0.001)	0.0000	0.0000
Japan	NA	NA	NA	0.008***	0.0001	0.0001	0.008***	0.0001	0.0001
	-	-	-	(0.001)	0.7105	0.7002	(0.001)	0.7105	0.7002
Luxembourg	0.031***	0.8600	0.8667	0.009***	0.3230	0.3917	0.016***	0.0075	0.0094
	(0.001)	0.4620	0.4484	(0.001)	0.9665	0.9384	(0.001)	0.9229	0.9194
Netherlands	0.043***	0.0186	0.0773	0.009***	0.9682	0.9719	0.015***	0.0000	0.0000
	(0.002)	1.0000	1.0000	(0.000)	0.0056	0.0057	(0.001)	0.0099	0.0654
Norway	0.032***	0.1591	0.1684	0.011***	0.7263	0.7587	0.015***	0.0391	0.0174
	(0.002)	0.9906	0.9898	(0.001)	0.5444	0.5763	(0.001)	0.3007	0.3056
Portugal	0.060***	0.1463	0.3066	0.014***	0.4927	0.5448	0.023***	0.0000	0.0002
	(0.003)	1.0000	0.9968	(0.001)	0.9905	0.9743	(0.001)	0.6860	0.7172
Spain	0.055***	0.0000	0.0000	0.006***	0.2092	0.3156	0.019***	0.0000	0.0000
	(0.002)	0.5957	0.5740	(0.000)	0.7330	0.4655	(0.001)	0.0000	0.0004
Sweden	0.028***	0.0000	0.0002	0.017***	0.9690	0.9687	0.016***	0.0100	0.0419
	(0.001)	0.6970	0.7032	(0.000)	0.2759	0.2715	(0.000)	0.0388	0.0551
United Kingdom	0.022***	0.5077	0.5647	0.017***	0.6674	0.7258	0.017***	0.2790	0.4297
	(0.001)	0.9838	0.9599	(0.001)	0.9872	0.9520	(0.000)	0.9276	0.7803
United States	0.015***	0.0010	0.0005	0.014***	0.5760	0.6778	0.013***	0.0805	0.2524
	(0.001)	0.9211	0.9231	(0.000)	0.9937	0.9767	(0.000)	0.8150	0.6236

*MacKinnon p-value for Z(t). The first p-value is without t, the second one includes a linear t.

Table A5 - Augmented Dickey-Fuller and Phillips-Perron test on ln (w).

Capital-labor ratio - ln(k)

	1960-1980			1980-2018			1960-2018		
	t	ADF	PP	t	ADF	PP	t	ADF	PP
Australia	0.007***	0.9979	0.9973	0.014***	0.9971	0.9962	0.013***	0.9991	0.9988
	(0.001)	0.9822	0.9836	(0.001)	0.9705	0.9485	(0.000)	0.8568	0.7986
Austria	0.045***	0.8065	0.8541	0.015***	0.1333	0.1147	0.023***	0.0000	0.0000
	(0.001)	0.9842	0.8507	(0.000)	0.9887	0.9909	(0.001)	0.9061	0.9163
Belgium	0.032***	0.9940	0.9914	0.010***	0.0012	0.0125	0.018***	0.0000	0.0001
	(0.000)	0.3507	0.2750	(0.001)	0.5291	0.5532	(0.001)	0.9890	0.9842
Canada	-0.002***	0.1315	0.1132	0.012***	0.9977	0.9943	0.008***	1.0000	0.9991
	(0.000)	0.5904	0.6413	(0.001)	0.9827	0.9417	(0.000)	0.9460	0.9251
Denmark	0.022***	0.9821	0.9700	0.011***	0.8981	0.8976	0.014***	0.3891	0.4929
	(0.001)	0.6730	0.6119	(0.000)	0.4424	0.3228	(0.000)	0.9345	0.8713
Finland	0.044***	0.0388	0.0226	0.015***	0.1389	0.3265	0.024***	0.0000	0.0000
	(0.001)	0.9970	1.0000	(0.001)	0.9522	0.8839	(0.001)	0.7530	0.7944
France	0.039***	0.6833	0.7877	0.012***	0.0008	0.0513	0.020***	0.0000	0.0000
	(0.001)	0.9946	0.9618	(0.000)	0.1981	0.2992	(0.001)	0.4981	0.7660
Germany	0.037***	0.0072	0.0204	0.009***	0.0030	0.0344	0.017***	0.0000	0.0000
	(0.001)	1.0000	0.9970	(0.001)	0.9926	0.9845	(0.001)	0.5129	0.6423
Greece	0.071***	0.0011	0.0331	0.013***	0.7309	0.7270	0.026***	0.0000	0.0000
	(0.002)	1.0000	1.0000	(0.001)	0.8775	0.5551	(0.002)	0.0432	0.2483
Ireland	0.048***	0.9545	0.9528	0.015***	0.2139	0.3696	0.026***	0.0005	0.0321
	(0.001)	0.7793	0.6577	(0.001)	0.7379	0.5522	(0.001)	0.9314	0.8987
Italy	0.042***	0.0000	0.0000	0.012***	0.0000	0.0001	0.021***	0.0000	0.0000
	(0.001)	0.9952	0.9961	(0.001)	0.9967	0.9937	(0.001)	0.2919	0.5078
Japan	0.057***	0.9983	0.9947	0.017***	0.0000	0.0000	0.031***	0.0000	0.0001
	(0.002)	0.3781	0.5070	(0.001)	0.9964	0.9950	(0.001)	1.0000	1.0000
Luxembourg	0.014***	0.7517	0.7612	0.004***	0.2385	0.2476	0.008***	0.0184	0.0773
	(0.001)	0.8596	0.7419	(0.000)	0.2959	0.2429	(0.000)	0.5289	0.5253
Netherlands	0.036***	0.6461	0.7638	0.003***	0.9181	0.8878	0.009***	0.0007	0.0132
	(0.001)	0.9970	0.9736	(0.001)	0.9182	0.9047	(0.001)	0.3974	0.5190
Norway	0.028***	0.5485	0.3761	0.011***	0.5451	0.6466	0.017***	0.0001	0.0009
	(0.001)	0.4965	0.5432	(0.000)	0.4696	0.3568	(0.001)	0.2498	0.3085
Portugal	0.034***	0.9965	0.9948	0.026***	0.0104	0.1057	0.031***	0.1037	0.3249
	(0.002)	0.7774	0.7551	(0.001)	1.0000	1.0000	(0.001)	1.0000	1.0000
Spain	0.047***	1.0000	1.0000	0.016***	0.1575	0.3469	0.027***	0.0020	0.0891
	(0.001)	0.0112	0.0007	(0.001)	0.7022	0.3715	(0.001)	0.9924	0.9713
Sweden	0.033***	0.0019	0.0023	0.016***	0.0177	0.1031	0.022***	0.0000	0.0002
	(0.001)	0.9967	0.9969	(0.001)	0.9830	0.9649	(0.001)	0.9800	0.9680
United Kingdom	0.027***	0.8396	0.8645	0.012***	0.0278	0.0999	0.017***	0.0007	0.0165
	(0.001)	0.9856	0.9178	(0.000)	0.7098	0.5998	(0.001)	0.9883	0.9759
United States	0.007***	0.1417	0.1020	0.014***	0.9697	0.9574	0.011***	0.9949	0.9908
	(0.001)	0.6129	0.6070	(0.000)	0.8960	0.7924	(0.000)	0.9587	0.9251

*MacKinnon p-value for Z(t). The first p-value is without t, the second one includes a linear t.

Table A6 - Augmented Dickey-Fuller and Phillips-Perron test on ln (k).

Markup - ln(μ)

	1960-1980			1980-2018			1960-2018		
	t	ADF	PP	t	ADF	PP	t	ADF	PP
Australia	-0.007***	0.6291	0.6584	0.005***	0.7143	0.8414	0.002***	0.6676	0.7522
	(0.001)	0.5099	0.4887	(0.000)	0.0116	0.0124	(0.000)	0.3939	0.4760
Austria	0.003***	0.4447	0.4915	0.003***	0.8099	0.7320	0.002***	0.6364	0.5785
	(0.001)	0.5297	0.5130	(0.000)	0.6756	0.5642	(0.000)	0.6535	0.5533
Belgium	-0.010***	0.9873	0.9796	0.001***	0.2317	0.2123	-0.001***	0.3512	0.2893
	(0.001)	0.6883	0.6555	(0.000)	0.4437	0.3817	(0.000)	0.8813	0.7964
Canada	-0.001*	0.4137	0.3166	0.002***	0.3650	0.3955	0.001***	0.2052	0.2034
	(0.001)	0.5820	0.5212	(0.000)	0.2021	0.1685	(0.000)	0.1866	0.1604
Denmark	-0.003***	0.1274	0.1460	0.002***	0.1904	0.2241	0.001***	0.0925	0.1198
	(0.001)	0.1853	0.1964	(0.000)	0.2569	0.2432	(0.000)	0.0154	0.0203
Finland	0.0010	0.3765	0.2513	0.005***	0.8122	0.8060	0.004***	0.7232	0.6949
	(0.002)	0.7222	0.5753	(0.001)	0.6124	0.5330	(0.000)	0.3508	0.2679
France	-0.003***	0.4505	0.4118	0.002***	0.2006	0.2379	0.002***	0.7484	0.6447
	(0.001)	0.5184	0.4265	(0.000)	0.9508	0.9311	(0.000)	0.7703	0.6142
Germany	-0.003***	0.5717	0.5376	0.005***	0.2379	0.1603	0.004***	0.8911	0.8826
	(0.001)	0.7179	0.6182	(0.000)	0.9779	0.9936	(0.000)	0.6864	0.6420
Greece	0.017***	0.1449	0.1418	0.003***	0.5457	0.4647	0.004***	0.0155	0.0186
	(0.002)	0.8110	0.7827	(0.001)	0.6552	0.5509	(0.001)	0.0947	0.0892
Ireland	0.0000	0.0430	0.0528	0.011***	0.9879	0.9811	0.007***	0.9957	0.9955
	(0.001)	0.2090	0.2505	(0.001)	0.9621	0.8950	(0.001)	0.9679	0.9388
Italy	0.0010	0.0692	0.0674	0.0010	0.3391	0.3288	0.003***	0.5745	0.5787
	(0.001)	0.1937	0.1986	(0.001)	0.8990	0.8844	(0.000)	0.9140	0.9130
Japan	NA	NA	NA	0.005***	0.6121	0.6142	0.005***	0.6121	0.6142
	-	-	-	(0.000)	0.5437	0.4184	(0.000)	0.5437	0.4184
Luxembourg	-0.009***	0.6267	0.6431	0.001**	0.0619	0.0819	0.0000	0.0440	0.0477
	(0.002)	0.6230	0.6227	(0.001)	0.3670	0.5246	(0.000)	0.1710	0.1824
Netherlands	-0.007***	0.0904	0.0063	-0.002***	0.1265	0.1559	-0.004***	0.0926	0.0812
	(0.001)	0.0558	0.0363	(0.000)	0.2211	0.2367	(0.000)	0.0661	0.0855
Norway	-0.005***	0.4742	0.4117	0.004***	0.1305	0.1410	0.004***	0.5334	0.5814
	(0.001)	0.9588	0.9029	(0.001)	0.2889	0.2715	(0.000)	0.2303	0.2291
Portugal	-0.011***	0.5345	0.4459	0.001*	0.7429	0.6428	0.001*	0.3812	0.2459
	(0.002)	0.8482	0.6687	(0.001)	0.9134	0.8565	(0.001)	0.5566	0.4326
Spain	-0.006***	0.6692	0.6653	0.001**	0.0837	0.0939	0.001***	0.6306	0.4099
	(0.001)	0.6529	0.5852	(0.000)	0.4591	0.4290	(0.000)	0.5797	0.4280
Sweden	-0.003***	0.6594	0.5295	0.001*	0.0603	0.0564	0.002***	0.5439	0.4814
	(0.001)	0.7813	0.6363	(0.001)	0.4518	0.4797	(0.000)	0.6320	0.5225
United Kingdom	0.003***	0.4953	0.3856	-0.002***	0.5234	0.3643	0.002***	0.3742	0.3200
	(0.001)	0.5659	0.4383	(0.000)	0.4323	0.3634	(0.000)	0.8186	0.7418
United States	0.0000	0.2813	0.2133	0.002***	0.9134	0.9091	0.001***	0.8298	0.8059
	(0.000)	0.4923	0.4454	(0.000)	0.7438	0.6883	(0.000)	0.7617	0.6986

*MacKinnon p-value for Z(t). The first p-value is without t, the second one includes a linear t.

Table A7 - Augmented Dickey-Fuller and Phillips-Perron test on ln (μ).

Labor Share - dln(LS)

	1960-1980			1980-2018			1960-2018		
	t	ADF	PP	t	ADF	PP	t	ADF	PP
Australia	0.0000	0.0010	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0100	0.0108	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Austria	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0000	0.0000	(0.000)	0.0000	0.0001	(0.000)	0.0000	0.0000
Belgium	0.0010	0.0096	0.0099	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0514	0.0536	(0.000)	0.0002	0.0003	(0.000)	0.0000	0.0000
Canada	-0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0004	0.0004	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Denmark	0.0000	0.0006	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0050	0.0038	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Finland	0.0000	0.0067	0.0071	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0347	0.0372	(0.000)	0.0002	0.0003	(0.000)	0.0000	0.0000
France	0.0000	0.0044	0.0046	0.000***	0.0003	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0210	0.0218	(0.000)	0.0001	0.0001	(0.000)	0.0000	0.0000
Germany	0.0000	0.0122	0.0135	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000
	(0.000)	0.0893	0.1016	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Greece	0.0020	0.0003	0.0003	0.0000	0.0000	0.0000	0.001**	0.0000	0.0000
	(0.002)	0.0025	0.0024	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Ireland	0.0000	0.0081	0.0110	-0.0010	0.0000	0.0000	-0.001*	0.0000	0.0000
	(0.001)	0.0587	0.0767	(0.001)	0.0000	0.0000	(0.000)	0.0000	0.0000
Italy	0.0000	0.0009	0.0009	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0075	0.0071	(0.000)	0.0006	0.0007	(0.000)	0.0000	0.0000
Japan	NA	NA	NA	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
	-	-	-	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Luxembourg	0.0010	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.003)	0.0006	0.0003	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Netherlands	-0.001*	0.0000	0.0000	0.0000	0.0000	0.0000	-0.000*	0.0000	0.0000
	(0.001)	0.0000	0.0000	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Norway	-0.002**	0.1316	0.1263	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0856	0.0858	(0.001)	0.0000	0.0000	(0.000)	0.0000	0.0000
Portugal	-0.0030	0.0508	0.0471	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.002)	0.1500	0.1489	(0.000)	0.0001	0.0001	(0.000)	0.0000	0.0000
Spain	-0.0010	0.0047	0.0053	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0110	0.0110	(0.000)	0.0008	0.0009	(0.000)	0.0000	0.0000
Sweden	-0.0010	0.0458	0.0549	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.1406	0.1540	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
United Kingdom	0.0000	0.0402	0.0448	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
	(0.001)	0.2019	0.2200	(0.000)	0.0001	0.0001	(0.000)	0.0000	0.0000
United States	0.0000	0.0316	0.0340	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.000)	0.1445	0.1490	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000

*MacKinnon p-value for Z(t). The first p-value is without t, the second one includes a linear t.

Table A8 - Augmented Dickey-Fuller and Phillips-Perron test on dln (LS).

Real Wages - dln(w)

	1960-1980			1980-2018			1960-2018		
	t	ADF	PP	t	ADF	PP	t	ADF	PP
Australia	-0.0010	0.0050	0.0056	0.0000	0.0008	0.0006	-0.001***	0.0000	0.0000
	(0.001)	0.0300	0.0343	(0.000)	0.0025	0.0020	(0.000)	0.0000	0.0000
Austria	-0.001**	0.1363	0.1135	-0.000***	0.0039	0.0046	-0.001***	0.0756	0.1629
	(0.001)	0.0417	0.0410	(0.000)	0.0052	0.0067	(0.000)	0.0007	0.0005
Belgium	0.0000	0.0026	0.0021	-0.001**	0.0000	0.0000	-0.001***	0.0079	0.0127
	(0.001)	0.0172	0.0146	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Canada	-0.001*	0.0701	0.0780	0.0000	0.0000	0.0000	-0.000**	0.0000	0.0000
	(0.001)	0.1038	0.1217	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Denmark	-0.002**	0.0001	0.0001	0.0000	0.0000	0.0000	-0.001***	0.0000	0.0000
	(0.001)	0.0000	0.0000	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Finland	-0.0010	0.0108	0.0113	-0.001***	0.0024	0.0028	-0.001***	0.0001	0.0001
	(0.001)	0.0407	0.0438	(0.000)	0.0003	0.0003	(0.000)	0.0000	0.0000
France	-0.002***	0.1361	0.1847	0.0000	0.0004	0.0005	-0.001***	0.0324	0.0410
	(0.001)	0.0378	0.0430	(0.000)	0.0040	0.0048	(0.000)	0.0325	0.0471
Germany	-0.002**	0.0880	0.0966	0.0000	0.0000	0.0000	-0.001***	0.0071	0.0154
	(0.001)	0.0644	0.0717	(0.000)	0.0001	0.0001	(0.000)	0.0007	0.0007
Greece	-0.0020	0.2297	0.2300	0.0000	0.0010	0.0008	-0.001***	0.0024	0.0028
	(0.001)	0.3543	0.4215	(0.000)	0.0078	0.0065	(0.000)	0.0012	0.0012
Ireland	0.0000	0.0074	0.0091	-0.001*	0.0000	0.0000	-0.001***	0.0000	0.0000
	(0.001)	0.0439	0.0529	(0.000)	0.0000	0.0001	(0.000)	0.0000	0.0000
Italy	-0.003***	0.2589	0.3397	-0.000*	0.0000	0.0000	-0.001***	0.0223	0.0579
	(0.001)	0.0025	0.0023	(0.000)	0.0000	0.0000	(0.000)	0.0001	0.0000
Japan	NA	NA	NA	-0.001***	0.0007	0.0006	-0.001***	0.0007	0.0006
	-	-	NA	(0.000)	0.0000	0.0001	(0.000)	0.0000	0.0001
Luxembourg	0.0000	0.0000	0.0000	-0.000*	0.0000	0.0000	-0.001***	0.0000	0.0000
	(0.001)	0.0001	0.0001	(0.000)	0.0001	0.0001	(0.000)	0.0000	0.0000
Netherlands	-0.002***	0.5479	0.6495	0.0000	0.0000	0.0000	-0.001***	0.0080	0.0159
	(0.001)	0.1925	0.2367	(0.000)	0.0000	0.0000	(0.000)	0.0014	0.0014
Norway	-0.003**	0.0478	0.0500	0.0000	0.0000	0.0000	-0.001**	0.0000	0.0000
	(0.001)	0.0284	0.0307	(0.001)	0.0000	0.0000	(0.000)	0.0000	0.0000
Portugal	-0.004**	0.2052	0.2093	-0.0010	0.0006	0.0007	-0.001***	0.0023	0.0033
	(0.001)	0.1941	0.2025	(0.000)	0.0021	0.0024	(0.000)	0.0004	0.0004
Spain	-0.003***	0.0738	0.0936	0.0000	0.0267	0.0268	-0.001***	0.0288	0.0422
	(0.001)	0.0070	0.0070	(0.000)	0.0863	0.0807	(0.000)	0.0077	0.0103
Sweden	-0.002***	0.2845	0.3105	0.0000	0.0000	0.0000	-0.000***	0.0000	0.0000
	(0.001)	0.1113	0.1031	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
United Kingdom	-0.0010	0.0377	0.0408	0.0000	0.0001	0.0001	-0.000*	0.0000	0.0000
	(0.001)	0.0972	0.1074	(0.000)	0.0008	0.0006	(0.000)	0.0000	0.0000
United States	-0.001***	0.2422	0.2798	0.0000	0.0041	0.0050	-0.000**	0.0006	0.0009
	(0.000)	0.0397	0.0426	(0.000)	0.0158	0.0215	(0.000)	0.0016	0.0020

*MacKinnon p-value for Z(t). The first p-value is without t, the second one includes a linear t.

Table A9 - Augmented Dickey-Fuller and Phillips-Perron test on dln(w).

Capital-labor ratios - dln(k)

	1960-1980			1980-2018			1960-2018		
	t	ADF	PP	t	ADF	PP	t	ADF	PP
Australia	0.001**	0.0445	0.0389	0.0000	0.0011	0.0015	0.000***	0.0001	0.0001
	(0.000)	0.0015	0.0006	(0.000)	0.0042	0.0066	(0.000)	0.0000	0.0001
Austria	0.0000	0.3161	0.2627	-0.000**	0.0000	0.0000	-0.001***	0.0110	0.0202
	(0.000)	0.5332	0.5423	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Belgium	0.0000	0.0402	0.0444	-0.001***	0.0096	0.0121	-0.001***	0.0270	0.0369
	(0.000)	0.1865	0.2014	(0.000)	0.0068	0.0072	(0.000)	0.0005	0.0006
Canada	0.0000	0.0001	0.0001	0.000*	0.0054	0.0047	0.000***	0.0011	0.0012
	(0.000)	0.0001	0.0001	(0.000)	0.0287	0.0253	(0.000)	0.0001	0.0001
Denmark	0.0000	0.1718	0.1626	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.5416	0.5258	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Finland	-0.002***	0.1001	0.1136	-0.001**	0.0938	0.0749	-0.001***	0.0217	0.0288
	(0.001)	0.0136	0.0165	(0.000)	0.1750	0.1594	(0.000)	0.0045	0.0051
France	0.0000	0.3819	0.4037	-0.000***	0.2010	0.1829	-0.001***	0.3991	0.4414
	(0.000)	0.6409	0.6959	(0.000)	0.3427	0.2868	(0.000)	0.1564	0.1464
Germany	-0.002***	0.3934	0.4398	-0.001***	0.0596	0.0694	-0.001***	0.1185	0.1987
	(0.000)	0.0933	0.1079	(0.000)	0.0331	0.0424	(0.000)	0.0018	0.0025
Greece	-0.002***	0.8659	0.9084	0.0000	0.0105	0.0086	-0.001***	0.2347	0.3430
	(0.001)	0.1908	0.1955	(0.000)	0.0504	0.0421	(0.000)	0.0562	0.0579
Ireland	0.0000	0.0026	0.0023	-0.0010	0.0473	0.0439	-0.001***	0.0261	0.0345
	(0.001)	0.0206	0.0190	(0.000)	0.1190	0.0983	(0.000)	0.0131	0.0134
Italy	-0.002***	0.3851	0.5146	-0.001***	0.2551	0.3834	-0.001***	0.3131	0.5316
	(0.000)	0.0053	0.0046	(0.000)	0.0123	0.0115	(0.000)	0.0003	0.0002
Japan	0.001**	0.5145	0.4548	-0.001***	0.4180	0.4316	-0.001***	0.8118	0.7915
	(0.001)	0.9465	0.9170	(0.000)	0.0706	0.0667	(0.000)	0.1671	0.1540
Luxembourg	0.0000	0.4885	0.4234	0.0000	0.0000	0.0001	-0.000**	0.0001	0.0001
	(0.001)	0.8187	0.7636	(0.000)	0.0004	0.0005	(0.000)	0.0002	0.0002
Netherlands	-0.0010	0.9617	0.9243	0.0000	0.0000	0.0000	-0.001***	0.0001	0.0000
	(0.001)	0.9916	0.9949	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Norway	-0.0010	0.0001	0.0001	0.0000	0.0201	0.0234	-0.000***	0.0000	0.0000
	(0.001)	0.0002	0.0001	(0.000)	0.0949	0.1060	(0.000)	0.0000	0.0000
Portugal	0.0010	0.0554	0.0568	-0.001***	0.0723	0.0776	-0.000***	0.0030	0.0030
	(0.001)	0.1447	0.1488	(0.000)	0.0255	0.0227	(0.000)	0.0030	0.0034
Spain	0.002***	0.1513	0.1908	-0.001*	0.1498	0.1165	-0.001***	0.1450	0.1044
	(0.000)	0.0908	0.1109	(0.000)	0.3438	0.2706	(0.000)	0.1149	0.0871
Sweden	-0.001***	0.3137	0.3310	-0.001***	0.0425	0.0494	-0.001***	0.0200	0.0330
	(0.000)	0.0248	0.0251	(0.000)	0.0441	0.0558	(0.000)	0.0030	0.0046
United Kingdom	0.0000	0.2772	0.2683	-0.000**	0.0076	0.0063	-0.000***	0.0061	0.0063
	(0.000)	0.5084	0.5401	(0.000)	0.0099	0.0086	(0.000)	0.0019	0.0025
United States	-0.0010	0.0075	0.0085	0.0000	0.0021	0.0019	0.0000	0.0001	0.0000
	(0.000)	0.0462	0.0687	(0.000)	0.0151	0.0137	(0.000)	0.0001	0.0002

*MacKinnon p-value for Z(t). The first p-value is without t, the second one includes a linear t.

Table A10 - Augmented Dickey-Fuller and Phillips-Perron test on dln(k).

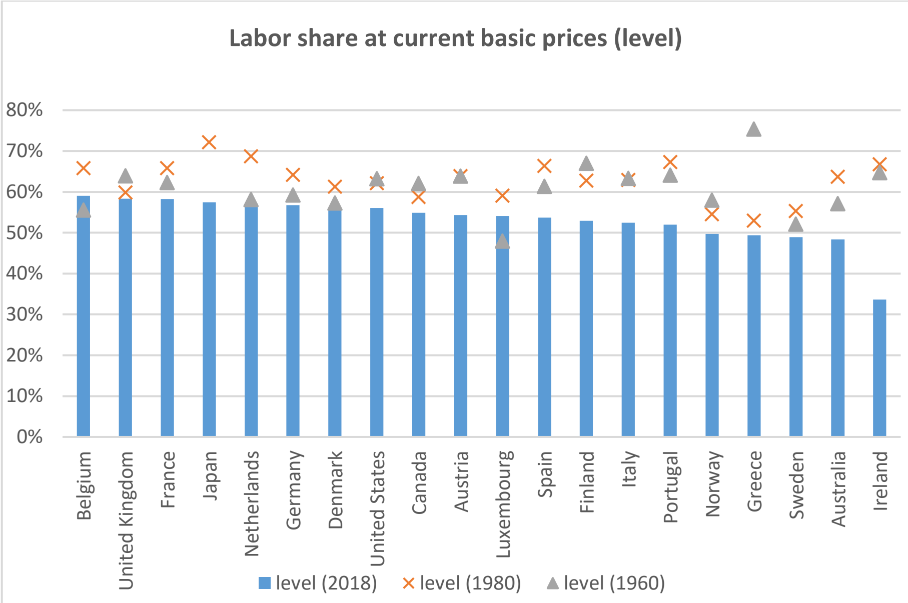
Markup - dln(μ)

	1960-1980			1980-2018			1960-2018		
	t	ADF	PP	t	ADF	PP	t	ADF	PP
Australia	0.0000	0.0005	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0059	0.0061	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Austria	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
	(0.001)	0.0000	0.0000	(0.000)	0.0005	0.0005	(0.000)	0.0000	0.0000
Belgium	-0.0010	0.0188	0.0183	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0876	0.0844	(0.000)	0.0001	0.0001	(0.000)	0.0000	0.0000
Canada	0.0000	0.0056	0.0056	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0304	0.0308	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Denmark	0.0000	0.0005	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0075	0.0072	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Finland	0.0000	0.0358	0.0315	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.1580	0.1428	(0.000)	0.0002	0.0004	(0.000)	0.0000	0.0000
France	0.0000	0.0007	0.0007	-0.000**	0.0005	0.0004	0.0000	0.0000	0.0000
	(0.001)	0.0079	0.0079	(0.000)	0.0005	0.0005	(0.000)	0.0000	0.0000
Germany	0.0000	0.0032	0.0034	-0.000**	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0306	0.0335	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Greece	-0.002*	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0005	0.0005	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Ireland	-0.0010	0.0026	0.0029	0.0010	0.0000	0.0000	0.001*	0.0000	0.0000
	(0.001)	0.0168	0.0188	(0.001)	0.0000	0.0000	(0.000)	0.0000	0.0000
Italy	0.0000	0.0001	0.0001	-0.000**	0.0001	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0015	0.0010	(0.000)	0.0001	0.0001	(0.000)	0.0000	0.0000
Japan	NA	NA	NA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	-	-	-	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Luxembourg	-0.0010	0.0002	0.0001	-0.0010	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.002)	0.0017	0.0013	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Netherlands	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.0000	0.0000	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Norway	0.0020	0.1082	0.1350	-0.0010	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.2178	0.2594	(0.001)	0.0000	0.0000	(0.000)	0.0000	0.0000
Portugal	0.0020	0.0283	0.0283	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.002)	0.1262	0.1297	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
Spain	0.0000	0.0144	0.0166	0.0000	0.0005	0.0005	0.0000	0.0000	0.0000
	(0.001)	0.0672	0.0766	(0.000)	0.0027	0.0026	(0.000)	0.0001	0.0001
Sweden	0.0000	0.0436	0.0449	-0.0010	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.1911	0.1959	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000
United Kingdom	0.0000	0.0331	0.0374	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.001)	0.1731	0.1922	(0.000)	0.0003	0.0004	(0.000)	0.0000	0.0000
United States	0.0000	0.0022	0.0023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.000)	0.0114	0.0117	(0.000)	0.0000	0.0000	(0.000)	0.0000	0.0000

*MacKinnon p-value for Z(t). The first p-value is without t, the second one includes a linear t.

Table A11 - Augmented Dickey-Fuller and Phillips-Perron test on dln(μ).

(iii) Additional tables and figures



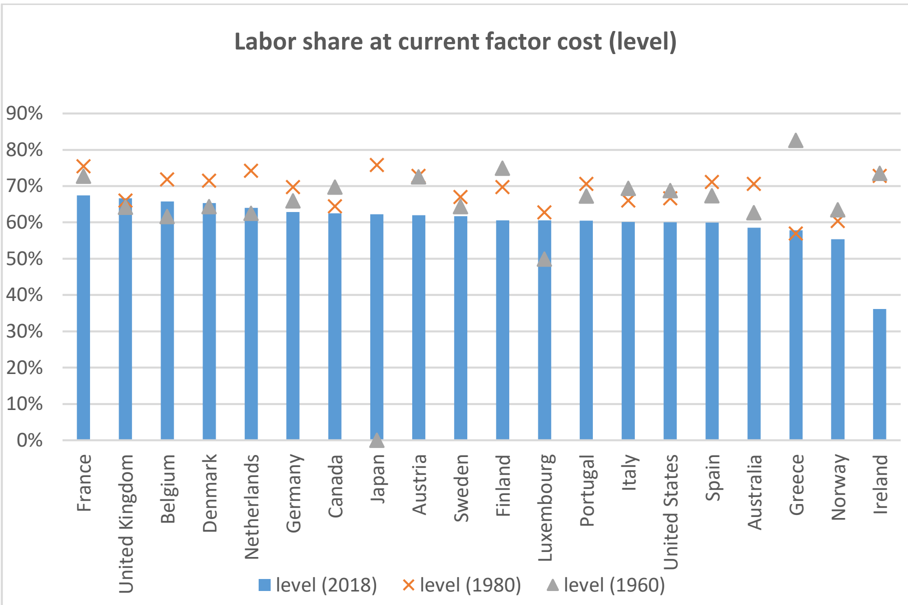


Figure A1 - Evolution of the labor shares at basic prices/factor costs (levels in 1960, 1980, 2018).

Source: Author's calculation on AMECO data.

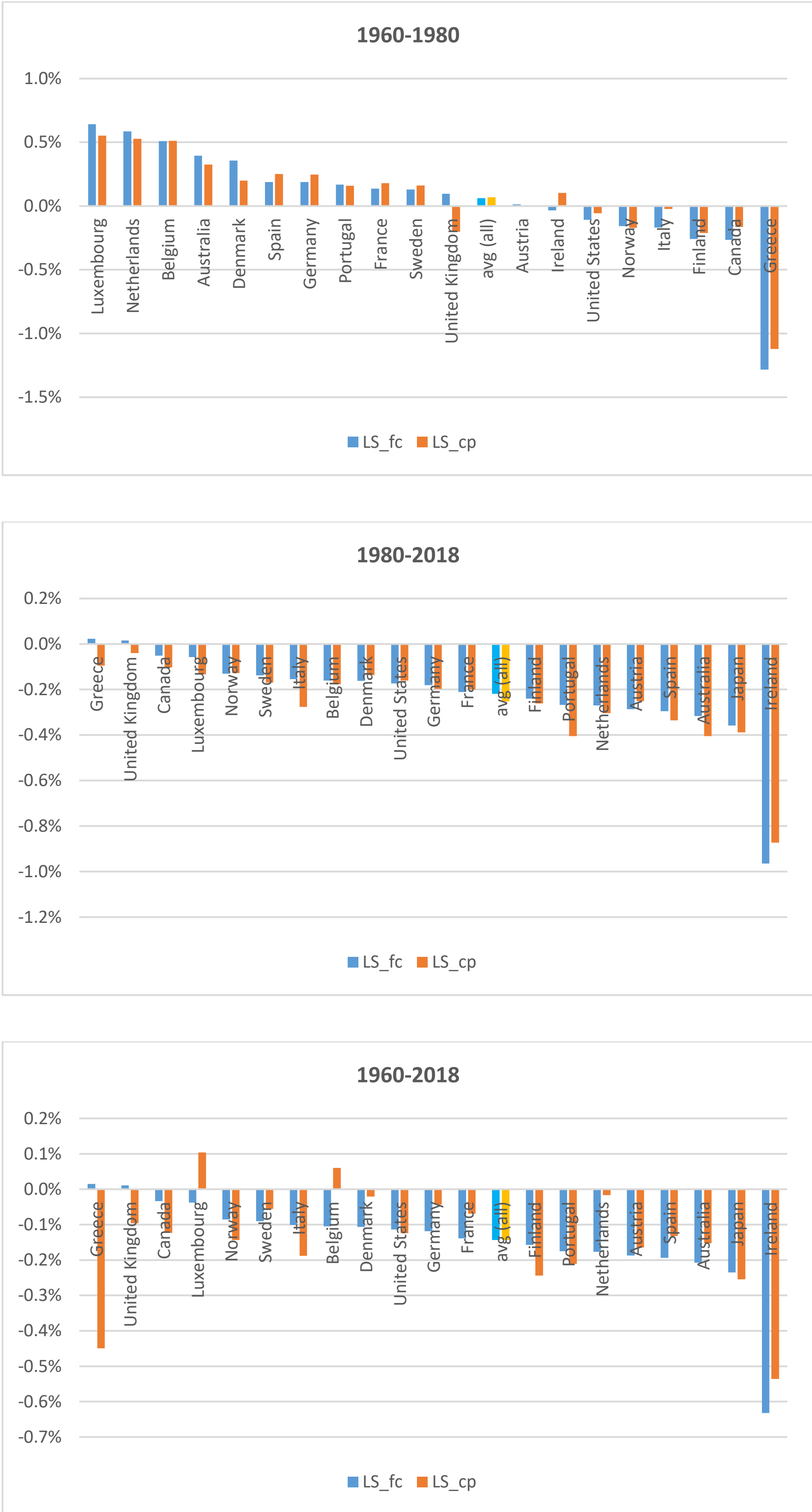


Figure A2 - Estimated trends in country labor shares (1960-1980; 1980-2018; 1960-2018).

Note: The figure shows estimated trends in the labor share for all countries in our dataset with at least 15 years of data starting in 1980. Trend coefficients are reported in units per years (i.e., a value of -0.5 means a 0.5 percentage point decline every years). The ordering of the countries follows the values of the change in the labor share at current factor cost in descending order (from the largest to the smallest). *Source:* Author's calculation on AMECO data.

	Current prices (avg growth rate)			Factor cost (avg growth rate)		
	1960-1980	1980-2018	1960-2018	1960-1980	1980-2018	1960-2018
Australia	0.30%	-0.40%	-0.15%	0.36%	-0.33%	-0.07%
Austria	0.02%	-0.25%	-0.16%	0.03%	-0.29%	-0.18%
Belgium	0.49%	-0.18%	0.06%	0.50%	-0.16%	0.07%
Canada	-0.14%	-0.10%	-0.12%	-0.18%	-0.05%	-0.13%
Denmark	0.15%	-0.14%	-0.02%	0.28%	-0.16%	0.02%
Finland	-0.14%	-0.26%	-0.24%	-0.17%	-0.24%	-0.25%
France	0.18%	-0.20%	-0.07%	0.14%	-0.21%	-0.09%
Germany	0.24%	-0.20%	-0.04%	0.17%	-0.18%	-0.05%
Greece	-0.90%	-0.10%	-0.45%	-1.09%	0.02%	-0.43%
Ireland	-0.01%	-0.87%	-0.54%	-0.08%	-0.96%	-0.64%
Italy	0.04%	-0.28%	-0.19%	-0.12%	-0.15%	-0.16%
Japan	-0.31%	-0.39%	-0.39%	-0.29%	-0.36%	-0.36%
Luxembourg	0.58%	-0.13%	0.10%	0.65%	-0.06%	0.18%
Netherlands	0.41%	-0.30%	-0.02%	0.45%	-0.27%	0.03%
Norway	-0.20%	-0.13%	-0.14%	-0.17%	-0.13%	-0.14%
Portugal	0.22%	-0.40%	-0.21%	0.18%	-0.27%	-0.12%
Spain	0.25%	-0.33%	-0.13%	0.23%	-0.30%	-0.13%
Sweden	0.13%	-0.17%	-0.06%	0.13%	-0.14%	-0.05%
United Kingdom	-0.24%	-0.04%	-0.10%	0.09%	0.02%	0.04%
United States	-0.10%	-0.16%	-0.12%	-0.14%	-0.17%	-0.15%
Mean	0.02%	-0.18%	-0.11%	0.01%	-0.18%	-0.11%
Standard Deviation	0.003	0.002	0.002	0.004	0.002	0.002

Table A12 - Estimated trends in national labor shares (1960-2018).

Note: The figure shows estimated trends in the labor share for all countries in our dataset with at least 15 years of data starting in 1960. Trend coefficients are reported in units per years (i.e., a value of -0.5 means a 0.5 percentage point decline every year). *Source:* Author's calculation on AMECO data.

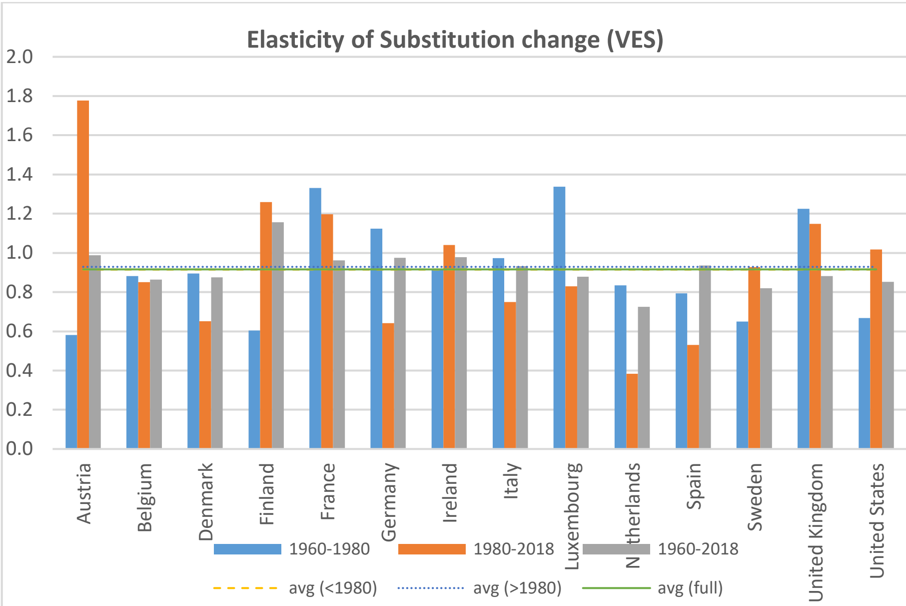


Figure A3 - Change in the elasticity of substitution (1960-1980).

Source: Author's own estimation.

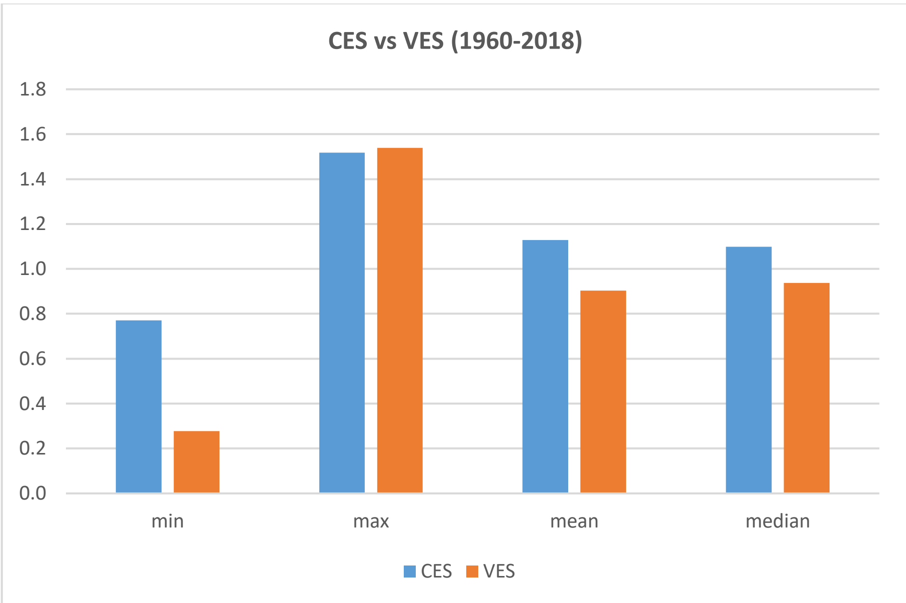
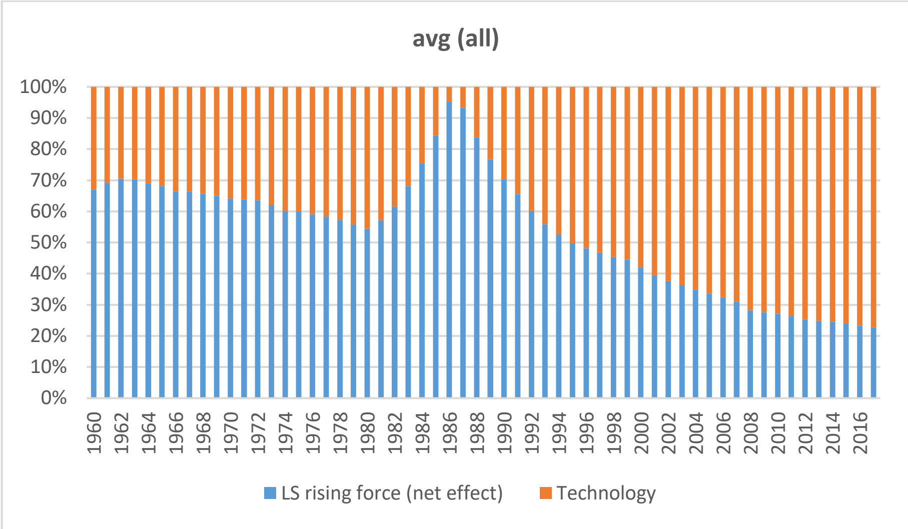
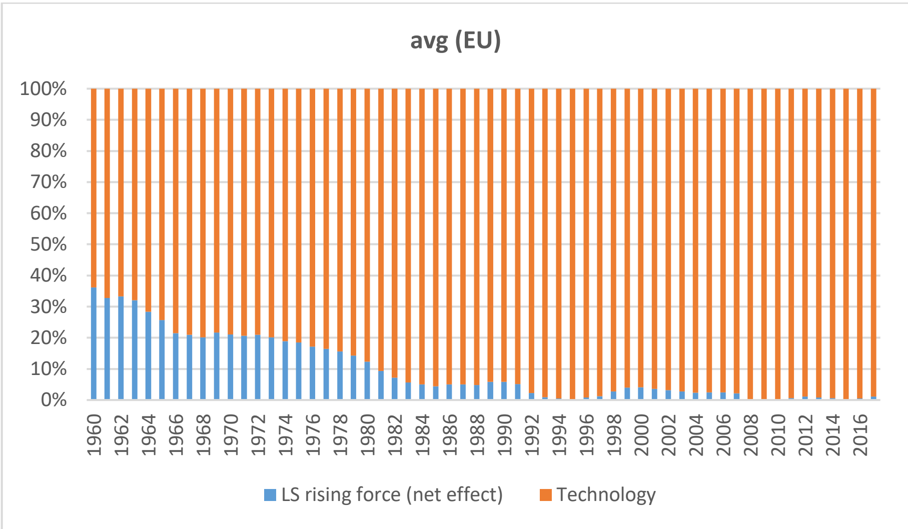
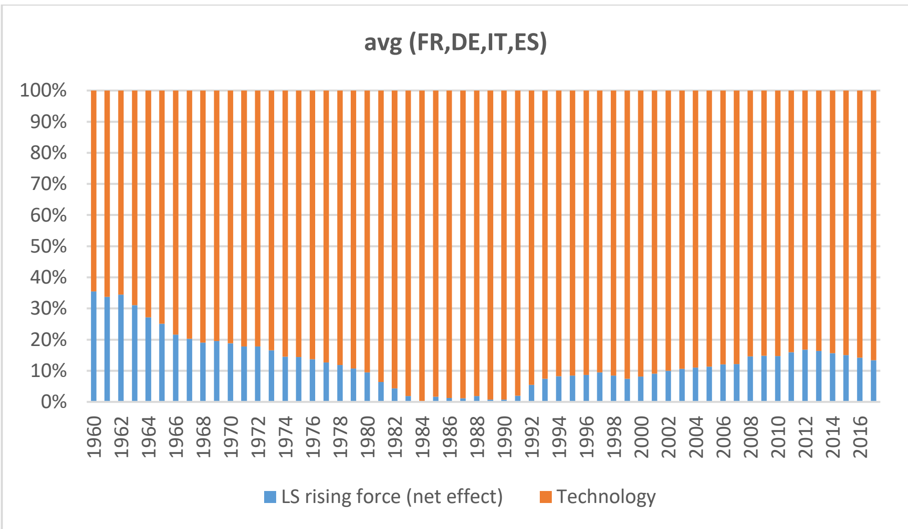


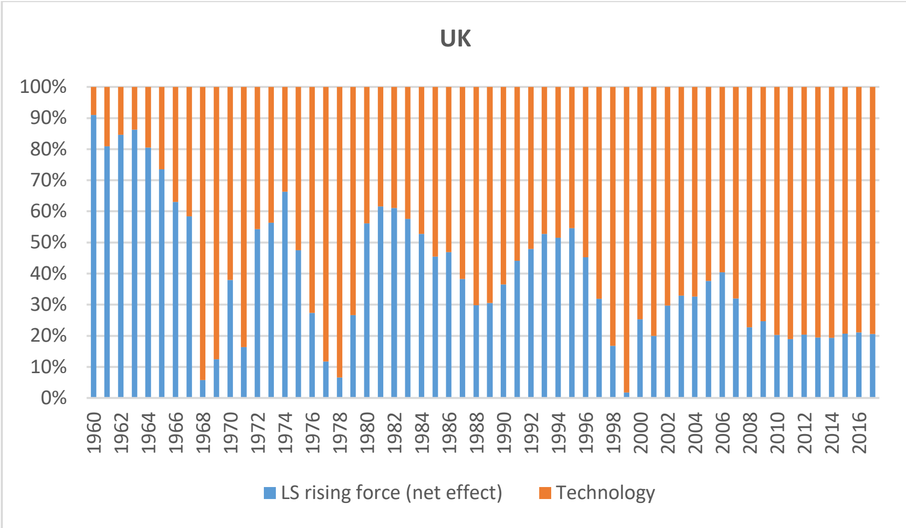
Figure A4 - Elasticity of substitution basic statistics (CES vs VES) - 1960-1980.

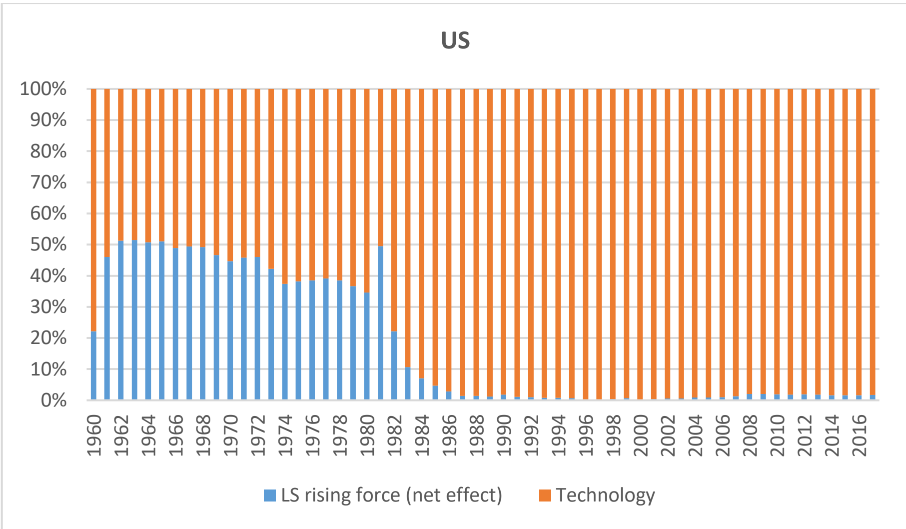
Source: Author's own estimation.


avg (all)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
LS rising force (net effect)
Technology


avg (EU)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
LS rising force (net effect)
Technology


avg (FR,DE,IT,ES)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
LS rising force (net effect)
Technology





Figures A5 - Labor shares' variance decomposition (1960-2018).

Note: The variance decomposition indicates the amount of information each variable contributes to the other variables. How much of the variance of the labor share can be explained by exogenous shocks to the other variables. *Source:* Author's own calculation.

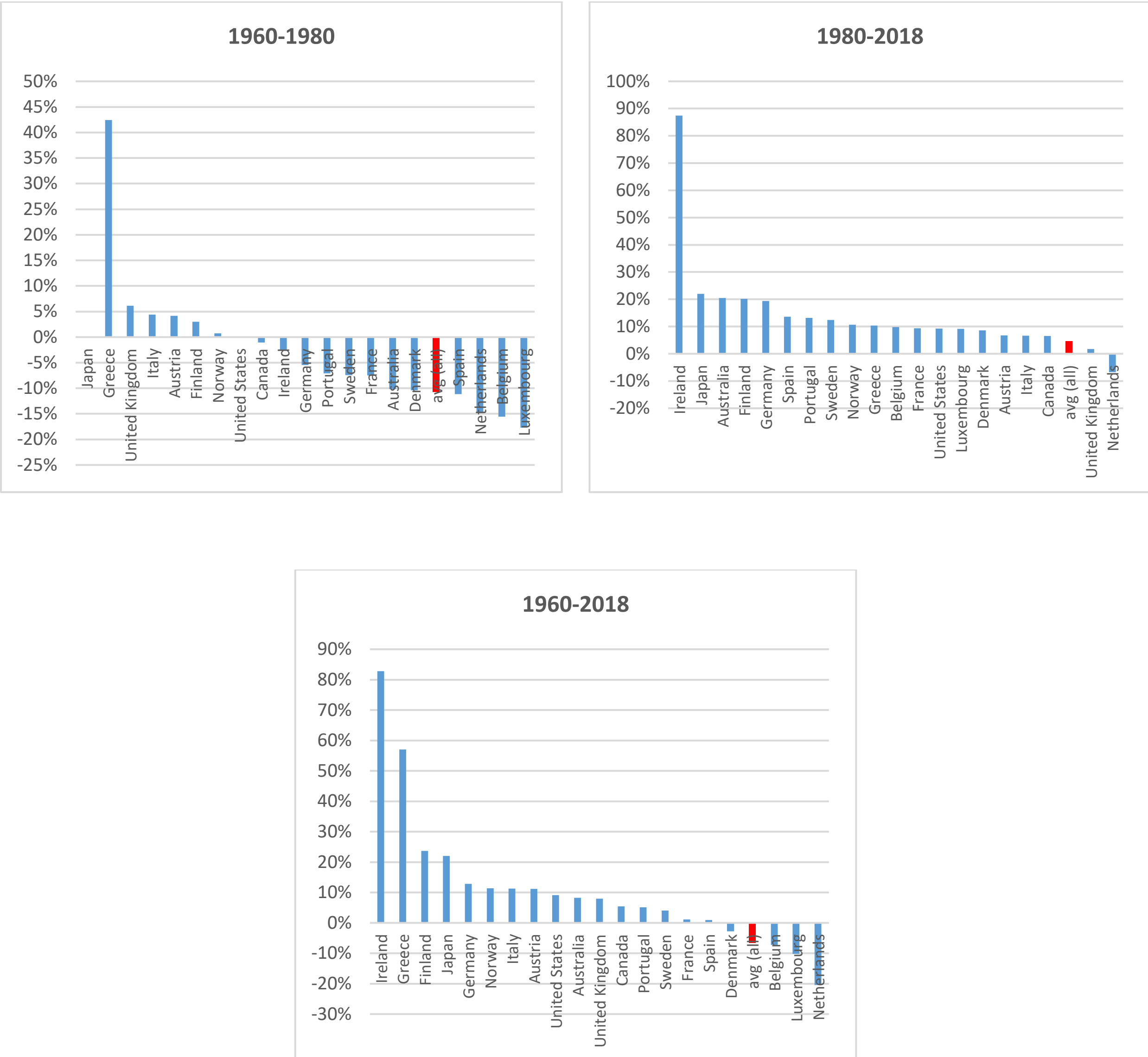
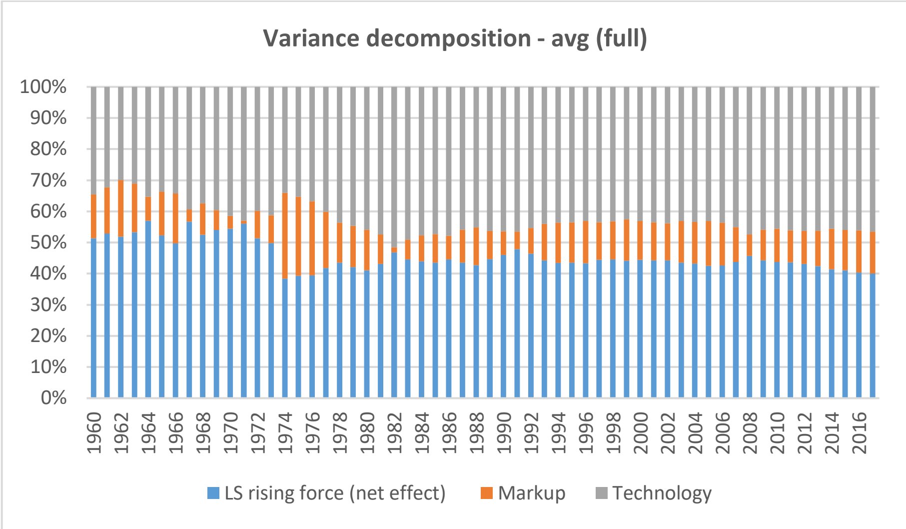
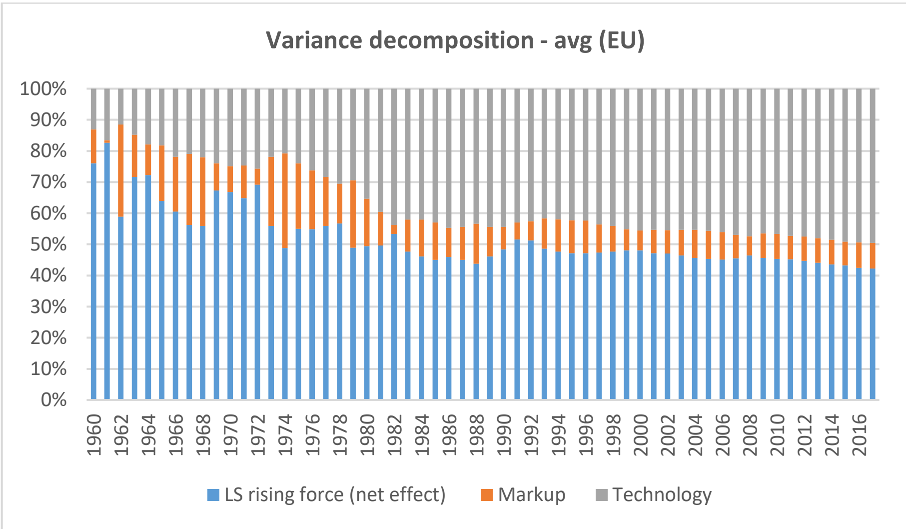
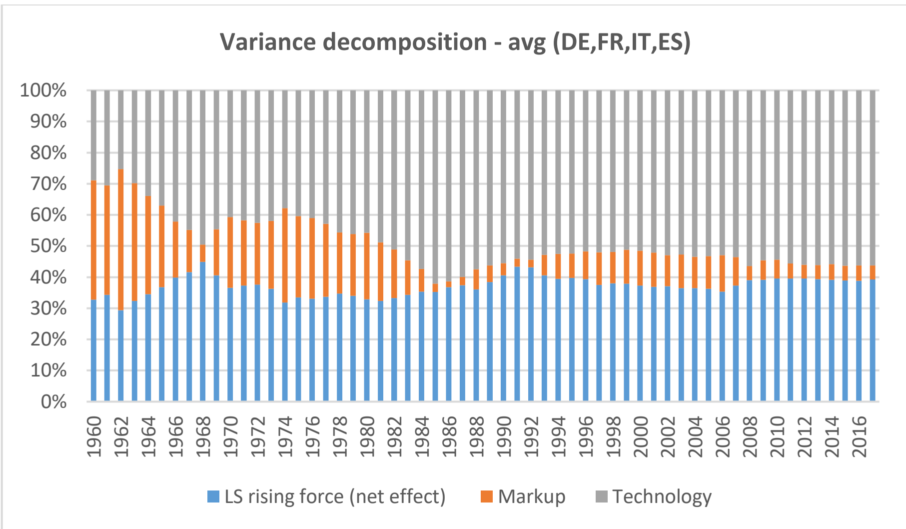


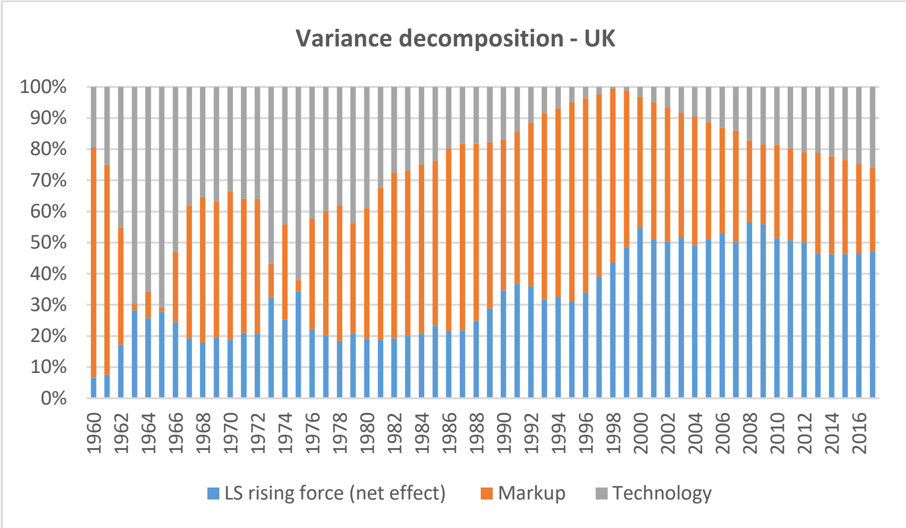
Figure A6 - Total (%) growth of the price markup index.

Source: Author's own calculation.


Variance decomposition - avg (full)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
LS rising force (net effect)
Markup
Technology


Variance decomposition - avg (EU)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
LS rising force (net effect)
Markup
Technology


Variance decomposition - avg (DE,FR,IT,ES)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
LS rising force (net effect)
Markup
Technology



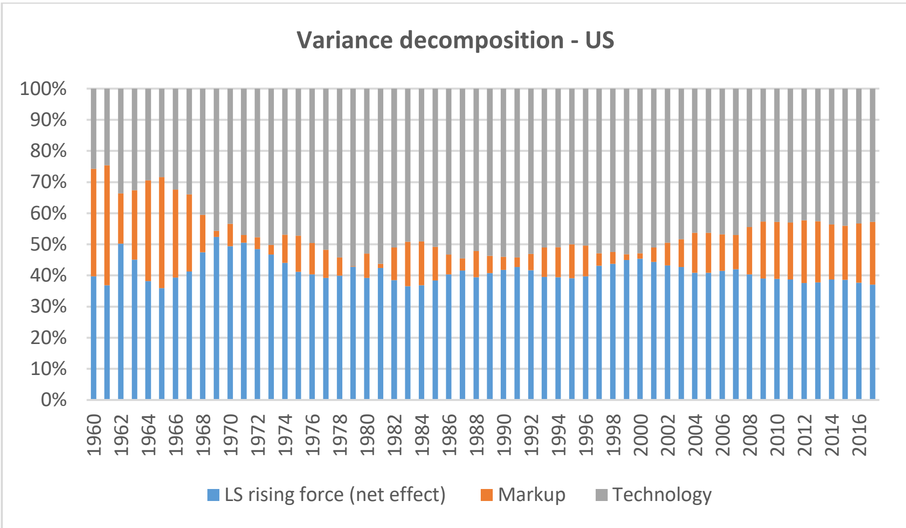


Figure A7 - Labor shares' variance decomposition (1960-2018).

Note: The variance decomposition indicates the amount of information each variable contributes to the other variables. How much of the variance of the labor share can be explained by exogenous shocks to the other variables. *Source:* Author's own calculation.

References

Acemoglu, D., and Restrepo, P. (2018). Artificial intelligence, automation and work. *No. w24196. National Bureau of Economic Research*.

Aghion, P., Jones, B. F., and Jones, C.I. (2017). Artificial intelligence and economic growth. *No. w23928. National Bureau of Economic Research*.

Alcalá, F. J., and Sancho, F. (2000). Inflation and factor shares.

Allen, R. G. (1938). *Mathematical analysis for economists.* Macmillan.

Andrews, D., Criscuolo, C., and Gal, P. N. (2015). Frontier Firms, Technology Diffusion. *OECD Background Paper*.

Antràs, P. (2004). Is the US aggregate production function Cobb-Douglas? *Contributions in Macroeconomics 4.1*.

Armenter, R. (2015). A bit of a miracle no more: the decline of the labor share. *Business Review Q3*.

Arrow, K., Chenery, H., Minhas, B., and Solow, R. (1961). Capital-Labor Substitution and Economic Efficiency. *The Review of Economics and Statistics, Vol. 43, No. 3*.

Arrow, K. J. (1962). The economic implications of learning by doing. *Readings in the Theory of Growth*.

Atkinson, A. B. (2009). Factor shares: the principal problem of political economy? *Oxford Review of Economic Policy 25.1.*

Autor, D., Azmat, G., Manning, A., and Van Reenen, J. (2020). The fall of the labor share and the rise of superstar firms. *The Quarterly Journal of Economics 135.2.*

Azmat, G., Manning, A., and Van Reenen, J. (2012). Privatization and the decline of labour's share: international evidence from network industries. *Economica 79.315*: 470-492.

Bairam, E. I. (1987). The Verdoorn law, returns to scale and industrial growth: a review of the literature. *Australian Economic Papers 26.48*: 20-42.

Bairam, E. (1989). Learning-by-doing, variable elasticity of substitution and economic growth in Japan. *The Journal of Development Studies 25.3*.

Barkai, S. (2020). Declining labor and capital shares. *The Journal of Finance* 75.5: 2421-2463.

Bental, B., and Demougin, D. (2010). Declining labor shares and bargaining power: An institutional explanation. *Journal of Macroeconomics 32.1*.

Bentolila, S., and Saint-Paul, G. (2003). Explaining movements in the labor share. *Contributions in Macroeconomics 3.1*.

Bils, M. (1987). The cyclical behavior of marginal cost and price. *The American Economic Review*.

Blanchard, O. (1997). The Medium Run. *Brookings Papers on Economic Activity, No. 2.*

Blanchard, O. J., and Fischer, S. (1989). *Lectures on macroeconomics.* MIT press.

Blanchard, O., and Giavazzi, F. (2003). Macroeconomic effects of regulation and deregulation in goods and labor markets. *The Quarterly Journal of Economics 118.3*.

Cantore, C., Levine, P., Pearlman, J., and Yang, B. (2015). CES Technology and Business Cycle Fluctuations. *Journal of Economic Dynamics and Control 61*: 133-151.

Caselli, F., and Coleman, W. J. (2006). The world technology frontier. *American Economic Review 96.3*: 499-522.

Chirinko, R. S. (2008). σ: The long and short of it. *Journal of Macroeconomics 30.2* .

Council of Economic Advisers (CEA). (2016). Benefits of Competition and Indicators of Market Power. *CEA Issue Brief*.

De La Grandville, O. (1989). In quest of the Slutsky diamond. *The American Economic Review*: 468-481.

De Loecker, J., Eeckhout, J., and Unger, G. (2020). The rise of market power and the macroeconomic implications. *The Quarterly Journal of Economics 135.2*: 561-644.

Diewert, W. E., and Nakamura, A.O. (2003). Index number concepts, measures and decompositions of productivity growth. *Journal of Productivity Analysis 19.2-3*: 127-159.

Duffy, J., and Papageorgiou, C. (2000). A cross-country empirical investigation of the aggregate production function specification. *Journal of Economic Growth 5.1*.

Elsby, M. W., Hobijn, B., and Şahin, A. (2013). The decline of the US labor share. *Brookings Papers on Economic Activity 2013.2*: 1-63.

European Commission. (2009). Understanding Labour Income Share Dynamics. *Economic Papers 379*.

EuropeanCommission. (2007). The labour income share in the European Union. *Employment in Europe*.

Foster, J., McChesney, R., and Jonna, R. (2011). Monopoly and competition in twentyfirst century capitalism. *Monthly Review 62.11*: 1.

Furman, J. (2016). Beyond antitrust: The role of competition policy in promoting inclusive growth. *Searle Center Conference on Antitrust Economics and Competition Policy*.

Gali, J. (1995). Product diversity, endogenous markups, and development traps. *Journal of Monetary Economics 36.1*.

Galí, J. (2015). *Monetary policy, inflation, and the business cycle: an introduction to the new Keynesian framework and its applications.* Princeton University Press.

Giovannoni, O. G. (2014). What Do We Know About the Labor Share and the Profit Share? Part I: Theories. *Levy Economics Institute at Bard College Working Paper No. 803*.

Gollin, D. (2002). Getting income shares right. *Journal of political Economy 110.2*: 458-474.

Gordon, R. J. (2012). Is US economic growth over? Faltering innovation confronts the six headwinds. *National Bureau of Economic Research*.

Grenestam, E., and Probst, J. (2014). Rising markups and the fall of the labor share: Predicting the effects of industry market power in the US.

Griliches, Zvi. (1967). Production functions in manufacturing: some preliminary results. The theory and empirical analysis of production. *NBER*: 275-340.

Growiec, J., and Muck, J. (2015). Isoelastic elasticity of substitution production functions.

Grullon, G., Larkin, Y., and Michaely, R. (2018). Are US industries becoming more concentrated? *Forthcoming, Review of Finance*.

Guschanski, A., and Onaran, Ö. (2018). The labour share and financialisation: Evidence from publicly listed firms. *Greenwich Papers in Political Economy*.

Gutiérrez, G., and Philippon, T. (2018). *Ho*w EU markets became more competitive than US markets: A study of institutional drift. *No. w24700. National Bureau of Economic Research.*

Henningsen, A., and Henningsen, G. (2012). On estimation of the CES production function - Revisited. *Economics Letters 115.1*.

Hicks, J. R. (1932). *The Theory of Wages*. Macmillan, London.

Hildebrand, G.H. and Litu, T. (1965). Manufacturing Production Functions in the United States, 1957. *Ithaca: New York State School of Industrial and Labour Relations. Cornell University.*

Hoff, A. (2004). The linear approximation of the CES function with n input variables. *Marine Resource Economics 19.3*: 295-306.

Hritonenko, N., and Yatsenko, Y. (1999). Mathematical Modeling in Economics, Ecology and the Environment. *Springer*.

ILO. (2012). Wages and Equitable Growth. *Global Wage Report 2012/13*.

ILO, and OECD. (2015). The Labour Share in G20 Economies. *Report prepared for the G20 Employment Working Group*.

IMF. (2012). Coping with High Debt and Sluggish Growth. *World Economic Outlook*.

IMF. (2017). World Economic Outlook, April 2017: Gaining Momentum? *World Economic Outlook.*

Irmen, A., and Maußner, A. (2014). Essential inputs and unbounded output: an alternative characterization of the neoclassical production function.

Jones, C. I. (2005). The shape of production functions and the direction of technical change. *The Quarterly Journal of Economics 120.2*.

Jones, R. W. (2008). The aggregate elasticity of factor substitution with middle products. *Journal of Macroeconomics 30.2*.

Kadiyala, K. R. (1972). Production functions and elasticity of substitution. *Southern Economic Journal*.

Kaldor, N. (1957). A model of economic growth. *The economic journal 67.268*.

Kaldor, N. (1961). *Capital accumulation and economic growth*. London: Palgrave Macmillan.

Kaldor, N., and Mirrlees, J. A. (1962). A new model of economic growth. *The Review of Economic Studies 29.3*.

Kalecki, M. (1938). The determinants of distribution of the national income. *Econometrica: Journal of the Econometric Society*.

Kalecki, M. (1943). Studies in economic dynamics.

Kalecki, M. (1954). *Theory of economic dynamics : an essay on cyclical and long-run changes in capitalist economy.* New York Rinehart.

Karabarbounis, L., and Neiman, B. (2014). Capital depreciation and labor shares around the world: measurement and implications. *National Bureau of Economic Research. No. w20606.*

Karagiannis, G., Palivos, T., and Papageorgiou, C. (2005). Variable elasticity of substitution and economic growth: theory and evidence. *New trends in macroeconomics*.

Kaz, M., and Papageorgiou, C. (2007). Endogenous aggregate elasticity of substitution. *Journal of Economic Dynamics and Control*.

Kazi, U. A. (1980). The variable elasticity of substitution production function: a case study for Indian manufacturing industries. *Oxford Economic Papers* 32.1: 163-175.

Kemal, A. R. (1981). Substitution elasticities in the large-scale manufacturing industries of Pakistan. *The Pakistan Development Review*.

Keynes, J. M. (1939). Relative movements of real wages and output. *The Economic Journal 49.193*.

Klump, R., and Preissler, H. (2000). CES production functions and economic growth. *Scandinavian Journal of Economics*.

Klump, R., McAdam, P., and Willman, A. (2007). Factor substitution and factor-augmenting technical progress in the United States: a normalized supply-side system approach. *The Review of Economics and Statistics 89.1*.

Klump, R., and Papageorgiou, C. (2008) Editorial introduction The CES production function in the theory and empirics of economic growth. *Journal of Macroeconomics 30.2*: 599-600.

Klump, R., McAdam, P., and Willman, A. (2012). The normalized CES production function: theory and empirics. *Journal of Economic Surveys 26.5*.

Kmenta, J. (1967). On estimation of the CES production function.

Koh, D., Santaeulalia-Llopis, R., and Zheng, Y. (2016). Labor share decline and intellectual property products capital.

La Grandville, O. d., and Solow, R. M. (2009). *Economic growth: A unified approach.*

Lavoie, M., and Stockhammer, E. (2013). *Wage-led growth: Concept, theories and policies.* London: Palgrave Macmillan.

León-Ledesma, M. A., McAdam, P., and Willman, A. (2010). Identifying the elasticity of substitution with biased technical change. *American Economic Review 100.4*.

Lovell, C. K. (1973). Estimation and prediction with CES and VES production functions. *International Economic Review*.

Lu, Y., and Fletcher, L. B. (1968). A generalization of the CES production function. *The Review of Economics and Statistics*.

Lucas, R. (1964). Substitution between Labor and Capital in U.S. Manufacturing, 1929-1958. *Unpublished dissertation. University of Chicago*.

Lynn, B., and Longman, P. (2010). Who broke america's jobs machine? Why creeping consolidation is crushing american livelihoods. *Washington Monthly*.

Macpherson, D. A. (1990). Trade unions and labor's share in US manufacturing industries. *International Journal of Industrial Organization 8.1*.

Maki, D. R., and Meredith, L. N. (1987). A Note on Unionization and the Elasticity of Substitution. *Canadian Journal of Economics*.

Mallick, D. (2012). The role of the elasticity of substitution in economic growth: A cross-country investigation. *Labour Economics 19.5*.

Miyagiwa, K., and Papageorgiou, C. (2007). Endogenous aggregate elasticity of substitution. *Journal of Economic Dynamics and Control 31.9*.

Motta, M. (2017). The Problems with Merger Control. *, Presentation at MaCCI Annual Conference*.

Nekarda, C. J., and Ramey, V. A. (2013). The cyclical behavior of the price-cost markup. No. w19099. *National Bureau of Economic Research*.

Oberfield, E., and Raval, D. (2014). Micro data and macro technology. *National Bureau of Economic Research. No. w20452.*

OCED. (2011). *OECD Employment Outlook 2011.* OECD Publishing.

OECD. (2012). Labour Losing to Capital: What Explains the Declining Labour Share? *Employment Outlook 2012*.

O'Mahony, M., Vecchi, M., and Venturini, F. (2015). The Long-Run Decline in Labor Share: Technology versus Institutions.

Palivos, T., and Karagiannis, G. (2010). The elasticity of substitution as an engine of growth. *Macroeconomic Dynamics 14.5*: 617-628.

Pereira, C. M. (2003). Empirical essays on the elasticity of substitution, technical change, and economic growth.

Piketty, T. (2014). Capital in the Twenty-First Century. *Harvard University Press*.

Piketty, T., and Zucman, G. (2014). Capital is back: Wealth-income ratios in rich countries 1700–2010. *The Quarterly Journal of Economics 129.3*.

Raurich, X., Sala, H., and Sorolla, V. (2012). Factor shares, the price markup, and the elasticity of substitution between capital and labor. *Journal of Macroeconomics 34.1*.

Revankar, N. S. (1971). A class of variable elasticity of substitution production functions. *Econometrica 39.1*.

Ricardo, D. (1891). *Principles of political economy and taxation.* G. Bell.

Rodriguez, F., and Jayadev, A. (2010). The declining labor share of income. *Journal of Globalization and Development 3.2:* 1-18.

Roeger, W. (1995). Can imperfect competition explain the difference between primal and dual productivity measures? Estimates for US manufacturing. *Journal of political Economy 103.2*.

Rognlie, M. (2015). What Lower Bound? Monetary Policy with Negative Interest Rates. *Job Market Paper 23*.

Romer, D. (2012). *Advanced Macroeconomics.* McGrawHill Companies.

Rotemberg, J. J., and Woodford, M. (1999). The cyclical behavior of prices and costs. *Handbook of macroeconomics 1*.

Sala, H., and Trivín, P. (2014). The decline of the labor income share: A reappraisal of the driving forces. *XXXIX Symposium of Spanish Economic Association*.

Sato, R., and Hoffman, R. F. (1968). Production functions with variable elasticity of factor substitution: some analysis and testing. *The Review of Economics and Statistics*.

Schlicht, E. (2016). Directed technical change and capital deepening: A reconsideration of Kaldor's technical progress function. *Metroeconomica 67.1*.

Sherman, H. J. (2014). *The business cycle: growth and crisis under capitalism*. Princeton University Press.

Solow, R. M. (2005). Reflections on growth theory. *Handbook of economic growth 1*: 3-10.

Thursby, J. G., and Lovell, C. K. (1978). An investigation of the Kmenta approximation to the CES function. *International Economic Review*.

Van Reenen, J. (2018). Increasing differences between firms: market power and the macro-economy.

Weche, J. P., and Wambach, A. (2018). The fall and rise of market power in Europe. *ZEW-Centre for European Economic Research Discussion Paper 18-03*.

Young, A. T. (2013). US elasticities of substitution and factor augmentation at the industry level. *Macroeconomic Dynamics 17.4*.

Yuhn, K. H. (1991). Economic growth, technical change biases, and the elasticity of substitution: A test of the de la Grandville hypothesis. *The Review of Economics*.

Chapter 3: Market power, capital-output ratios, and technological change: the firm-level determinants of labor share

Alessandro Bellocchi[1] Giuseppe Travaglini[2] Giovanni Marin[3]

Abstract

The worldwide fall of labor shares of GDP in recent decades is well documented but its underlying causes remain still unclear. Existing empirical analysis typically rely on industry or aggregate macro data, thus downplaying the importance of heterogeneity among firms. In this paper, we analyze micro panel data from AMADEUS and seek to understand the dynamics of the labor share in 19 broad sectors of the EU28. We start by documenting basic empirical regularities to give an interpretation of the fall in the labor share based on firm level dynamics. More specifically we explore the role of technological change, product and labor market imperfections. While theoretical explanations for declining labor shares rely on models with representative firm, we built on insights from Bentolila and Saint-Paul (2003), Blanchard and Giavazzi (2003), Azmat et al. (2012), Karabarbounis and Neiman (2014) and econometric techniques from De Loecker and Warzynski (2012), to propose a model in which firms can be heterogeneous in terms of capital employed, market power and productivity. The core argument of our theoretical framework is the relationship between the labor share and the capital-output ratio. We show that this relationship holds for firms and acknowledge the possible existence of relevant non-linearities. Labor share's movement turns out to be driven by a complex interplay of conditions for capital and labor, the nature of technological change and imperfect market structures which can shift the curve but also cause departures from it. Broadly confirming results from previous cross-country and industry-level studies, we find that the main factor decreasing the labor share are connected to capital deepening (a 1% increase in the capital-output ratio reduces the labor share by 0.03 percentage points) in conjunction with capital-augmenting technical progress and labor substitution (-0.15). Although institutional factors play a significant role in specific industries (like for instance Construction, Manufacturing, Mining and Transportation), they appear to be of somewhat less importance for the aggregate economy. However, our most important result is to show that when non-linear terms for capital-output are included in the model the effect of capital accumulation on the labor share gives rise to complex and heterogeneous dynamics. The results of our analysis are robust to several econometric issues, namely heterogeneity, endogeneity and cross-sectional dependence.

Keywords: Labor shares, Capital-output ratios, Elasticity of substitution, Technological change, Markups.

[1,2,3] University of Urbino Carlo Bo, Italy. e-mail(s): {alessandro.bellocchi; giovanni.marin; giuseppe.travaglini@uniurb.it}.
This paper was presented at the XXI AISSEC Conference on Economic Development and Inequalities held online on October 8-9, 2020.

1. Introduction and some stylized facts

National income is the sum of all income available to the residents of a given country each year. The division of national income between labor and capital is called functional distribution of income. The labor share - i.e., the share of national income paid in wages including benefits to workers, plus an imputed labor remuneration for the self-employed - has been on a downward trend in many countries (Blanchard, 1997; Rodríguez and Jayadev, 2010; Elsby et al., 2013; Karabarbounis and Neiman, 2014; Piketty, 2014). Dao et al. (2017) indicate a general decline of the labor share between 1990 and 2015 in 30 large countries that account for about 70% of the world GDP. Across sectors, the share of labor income has declined in 8 out of 10 most important sectors, with the sharpest declines occurring in tradable industries, such as manufacturing, transportation and communication. Although there is still a dispute over the extent to which the decrease in the labor share is due to evaluation problems such as the treatment of certain technical items like capital depreciation (Karabarbounis and Neiman, 2014; Bridgman, 2018)[2], self-employment (Gollin, 2002; Elsby et al., 2013)[3], intangible capital (Koh et al., 2019)[4] and business owners taking capital income as a form of compensation for their labor activities (Krueger, 1999; Smith et al., 2019)[5], there is a general and broad consensus among economists that the fall is strong and significant.[6] Figures 1 and 2 illustrate the great fall in 28 European countries. This fact is crucial for several reasons. (i) First, it contradicts one of the stylized facts highlighted by Kaldor (1961) which has become a standard foundation in growth theories. (ii) Second, it is at odds with a key building element of sound macroeconomic models, the Cobb-Douglas production function (see Bellocchi, 2020). (iii) Finally, it suggests that the total value added produced by economies is getting distributed less to those who produce it and more to the owners of the means of production, bringing back the distributional conflict between workers and capitalists (Sala and Trivin, 2014).

---

[2] Since there is a great share of production (i.e. taxes on production and depreciation), that do not add to labor or capital while it is included in aggregate output, using gross or net labor share would tell the same story only if the share of these items is constant over time. The authors show that US labor share has not fallen as much once items that do not accrue to capital are excluded.

[3] They show that about 1/3 of the observed decline in the labor share appears to be the result of the statistical procedures used to impute the labor part of self-employment income to the measure.

[4] They show that the capitalization of intellectual property products in national income and product accounts entirely explains (from an accounting perspective) the observed decline of the US labor share.

[5] They show that a primary source of top income is private and actually pass-through business profits. This usually include entrepreneurial labor income for tax reasons. The presence and growth of a consistent share of labor income that actually adds to capital reduces the measured labor share in the US corporate sector.

[6] The Dataset we use includes only employer firms (with more than 1 million euro in terms of total operating revenues), hence leaving out income of the self-employed. Therefore, there is an issue on how to allocate this portion of income to the owners of their own businesses. However, Smith et al. (2019) show that this can account for a maximum of 1/8 of the decline in the labor share.

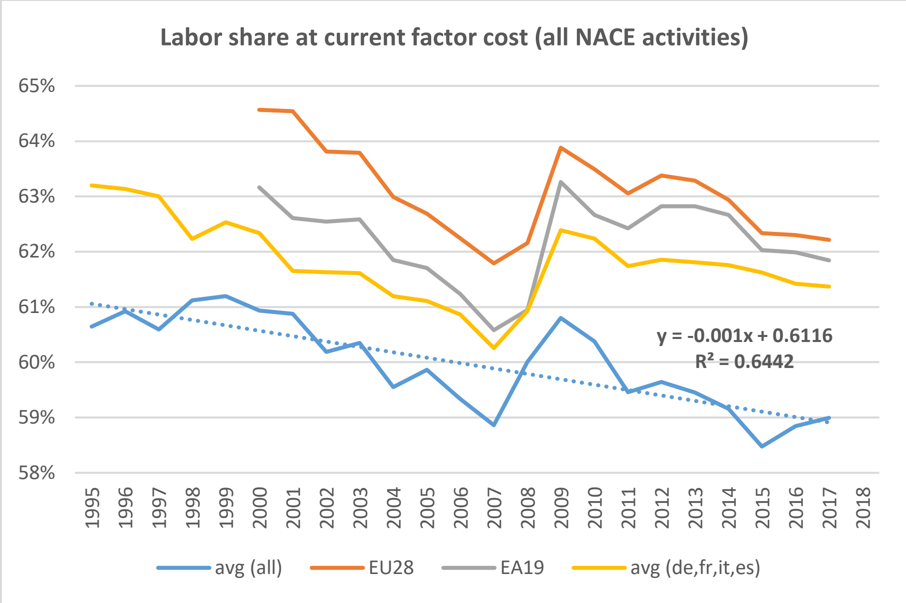


Figure 1 - Labor share of income (whole economy) in the European Union (1995-2019).[7]

Note: The figure shows average values weighted by real GDP. *Source:* Authors' calculation on EUROSTAT data.

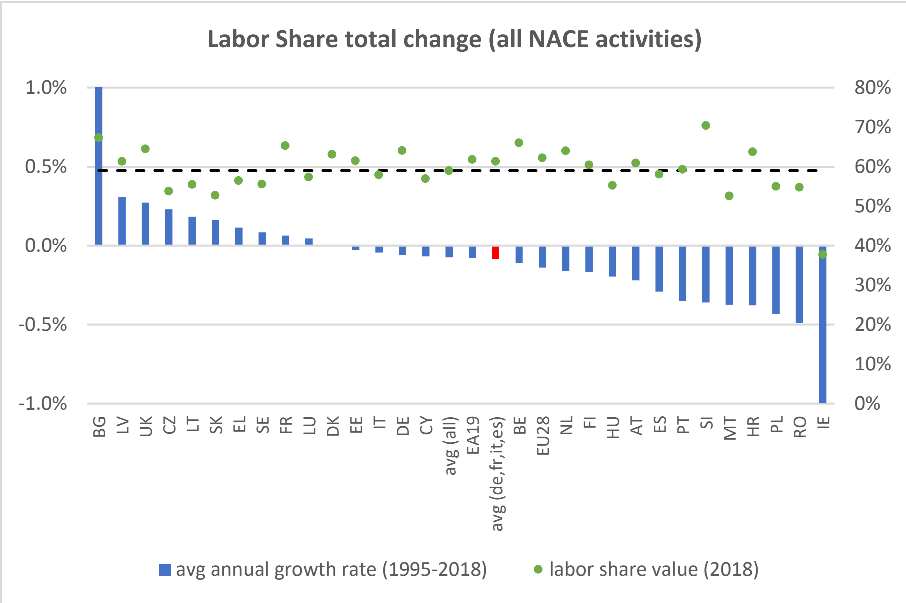


Figure 2 - Labor share of income (total % change and levels) in the European Union (1995-2019).

Note: Bars indicate the % change and the points its level in 2017. *Source:* Authors' calculation on EUROSTAT data.

[7] We compute an adjusted version of the labor share by employing the Gollin (2002) method, i.e. by assuming Identical wage rates. More specifically we assign the same average wage to each worker regardless his status (employee or self-employed). This means that resulting labor share can be considered as a lower bound, since self-employment covers professions such as doctors, consultants, lawyers and business owners whose income is more likely to be above the market average than below. The labor share obtained in this way is computed for the whole EU28.

The functional distribution of income was once an interesting topic for economists (Ricardo, 1911). Then factor shares were considered stable and therefore attracted little attention from academia and policy discussions. In these years, their role, as well as the space they used to have in economic textbooks has been progressively reduced (Atkinson, 2009). In recent decades, however, this conventional wisdom has been challenged by growing empirical evidence indicating a decline in the share of labor in many of the countries for which data are available.[8] [9] This is well acknowledged by economic literature. What we know is that the degree of the decline has been extremely different across countries, industry and firms. The (adjusted) labor shares fell from an average of about 65 per cent to 60 per cent of income in the most advanced countries of the EU, and from 57 per cent to 54 per cent in Eastern and developing European countries between 2000 and 2019.[10] Further, none of them (with the partially exception of Bulgaria) experienced any significant trend increase. The implication is that, in these countries, labor is obtaining an increasingly smaller share of the private-sector's pre-tax revenue. Data using several different sources and different definitions of salary (such as the narrow concept of wages instead of the broader concept of labor compensation) or if factor costs are used instead of current market prices lead to the same picture - and reveal a decline in most countries[11] (see Appendix A - Figures A1 and A2).

Figure 1 reveals another important stylized fact on the short-term behavior of the labor share. In fact, during the heaviest years of the global economic crisis, the long-term downward trend stopped (and reversed for a couple of periods) to collapse again after 2009. This reflects the fact that wages tend to be less volatile than profits during economic recessions.[12] Indeed, the labor share is known to increase in the phases of adverse economic cycle to resume its long-run trend

[8] The OECD (2012) has noted, for instance, that over the period which runs from the early 90s to 2010 the share of labor compensation in national income fell in 25/30 industrialized economies, and calculated that the median (adjusted) labor share across these countries declined from 66% to 61% of GDP. More recently, OECD (2015) finds that the average (adjusted) labor share in G20 countries declined by about 0.30% a year between the early 80s and the late 2000s. Similar downward trends have been observed as well by other international institutions (EC, 2009; IMF, 2017; ILO, 2019).

[9] For what concerns emerging and developing economies, the evidence appears to be more mixed. Nevertheless, the ILO found that in many of them the decline of the labor share of income was even stronger than in advanced economies (in particular Asia and North Africa) (ILO, 2019). More recently, two comprehensive reviews of the subject also documented significant declines in some labor-abundant emerging economies (Karabarbounis, 2014), while at the same time highlighting large fluctuations in developing ones (Guerriero and Sen, 2012).

[10] Very large falls in the aggregate labor share were observed in Ireland (-0.81%), Romania (-0.63%), Croatia (-0.34%), Malta (-0.31%), Portugal (-0.29%), Slovenia (-0.27%), Poland (-0.27%), Hungary (-0.25%), Spain (-0.25%), Austria (-0.21%), where the cumulative decline for the whole economy exceeded 5 percentage points and is even more pronounced if we consider the private sector alone.

[11] The adjusted labor share can be calculated over GDP at current market prices as well as with GDP at current factor cost (i.e. subtracting taxes and adding subsidies). According to Guerriero and Sen (2012) the latter version is more meaningful, since taxes do not represent any kind of return to either capital or land.

[12] As the OECD states: "In times of recession, the decline [in the wage share] has usually paused, but then subsequently resumed with the economic recovery. The recent economic crisis and subsequent sluggish recovery have not deviated from this pattern" (OECD, 2012).

immediately afterwards. This countercyclical behavior of labor shares in advanced economies has been well documented by business cycle research (see for instance the IMF, 2017) and is usually explained by the presence of insurance mechanisms for both households and firms in the wage bargaining process (Charpe et al., 2019). Wage trends in Europe are largely predetermined by collective agreements at sector level, which continue to apply for relatively long periods of time. These agreements are usually negotiated on inflation expectations which slowly adjust to actual price dynamics. This generates a strong inertia and rigidities in the behavior of wages, preventing labor cost from adjusting rapidly to changes in labor market conditions. On the other hand, while wages remain quite unaffected by business cycle movements there are substantial changes in employment (Schneider, 2011; Cournède et al., 2016). Therefore labor adjustments cost along with labor hoarding may certainly explain part of the most recent rise in the labor share in Europe (EC 2009; Torrini, 2016).[13] To put it another way, Castaneda et al. (1998) and later Choi and Rios-Rull (2009) argued that the behavior of the labor share in the short term is such that it can be described as relatively volatile, anti-cyclical, very persistent, lagging behind production and tending to exceed the initial loss as a result of a positive technological innovation.[14]

A falling labor share implies that product wages grow more slowly than average labor productivity (Table 1 and Figure 3).[15] If labor productivity increases rapidly thanks to technological progress, and this comes hand in hand with a steady increase in labor incomes, a declining labor share can be viewed as a by-product of a positive economic development (IMF, 2017). However, in several economies, the decline in labor shares is due to the fact that product wage growth has failed to keep pace with a rather weak productivity growth.[16] If this is the case, the decline in the labor share is usually accompanied by an increase in income inequality, since capital ownership is typically more concentrated than wages (Piketty and Zucman, 2014; Wolff, 2017) (See figure A3 in Appendix A). Inequalities can not only fuel dangerous social tensions in society, but, as recent research points

[13] Countercyclical movements of the labor share have been confirmed in all the countries of the European Union except Germany.

[14] A number of papers analyze movements of the factor shares over the cycle in DGEM and, similarly to the endogenous growth literature, conclude that there are likely to be rigidities in markets that prevent prices and volumes from adjusting immediately to shocks. In other words, friction in markets or adjustments exist in the short-run, but in the long-run the labor share should remain stable (Gomme and Greenwood, 1995; Boldrin and Horvath, 1995).

[15] Recall that the labor share of income can be written as: $(WL)/(PY) = (w/P)/(Y/L) = (w/y)$, where: W is the nominal money wage (including benefits) per worker; L is the employment (usually in terms of hours worked); Y is the real output and P is the GDP deflator. Therefore, this means that Y/L is the labor productivity (y), while W/P is the wage expressed in units of domestic output and is also called (real) product wage (w). The product wage can (in some cases) be different from the consumption wage (i.e. wage measured in terms of consumption), as the latter takes into account the terms of trade (the price of imports in terms of exports) and is usually a measure of the purchasing power of workers' wage income.

[16] For a better understanding of the link between real wages and labor productivity, see ILO, 2015. For what concerns the productivity slowdown, see also Ollivaud et al., 2016 and IMF, 2017.

out, they can also limit the potential long-run growth of an economy. (Aghion et al., 1999; Berg and Ostry, 2017). Low labor productivity growth, if persistent, leaves little room for positive expectations of a significant recovery in real wage growth unless there is a reversal of the trend towards higher labor shares. If the global economy remains stuck in a path of weak growth, the growing recognition that the benefits of economic growth have not even been shared fairly among economic actors has reinforced a violent reaction against the process of economic integration and strengthened the power of groups in favor of policies oriented towards the internal market. In a recent work, Grossman et al. (2017) propose an effective explanation on how this productivity slowdown may have induced the decline in labor income share. They show that in a standard neoclassical growth model with endogenous human capital and capital-skill complementarity a decline of roughly 1 percent in the growth rate of labor productivity can account for between 50% and all the observed decline in the US.[17] While they focus on relatively recent trends, there is some evidence that a similar correlation between productivity growth and the functional distribution of income can hold also over longer periods of time (Growiec et al. 2018).

[17] The process works through optimal schooling choices. More specifically a slower growth reduces the real interest rate, inducing single individuals to raise their human capital for a given level of the real capital stock. Since it is assumed that skills are capital-using, this variation in the real interest rate is equivalent to a reduction in capital-labor ratio and operates a redistribution of income toward capital when the elasticity of substitution between capital and labor is lower than one.

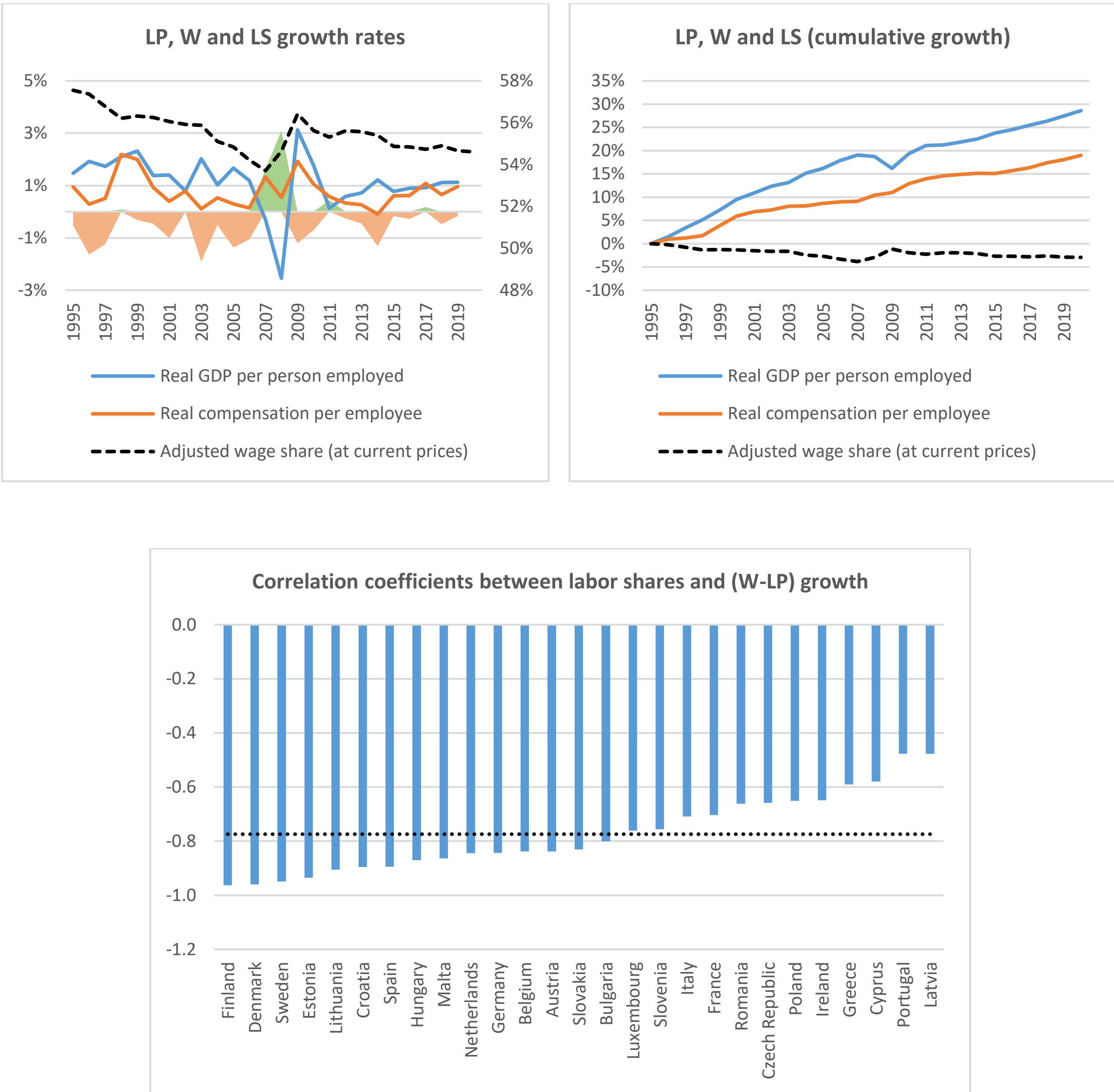


Figure 3 - Labor productivity, real compensation and the labor share in the EU28.

Note: % growth rates (panel a) and cumulative growth (panel b). Red areas are those where $\dot{LP} > \dot{RW}$ (decreasing the LS), green areas those where $\dot{LP} < \dot{RW}$ (increasing the LS). Panel c shows the correlation coefficients between labor shares and the excess of wage growth over productivity. *Source:* Authors' calculation on EUROSTAT data.

Average annual growth rates (1995-2019) - all NACE activities							
Country	dY	dL	dHW	dW	d(Y/L)	dW-d(Y/L)	d(wL/Y)
EU28	2.16%	0.57%	0.29%	0.71%	0.97%	-0.25%	-0.14%
EA19	1.89%	0.61%	0.29%	0.55%	0.69%	-0.14%	-0.08%
Belgium	2.28%	1.04%	1.04%	0.82%	1.01%	-0.19%	-0.11%
Bulgaria	2.69%	0.01%	-0.17%	7.08%	2.67%	4.41%	1.16%
Czechia	3.37%	0.21%	0.03%	3.80%	3.01%	0.78%	0.23%
Denmark	1.81%	0.54%	0.49%	1.13%	1.13%	-0.01%	0.00%
Germany	1.79%	0.74%	0.26%	0.79%	0.90%	-0.11%	-0.06%
Estonia	6.66%	-0.03%	-0.36%	6.61%	6.73%	-0.13%	-0.03%
Ireland	8.89%	2.80%	2.10%	0.71%	3.77%	-3.06%	-1.00%
Greece	0.76%	-0.01%	-0.15%	1.03%	0.78%	0.25%	0.11%
Spain	2.64%	1.81%	1.63%	0.08%	0.59%	-0.51%	-0.29%
France	1.95%	0.81%	0.49%	1.10%	0.97%	0.12%	0.06%
Croatia	2.68%	0.19%	-0.05%	1.59%	2.39%	-0.80%	-0.38%
Italy	0.69%	0.67%	0.29%	-0.07%	0.01%	-0.08%	-0.04%
Cyprus	3.38%	1.70%	1.45%	1.08%	1.22%	-0.14%	-0.07%
Latvia	6.18%	-0.22%	-0.41%	8.10%	6.72%	1.39%	0.31%
Lithuania	6.31%	-0.37%	-0.02%	8.21%	7.27%	0.93%	0.18%
Luxembourg	4.84%	4.56%	4.06%	0.23%	0.14%	0.09%	0.05%
Hungary	3.21%	0.71%	0.17%	1.68%	2.16%	-0.48%	-0.20%
Malta	NA	2.43%	NA	NA	NA	NA	-0.37%
Netherlands	2.56%	1.17%	0.99%	0.81%	1.10%	-0.29%	-0.16%
Austria	2.29%	1.05%	0.52%	0.60%	1.01%	-0.41%	-0.22%
Poland	6.08%	0.47%	0.34%	3.67%	5.09%	-1.41%	-0.43%
Portugal	1.48%	0.27%	0.21%	0.48%	1.14%	-0.65%	-0.35%
Romania	3.90%	-1.17%	-1.24%	4.95%	6.82%	-1.86%	-0.49%
Slovenia	3.63%	0.33%	-0.04%	2.31%	3.08%	-0.77%	-0.36%
Slovakia	6.14%	0.57%	0.19%	5.63%	4.95%	0.68%	0.16%
Finland	2.71%	1.11%	0.68%	0.96%	1.29%	-0.33%	-0.16%
Sweden	3.44%	0.98%	0.92%	2.25%	2.03%	0.23%	0.08%
United Kingdom	2.78%	1.10%	0.92%	1.95%	1.35%	0.60%	0.27%
Norway	2.36%	1.34%	0.92%	0.64%	0.78%	-0.14%	-0.07%
Mean	3.48%	0.86%	0.54%	2.44%	2.50%	-0.07%	-0.07%
Standard Deviation	0.02	0.011	0.01	0.025	0.022	0.012	0.004

Table 1 - Average growth rates of real GDP, employment, hours worked, real wages, productivity and the labor share.

Note: relevant period 1995-2019. *Source:* Authors' calculation on EUROSTAT data.

As already mentioned, trends in labor shares are to a great extent driven by the joint dynamics of average wages and labor productivity. In most cases, when average wages increase more rapidly than average labor productivity, the labor share increases. In contrast, when the growth of average wages lags the growth of labor productivity, we observe a fall in the labor share. However, this relationship can become more difficult to interpret if the share of wages in total compensation changes over the period of analysis[18], or if different measures are used to deflate respectively wages and output per worker (CPI and GDP deflators can be very different from each other). However, the ILO (2015) has shown that in several countries where labor shares declined, wage growth has lagged productivity growth even when different deflators are used or if total compensation is considered the relevant variable instead of the narrow concept of wage (we will discuss this point better in Section 3). Because most large EU economies, including Germany, Italy and Spain, have seen wage growth lagging productivity growth, labor productivity has outpaced real average wage growth in a group of 28 European economies for which data is available since 1995 (Table 1). In most of these countries, the aggregate growth of real wages was significantly slower than that of aggregate productivity even considering the dynamics of prices, hence accounting for the decline in the labor share.

Nevertheless, it has been argued that this does not necessarily mean that the growth of average real wages has been slower than that of aggregate labor productivity within all the industries. In many countries, real wages have grown faster than productivity in several industries and less than productivity in others. Yet, in these countries, the labor share still decreased on average within industries because labor productivity used to grow faster in high-productivity industries, thus raising the average growth of labor productivity at a level above that of real wages. This phenomenon is exactly quantified in the third section of the paper.

To anticipate a first result, what emerges from the shift-share analysis for the EU28 is a within downward trend which is common to almost all the countries considered (and which contributed substantially and decisively to the decline of the labor share in 18 countries of the EU). The fact that many advanced and emerging markets, as well as developing economies, have experienced decline through somehow synchronized evolutions - through domestic economic cycles and in a period of intense structural transformation - suggests that at least some of the key driving forces are probably

[18] Indeed, as discussed in greater details in the introduction of the theses, wages represent only one component of labor costs. For this reason, it may be more appropriate to compare gains in labor productivity with increases in average compensation per employee (as opposed to wages). Compensation of employees includes wages and salaries payable in cash or in kind and social insurance contributions payable by employers (IMF, OECD, UN and WB).

global. At the same time, the strong heterogeneity among sectors and firms' experiences may be connected to different degrees of exposure to the common global forces. The situation is made even more complex by the fact that this fall in the labor share within-industries is dominated by a reallocation of value-added between-firm.

Here and in the next sections of the paper we show that all these processes which are taking place worldwide go through an influence on the individual characteristics of firms. For this reason, we emphasize how changes in the labor share can be fully understood and captured only with a perspective strictly focused on firms. Our micro analysis differs from most of the existing empirical evidence which is largely based on macro/industry-level patterns and is instead linked to a recent and emerging strand of literature that studies the labor share starting from the bottom (Autor et al., 2020). In fact, in our view, while the more aggregate approaches remain valid in many of their dimensions, they tend to partially overshadow the underlying low-level dynamics and to dispel the implications of several contrasting theories - such as the contrast between models of heterogeneous change versus models of homogeneous change in the labor share between companies in each sector.[19]

2. What is driving the labor shares down?

Besides these well-established facts, there is less consensus, however, on what are the causes of the recent decline in labor shares. Partly also because the forces behind its apparent medium run movement and the variety of experiences of industry and firms are not yet fully understood. Analysts focusing primarily on advanced economies have put forward four main explanations for the observed downward trends in factor shares: (1) rapid technological progress (Bentolila and Saint-Paul, 2003); (2) the globalization of trade and capital (Guscina, 2006); (3) product and labor market institutions (Blanchard and Giavazzi, 2003), with attention to market concentration (Autor et al., 2020); (4) the bargaining power of labor and unemployment (Benjamin et al., 2010).[20]

[19] In this sense, some notable exceptions are the works of Bockerman and Maliranta (2012) which employ Finnish manufacturing longitudinal plant-level data over a 30-year period to operate a decomposition of variations in the labor share. They found that microlevel restructuring is the link between the decline in the share of labor and the increase in productivity with a leading role in international trade; Autor et al. (2020) which employ firm-level panel data to show that the increase in concentration is largely due to reallocation of market share toward the preexisting set of large and productive firms and Kehrig and Vincent (2018) who find the same results by decomposing data in the US manufacturing industry.

[20] Here we mention only "pioneering" papers which contributed in an original way to the expansion of the literature in new directions Subsequently, for each new strand, we make a comprehensive review by focusing on those works which have acquired importance.

There is a wide diversity of findings in the literature on the relative importance of these factors. The broad consensus is that, despite significant adjustment costs that these forces have imposed on some groups of workers, all the trends have contributed positively to global economic growth and worldwide shared prosperity, as well as to a partial income convergence between developing and developed economies. Specifically, the benefits of extended trade and financial integration for emerging markets and developing economies - where it has boosted convergence, increased average incomes, enlarged the access to goods and services and brought millions of people out of poverty - are well documented.[21] On the other hand, empirical analysis has also shown that, in some advanced economies, the automation of "routine" jobs, along with offshoring and an increasing competition on import, led to a consistent loss of jobs for either lower and middle-skilled occupations.[22] [23]

Indeed, technological progress is often presented as the main responsible for labor share movements, with authors focusing on the role of capital accumulation and capital-augmenting technical change (e.g., Bentolila and Saint-Paul, 2003; Arpaia et al., 2009; Driver and Muñoz-Bugarin, 2010; Lawless and Whelan, 2011; Raurich et al., 2012; Karabarbounis and Neiman, 2014; Piketty and Zucman, 2014). One of the many ways in which embodied technological change has affected factor shares is through a sharp reduction in the relative price of capital goods. This has lowered the user cost of capital for firms providing them a strong incentive to replace labor with capital (Karabarbounis and Neiman 2014).[24] [25] More recently, Eden and Gaggl (2015) and Acemoglu and Restrepo (2018) employed and extended this theory by focusing on respectively the role of ICT

[21] The benefits of an increased integration of global markets are widely documented. A recent and exhaustive review can be found in Baldwin (2016). Other recent studies on the subject include Wacziarg and Welch (2008), Costinot and Rodriguez-Clare (2014), Donaldson (2015), Fajgelbaum and Khandelwal (2016). All of them document that stronger capital inflows usually come together with higher per capita growth in both emerging and developing economies.

[22] There is strong evidence that within the workforce of advanced economies, low and medium-skilled workers are those who have suffered the fall of the labor share more than anyone else, along with the persistent decline in medium-skilled occupations and large income losses for medium-skilled workers (Autor and Dorn 2013; Goos et al. 2014).

[23] Autor and Dorn (2013) found a strong link between the adoption of ICT technology and the polarization of employment and wages in the US, while Autor et al. (2016) and Pierce and Schott (2016) show that that in the US there were consistent employment losses in industries more exposed to import competition from developing countries. Finally, Goos et al. (2014) provide evidence that routine-biased technological change and the offshoring of some stages of the production process can explain job polarization in advanced European economies.

[24] Thanks to the development of automation and the diffusion of ICT, the new vintages of capital goods not only became cheaper but also increasingly able to substitute workers' in their routine tasks.

[25] The user cost of capital is the opportunity cost of using rather than selling the existing capital stock of capital. It increases with the price of capital, the interest rate, the depreciation rate, and the (expected future) decline in the price of capital. Technology that produces investment goods more efficiently lowers the price of capital and hence the user cost. A decline in either the interest rates or the capital depreciation rate could play a role similar to that of technological progress in lowering the user cost of capital for firms. Acemoglu (2002) argues, for instance, that firms may invest into creating a technology which is biased towards one input if the relative price of this input is much lower.

capital and robots. Koh et al. (2019) emphasized the rise in the importance of intangible capital, such as intellectual property products, R&D and knowledge in the production functions of developed economies. A common element in the argument of these papers is that the elasticity of substitution between equipment or intangible capital and labor is estimated greater than unity. Recent empirical works by Oberfield and Raval (2014) and Chirinko and Mallick (2017) cast serious doubt on this hypothesis, even at higher levels of aggregation. The value of the elasticity is a matter of first-order importance for analyzing long-rung movements of income distribution. However, even if capital and labor are gross complements (i.e., the elasticity of substitution is lower than one), Grossman et al. (2017) show that a slowdown in the growth of labor productivity or capital-augmenting technological progress can eventually lead to a declining labor share. Finally, Alvarez-Cuadrado et al. (2018) show that industry-level specificities in technological progress and the elasticity of substitution between labor and capital are important factors in determining the dynamics of factor shares within industries.

Alternatively, studies typically find negative (but small) effects of globalization on the labor share in developed countries (IMF, 2007; ILO, 2012).[26] Actually, world trade and financial integration of national markets have increased tremendously over the past 40 years. These processes have been driven by the progressive reduction of restrictions, barriers and tariffs on international trade and capital mobility, which, together with the decrease in transport and communication costs have pushed companies towards a global reallocation of factors. A growing competition on imports encouraged the relocation of lower-skill and labor-intensive stages of production to cheaper labor abundant locations in emerging and developing economies (Dao et al., 2017). In this perspective, it is also possible that redistribution from labor to capital has occurred through the so-called "threat effects" which can take place even without an effective change in the locations of production (Burke and Epstein, 2001). Empirical evidence on the matter is still not clear. Elsby et al. (2013) emphasized the importance of international trade and outsourcing, with China, and have found in offshoring an important driver of the decline of the labor share in the United States.[27] This has been also confirmed by Nayar et al. (2015) that employed plant-wide data, founding that offshoring was a major cause of employment cuts in US manufacturing, while it increased profits in the remaining

[26] From a theoretical point of view, theories of international trade which are based on differences in factor endowments between countries predict that trade integration would reduce labor shares in capital-abundant advanced economies and raise them in labor-abundant developing ones. The observed evolution of labor shares in the latter group of countries is, however, at odds with this prediction. Indeed, the whole process of integration could be much more complex than captured by classical trade models, since it involves the transfer of factors and technology across borders as well as shifts in relative bargaining power of either labor or capital.

[27] Bockerman and Maliranta (2012) present similar evidence for Finland.

production plants. However, more recently, Autor et al. (2017) showed that the decline in the labor share involved both tradable and non-tradable sectors, thus weakening a lot the hypothesis that globalization is a key driver in the decline of the labor share. On the other hand, by examining a global sample of countries - including both developed and developing - Guerriero and Sen (2012) found that the overall impact of trade is eventually positive.

The role of financial markets has also been stressed, through its pressure on firms to increase value for shareholders and focus on their core activities while exporting the low-value labor-intensive stages of production (Weil, 2014)**.** Even if some groups of workers, in particular top managers, may have benefited from this process - by relying on other forms of compensation like pension funds or capital gain - there is strong evidence which indicates that for the average worker the extent and magnitude of such gains is very circumscribed (Bell and Van Reenen, 2013).

Finally, institutional factors have been explored. Although the technological conditions determine factor substitutability, the speed at which firms replace one inputs of production with another depends on the frictions in factor markets, which are ultimately determined by the institutional setting in force in that country. Labor market institutions, product market regulations, the degree of public ownership, bargaining power of workers and the structure of the welfare state are all variables that have been discussed as potentially able to influence the labor share. Special attention has been paid to factors and institutions such as union density, minimum wage, unemployment benefits and compensation for dismissal. The strong decline in union density in modern times - for instance when measured in terms of trade union members as a percentage of total employees - in many developed economies has often been linked to a reduction in the bargaining power of workers, with a negative effect in their ability to negotiate a larger share of productivity gains in compensation for their labor (Fichtenbaum, 2011). Similarly, the level of minimum wage, including the employment protection legislation (EPL), the generosity of unemployment benefit, as well as the role of social norms and other labor market institution, are institutional variables that have been widely analyzed in empirical studies (EC, 2007; Charpe, 2011; ILO, 2012; OECD, 2012; Piketty, 2014; Pak and Schwellnus, 2019).[28] A high unemployment rate can exert a downward pressure on the wage demand curve and hence on the labor share, while the level of unemployment benefits can have an impact on the latter by affecting the "reservation wages" of workers - i.e. the "minimum" payment accepted as a compensation by a worker for his

[28] However, it could be claimed that the common experience of a generalized decline in labor shares across countries with different extents of unionization and other labor market institutions as present in the data somewhat vitiates this argument (Autor et al., 2020).

job. Blanchard and Giavazzi (2003) argue that weakening employment protection policies has contributed consistently to the decline of the labor share in OECD countries. Other studies have attributed to labor market deregulation most of the decline (Peters, 2008; Bassanini and Duval 2009; Suchanek 2009). Azmat et al. (2012) show that a reduction in product market competition and declining employment protection policies have both depressed labor shares in European industries but did not find any evidence of this latter effect. Bassanini and Manfredi (2012) have associated increasing competitiveness of the markets with increasing labor shares, as the fall in barriers to entry decreases rents of firms and increases the value accruing to workers. Along with these factors Piketty (2014) highlighted the role of social norms. Among all the institutional factors which we have mentioned, empirical evidence suggests that the role of those influencing workers' bargaining power is the greatest (OECD, 2012). The importance of institutional variables in the process is quite clear, but the evidence is - once again - mixed.

The main objective of this paper is to provide a novel contribution to the ongoing debate with new evidence on the role of technology and institutional factors. Although previous research has widely recognized the importance of technological change, we extend the current literature by focusing on a large group of European countries, thus contributing to a debate that so far has been dominated by evidence from the United States. The role of institutional factors is typically one of the most challenging to be assessed, partly also because of the difficulty in finding reliable proxies to measure their impact. Indeed, little time and cross-sectional variation generally characterizes the available index of market regulations, especially at lower level of aggregation. For this reason, to our knowledge, all these explanations have been largely tested only at the country and industry level, even though the aggregate labor share is the result of production decisions and wage-setting processes occurring in large part in individual, heterogeneous firms. Despite the intrinsic microeconomic nature of potential drivers of the labor share, empirical research has so far focused on the relationship between macroeconomic aggregates, and the exceptions that have ventured into more detailed analysis are to be counted on the tips of the finger. The recent results of Autor et al. (2020) showed that increasing market concentration, favored by the employment of new technologies, is likely to drive the decline of the labor share in the United States. For this reason, the role of market regulation is now in the front line in different explanations and certainly deserves further investigation. Following the pioneering work of Autor et al., Adrjan (2018) employed UK longitudinal firm-level data covering the period from 2005 to 2012 and found that firms with greater market power and a higher capital to labor ratio allocate a smaller proportion of their value added to their workers. Bauer and Boussard (2019) with a database of French firms from 1966 to 2016 documented the role of market power in explaining variations of the aggregate labor share, as opposed to other technological factors. They found that, from a micro point of view, reallocation contributed negatively, and firm level markups contributed positively to its decline, while, on the other hand, the contribution of technology was almost negligible. Dall'Aglio et al. (2015) analyzed the short and medium-run dynamics of the labor share for a sample of Italian firms from 2004 to 2007 and found that the capital-output ratio plays a key role in both the short and the medium run. Further, while increases in the markup over production costs and technological progress have positive effects on the labor share in the short run, they became negative in the medium run. Finally, Perugini et al. (2017), using a sample of firms from 6 countries of the European Union, showed that the labor share decreased more for firms which were strongly integrated in internationalization processes, but the effect is not related in any way to differences in the composition of the labor force, technological factors or market power.[29]

Using AMADEUS data[30] we propose a methodology for calculating the labor share of value added and the capital-output ratio at the firm level in 28 European Countries. For these countries we provide microeconomic evidence on the evolution of labor shares in 19 major sectors of the economy. We show that the labor share varies significantly across firms, even within narrowly defined industries, as well as within firms over time. We then investigate what determines the labor share of individual firms and focus on the crucial role played by the capital-output ratio. To guide our empirical analysis, we build on the theoretical insights of Bentolila and Saint-Paul (2003) and express the labor share of output (value added) as a function of a set of technological factors. We show how distribution in firm-level characteristics can drive and explain observed firm-level differences in labor shares and, in turn, influence the aggregate pattern of the labor share itself over time. We allow firms to differ by the capital intensity of their production processes, their market power, productivity and consider potential non-linearities in these relationships. Our micro-level analysis is distinct from most existing empirical evidence that is largely based on macroeconomic

[29] Outside the European context, a few notable exceptions also exist. For instance, Berkovitz et al. (2017) studied the evolution of the labor share over the period 1995-2010 for a sample of Chinese firms. They linked the decline mainly to institutional factors (namely market reforms in the state sector and product market deregulation) and also highlight (following the line of Autor et al., 2020) the increasing importance of large "superstar" firms, with relevant market power and a small labor share. Hwang and Lee (2015) studied the same dynamics in the Republic of Korea during the period from 2005 to 2011 and found that, besides the factors related to production technology and market power, employees' bargaining power and the corporate strategies for labor are of primary importance in explaining the observed heterogeneity in labor shares.

[30] Amadeus is a database of comparable financial and business information on Europe's largest 520,000 public and private companies by total assets. It covers 43 countries and is published by Bureau van Dijk / Moody's Analytics. Amadeus provides standardized annual accounts (consolidated and unconsolidated), financial ratios, sectoral activities and ownership data.

and industry-level variation and emphasizes the insights obtained from taking a firm-level perspective to analyze changes in the labor share. As already stated more aggregate approaches, while valid in many of their dimensions, have the disadvantage of obscuring part of the picture. To this extent, we believe that the model presented in this paper can contribute to shed some more light on the channel through which an increase in capital intensity can influence the firm's payments to labor as a share of value added.

The model predicts that as capital increase (for a given level of output), the firms will pay lower labor shares when capital and labor can be easily substituted in the production function. However, at a certain point, for high levels of capital employed in production the $LS - k$ relationship change its slope, and substitution between factors turn out to be more difficult.[31] Further and beyond this, firm with a higher market power will always have lower labor shares in most sectors. However, as we will see, when estimating for the aggregate economy, the role of this latter factor is strongly downsized compared to existing literature. This result which at first sight may be difficult to interpret since the markup and the labor share usually move in opposite directions, can be reconciled with recent models which consider the expansionary role of labor - where the co-movement can be reversed (Kaplan and Zoch, 2020). On the other hand, the effect of capital-augmenting technological progress as proxied by the TFP is always negative and significant, as it is that of labor adjustment costs. A 1% increase in the capital-output ratio of firms decrease (on average) the labor share by 0.03 percentage points and TFP reinforce this effect with an additional 0.15%.

To sum up, market power, technological change and the bargaining power of workers can explain a large part of the variation in labor share across firms. Consequently, any change in the value of TFPs and markups as well as a rightward shift in their distribution at the firm level can explain part of the declining trend in the aggregate labor share. Further, for those firms which operates in the part of the curve with a negative slope (i.e., they have an elasticity of substitution that exceeds unity), an increase (or a rightward shift) in capital intensity of all firms also depresses the overall aggregate labor share. On the other hand, for those firms which are in the part of the curve with a positive slope (i.e., the elasticity of substitution is lower than one), a rightward shift in

[31] According to the usual assumptions, when the elasticity of the substitution between capital and labor in the production function of a firm exceeds (is lower) the unit, a firm that becomes more capital intensive will have a lower (higher) labor share. This implies that a rightward shift in the distribution of capital intensity tends to depress labor shares in those sectors where the elasticity of substitution is greater than one. Finally, when the elasticity of substitution between capital and labor is unity (the Cobb Douglas case), a firm's labor share is independent of its capital-output ratio. Our model encompasses all of these three cases by relying on a non-linear relationship between the capital-output ratio and the labor share.

the capital intensity of firms increase the overall aggregate labor share. The non-linear relationship between k and the LS is the most important result of the paper, since potentially able to reconcile most of the conflicting findings in the literature.

We organize the remaining part of the paper as follows. Section 3 starts with a simple shift-share analysis and accurately describes how the labor shares have evolved within and between industries and firms. Section 4 presents the theoretical model. Sections 5 and 6 respectively the empirical strategy, data description, summary statistics and results. Finally, section 7 concludes with a comprehensive discussion on policy implications and further research. Appendix A provides additional charts and tables; Appendix B is a mathematical appendix which presents the derivation of the model, of the formulas employed in the shift-share analysis and additional information on technical aspects connected with the estimation of TFPs and Markups; Appendix C is a data appendix with information on the dataset and variables.

3. Shift-share decomposition

Several studies have suggested that the observed trends in the aggregate labor share in Europe and the United States could potentially hide important compositional factors (see De Serres et al., 2002; Ruiz, 2005; Arpaia et al., 2009; Dao et al., 2017 and Dimova, 2019).[32] Indeed, since the early 90s, a number of industries characterized by low labor shares - in particular services such as financial intermediation and insurance activities or the real estates - have gained importance in most countries of the EU, while other traditionally considered labor-intensive - such as part of the manufacturing like textiles - have shrunk, thus depressing the aggregate labor share. Therefore, an essential question is whether the decline in the aggregate labor share has been the result of a structural shift away from labor-intensive activities, or whether, on the other, it can be considered the result of a generalized decline in labor share within each industry. This question can be answered by means of a standard shift-share analysis. Based on comparable data for 28 European Countries and 11 industries from the Eurostat Database at the NACE one-digit level[33], variations in the labor

[32] De Serres et al. (2002) found that for their period of analysis (from the mid-1970 to the mid-1990s) most of the variation in the labor share in Belgium, France, Italy, and the United States is connected with the within-sector component; while for Germany they find that the downward trend in the labor share of the business sector is fully explained by a compositional shift towards industries with lower labor shares. In this latter case their explanation is based on structural change with service activities gaining importance in aggregate value-added at the expenses of manufacturing. Garrido Ruiz (2005) and Arpaia et al. (2009) confirm this for single countries or blocks of countries (respectively Spain and the EU15) and over specific periods. Ibarra and Ros (2017) for Mexico.

[33] Data used for the shift-share analysis are from the National Accounts aggregates by industry (up to NACE A64) of Eurostat. We included the following sectors: (1) Agriculture, forestry and fishing; (2) Arts, entertainment and recreation; (3) Construction; (4)

share of the aggregate economy can be decomposed into the contribution of within-industry changes and that of changes in the value-added share of industries with below/above average labor shares. Formally, the shift-share decomposition can be written as:

$$\Delta LS = (LS_t - LS_{t-1}) = \sum_i s\overline{VA}_i(ls_{it} - ls_{it-1}) + \sum_i (sVA_{it} - sVA_{it-1})\,\overline{ls}_i \qquad (1)$$

Where:

- LS represent the aggregate labor share;
- ls_i represent the labor share of industry i;
- sVA_i is the share of industry i in total value added;
- A bar over the variable represents the average value of the latter over the period.

The effect of compositional changes in the structure the economy along with variations in the labor share of income which occurred within single industries can be measured by comparing the observed values of the labor share with an alternative aggregate measure obtained by keeping the sector weights constant at their average value. This alternative version of the labor share is hence estimated year by year as $\sum_i s\overline{VA}_i(ls_{it} - ls_{it-1})$ for the EU28 and for the EA19, where $s\overline{VA}_i$ is the average value of the share of sector i in nominal value added during the period of analysis (1995-2019). In other words, the first term on the right-hand side of equation (1) is a weighted average of intra-industry changes in the labor share (we will call this a "shift" component) while the second term represents the contribution of reallocation of VA across industries with different labor shares (i.e., the so-called between industry component). The detailed breakdown for each country is shown in Table 1 - Appendix A.

Financial and insurance activities; (5) Industry (except construction); (6) Information and communication; (7) Manufacturing; (8) Professional, scientific and technical activities; (9) public administration, defense, education, human health and social work activities (10) Real estate activities; (11) Wholesale and retail trade, transport, accommodation and food service activities.

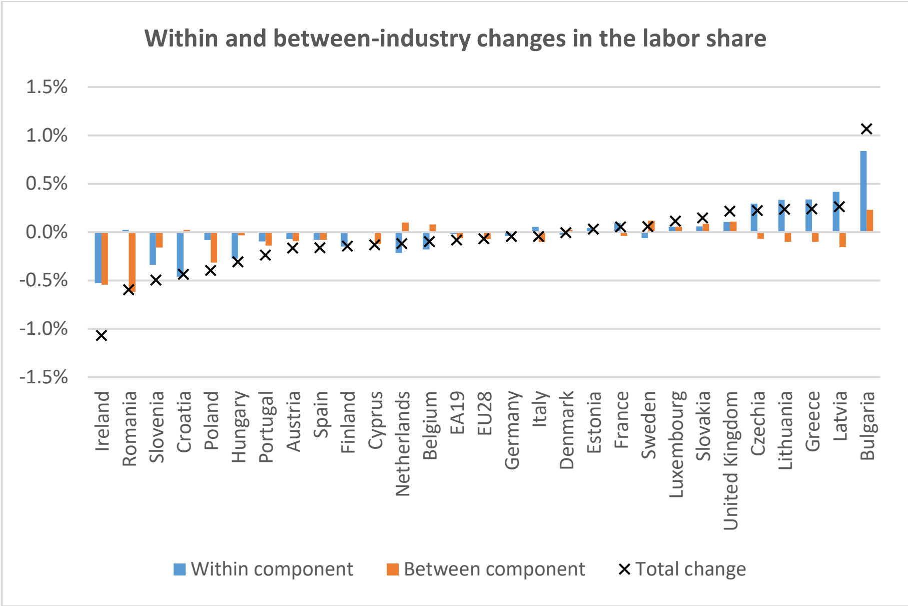


Figure 4 - Within and between-industry changes in the labor share.

Note: relevant period 1995-2019. Shift-share decomposition of the variations in the labor share of the whole economy, partitioned in 11 industries. The wage of the self-employed is imputed assuming that in each industry their hourly wage is the same of an average employee in the industry. *Source:* Authors' calculation on EUROSTAT data.

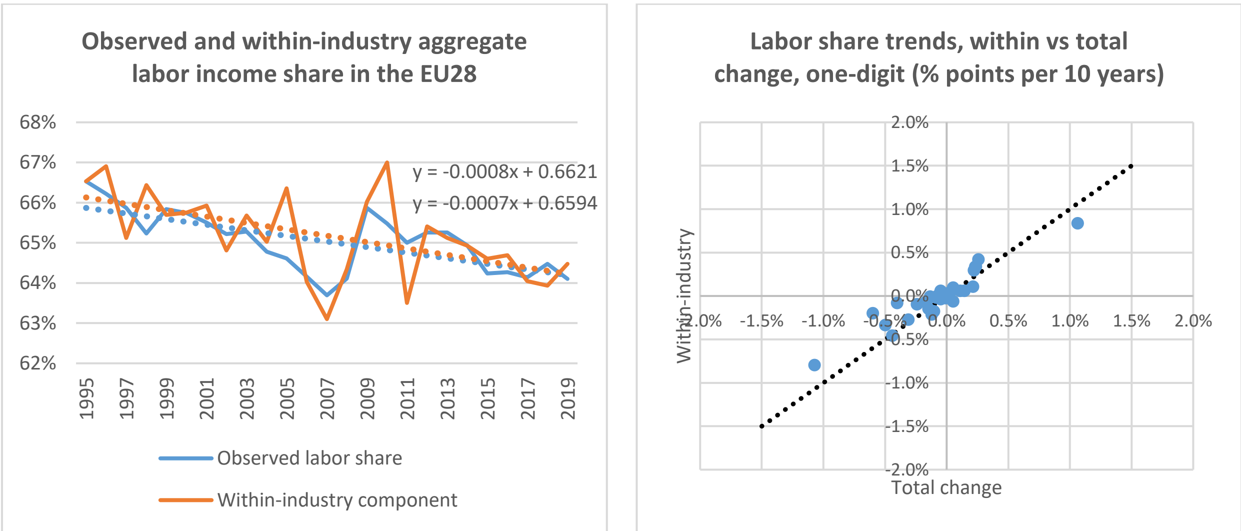


Figure 5 - Observed and within-industry component of the labor share (cross-country average for EU28) (panel a). Contribution of the within-industry change defined as weighted average of within-industry changes (panel b).

Note: relevant period 1995-2019. More than 80 percent of variation in labor share trends across countries is explained by within one-digit sector variation. The role of between-sector reallocation is small on average but plays a dominant role in Ireland, Romania, Poland and Bulgaria. *Source:* Authors' calculation on EUROSTAT data.

Figure 4 shows the within and between-industry variations of the labor share for the whole economy in all the countries of the EU28 over the period 1995-2019. Figure 5 (panels a and b) shows respectively the observed and adjusted (within component) values of the labor share for the period 1995-2019 and the contribution of the within component to the observed total change in different countries of the EU. We did the exercise by focusing on either the whole economy (the results presented here) and the private business sector (in Appendix A), which excludes a series of sectors whose accounting data are not completely comparable or largely dominated by the public and therefore not fully underlying a market logic.[34] However, with some small differences in terms of magnitude, it is worth noting that the results are virtually identical.

As can be seen from the graphs, the evolution of the within labor share replicates very closely the evolution of the observed labor share, suggesting that the between-industry component, which captures structural change in the composition of the economy, played overall a secondary role. The same conclusion applies when we replicate the exercise for countries of the Euro Area (which are reported in Appendix A - Figure A4). The result can be explained by a relatively stable industrial structure together with the fact that the reallocation of resource has taken place not between sectors with higher and lower labor shares but rather among sectors with a relatively high labor share of income. Within industries, the labor share declined by as much as 1.07 percentage points per year in Ireland, 0.60 in Romania and 0.50 in Slovenia. In most countries where a significant contraction of the aggregate labor share was observed, within-industry changes accounted for close to 100% of that decline, with the partial exception of Cyprus and Poland, where this proportion is reduced to roughly 1/5.[35] This is also confirmed by Figure 5 (panel B) where most countries are clustered around the 45-degree line, clearly indicating that trend changes in labor shares emerge strongly from trend changes in the within-industry component rather than from the reallocation of value added across industries. Large between industry components, implying noteworthy reallocation away from high-labor-share industries, were observed in Romania (-0.62%); Ireland (-0.54%); Poland (-0.31%); Slovenia (-0.16%); Latvia (-0.16%) and Portugal (-0.15%). In these countries, structural reallocation across industries accounted for a decrease of the aggregate labor share greater than 0.15 percentage points per year. By contrast, in a few other countries, and notably

[34] The main adjustments involved when calculating the labor share for the private business sector are the exclusion of: (i) real-estate services, whose value added is in great part reported as capital income since results from the imputation of owner-occupied housing in National Accounts; and (ii) public administration and social services, which are provided by the public sector and whose value added is almost equal to the sum of labor costs.

[35] Denmark (99%); Netherlands (99%); Belgium (99%); Croatia (99%), Finland (99%); Hungary (89%); Germany (82%); Slovenia (68%); Spain (50%); Ireland (49%); Austria (44%); Portugal (41%);Poland (21%); Cyprus (8%).

Belgium and Sweden, reallocation to high-wage share industries limited somehow the aggregate consequences of sizeable within-industry falls in the labor share. Finally, in Slovakia, a similar shift in industry composition is responsible for a major part of the significant increase in the labor share in that country. In all other countries that experienced a consistent reduction in the labor share, reallocation of value added across industries played a minor role. However, in the few cases where this happened, most of the reallocation has taken place from agriculture, manufacturing, accommodation, food and other service activities towards construction, transportation and professional/technical activities. It is worth noting that most - even if by no means all - of these sectors feature higher than average labor income shares at the beginning and end of the period.

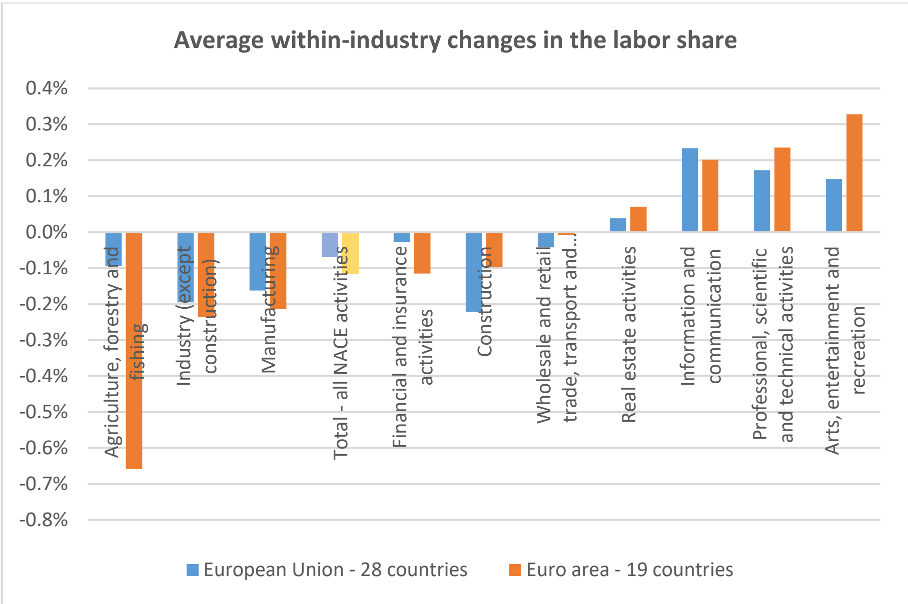


Figure 6 - Cross-country average of within-industry changes in the labor share (1995-2019).

Note: average of within-industry annual percentage-point variations. *Source:* Authors' calculations on EUROSTAT data.

Another fundamental question is whether the decline in the labor share has been homogeneous across sectors or whether such a phenomenon has been more important in some specific sectors of the economy. Figure 6 shows that on average across European countries, within-industry changes in the labor share declined or remained rather stable in all business-sector's industries with the exceptions of (M) Professional, scientific and technical activities; (J) Information and communication (ICT); and notably (R) Arts, entertainment and recreation where the labor shares rose substantially by almost 0.54 percentage points per year (0.64 if we consider the EU19). However, these sectors together account for less than 1/3 of the total value added generated in Europe. Further, the Professional, scientific and technical activities is a composite industry, which includes sub-sectors that make an extensive use of medium-skilled workers and are extremely intensive in terms of physical capital along with sub-sectors that, on the other hand, employs high-skilled labor (e.g., R&D, ICT activities, legal and technical services) which expanded dramatically in advanced economies over the past twenty years. The expansion of the labor share in this sector is therefore likely to reflect to a large extent within-industry changes in the composition of the sub-industries themselves. By contrast, large contractions in the labor share (above 0.34 percentage points per year on average in the EU28 and 0.26 in the EU19) occurred in the Construction industry as well as in high technology manufacturing, while declines were typically small in other service activities and the low-tech part of manufacturing.

The evolution of the labor share in each industry can also be linked to the different evolution of real wages, labor productivity, adjusted GDP and consumption prices (see Torrini, 2005 which operates this decomposition for Italy or Dimova, 2019 for European countries). By using logarithmic approximations, we can write:

$$ln\left(\frac{LS_t}{LS_{t-1}}\right) = ln\left(\frac{W_t}{W_{t-1}}\right) - ln\left(\frac{y_t}{y_{t-1}}\right) + ln\left(\frac{\frac{P_t}{D_t}}{\frac{P_{t-1}}{D_{t-1}}}\right) \tag{2}$$

That is, the aggregate variation of the labor share LS can be further decomposed into the percentage growth of the aggregate real gross wage W (deflated with the consumption price index P) minus the percentage growth in hourly productivity y (deflated with the aggregate value-added deflator D) and the percentage change in the relative price of consumption with respect to domestic output (P/D). As proposed by Böckerman and Maliranta (2012) equation (2) can be used to extend the standard shift-share decomposition - as performed with 1 - in order to investigate the relative contributions of wages, productivity and prices to within and between-industry changes of the labor share. If we follow this road, as demonstrated in the first section of Appendix B, the percentage change in the aggregate labor share can be approximated by:[36]

[36] Note that the formula in (3) is exact (i.e. $=$) for standard growth rates and only approximated (i.e. $\cong$) for log differences.

$$
\begin{aligned}
\Delta LS &= log\frac{LS_t}{LS_{t-1}} \\
&\cong \left[\sum_i \bar{h}_i\left(ln\frac{w_{it}}{w_{it-1}} - ln\frac{y_{it}}{y_{it-1}}\right)\right] \\
&+ \left[\sum_i \bar{h}_i ln\frac{w_{it}}{w_{it-1}}\left(\frac{\bar{w}_i - \bar{W}}{\bar{W}}\right) - \sum_i \bar{h}_i ln\frac{y_{it}}{y_{it-1}}\left(\frac{\bar{y}_i - \bar{Y}}{Y}\right)\right] \\
&+ \left[\sum_i \bar{h}_i ln\frac{\frac{P_t}{d_{it}}}{\frac{P_{t-1}}{d_{it-1}}} - \sum_i \bar{h}_i ln\frac{\frac{P_t}{d_{it}}}{\frac{P_{t-1}}{d_{it-1}}}\left(\frac{\bar{y}_i - \bar{Y}}{\bar{Y}}\right) + res\right] \\
&+ \left[\sum_i (h_{it} - h_{it-1})\left(\frac{\bar{w}_i}{\bar{W}} - \frac{\bar{y}_i}{\bar{Y}}\right)\right]
\end{aligned} \qquad (3)
$$

Where:

- W and w represent respectively real wages at the aggregate and industry level - both deflated by the consumer price index.
- Y and y represent respectively real value added per hour worked at the aggregate and industry level - both deflated by the aggregate value-added deflator.
- h stands for the share of industry i in total hours worked;
- res is a residual; [37]
- A bar over the variable represents the average between the initial and ending value of the period.

In Figure 7 below, percentage changes in the aggregate labor share are decomposed into:

(i) The contribution of the average relative within-industry growth of real wages with respect to productivity to the evolution of the aggregate labor share.

(ii) The contribution of convergence/divergence patterns in real wages and labor productivity. This means that real wages provide a greater contribution to variations in the labor share when they grow faster in industries characterized by above average wages; on the other hand, when productivity grow faster in industries with above average productivity levels, the labor share is inevitably reduced.

[37] This term which usually is very small, could be significantly different from zero under two circumstances: (i) if the aggregate deflators of value added and the consumption price index diverge and (ii) if employment growth during the observation period had strong and opposite correlations with the shares in value added at the beginning and end of the period.

(iii) A relative price effect, which if positive means that on average the consumption price index grows faster than the output deflator. This relative price effect can be further decomposed into a within and a convergence component plus a small residual. However, since most of the action occurs within industries, for simplicity, we present the three terms grouped together.

(iv) The reallocation of labor from (to) industries that are relatively higher in wages (productivity). More specifically, this latter component is positive if expanding industries are higher in wages than they are in terms of productivity and is roughly equivalent to the between component of the decomposition in (1).

The terms in the first, second and third brackets of equation (3) decompose within industry changes in the labor share - exactly as computed in equation (1), with the exception that they are expressed in % instead of percentage points - into average within-industry growth of the ratio of real wages to that of productivity, convergence/divergence dynamics and relative price growth. This approximation is accurate - meaning that the sum of the terms in equation (3), except those in the fourth bracket, closely corresponds to the within component of (1) - when h and s are sufficiently close, which turns out to a verified condition in the data considered here.

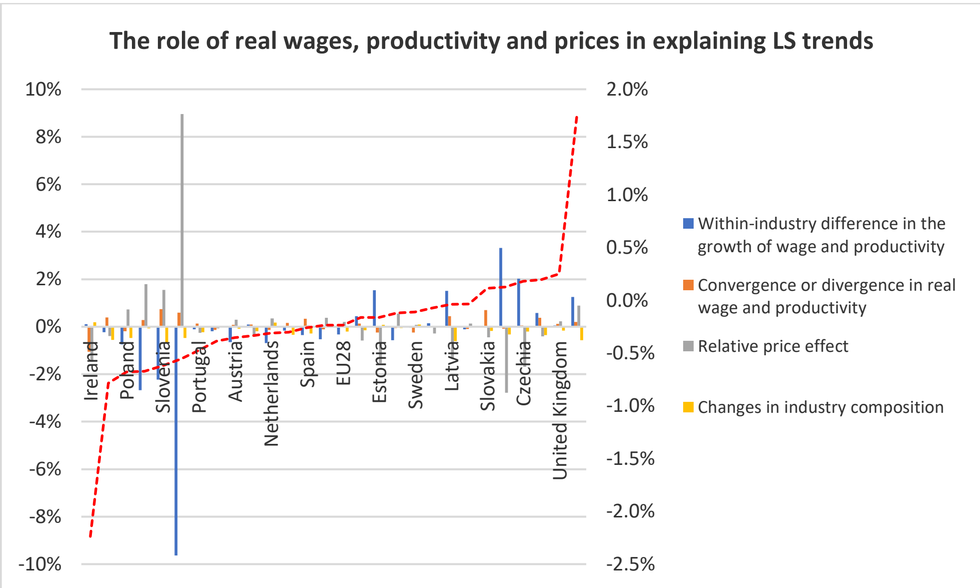


Figure 7 - The role of real wage, productivity and prices in explaining trends in labor shares (1995-2019).

Note: extended shift-share decomposition of the percentage change of labor share in the business sector, partitioned in 11 industries, excluding the real estate. *Source:* Authors' calculations on EUROSTAT data.

	Within-industry difference in the growth of wage and productivity	Convergence (or divergence) between real wage and productivity	Relative price effect	Changes in industry composition	Total % change (avg annual rate)
	(1)	(2)	(3)	(4)	(1+2+3+4)
Ireland	0.11%	-1.05%	-1.48%	0.18%	-2.24%
Croatia	-0.23%	0.39%	-0.39%	-0.55%	-0.79%
Poland	-0.74%	-0.19%	0.73%	-0.47%	-0.68%
Hungary	-2.67%	0.28%	1.79%	-0.07%	-0.67%
Slovenia	-2.23%	0.75%	1.55%	-0.69%	-0.62%
Romania	-9.63%	0.59%	8.96%	-0.47%	-0.56%
Portugal	-0.11%	0.13%	-0.26%	-0.23%	-0.47%
Finland	-0.18%	-0.13%	-0.07%	0.00%	-0.39%
Austria	-0.66%	0.08%	0.29%	-0.08%	-0.35%
EA19	0.10%	0.09%	-0.33%	-0.19%	-0.34%
Netherlands	-0.69%	-0.14%	0.35%	0.17%	-0.31%
Cyprus	-0.16%	0.17%	0.04%	-0.34%	-0.30%
Spain	-0.36%	0.33%	0.05%	-0.28%	-0.26%
Belgium	-0.53%	-0.11%	0.38%	0.02%	-0.24%
EU28	-0.32%	0.10%	0.20%	-0.21%	-0.23%
Italy	0.44%	0.14%	-0.58%	-0.16%	-0.16%
Estonia	1.54%	-0.24%	-1.54%	0.08%	-0.16%
Germany	-0.56%	-0.05%	0.55%	-0.06%	-0.12%
Sweden	-0.05%	-0.24%	0.08%	0.09%	-0.11%
Denmark	0.14%	0.03%	-0.29%	0.04%	-0.07%
Latvia	1.51%	0.44%	-1.37%	-0.61%	-0.04%
France	-0.11%	-0.09%	0.14%	0.03%	-0.03%
Slovakia	0.04%	0.70%	-0.44%	-0.18%	0.12%
Lithuania	3.32%	-0.09%	-2.78%	-0.33%	0.13%
Czechia	2.02%	0.05%	-1.68%	-0.20%	0.18%
Luxembourg	0.58%	0.37%	-0.41%	-0.35%	0.20%
United Kingdom	0.05%	0.12%	0.23%	-0.16%	0.25%
Bulgaria	1.26%	0.20%	0.89%	-0.56%	1.78%
Mean	-0.29%	0.09%	0.16%	-0.20%	-0.23%
Standard Deviation	0.022	0.003	0.020	0.002	0.006

Table 2 - The role of real wages, productivity and prices in explaining trends in labor shares (1995-2019).

Note: average annual growth rates. *Source:* Authors' calculations based on EUROSTAT data.

The most interesting feature of this decomposition is that it allows us to identify in a practical way three factors that simultaneously and to different degrees, seems to be crucial in determining patterns of the within-industry labor share in different countries of the EU. The joint movements of wages and productivity but also the fact that, within single industries, on average, the growth rate of real wage has been far lower than that of labor productivity (15 countries out of 25), the role of relative prices with the deflators running more than consumer prices (11 countries out of 25), and the correlation between growth and levels of wages and productivity with productivity which in many cases used to grow faster in industries characterized by higher than average productivity (10 countries out of 25). In particular, the latter factor represents another type of structural shift to which an economy is subjected, and if the growth rate of real wages is somewhat homogeneous across industries while productivity grows faster in industries with high productivity, this inevitably end up with a negative effect on the labor share. In almost all the countries considered (except for Slovakia, United Kingdom, Ireland, Italy, Luxembourg, Bulgaria, Latvia, Estonia, Czechia, Lithuania), within-industries, hourly productivity grew faster or in line with hourly wages between 1995 and 2018. Nevertheless, in most of them (Lithuania, Czechia, Estonia, Ireland, Latvia, Italy, Slovakia, Luxembourg, Croatia, Portugal, Finland), the price of domestic output - net of input costs - increased less than the price of consumption goods and services, to witness that the quality of goods and services internally produced by the domestic sector increased more, on average, than that of non-market activities, fuel and imports. Yet, in almost all countries for which significant falls in the labor share were observed within-industry during the period, real wage growth was significantly slower than that of labor productivity even considering the dynamics of relative prices (see Table 2 above). In some of the many countries where the labor share declined (i.e., France and Sweden), the slower growth rate of real wages came hand in hand with a greater growth of the consumption deflator with respect to that of value-added. This means that in other words, in these countries, if measured using the same deflator, wages and labor productivity grew at the same rate. However, also in these countries, as stands out from the second component of the formula (what we have called the divergence factor), the labor share declined because labor productivity grew faster in industries with higher levels of productivity while real wage growth was homogeneous across sectors. For instance, in the case of France, Germany, Italy and the United Kingdom, productivity grew faster in the Information and communication industry (on average 4% a year), which has a high nominal output per hour worked, while productivity growth was particularly low in Construction where it decreased on average by 0.16% a year. But real wage growth differences were, on average, less impressive (respectively 0.77% a year in Construction and 1.00% in the ICT). Even more striking, this pattern of divergence of industry-level productivities along with that of prices explains half of the entire drop of the aggregate labor share in Ireland, where the difference between within-industry growth rates of labor productivity and real wages was, on average, small, but the distribution of labor productivity growth was skewed towards industries with high productivity levels.

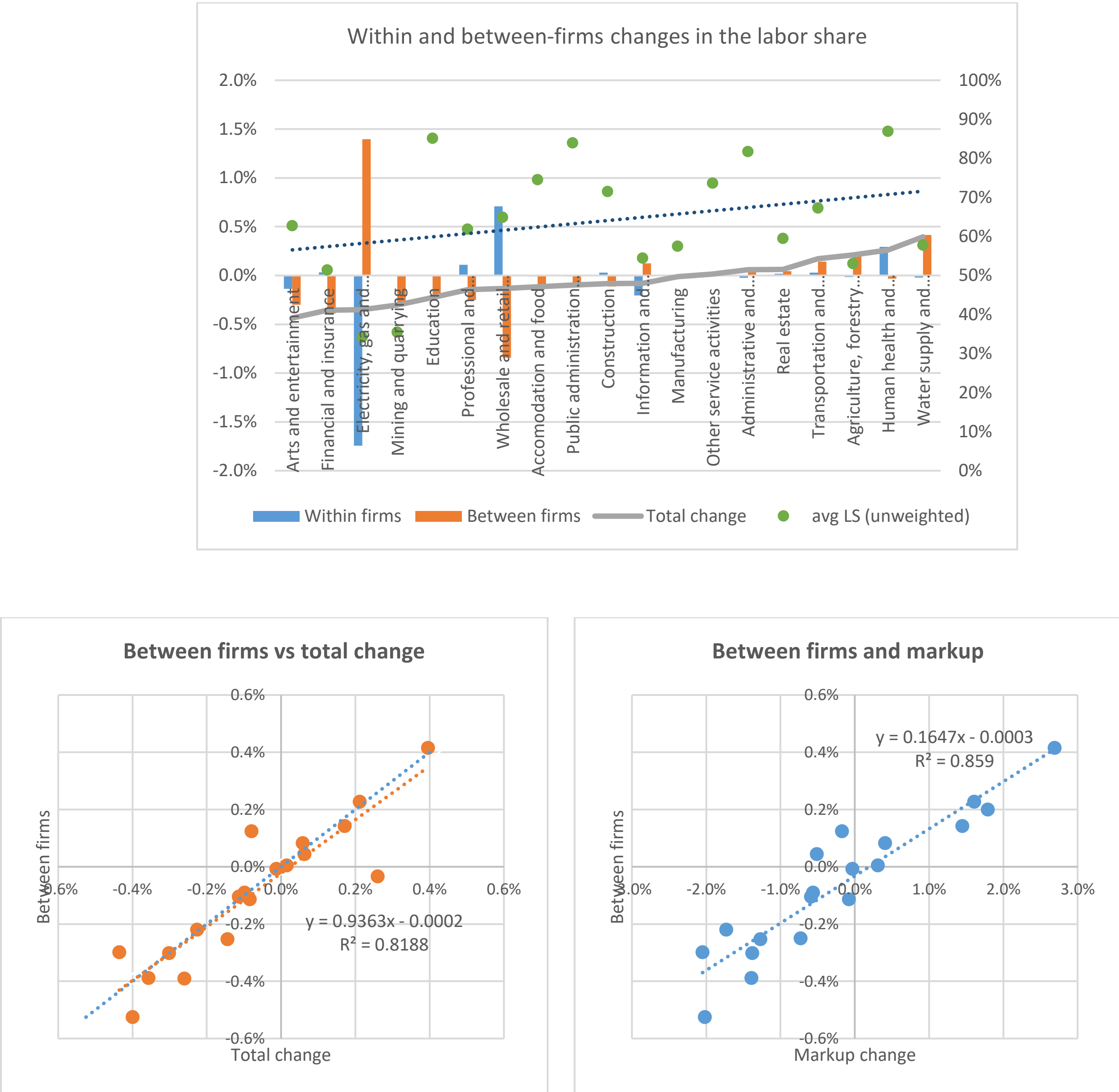


Figure 8 - Decomposition of the variations in the labor share between and within-firms (2011-2019).

Note: Roughly 70% percent of variation in labor share trends within industries is explained by between-firms' variations. However, the role of within-firms still plays an important role, especially in some sectors. See Table A2 in Appendix A.
Source: Authors' calculation on AMADEUS data.

A final extension of the approach is that proposed by Autor et al. (2020). They built a model based on “superstar firm” suggesting that industries are becoming increasingly characterized by “winner take most” features. Under this setting, a small number of very productive firms (characterized by higher markups and lower labor shares) can gain a very large share of the market. Therefore, it is essential to check with a specific firm-level decomposition if changes in the labor share within-industries are driven by between-firms or within-firms’ movements. At the purpose, we employ the traditional technique in eq. (1) and perform the decomposition shown in Figure 8. Micro data from AMADEUS is the best available source for comparable, cross-country firm-level data to explore the role of between-firms reallocation of value-added in falling labor shares.[38] In 12 of the 19 industries considered we observe a decline of the aggregate labor share of value-added over the period 2011-2019.

The main finding is that the fall in the labor share is dominated by a within-industry between-firm reallocation, however the within-firm component - accounting for 30% of the observed decline - is significant as well. In some sectors, the within-firms contribution increases the labor share (i.e., wholesale and retail trade; professional, scientific and technical activities; financial and insurance; transportation and storage and construction). In the others, it is relatively small compared to the reallocation term that operates between firms within the industry (i.e., services, ICT, real estate, utilities and transportation). These results are in line with those of Kehrig and Vincent (2018) and Autor et al. 2020 who find that the reallocation term dominates for the aggregate fall in the labor share. We also confirm the patterns of Autor et al. (2020) and De Loecker, et al. (2020) that the weighted average Markup over variable cost has been rising with the rise due to a reallocation of value-added. Indeed, the fall in the between component of falling labor shares is most marked in the industries where concentration is rising more (Figure 8 - panel c). Autor et al. (2020) show that this is the result of superstar firms gaining market share through their higher level of productivity and the intensification of competition.

The mechanism of reallocation between firms - which can explain about 70% of the observed decline in the aggregate labor share - has already been studied in great detail by the already mentioned works. Therefore, we try to solve the remaining part of the puzzle by focusing on the decline of the labor share within individual companies which still accounts for the remaining 30/35%. In this sense our contribution and that of Autor (2020) can be seen as complementary.

[38] National accounting regulations and time coverage differ across countries; however, we confine the analysis to the EU28 for which reasonable quality data are available for the last ten years.

4. A theoretical model to explain the within-industry labor share

In this section we present a simple microeconomic model to show why the share of labor in national income may vary from one firm to another even within strictly defined sectors and under the assumption that the production technologies are identical. The aim is exactly that of motivating the empirical analysis that follows in an intuitive way before proceeding to a more detailed discussion of the data and the strategies employed for estimation. To analyze the determinants of the labor share, we rely on the model proposed by Bentolila and Saint-Paul (2003) and then we add our own working hypotheses. By definition, labor share LS_i[39] on value added of a firm i can be defined as $LS_i = W_i L_i / P_i Y_i$, where W_i is the compensation paid to labor input L_i; $Y_i$is value added, and P_i is the selling price. It is possible to show that under the assumption of Constant returns to scale (CRS), competitive markets and labor-augmenting technical progress – i.e. $Y_i = F(K_i, B_i L_i)$, there is a one-to-one relationship between LS_i and the capital-output ratio ($k_i = K_i / Y_i$), the so-called $LS - k$ curve:

$$LS_i = f(k_i) \tag{4}$$

Where:

- $LS_i \equiv \frac{w_i L_i}{p_i Y_i}$ is the labor share of firm i;
- $k_i \equiv \frac{K_i}{Y_i}$ is the capital-output ratio of firm i.

Thus, there exists a unique function $f(\cdot)$[40] to explain the LS_i of a firm based on its observable capital-output ratio, which in turn depend on factor prices and labor-augmenting technical progress.[41] This implies that variations of the labor share ΔLS across firms, sectors and countries may be due to different values of the capital-output ratios and different elasticities of substitution between factors. From a theoretical point of view, the response of the labor share to the capital-output ratio is related to the elasticity of substitution in the production function between capital and labor (indicated by the Greek letter σ) and the elasticity of labor demand to wages (ε):

---

[39] Subscript i, which denotes industries in the original setup, here refers to individual firms. Bentolila and Saint-Paul (2003) called this stable relationship "the share-capital (SK) schedule". See the derivation of the relationship in the second section of Appendix B.

[40] Notably, the relationship between the labor share and the capital-output ratio exists independently from the functional form employed to model the technology of production and this gives extreme flexibility to the model.

[41] This means that any change in the labor share which is triggered by those factors will be along the curve and cannot explain any deviation from the relationship.

$$\frac{dLS_i}{dk_i} = -\frac{1+\sigma_i}{k_i \varepsilon_i} \quad (5)$$

Where:

- ε_i is the labor demand elasticity with respect to wages; [42]
- σ_i is the elasticity of substitution between factors.

To sum up, taking capital as constant and the labor demand elasticity to wages as given, a positive slope of the schedule (i.e. a positive coefficient in a regression of LS_i on k_i) means that the elasticity of substitution between factors (σ_i) is lower than one (factor complementarity);[43] vice-versa, for $|\sigma| \geq 1$, firms substitute capital for labor and the LS curve in the (LS, k) plane is downward-sloping. Finally, when $|\sigma| = 1$ (i.e., the Cobb-Douglas case), changes in relative factor intensities are exactly offset by changes in their relative prices, therefore the labor share is independent of capital intensity. All the possible cases described are summarized in Table 3 below.

Elasticity of substitution (σ_i)	Effect of capital intensity and capital augmenting technological change on the labor share	Description
> 1	< 0	K and L are strong substitutes. → technological change has a negative impact
1	0	Unitary elasticity (Cobb-Douglas) → no impact of technological change
< 1	> 0	K and L are weak substitutes. → technological change has a positive impact

Table 3 - Different elasticities of substitution between Capital and Labor and the effect of k on the labor share.

Source: Authors' own elaboration.

[42] Recall that several factors affect the wage elasticity of labor demand: (i) labor costs as a percentage of total costs. When labor expenses constitute a high % of a firm's total costs, then labor demand is relatively more elastic. (ii) the ease of factor substitution. Labor demand is more elastic when a firm can substitute easily labor for capital. (iii) price elasticity of demand for the final product. This determines whether a firm can pass his higher labor costs to consumers by commanding higher prices. (iv) the time period considered. In the long run it is generally easier for firms to switch factor inputs.

[43] Exceptions are possible under special circumstances. Grossman et al. (2017) develop a neoclassical growth model with endogenous human capital accumulation and capital-skill complementarity to show that a decline in the labor share of national income is feasible with a scenario where $\sigma < 1$ if there is a slowdown of labor productivity growth. Paul (2019), by relying on the literature on differential capital-skill substitutability (mainly the work of Krusell et al., 2000) shows that it is possible to have a declining labor share as a consequence of a fall in the relative price of capital when the aggregate $\sigma_{AGG} < 1$.

From an empirical point of view, the first situation (i.e., $\sigma < 1$) has been often associated with developed economies, because of the large share of skilled workers on total workers make them relatively more complementary to capital (compared to unskilled ones). On the other hand, the second scenario (i.e., $\sigma > 1$) is more likely to reflect what are experiencing developing economies, where the large share of low-skilled workers makes capital and labor relatively more substitutes. Bentolila and Saint-Paul (2003) and Bassanini and Manfredi (2012) obtain both a significant and negative effects of capital intensity as well as TFP (used as a proxy for capital augmenting technological progress) in a sample of OECD countries. Similarly, Karabarbounis and Neiman (2014) provide evidence for a negative effect of technological change on the labor share and increasing capital intensity worldwide. Finally, an elasticity of substitution greater than one is also the result found by Piketty and Zucman (2014) using data from 1970-2010 in the top eight developed economies. In contrast, there is an equally thriving literature that find none or a positive effect of capital intensity, implying an elasticity of substitution that is below or equal to one (Harrison, 2005; Elsby et al., 2012; Stockhammer, 2017). This is also the result of many studies that over the years have tried to estimate the value of this parameter as accurately as possible (Leon-Ledesma et al., 2015; Oberfield and Raval 2014; Chirinko and Mallick, 2017).[44] Without doubt, the exact value of the elasticity of substitution between capital and labor is one of the most controversial themes of empirical economic research. Finally, to close the circle, the IMF (2017) cannot find any significant effect of the relative price of investment on the labor share in tradable sectors, while they found significant evidence for a negative effect in non-tradable sectors, in particular those with a high exposure to routinization of activities.

It is precisely this mixed evidence that has raised our concerns about the possible existence of non-linearity in the impact of the capital-output ratio on the labor share. This latter eventuality (that we prove to be supported by the data) would allow to reconcile the contrasting results obtained over the years by the literature. In fact, in standard microeconomic analysis, elasticity is usually assumed to be determined by the structure of the technology and is only subject to change in the long run.[45] However, this framework which has made famous the constant elasticity

[44] The average value found by these latter studies is actually below one and falls in the range between 0.4 and 0.7.

[45] Another flourishing part of literature based on the pioneering work of Autor and Dorn (2013) on job polarization has tried with a different approach to estimate different elasticity of substitution for different types of capital. This specific hypothesis suggested a negative impact of technological change on medium-skilled workers. According to this research, technological progress in the last 30 years was driven mainly by Information and Communication Technology (ICT), that allowed to replace workers by machines for tasks that can be easily automatized, which were mainly performed by medium-skilled workers.

production functions (CES) has recently been challenged by more flexible variable elasticity models (VES) which provide stronger empirical support to the accumulation principle.

Back to the fundamental dynamics of our model, equation (4) tell us that we can also observe a negative relation between capital intensity and the labor share which is not connected with the substitution of capital for labor. More exactly three types of variables are responsible for movements and movements out of the curve.

First and foremost, the $LS-k$ curve is stable only if the pattern of technical progress is in the kind of a labor-augmenting one. Conversely, for capital-augmenting technical progress - $Y_i = f(A_iK_i, B_iL_i)$ - changes in A_i shift the curve, in a way that the effect of A_i and k_i on LS_i should always have the same sign.[46] Only in the special case of a CES production function where the LS is given by $LS_i = 1-\alpha(A_ik_i)^{\gamma}$, the LS_i is monotonic in k_i and the relationship between the two variables is simpler (either increasing or decreasing depending on the sign of γ) - with technical changes A_i which always reinforce the effect of capital intensity k_i. In all the other cases and for more general production functions, the relationship need not be monotonic, so that the labor share can go up and down as some variable driving changes in k_i varies. Finally, movements off the $f(k)$ function are also possible. In an environment characterized by product and labor market imperfections, there is a gap between the real wage rate and labor productivity. Therefore, all institutional variables that influence this gap are potentially able to cause changes of the LS_i and departures from the curve.

(i) For instance, under *imperfect competition in the product market*, profit-maximizing firms charge their price of a mark-up (μ_i) to achieve a certain profit target. This causes the final product to cost more than its marginal cost and causes the LS_i to be influenced the market power of firms. A rise in the mark-up exerts downward pressure on LS_i and counter-cyclical variation in the price mark-up causes pro-cyclical shifts in the LS_i. This has been documented by Rotemberg and Woodford (1999) and Nekarda and Ramey (2013).[47]

$$LS_i = \mu^{-1} f(k_i) \tag{6}$$

[46] As shown by Bentolila and Saint Paul (2003), this means that if A_i shifts the $LS-k$ curve but violates that condition, the technological progress is neither labor nor capital-augmenting.

[47] As stressed by Rotemberg and Woodford (1999), this countercyclical behavior is necessary to reconcile theory and empirical evidence on the procyclical behavior of wages.

Very often in empirical analysis markups are used as a measure of product market regulation, with the idea that a reduction in their strictness cause a reduction of the monopolistic positions of firms and a consequent decrease of the LS.[48] It should be noted that the reduction of barriers to entry, consistent with the hypothesis of product markets with homogeneous firms and workers, would lead to greater competition between companies, an increase in demand for labor and a shift upwards of the $LS - k$ schedule (Blanchard and Giavazzi, 2003). From this perspective, an interesting micro channel for the decline of the labor share is the one highlighted by Autor et al. (2020), which propose and empirically explore an alternative hypothesis based on the rise of "superstar firms". They show that a large class of models of imperfect competition may end up generating large price-cost markups for firms with a high market share. The reason of this are to be found in the fact that mark-ups (μ) are generally falling in the absolute value of the elasticity of demand η_i, since according to Marshall's "Second Law of Demand," consumers will be relatively more price-inelastic at higher levels of consumption and lower levels of price.[49] The main implication is that since labor shares are lower for larger firms, in standard models, an exogenous shock that reallocates market share towards these firms (e.g. a change in the economic context that favors the most productive firms in a given industry) will depress the aggregate labor share. Intuitively, as the weight of the economy shifts toward larger firms, the average labor share declines even without a fall of the labor share within any given firm. The negative relationship between markups and labor share is so strongly rooted in macroeconomic thinking that it forms the basis for most empirical efforts to measure the cyclicality of markups. However, it is worth pointing out the results of Kaplan and Zoch (2020) which shows that equation 6 is not always valid and whether an increase of the markup leads to an increase or a decrease in the labor share depends on the share of expansionary labor in the economy.[50] In a modern industrial economy as opposed to the traditional role of labor as an input in the production function for manufacturing existing goods to be sold in existing markets there is an alternative role of labor which facilitates extensive-margin replication. When this is the case and the fraction of labor income to compensate is large enough, the co-movement between the labor share and the markup can eventually be reversed.

---

[48] In the long run, markups tend to reflect the nature of competitive forces at stake and are the central channel through which industrial and trade policy affect the economy. On the other hand, in the short-run, movements in the markup are the main channel through which demand shocks and monetary policy affect the economy in standard business cycle models.

[49] As shown by Autor et al. (2020), most utility functions deliver this implication. Let's think at the quadratic utility function which generates a linear demand curve, but also the CES when there are fixed costs of overhead labor that do not rise in a proportional way with firm size. For more details see Mrazova and Neary (2017).

[50] Expansionary labor activities include a wide range of business activities such as overheads, product design, R&D, logistics and marketing. Incorporating this particular use of labor has important implications for aggregate labor income dynamics and inequality.

(ii) A second source of departures from the $LS - k$ curve relates to *collective bargaining*. If the labor markets are not fully competitive, the bargaining relationships between capital and labor may determine a distribution of income more in favor of capital (besides capital intensity and capital augmenting technological change). In models of bargaining power, capital and labor bargain for wages and in some cases employment. Both parties have an interest in concluding negotiations in the best possible way for themselves and the distribution of added value depends on their respective backstop options.[51] The bargaining practices of European countries are either described by a "right to manage" or a "efficient bargaining" model (Espinosa and Rhee, 1989; Layard et al., 2005; Vogel, 2007; Fanti, 2015). Under the first regime, firms and unions bargain over wages and then firms set employment unilaterally, taking wages as given. Labor demand, obtained from the profit maximization condition, requires equality between the marginal product (or the marginal revenue of labor) and the real wage. This means that wage pressures cause changes in the capital-output ratio and movement along the $LS - k$ curve, rather than away from it. In contrast, in the efficient bargaining model trade unions cause departures from the $LS - k$ schedule whenever they negotiate with firms over both wages and employment. In this case the wage rate differs from the marginal product of labor and unions create a gap between these two variables. Wages and employment, obtained as solutions of a Nash bargaining game, are given by the "contract curve" (i.e., the set of points where the indifference curve of trade unions and the profit curve of firms are tangent) where, however, the relationship between LS and the capital-output ratio is off the one implied by the $LS - k$ schedule. The contract curve is upward-sloping and starts from the intersection of the labor demand curve and the reservation wage. A rise of this latter implies that everywhere the new contract curve lies above the old one (Mc Donald and Solow, 1984; Bentolila and Saint-Paul, 2003). Therefore, in this framework, a rise in union bargaining power raises both the real wage and employment, and thus the LS_i.

(iii) For what concerns *labor hoarding*, the literature on LS has mainly investigated the effects of labor adjustment costs (such as firing and hiring restrictions, search and training costs of employees). Specific indicators for labor market reforms were developed and employed by the literature, usually based on "hiring and firing legislations" or similarly "business regulations". Firing

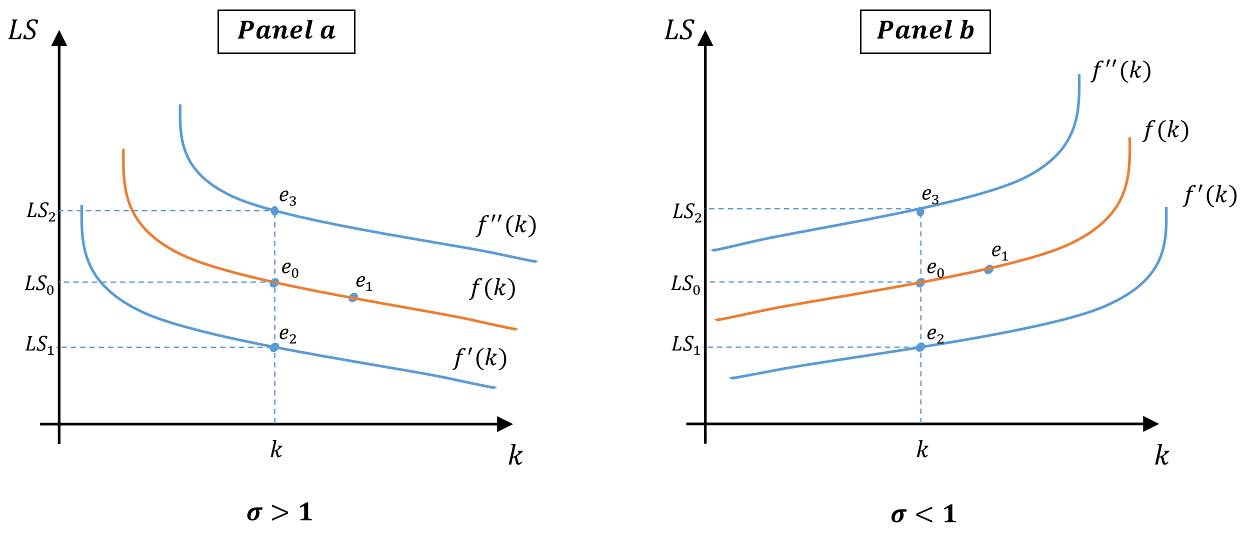
[51] Measures of bargaining power related to labor market institutions can be divided into two distinct categories: direct and indirect factors. Direct factors are those who strengthen workers' power in negotiations, whereas indirect factors improve their stop back options in case negotiations are broken off. For instance, we can put in the first category unemployment benefits. A similar effect can be expected from welfare provided by the state which allow workers to rely on the stop back option of a basic income to meet their basic needs in case they lose their job (Jayadev, 2007; Bental and Demougin, 2010; Kohler, 2019). For what concerns measures, the bargaining power is usually proxied by indicators such as union density, strike activity, collective bargaining and minimum wages.

(hiring) costs for instance force firms to fire (hire) less in recessions and hire (fire) less in booms causing wage costs to fluctuate less cyclically than output, thus reducing volatility and inducing the observed countercyclicality in the labor share. This is a matter of particular interest for analyzing European countries, whose regulation impose high hiring and firing costs. In this context, changings in the employment legislation are responsible for movements off the $LS - k$ curve which take place in the short run during the transition between two different equilibria (Blanchard, 1997; Caballero and Hammour, 1998). Bentolila and Saint-Paul (2003) argued that enhancing labor adjustment would boost the wedge between the real wage and the marginal revenue product of labor. An increase in the marginal adjustment cost generated by an extra unit of labor will push the marginal cost of labor above the wage when the firm is hiring and below it when it is firing. If adjustment costs are convex in the change in employment $AC(\Delta L)$[52], they translate into a gradual distribution over time of the employment change, which rationalizes a delayed employment response to changes in production. Adjustment costs have two effects on the labor share. First, they influence the demand for labor of firms and the equilibrium real wage. For a given average employment level, the firm's marginal costs are higher when employment adjustment is costly, which implies a lower wage share. On the other hand, since labor income is made up of work and a monetary transfer corresponding to the value of the insurance against unstable employment provided by the adjustment costs, adjustment costs raise the labor share if they are equivalent to such payments to workers.[53] The overall effect on the curve is however less clear-cut.

All the discussions made so far on the $LS - k$ curve, movements along it for different values of the elasticity of substitution along with its shifting factors are summarized in Figure 8.

[52] To make the analysis simpler, adjustment costs have often been represented using a convex symmetric function, even if a growing body of empirical literature has rejected the hypothesis of "symmetric adjustments" in favor of some forms of asymmetry (see Hamermesh and Pfann, 1996).

[53] One could distinguish between adjustment costs that that take the form of a firm's payments to the worker (e.g. severance payments, training costs or recruitment services) from costs which are not related directly or indirectly connected to labor.



e_0: initial equilibrium.
e_1: increase in real wages or labor-augmenting technical change.
e_2: increase in the markup or capital augmenting technical change.
e_3: increase in the bargaining power of workers.

Figure 9 - $LS - k$ curve for respectively an elasticity of substitution > or < 1.

Note: an increase in real wages (or a decrease in the user cost of capital) results in movements along the curve and variations in the labor share which depend on the elasticity of the substitution between labor and capital. A high elasticity of substitution (i.e., $|\sigma| \geq 1$) provides firms with a strong incentive to replace labor with capital thus decreasing the labor share, since higher wages are largely offset by a decrease in employment, for a constant level of production (panel A). On the other hand, the complementarity between labor and capital (i.e., $|\sigma| < 1$) leads the same increase in wages (or a decrease in the user cost of capital) to raise the labor share, due to the very strong increase in employment (panel B). *Source:* Authors' own compilation.

One of the most important lessons we have drawn from the literature review in Section 2 is the one concerning the possibility of non-linear relationships between the labor share and some of its driving forces. This should be one more reason to warn researchers against the estimation of a constant, immutable (and an exogenously given) elasticity of substitutions (σ) (Karagiannis et al., 2005; Palivos, 2008). In fact, the diversity of results in this area is remarkable and explains the difficulty of obtaining agreement on an empirical consensus for the value of elasticity (Miyagiwa and Papageorgiou, 2007; Knoblach and Stöckl, 2019). Using the CES production framework, Piketty (2014) and Karabarbounis and Neiman (2014) estimate the values of elasticity of substitution between capital and labor to be greater than unity. However, many studies find σ to be significantly lower than one both at higher and lower level of aggregation (Oberfield and Raval, 2014; Chirinko and Mallick, 2017). For instance, Raval (2019) using American plant-level data estimates it in the order of 0.3/0.5, obtaining similar results across industries. Production technology determines the characteristics of σ and the relationship between the allocative efficiency of factors. Paul (2019) shows how both capital-output ratio and the labor share of income increased concurrently in most industrial sectors in Japan between 1970 and 2012, while estimates of σ obtained by means of a standard CES framework are predominantly greater than unity across sectors. All these findings point to an apparent puzzle. Here we try to solve this puzzle and show how the assumption of a non-unitary σ along the isoquants of firms can potentially explain the observed movements in the labor income share over time and reconcile the different results of the literature on the matter. On a practical level, our firm-level framework is strongly supported by the fact that since the elasticity of substitution can be regarded as "a measure of the efficiency of the productive system" - i.e., reflecting technical before than institutional features - it makes more sense to assume that this parameter it is firm rather than sector specific and expect wide variations also across different firms within a given sector (De La Grandville, 1989).

Therefore, the relationship between capital-product and labor share may not be as simple as described in previous studies. One possibility that will be explored in the next chapter is that of a non-linear relationship. We show that this is the case (Figure 10), and labor income share moves along a stable and non-linear curve (which we approximate by means of a third-degree polynomial) with some factors (either institutional technological) shifting it upwards or downwards, as also noted in previous literature. Capital-output depress labor income at low levels of the capital accumulation curve but enhance labor income when a moderate level of capital stock has already been attained.

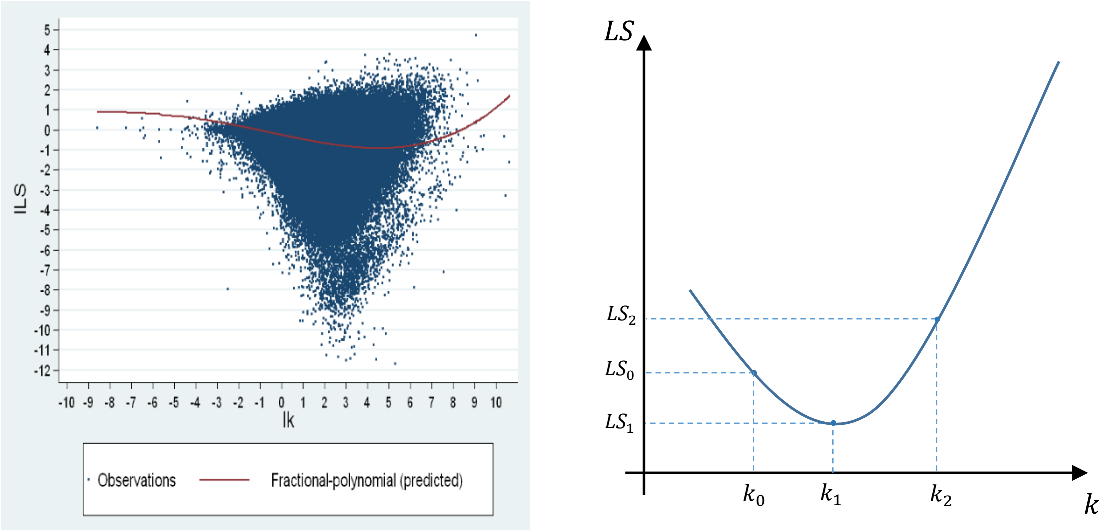


Figure 10 - Empirical relationship between the labor share and capital-output ratios (panel a) and the $LS - k$ curve when the relationship between the LS and k is non-linear (panel b).

Note: under the non-linear hypothesis in the relationship between the capital-output ratio and the labor share, the effects of a variation in factor prices result in movements along the curve and changes in the labor share which are no longer unidirectional (i.e., leading always to an increase or a decrease of the LS) since they depend on the part of the curve in which the company is operating. For low levels of k, below the critical value k_1 we have a $\sigma < 1$ and hence gross complementarity between the factors of production; on the other hand, for high levels of k, above the critical value k_1 we have $\sigma > 1$ and hence gross substitutability. *Source:* Author's calculation on AMADEUS and Authors' own compilation.

When the relationship between the labor share and the capital-output ratio is non-linear, the case in which the elasticity of substitution is greater than one ($\sigma > 1$) thus decreasing the labor share - provided that all technical progress is labor-augmenting - is just part of the picture (Figure 10 - panel b), which turns out to be valid for firms which operate in the second part of the curve (at the right of the critical value k_1). On the other hand, for lower level of capital accumulation (when $\sigma < 1$) the dynamic is reversed and increases in k reduce the labor share (since the firm is now operating on the left of the critical threshold k_1). Only in one special equilibrium point (i.e., k_1) the elasticity of substitution is equal to 1 ($\sigma = 1$) and hence, the labor share of the firm is determined independently from the capital-output ratio (i.e., Cobb-Douglas case). Therefore, the theoretical constancy in the behavior of factor shares to different levels of k at all frequencies resulting from assuming a Cobb-Douglas technology and maintaining the connection between factor prices and their respective marginal productivity as happens in most real business cycle models that ignore fluctuations in factor shares could be misleading.

In what follows, we augment in qualitative terms the model formulated by Bentolila and Saint-Paul (2003) by adding our own working hypotheses, which relies on the large empirical evidence about the possibility that the elasticity of substitution of firms changes with capital accumulation along their isoquants. However, since production technology governs the characteristics of σ, in the empirical analysis we will try to keep the framework as flexible as possible. Hence, we abstain from any consideration concerning the functional form and rely on a general production function as the one expressed in equation 4.

5. Empirical strategy

The $LS - k$ curve is basically a technological relationship, and so it is more appropriate to investigate it at the firm rather than at the country level. Therefore, we verify the hypotheses discussed above by estimating the impact on the labor share LS_{it} of changes in the capital-output ratio (k_{it}) for firm i and year t, capital-augmenting technological progress proxied by firm-level TFP (A_{it}), market competition proxied by firm-level markups (μ_{it})[54] and labor adjustment costs proxied as in Bentolila and Saint-Paul (2003) by changes in employment at the industry level (ΔlnE_{jt}). To this purpose we do not restrict the functional form of the labor share to one derived for a specific production function and start from a general form representing an augmented $LS - k$ curve:

$$LS_{it} = f\left(k_{it}, A_{it}, \mu_{it}, \Delta lnE_{jt}\right) \quad (7)$$

Equation 7 is estimated on our unbalanced panel of 716.094 firms belonging to 19 1-digit NACE rev. 2 sectors, 28 EU countries and for the period 2011-2019. Sub-indices denote respectively the firms of the sample (i), industries (j), and time (t).[55] We take the log of equation 7 and estimate the following linear basic specification:

$$\ln\ LS_{it} = \alpha_i + \beta \ln k_{it} + \psi \ln TFP_{it} + \delta \ln \mu_{it} + \theta \Delta \ln E_{jt} + \tau_t + u_{it} \quad (8)$$

[54] TFPs and Markups are estimated employing the procedure developed by De Loecker and Warzynski (2012). We assume cost-minimizing producers and the existence of at least a variable input of production and follows a two-stage procedure. The first step consists in estimating a Translog production function using GMM and then, once the structural variables from each firm specific production function are identified, use the structural parameters to estimate firm-level TFPs (TFP_{it}) and markups (μ_{it}). In Appendix B, we describe this procedure in greater details.

[55] Subscript i denotes individual firms. With respect to Bentolila and Saint-Paul (2003), we proceeded by estimating the equation at the firm level and only then we aggregated the results at the industry and national level.

Where:

- LS_{it} is the labor share of firm i at time t;
- $k_{it} = K_{it}/L_{it}$ is the capital-to-output ratio of firm i at time t;
- TFP_{it} is the total factor productivity of firm i at time t;
- μ_{it} is the markup of firm i at time t;
- ΔE_{jt} is the employment growth rate in industry j at time t;
- α_i is the firm fixed effect to account for all time-invariant firm-specific unobservables;[56]
- τ_t is a series of year dummies accounting for common trends.

Equation (8) is estimated using standard panel data techniques, both in levels and first differences, where individual units of observation are firm-industry pairs. From a theoretical perspective, the estimates in levels provide useful information for what concerns the determination of the medium-run $LS - k$ curve, while the estimates in first differences, on the other hand, describe the short-run dynamics of the labor share. Modeling the drivers of the labor share poses some identification issues. A relevant one relates to potential sources of endogeneity. To cope with it, in line with Bentolila and Saint-Paul (2003) we use as instrumental variables for the levels of capital-output ratio, TFP, markup and changes in industry-level employment the lagged first difference of the same variables, thus limiting endogeneity coming from simultaneity. As a robustness check, in Tables A8/A9 - Appendix A, we also report results where we do not account for such endogeneity.

In Section 4, we argued that the relationship between the labor share and the elasticity of substitution between capital and labor may not be easy to interpret because of the (potential) dependencies across the variables involved which could indeed turn out to be very significative. Consequently, the estimation of a standard linear additive model with all explanatory variables considered independent may be inferior to the alternative of estimating a multiplicative model with interaction and where some of the explanatory variables are considered dependent on each other. Indeed, as explained in Brambor et al. (2006), this is the appropriate way of modelling whenever the hypothesis being tested is conditional in nature, as it is in our case. Therefore, we also attempt to make a step ahead for what concerns the empirical strategy and decided to estimate new versions

[56] The key insight is that "if the unobserved variable does not change over time, then any changes in the dependent variable must be due to influences other than these fixed characteristics" (Stock and Watson, 2018).

of the standard model of Bentolila and Saint-Paul (2003) by including multiplicative interaction.[57] In turn, the corresponding multiplicative interaction model takes the following form:

$$\begin{gathered} lnLS_{it} = \alpha_i + \beta_1 \ln k_{it} + \beta_2 \ln {k_{it}}^2 + \beta_3 \ln {k_{it}}^3 + \pi_1 \ln TFP_{it} \\ +\pi_2 \ln \mu_{it} + \pi_3 \Delta \ln E_{jt} + \pi_4 \ln TFP_{it} \ln \mu_{it} \\ +\pi_5 \ln TFP_{it} \Delta \ln E_{jt} + \pi_6 \ln \mu_{it} \Delta \ln E_{jt} \\ +\pi_7 \ln TFP_{it} \ln \mu_{it} \Delta \ln E_{jt} + \tau_t + u_{it} \end{gathered} \tag{9}$$

The addition of empirical controls should be considered a matter of judgment that reflects the authors' opinion on what is important to capture changes along, inside or outside the curve. Since with this model our main purpose is to estimate the exact form of the latter, we decided to add a whole series of interaction terms to remove the confounding effects around the values of β_1, β_2 and β_3.[58] Indeed, the complexity surrounding the relationship between the capital-output ratio and the labor share is well acknowledged by Bentolila and Saint-Paul (2003), which denoted it as a complex issue deserving special attention. From an econometric point of view, adding nonlinearities raise some additional problems and requires carefulness when evaluating the coefficients. The presence of interactive terms alters the interpretation of the estimated parameters in a crucial and not always simple way. The reason is that in a standard linear model, TFP_{it}, μ_{it} and $\Delta \ln E_{jt}$ are considered independent of each other, whereas in the non-linear model they are not. In other words, in the additive model the effect, for instance, of TFP_{it} on LS is considered to be constant while, in the multiplicative interaction model, this effect depends on the values taken by the variables μ_{it} and $\Delta \ln E_{jt}$. Therefore, the coefficient π_1 in equation (9) is what is called a conditional marginal effect, i.e., the effect of TFP_{it} on LS when $\mu_{it} = \Delta \ln E_{jt} = 0$. An equivalent interpretation holds for π_2 regarding μ_{it}, and π_3 regarding $\Delta \ln E_{jt}$. This means that overall, the conditional marginal effect of TFP_{it}, μ_{it} and $\Delta \ln E_{jt}$ on $ln\ LS$ is:

$$\begin{cases} \dfrac{\partial ln\ LS}{\partial TFP_{it}} = \pi_1 + \pi_4 ln\ \mu_{it} + \pi_5 \Delta \ln E_{jt} + \pi_7 ln\ \mu_{it} \Delta \ln E_{jt} \\ \dfrac{\partial ln\ LS}{\partial \mu_{it}} = \pi_2 + \pi_4 ln\ TFP_{it} + \pi_6 \Delta \ln E_{jt} + \pi_7 ln\ TFP_{it} \Delta \ln E_{jt} \\ \dfrac{\partial ln\ LS}{\partial \Delta \ln E_{jt}} = \pi_3 + \pi_5 ln\ TFP_{it} + \pi_6 ln\ \mu_{it} + \pi_7 ln\ TFP_{it} ln\ \mu_{it} \end{cases} \tag{10}$$

[57] To further explore the role of interactive terms, see also the works of Aiken et al. (1991), Berry et al. (1995), Braumoeller (2004), Brambor et al. (2006) and Hainmueller et al. (2019).

[58] According to Brambor et al. (2006) the omitted terms are one of the two common problems that affect most of the literature using this methodology.

As equation 10 made clear, the coefficients of $ln\,\mu_{it}/ln\,TFP_{it}/\Delta\ln E_{jt}$ only captures the effect of $ln\,\mu_{it}/ln\,TFP_{it}/\Delta\ln E_{jt}$ on $ln\,LS$ when respectively $ln\,\mu_{it}\Delta\ln E_{jt}/ln\,TFP_{it}\Delta\ln E_{jt}/ln\,TFP_{it}ln\,\mu_{it}$ are zero.[59] It is exactly for this reason that the influence of the terms involved in the interactions cannot be evaluated until their effects have been calculated through a specific "marginal analysis". However, as argued by Hainmueller et al. (2019) for this kind of analysis to make sense there should be sufficient support in the data to reliably compute the conditional effects. If this is not the case, and the conditional marginal estimates are based on extrapolation (or interpolation) of the functional form to an area of the plane where there is no data (or they are very sparse), the validity of the estimates is rather weak (King and Zeng, 2006). This is exactly the reason why we abstain from such considerations.

To sum up, our empirical model assesses the cross-dependencies among capital-output ratio, total factor productivity (TFP_{it}), the markup (μ_{it}) and labor adjustment costs (ΔE_{it}) which requires the estimation of an equation such as (9). In this way, the reference model of Bentolila and Saint-Paul (2003), is upgraded in two dimensions. We scale down the level of analysis at the single firm and include interactions among variables and more controls.

6. Data description, summary statistics and results

We now investigate empirically the factors driving the evolution of the labor share in 28 EU countries and 19 sectors over the period 2011-2019, following the model. There are two main questions that we aim to address with this analysis. The first one concerns the estimation of the $LS - k$ curve, the elasticity of the labor share to the capital-output ratio along the latter and hence empirically validate the non-linear model. The second one to determine the sign (and possibly the magnitude) of respectively movements along it and whose effect is entirely mediated by k (such as changes in the relative price of factors and labor-augmenting technical progress), the effect of a shifter: the TFP and forces which may lead the economy off the equilibrium, namely changes in the markup and labor adjustment costs.

[59] Note from (10) that one of the features of models with interactions is that they are symmetric. As a result, these models (and the data) cannot distinguish between the causal story where for instance a variable modifies the effect of the others on the labor share (LS) and the causal story where the other variables modify the effect of a variable on the LS. This choice has inevitable consequences if the aim is that carrying out a careful marginal analysis on the role of $ln\,TFP_{it}$, $ln\,\mu_{it}$ and $/\Delta\ln E_{jt}$.

We start by documenting a few stylized facts present in the data and finally show the empirical results. To compose our sample, we use balance sheet data from AMADEUS[60], which includes information on output, employment and capital for 520.000 public and private companies in 43 European countries. AMADEUS is the best publicly available database for comparing firm panels across countries in Europe since it is updated weekly, with standardized annual accounts for the most recent ten years. Appendix C (Data Appendix) provides details on the database, variables, data construction, the number of unique firms and the number of observations. The covered establishments in these 19 sectors comprise approximately 90 percent of both total employment and value-added. Of these we have excluded from the analysis two industries due to a lack of data and usefulness for our estimates, namely T (Activities of households as employers of domestic personnel and services producing activities of private households for own use) and U (Activities of extraterritorial organizations and bodies) which together represents less than 0.0023% of the total observation. On the other hand, we decided to break down the results of manufacturing (C) which is a composite and heterogeneous industry and accounts for 1/4 of the total observation at the level two of NACE classification (i.e., from C10 to C33). For each company, AMADEUS reports the total annual payroll (compensation of employees), total turnover, value added, total employment, the stock of tangible and intangible capital, depreciation & amortization and, more importantly for our purposes, an identifier for the industry to which the firm belongs. Total compensation includes all forms of paid compensation, such as wages and salaries, paid in cash or in kind, as well as employer contributions to pensions, healthcare, and social insurance. The gross value added is estimated as sales minus the cost of intermediate inputs different from employee compensation (calculated from the financial statements as earnings before interest, tax, depreciation, amortization plus the expense for employee compensation). The stock of capital is calculated as the sum of tangible and intangible assets net of accumulated depreciation per employee. Finally, to obtain its real value which is necessary to compute capital intensity as well as for the estimation of the production function we supplement AMADEUS database with data on sector-specific deflators from the National Accounts by 64 branches of Eurostat. Although great effort was made to make these measures comparable across countries, there are still some important differences that affect the

[60] In these economies, Amadeus's coverage approaches 100% of available coverage from public and official sources.

reliability of cross-country comparisons.[61] Our key variables are the firm's labor share, LS_{it} and the firm's capital-output ratio, k_{it}.

We consider a specific production unit i (i.e., firm) at time t that employs L_{it} workers at a wage rate W_{it} to produce Y_{it} units of a good sold at price P_{it}. The labor share of that unit is then equal to the ratio of its labor cost to the nominal gross value added and summing up across units, one can express the aggregate labor share as the weighted sum of the individual labor shares:[62]

$$LS_{it} = \frac{\text{Employee Compensation}}{\text{Gross Value Added}} = \frac{w_{it}L_{it}}{p_{it}Y_{it}} = \frac{\sum_i w_{it}L_{it}}{\sum_i p_{it}Y_{it}} = \sum_i \omega_{it}LS_{it} \tag{11}$$

Where:

- $w_{it}N_{it}$ is the total compensation of employees in firm i at time t;
- $p_{it}Y_{it}$ is the nominal value-added;
- $\omega_{it} \equiv \frac{p_{it}Y_{it}}{\sum_i p_{it}Y_{it}}$ denotes the weight in value-added of unit i.

One advantage over macroeconomic data is that focusing on firms and their employees removes the confounding effects of self-employment on labor share estimates.[63] Although some self-employed individuals may in fact operate in the economy as incorporated businesses, their impact on the data is mitigated. At this purpose we show that the conclusions of the paper still hold when the smallest firms are excluded.

---

[61] This is a problem closely related to the nature of the dataset. Actually, different countries use different reporting thresholds when defining their sampling frames. For example, data from Belgium covers all companies, while data from France covers only companies with a high level of turnover. As a result, countries differ in the fraction of employment or value added included in the sample. The coverage of the small and medium-sized enterprises (SMEs) segment is particularly good in Italy, Portugal and Spain. Although the latter is considerably smaller in Germany, AMADEUS still captures 2/3 of the activities of the business sector.

[62] In standard formulations based on national accounts, the numerator of the labor share typically includes both a wage-related and non-wage-related part of the compensation of employees. In the denominator, income is usually measured by aggregate gross value added. Gross value added is often used as a measure of income when the labor share is calculated for individual sectors or firms. This is because GDP includes taxes on products, such as the VAT, which are only known for the whole economy. In Europe, GVA accounts for approximately 90% of GDP (ONS, 2016).

[63] Indeed, a well-documented problem when calculating the labor share using aggregate national data is that it does not account correctly for the income of self-employed individuals. While the production of the self-employed is part of the national income, the work component of their remuneration is not captured by the remuneration of employees. This underestimates the labor share and affects cross-country comparisons (Gollin, 2002).

Variable	Obs	Mean	Std. Dev.	Min	Max
Labor share (LS)	3,339,369	0.612	0.236	0.000	1.832
Capital-output (k)	3,192,976	3.799	2.581	-8.884	16.297
Employment growth (dE)	2,342,821	0.019	0.095	-0.423	0.493
Labor productivity (Y/L)	3,192,976	0.798	0.418	-0.369	1.91
Tfp (translog)	3,340,295	4.077	0.965	1.203	6.555
Tfp (cobb-douglass)	3,337,590	3.786	1.625	0.236	6.826
Markup (translog)	3,279,032	1.539	0.408	0.197	2.233
Markup (cobb-douglass)	3,249,452	0.921	0.342	0.030	2.131

Table 4 - Descriptive Statistics of the main variables (2011-19)

Note: The labor share and the employment growth rate are percentages, total factor productivity and the markup are indexes, and the remaining variables are ratios. The data correspond to an unbalanced panel of 19 industries and 28 European countries. Total number of observations: 3,057,782. See definitions of variables and number of observations by industry in Appendix C (Data Appendix).

Table 4 presents the summary statistics of the variables for all industries, countries, and years in the sample.[64] Table 5 and Table 6 show 2011-2019 averages for the LS and k by industry and country. The same statistics for the remaining variables are provided in Appendix A (Table A3 for TFP and A4 for Markups). As expected, given the technological determinants of the labor share, within our sample both variables vary more widely across industries (st.dev. = 0.143 and 0.739) than across countries (st.dev. = 0.064 and 1.375): the range for the labor share, for instance, varies from 35% in (D) - Electricity, gas, steam and air conditioning supply to 87% in (Q) - Human health and social work activities. For what concerns the capital needed to produce one unit of output, some sectors are more capital intensive than others and the ratio varies from a minimum of 1.58 in (Q) - Human health and social work activities to a max of 6.98 in (D) - Electricity, gas, steam and air conditioning supply. TFP is particularly high in (D) Electricity, gas, steam and air conditioning supply - 5.06 as opposed to that of the Public administration and defense - 4.561; finally, the Markup can range from 1.78 in Electricity, gas, steam and air conditioning supply to 0.99/1.06 in respectively (O) Public administration and (P) Education.

[64] Due to the fact that the labor share is computed at the firm level on a year by year basis, and that in some years the labor costs of the firm largely exceed the total value added generated we have that in in 172.667 of the 3.339.369 observations the labor share exceeds 1, which explains the maximum value in the able. Similarly, the negative minimum value for k is connected with some firms that recorded periods (a limited number) of negative gross value added (GVA), which also explains the minimum value for labor productivity in terms of output per worker. For more details on the implications, see Aradanaz-Badia et al. (2017).

f	AT	BE	DE	DK	ES	FR	IE	IT	PL	SE	EU28
A	0.487	0.549	0.551	0.535	0.571	0.650	0.622	0.595	0.430	0.443	0.538
B	0.217	0.501	0.471	0.429	0.403	0.534	0.567	0.431	0.516	0.528	0.416
C	0.640	0.547	0.604	0.522	0.606	0.682	0.503	0.578	0.518	0.617	0.599
D	0.391	0.489	0.419	0.157	0.162	0.429	0.573	0.246	0.332	0.258	0.348
E	0.607	0.538	0.552	0.574	0.736	0.714	0.607	0.535	0.429	0.534	0.610
F	0.779	0.692	0.733	0.866	0.737	0.837	0.716	0.694	0.683	0.804	0.740
G	0.709	0.643	0.681	0.619	0.676	0.760	0.673	0.640	0.521	0.683	0.670
H	0.715	0.638	0.744	0.693	0.613	0.727	0.539	0.681	0.606	0.732	0.688
I	0.764	0.814	0.759	0.777	0.660	0.859	0.611	0.724	0.657	0.760	0.737
J	0.523	0.630	0.558	0.640	0.562	0.576	0.424	0.521	0.541	0.711	0.560
K	0.480	0.599	0.556	0.621	0.436	0.660	0.560	0.496	0.495	0.559	0.535
L	0.604	0.677	0.672	0.694	0.495	0.593	0.634	0.512	0.838	0.740	0.618
M	0.475	0.550	0.733	0.576	0.667	0.640	0.513	0.528	0.643	0.737	0.641
N	0.901	0.877	0.754	0.831	0.861	0.856	0.451	0.868	0.892	0.888	0.813
O	0.967	0.845	0.903	0.796	0.806	0.821	0.961	0.843	0.846	0.887	0.851
P	0.937	0.600	0.890	0.907	0.766	0.826	0.697	0.730	0.818	0.869	0.854
Q	0.979	0.903	0.904	0.640	0.849	0.783	0.634	0.911	0.953	0.928	0.878
R	0.708	0.562	0.631	0.624	0.588	0.760	0.524	0.679	0.458	0.646	0.638
S	0.653	0.654	0.792	0.787	0.705	0.776	0.526	0.676	0.555	0.846	0.750
Total	0.607	0.619	0.643	0.593	0.569	0.632	0.591	0.578	0.561	0.674	0.612

Table 5 - Descriptive statistics of the labor share by industry and country (2011-2019).

Note: LS - Labor share (in percentages). N. of observations by industry are reported in Tables A13/14 in Appendix C.
Source: Authors' calculations on EUROSTAT data.

f	AT	BE	DE	DK	ES	FR	IE	IT	PL	SE	Total
A	5.008	3.241	3.329	2.858	4.165	4.198	3.571	6.065	4.794	5.665	4.484
B	3.240	6.299	3.153	5.034	5.057	3.730	5.184	4.813	4.110	2.774	4.543
C	2.540	4.406	3.731	2.114	4.159	3.714	4.141	4.074	3.966	2.770	3.777
D	6.138	8.130	5.963	5.529	6.825	7.740	3.116	6.167	7.541	6.727	6.987
E	3.279	6.434	4.649	3.143	5.061	4.661	2.898	4.544	6.772	4.608	4.761
F	2.669	3.418	2.601	1.752	4.558	2.604	3.273	4.619	4.126	1.504	3.579
G	2.828	4.278	3.049	2.957	3.858	3.479	3.451	4.493	3.464	2.695	3.737
H	2.680	3.402	2.366	2.238	3.485	6.515	3.722	4.410	3.701	2.375	3.761
I	1.621	2.133	1.731	2.280	3.340	1.612	5.180	3.022	3.789	1.156	2.688
J	1.967	2.673	2.981	2.406	2.701	3.330	3.798	3.449	1.787	1.732	3.029
K	4.900	4.024	4.525	2.984	5.421	3.967	3.772	5.125	6.557	4.287	4.630
L	3.383	3.126	2.878	2.315	4.904	4.033	4.282	5.407	1.221	2.491	3.700
M	6.438	3.183	2.496	3.317	3.098	2.818	7.058	3.506	2.873	1.461	2.886
N	0.890	1.246	2.099	1.811	1.438	1.771	4.173	1.621	1.289	1.010	1.810
O	0.798	2.026	1.278	2.056	1.830	2.065	0.603	2.007	4.149	0.643	1.759
P	2.094	2.703	1.480	0.880	1.963	1.619	2.336	2.869	2.080	0.813	1.666
Q	0.352	1.230	1.302	2.904	1.637	3.352	1.134	1.392	1.047	0.431	1.580
R	2.650	3.121	1.953	2.478	3.092	2.172	4.347	2.819	1.409	2.153	2.675
S	2.368	1.933	2.296	2.671	3.486	1.962	3.921	2.293	1.791	1.383	2.425
Total	3.406	3.850	3.291	2.908	4.251	4.138	4.154	4.330	3.836	2.769	3.799

Table 6 - Descriptive statistics of the labor share by industry and country (2011-2019).

Note: k - Capital-output ratios. N. of observations by industry are reported in Tables A13/14 in Appendix C.
Source: Authors' calculations on EUROSTAT data.

Starting from the data we document several salient facts by combining both known patterns already widely discussed by the literature and partially new ones that emerge by looking at the joint evolution of the variables through the lenses of our model. Then we try to interpret the implications in the context of our simple conceptual framework. (i) First, we confirm that the labor share for the whole economy decreased by 0.1 percentage points between 2011 and 2019 (Figure 11). [65]

Figure 11 - Labor shares and labor shares' changes by sector (2011-2019).

Note: a) Unweighted labor share, by sector (in % of VA), 2011-2019; b) Aggregate labor share weighted by the number of employees, by sector (in % of VA), 2011-2019; c) Average annual (%) change in the aggregate labor share, by sector. *Source:* Authors' calculation on AMADEUS data.

[65] We calculated the labor share for the whole economy and its sectors, using value added and the amount of wages and salaries paid to employees. The whole economy includes all the sectors of the economy; (1) The primary sector is oriented to agriculture, forestry, fishing, mining and quarrying (NACE codes A and B); (2) The secondary sector includes economic activities related to fabrication, manufacturing, proceeding of energy and water supply or construction (codes C-F); (3) The tertiary sector contains services (codes G to S excluding O and P); finally the Public sector includes Public administration, defense (O) and Education (P).

With reference to the average size of firms in terms of added value, it is known how it differs in between various sectors of the national economy; therefore, there is an apparent distinction of the labor share in Figure 12 - panel a and Figure 12 - panel b, where the ranking is based on the total weighted labor shares. Among all the EU sample countries the average total weighted labor share of the whole economy accounted for 61%, in the primary sector - 48%, in the secondary - 58%, in the tertiary - 63%. On the other hand, the labor share is substantially higher in the public sector - 85,5%. From a country perspective, the highest total labor share corresponds to Sweden (67%), while the lowest one is that observed in Latvia (38%). Almost in all EU countries of the sample, the shares of secondary and tertiary sector employment coincided; however, the tertiary sector is predominant in terms of a higher employment share. During the period under consideration, the aggregate weighted labor share adjusted to the log of value added decreased in all the sectors of the sample except the secondary one. The highest rates of the aggregate wage share drop have been observed in the primary sector (Figure 11 - panel c).

Nevertheless, there are highly heterogeneous dynamics at the industry level (Figure 12 - panel b). Some industries like for instance: (R) - Arts, entertainment and recreation; (I) - Accommodation and food service activities; (M) - Professional, scientific and technical activities; (A) - Agriculture, forestry and fishing; (B)- Mining and quarrying; (H) - Transportation and storage lost a total of more than 1.5 percentage points over the period, while others, like (S) - Other service activities; (F) - Construction; (K) - Financial and insurance activities; (J) - Information and communication gained up to 1.5% points. The industries where the labor share is in decline are higher in number than those where it is not, and the average declining rate (-1.77%) is higher than the average growth rate registered in the growing ones (0.99%). However, overall, the labor share has not declined since these latter sectors have increased their share in the total value added generated by roughly 0.60%. Human health and social work activities (Q) - 87.34%, Professional, scientific and technical activities (N) - 81.14%, Accommodation and food service activities (I) - 75.99%, Construction (F) - 70.35% are industries traditionally characterized by above average labor shares (and where the latter is increasing) but accounts for a very small share of the aggregate value added generate in the economy. On the other hand, Manufacturing (C) - 57.16%, Real estate activities (L) - 60.07%, Wholesale and retail trade (G) - 64.65% and Information and communication (J) - 51.62% are industries traditionally characterized by below average labor shares (and where the latter is decreasing) and accounts for a consistent part of the value added generate in the economy (Figure 12 - panel a).

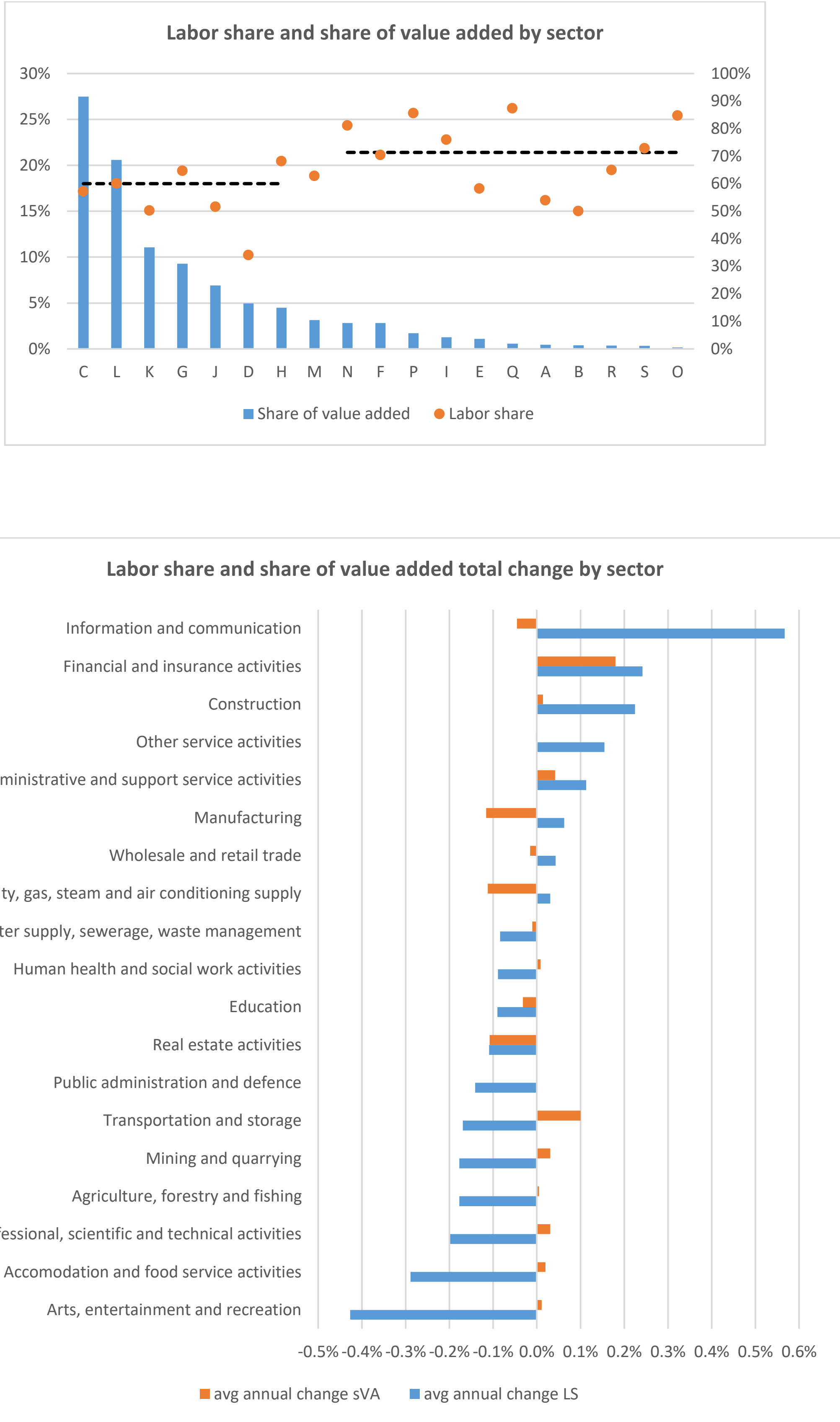


Figure 12 - Labor share and share of value-added, levels and shares (panel a) and variations by industry (panel b).

Note: relevant period 2011-2019. Nace_2digit industries. *Source:* Authors' calculation on AMADEUS data.

Second, (ii) we confirm that the distributions of the aggregate labor shares and that of the capital-output ratios have remained almost constant within the sample (Figure 13 and Table A5 in Appendix A), with that of the capital to output that has become more skewed towards its mean value at the expense of higher values of k. However, the average value of both the variables remains unchanged.

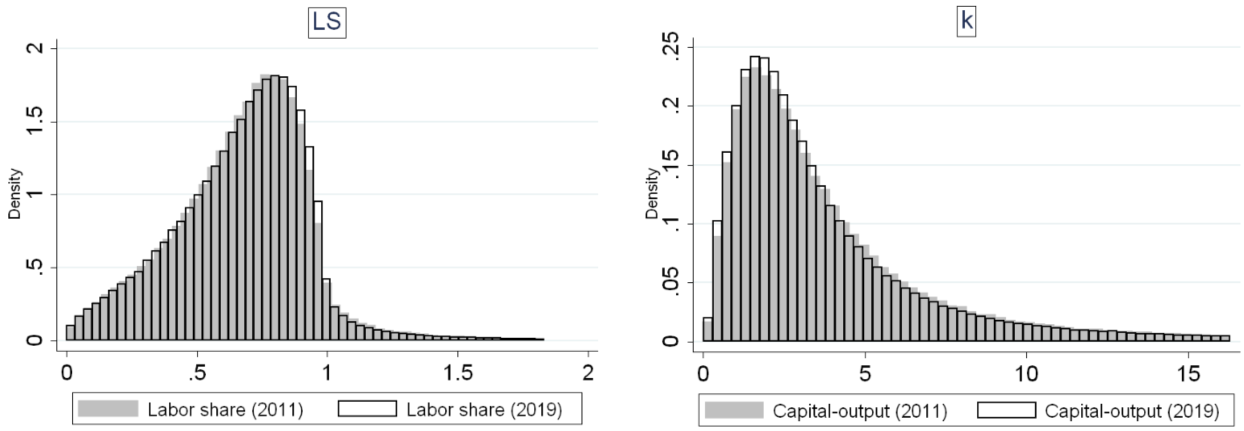


Figure 13 - The "not too much" changing distributions of the labor share (LS) and the capital-output ratio (k).

Note: The grey area reflects the weighted raw distribution of respectively labor shares (panel a) and capital-output ratios (panel b) in 2011, while the black shaped overlay area that of the same variables in 2019. The picture shows no significant shift of frequencies for firm-level labor shares from 2011 to 2019; the fattening of tails indicates a polarization of labor shares that does not affect the aggregate labor share. On the other hand, the distribution of k in 2019 is a little bit more skewed toward its mean value with a flattening on the right tail and a raising of the left one. The average value remains unchanged. *Source:* Authors' calculation on AMADEUS data.

This, however, also hides contrasting movements at the micro level between different groups of firms. Indeed, from this perspective, alongside the aggregate constancy in the mean value of the labor share and its distribution (meaning that the median firm did not see any substantial change in its labor share) there has been a substantial redistribution between groups. If we look at firms in terms of their size, we find that the relatively contained decline of the (weighted) aggregate labor share has been entirely driven by a reallocation of value added toward the small and medium-sized firms of the sample which nevertheless have decreased both their average and median labor shares (see Figure 14 and Table A6 in Appendix A). In these latter groups (defined as those with less than 250 and 500 employees) the share of labor in 2011 was respectively 1.35 and 1.79 percentage points higher than the level registered in 2019. On the other hand, companies with more than 500 employees seem to have withstood the impact better even if they have lost ground in terms of value-added. However, it is worth noting that big firms represent roughly 80% of the total value added in the economy, this is a shortcoming of our database which, by construction, is biased towards large companies.[66]

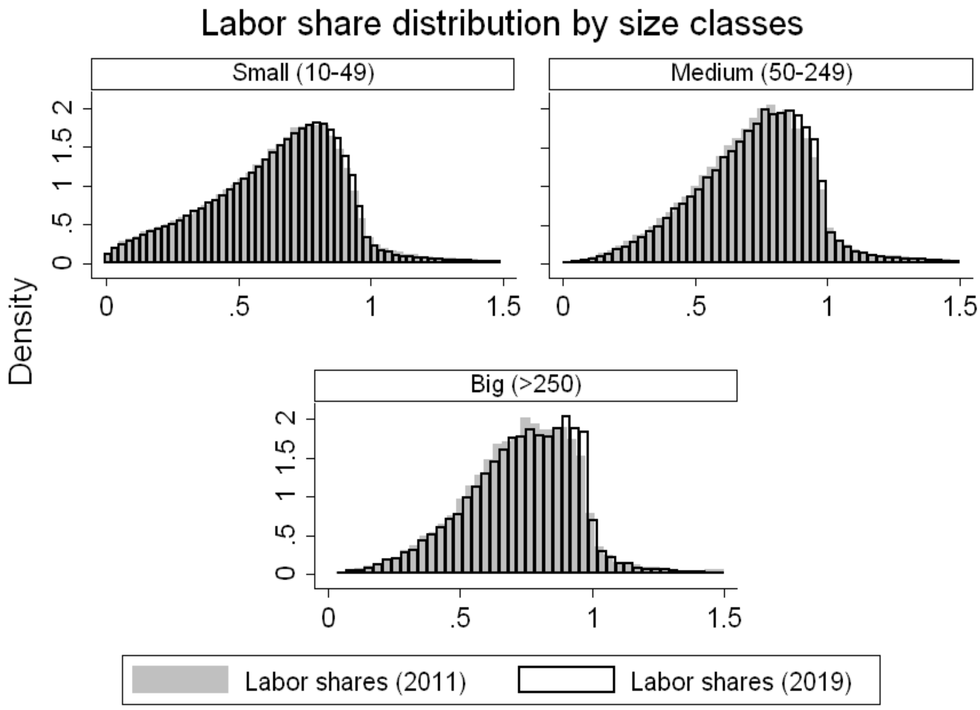


Figure 14 - The changing distribution of the labor share by size class (2011 and 2019).

Note: The grey area reflects the weighted raw distribution of labor shares by size classes in 2011, while the black shaped overlay area that in 2019. *Source:* Authors' calculation on AMADEUS data.

The first characteristic that should catch the eye when looking at Tables 7 and A6 (Appendix A) is that the labor share (in levels) of different groups of firms are not so different from each other (for instance, the average of small and big firms is in both cases roughly 61%). This result should not surprise too much because our model clearly states that the size of the company is not itself a feature that can influence its labor share. What influences the firm's labor share are instead its underlying characteristics in terms of the variables that we have identified to be relevant in affecting

[66] The discrepancy between AMADEUS and national figures may be explained by two facts strictly connected with the construction of the dataset: (1) for a significant number of firms present in AMADEUS, we do not have data on employment; (2) AMADEUS is generally not the best source of data to conduct international cross countries comparisons. Actually, samples may not be representative of the economy in a given year, because BvD may have access to a specific data source only in certain years. This means that depending on the country, data availability of sources may have varying degrees of coverage from a year to another. For instance, new sources can be created over time with increases of coverage which results in large increases in sample size that are hence not due to a high rate of entry, but rather to the availability of new registries. And this can happen to different extents for different countries. Therefore, we have always to keep in mind that investigation of entry and exit, reallocation, and macro studies where firm-level data is aggregated at the national level are difficult and likely to suffer from sample bias.

its behavior (i.e., the capital-output ratio, the TFP and the Markup). The average values of the latter for 2011 and 2019 are shown as weighted average of the firm-level values for firms in the sample in Table A6. Actually, except for the markup, which is substantially higher in big firms, for all the other variables there are no such large and consistent differences. For instance, the capital-output is on average 3.60 in medium-sized firms and 3.80 in big. Similarly, the TFP which, depending on how it is measured (i.e., estimated using a Cobb-Douglass or Translog specification) ranges around 3.1/4.1 for small enterprises and, respectively 3.39/4.28 for medium and 3.93/4.05 for big. Finally, in both the small and medium-sized companies which have witnessed a decline in the labor share the capital output ratio on average has decreased over time and the markup has increased. We will explain the implications of these dynamics later. For now, let us keep aside these considerations on the stylized facts highlighted here, and then we will put them together with those related to labor productivity to better understand the role of variations in capital-output ratios and other variables after the model estimation in the next paragraph.

	Small firms (<250 employees)									
	2011					*2019*				
	Obs	Mean	St.Dev.	Min	Max	Obs	Mean	St.Dev.	Min	Max
LS	201.77	0.60	0.291	0.00	1.83	299.71	0.60	0.276	0.00	1.83
k	191.67	4.39	3.337	-1.96	16.30	286.41	3.98	3.069	-4.59	16.30
dE	190.12	0.00	0.127	-0.42	0.49	279.24	0.03	0.132	-0.42	0.49
tfp_tl	202.24	4.11	0.840	1.20	6.55	300.08	4.10	0.823	1.20	6.55
markup_dlw~l	198.69	1.07	0.331	-0.19	2.23	293.99	1.11	0.330	-0.20	2.23
tfp_cd	202.50	3.11	1.124	-0.21	6.82	300.31	3.10	1.118	-0.20	6.82
markup_dlw~d	196.36	0.86	0.318	0.05	2.13	290.30	0.90	0.309	0.04	2.13
labprod	194.66	0.65	0.389	0.00	1.91	288.02	0.65	0.388	0.00	1.91
	Medium firms (250<employees<500)									
	2011					*2019*				
	Obs	Mean	St.Dev.	Min	Max	Obs	Mean	St.Dev.	Min	Max
LS	50.11	0.65	0.262	0.01	1.83	64.95	0.64	0.261	0.00	1.83
k	49.78	3.68	2.876	-2.70	16.28	64.69	3.50	2.719	-3.36	16.29
dE	48.69	0.01	0.106	-0.42	0.49	62.27	0.03	0.112	-0.42	0.49
tfp_tl	49.85	4.27	0.817	1.22	6.56	64.66	4.29	0.828	1.24	6.55
markup_dlw~l	49.72	1.25	0.310	-0.10	2.23	64.26	1.28	0.311	-0.12	2.23
tfp_cd	49.56	3.38	1.187	-0.19	6.82	64.37	3.39	1.224	-0.21	6.82
markup_dlw~d	49.98	0.85	0.299	0.06	2.13	64.66	0.88	0.305	0.03	2.13
labprod	49.03	0.71	0.399	0.00	1.91	63.10	0.73	0.407	0.00	1.91
	Big firms (>500 employees)									
	2011					*2019*				
	Obs	Mean	St.Dev.	Min	Max	Obs	Mean	St.Dev.	Min	Max
LS	17.26	0.60	0.242	0.04	1.83	20.56	0.60	0.231	0.04	1.83
k	17.18	3.86	2.433	-2.15	16.27	20.50	3.85	2.424	-5.75	16.26
dE	16.88	0.01	0.090	-0.42	0.49	19.87	0.04	0.087	-0.42	0.49
tfp_tl	17.05	4.09	0.971	1.24	6.55	20.33	4.02	0.981	1.22	6.54
markup_dlw~l	16.63	1.62	0.366	-0.12	2.23	19.73	1.65	0.359	-0.18	2.23
tfp_cd	16.77	4.02	1.713	-0.18	6.82	20.01	3.84	1.718	-0.18	6.82
markup_dlw~d	17.21	0.92	0.356	0.07	2.13	20.46	0.93	0.357	0.07	2.13
labprod	16.70	0.83	0.424	0.00	1.90	19.64	0.82	0.419	0.00	1.91

Table 7 - Summary statistics of the main model variables of the model by firm size (2011 and 2019).

Source: Authors' calculation on AMADEUS data.

(iii) We find a confirm in data of the patterns suggested by Autor et al. (2020). They show that, if globalization or technological change push sales towards the most productive firms in each industry of the economy, product market concentration will rise as industries become increasingly dominated by the so-called “superstar firms”. Since these latter are characterized by higher markups and a lower labor share of value-added, such a framework implies that the reallocation of economic may be crucial to understand movements in the aggregate labor share. Looking at our data, markups of the high-productivity firms (i.e., the top 10% in terms of labor productivity) turns out to be, on average, 10% higher than in medium productivity firms and as much as 40% above that of the low productive ones (i.e., the bottom 10% of the distribution) (Table 8 below). Notably, high-productive firms also have higher TFPs (which range from 11/15% that of the medium and low productive ones if we estimate them by means of the Translog and as much as 8/42% if estimated with a standard Cobb-Douglass production function) and employ relatively more capital in production (respectively 47-53% more). All these conditions reflect in lower labor shares. Indeed, the labor share of the most productive firms (top 10%) is 35 percentage points lower than that of medium productive ones and up to 48 percentage points lower than that of the low productive (see Figure 15 and Table A8 in Appendix A). This means that the observed fall in the labor share over the long run may be largely ascribable to the reallocation of value-added between heterogeneous firms rather than a general fall in the labor share within incumbent firms. Our model perfectly covers this hypothesis and even if our data, due to their limited extension in time are not able to robustly demonstrate the growth of the value-added share of the most productive enterprises within the economy, they are perfectly able to demonstrate and explain the persistent differences that exist between these and the remaining groups of firms. From this perspective, we will show that differences in terms of productivity, along with the capital-output ratios are the main engine of industry-specific dynamism which drives the labor share. And since these patterns are highly connected with technology, they are transnational and common to all the countries of Europe. This is for sure one of the major insights gained from taking a firm-level perspective on analyzing changes in the labor share. Further, we observe a clear upward trend in markups over time for all the groups of firms: according to all our measure, industries have become more concentrated on average. However, the increase was more marked for the most productive companies, which already had higher markups. To further clarify this point, we regressed the change in the labor share on the change in the markup across all the one-digit industries for our sample window of 2011 through 2019. In each of the 19 sectors, we separately estimate OLS regressions in log differences (indicated by Δ).[67] We allow for the standard errors to be correlated over time by clustering them at the industry level. Results are reported in tables A10/A11 in Appendix A. We detected a striking relationship between changes in the markups and changes in the share of compensation in value-added. Industries where concentration rose the most were those where the labor share fell the most.

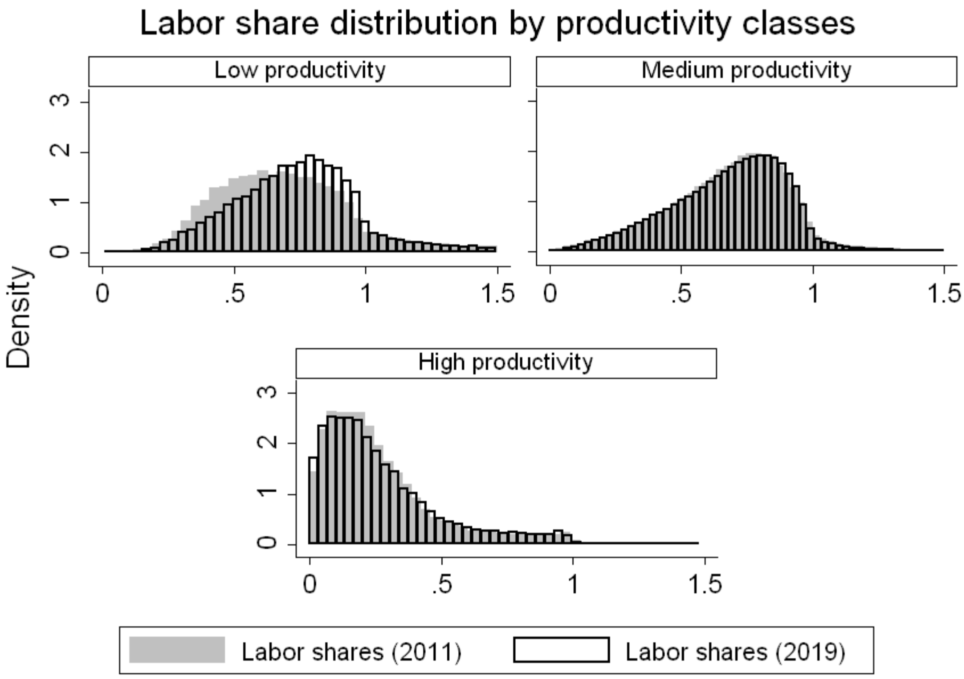


Figure 15 - The changing distribution of the labor share by labor productivity class (2011 and 2019).

Note: The grey area reflects the weighted raw distribution of labor shares by labor productivity classes in 2011, while the black shaped overlay area that in 2019. *Source:* Authors' calculation on AMADEUS data.

[67] The regression model employed is the following: $\Delta LS_{jt} = \beta \Delta \mu_{jt} + \tau_t + u_{jt}$ where LS_{jt} is the labor share of one-digit NACE industry j at time t, $\Delta \mu_{jt}$ is a measure of concentration, τ_t is a set of period dummies, and $u_{jt}$is an error term.

	Low productivity firms (bottom 10%)									
	2011					*2019*				
	Obs	Mean	St.Dev.	Min	Max	Obs	Mean	St.Dev.	Min	Max
LS	14,922	0.83	0.314	0.03	1.83	17,679	0.86	0.218	0.01	1.83
k	14,662	4.45	4.111	-0.78	16.28	17,562	3.11	2.870	-0.47	16.28
dE	14,076	0.01	0.135	-0.42	0.49	16,475	0.00	0.117	-0.42	0.49
tfp_tl	15,422	4.05	0.783	1.22	6.51	18,154	4.25	0.666	1.20	6.54
markup_dlw~l	15,223	1.16	0.372	-0.14	2.23	18,003	1.35	0.428	-0.15	2.23
tfp_cd	15,445	2.65	1.346	-0.19	6.80	18,174	2.70	1.127	-0.18	6.77
markup_dlw~d	14,711	0.95	0.355	0.08	2.13	17,742	1.01	0.284	0.09	2.13
labprod	15,457	0.06	0.016	0.00	0.08	18,157	0.06	0.024	0.00	0.08

	Medium productivity firms									
	2011					*2019*				
	Obs	Mean	St.Dev.	Min	Max	Obs	Mean	St.Dev.	Min	Max
LS	241,177	0.67	0.205	0.00	1.83	34,772	0.67	0.196	0.00	1.83
k	233,043	3.52	2.314	-2.70	16.30	337,019	3.52	2.347	-5.75	16.30
dE	229,964	0.02	0.094	-0.42	0.49	327,196	0.04	0.096	-0.42	0.49
tfp_tl	241,496	3.99	0.912	1.20	6.56	347,861	3.91	0.920	1.20	6.55
markup_dlw~l	23,891	1.51	0.401	-0.19	2.23	343,548	1.54	0.395	-0.20	2.23
tfp_cd	241,503	3.83	1.637	-0.21	6.82	347,921	3.64	1.592	-0.21	6.82
markup_dlw~d	23,756	0.91	0.328	0.06	2.13	340,958	0.90	0.313	0.03	2.13
labprod	242,764	0.76	0.363	0.08	1.69	349,145	0.77	0.384	0.08	1.69

	High productivity firms (top 10%)									
	2011					*2019*				
	Obs	Mean	St.Dev.	Min	Max	Obs	Mean	St.Dev.	Min	Max
LS	12,141	0.30	0.172	0.00	1.76	18748.00	0.34	0.201	0.00	1.64
k	10,035	5.45	2.880	-0.17	16.28	15947.00	4.99	2.764	-0.80	16.30
dE	10,765	-0.01	0.096	-0.42	0.49	16647.00	0.02	0.085	-0.42	0.49
tfp_tl	1,134	4.58	0.953	1.24	6.55	17983.00	4.58	0.909	1.24	6.55
markup_dlw~l	10,046	1.64	0.414	-0.19	2.23	15378.00	1.65	0.409	-0.19	2.23
tfp_cd	10,984	4.01	1.620	-0.18	6.82	17526.00	4.02	1.753	-0.17	6.82
markup_dlw~d	10,399	0.92	0.450	0.05	2.13	15641.00	1.03	0.465	0.12	2.13
labprod	2,166	1.79	0.059	1.69	1.91	3451.00	1.78	0.059	1.69	1.91

Table 8 - Summary statistics of the main model variables of the model by labor productivity class (2011 and 2019).

Source: Authors' calculation on AMADEUS data.

Table 9 below shows the estimates of our basic specification in equation (8). Firm's capital-output ratio turns out to be very significant (p-value: 0.00), indicating a clear departure from the Cobb-Douglas specification. The coefficients are either positive or negative, suggesting that labor and capital can be either complements or substitutes depending on the industry. It could be argued that this result may ultimately relate to the shares of skilled labor and the shares (but also the role) of tangible and intangible capital in different firms and industries. The t-ratios (i.e., the ratio of the departure of the estimated value of the parameter from its hypothesized value to its standard error), indicate that also industry coefficients for k are statistically significant, except for three industries, namely (L) - Real estate activities, (O) - Public administration and (P) - Education.

As a check of the results, in the spirit of Bentolila and Saint-Paul (2003) we employ the estimated coefficients to compute industry-specific measures of the elasticity of substitution between K and L, $-\sigma_{KL}$. Following their methodology, from equation (8)**,** we compute it as: $\sigma_{KL} = -\left(1 + \frac{\partial \ln LS}{\partial lnk}\overline{LS}\eta\right)$. To this aim, we need an estimate of η, i.e. the elasticity of the labor demand with respect to the wage.[68] Wage elasticity estimates abound in literature, but they depend strongly on the specificities of the particular studies.[69] Therefore we rely on all the previous research and in particular the works of Lichter et al. (2015) which building on 942 elasticity estimates from 105 different studies find an overall mean (median) own-wage elasticity of labor demand of -0.508 (-0.386), with a standard deviation of 0.774. Table 12 shows our estimates for σ_{KL}. Using these values for η, we obtain elasticities above 1 in 10 out of 19 cases, varying across sectors from 0.77 to 1.35. All of them, with the exclusion of (D) - Electricity, gas, steam and air conditioning; (F) - Construction; (H) - Transportation and storage; (K) - Financial and insurance; (L) - Real estate; (O) - Public administration and (P) - Compulsory social security Education are significantly different from 1 (i.e. the Cobb-Douglas) at the 5% level.

The main shifter of the $LS - k$ relationship, i.e. the firm-level TFP, meant to capture the effect of capital-augmenting, or more generally "not labor-augmenting", technical progress on the labor share, the estimated coefficient is also negative and significant, attracting negative

[68] Elasticity of labor demand measures the responsiveness of demand when there is a change in the wage rate. It can be calculated using the following formula: (%Δdemand for labor/%Δwage rate). There are several factors affecting the elasticity of wages: (i) Labor costs as a % of total costs. (ii) Ease and cost of factor substitution. (iii) Price elasticity of demand for the final product. (iv) The time period considered. Since for a correct estimation one should control for all these factors and the estimates are also strongly dependent on the specificities of the particular studies, to obtain this parameter we rely on previous literature and in particular the works of Lichter et al. (2015).

[69] Despite the extensive research on the matter, estimates of labor demand elasticities are still subject to a great degree of heterogeneity. Lichter et al. (2015) for instance built on 942 elasticity estimates from 105 different studies and identify the sources of variation in the absolute value of this parameter. Heterogeneity can be ascribable to theoretical and empirical specification of the labor demand model, different datasets used or sectors and countries.

coefficients in six industries, namely A, D, G, J, M and R (see the footnote for the description).[70] Significance of the coefficients for TFP is at 1% in all the sectors. On average, an increase in the TFP by one percent lead to a decrease of the labor share by 0.15 percentage points. Therefore, capital biased technological progress decreases the labor share of income in European Countries. This finding confirms that of other studies also at higher levels of aggregation such as that of Guscina (2006) which, using labor productivity as a proxy for technological progress, analyzes the impacts of the evolution in technology on the labor share of income for 18 industrialized countries between 1960 to 2000. As pointed out above, if total factor productivity is strictly capital augmenting, it should come out with the same sign of the capital-output ratio. Indeed, this is the case for most sectors, but not all, suggesting that a more complex effect of productivity on the production function may be at stake. We will consider this fact in estimating the model with interactions afterwards.

Turning to movements off equilibrium (i.e., off the established $LS - k$ curve), in Table 9 the variable capturing the effects of labor adjustment costs, namely the employment growth rate, shows the expected negative sign, as does the markup (which however is positive for the whole economy). Both are significant; however, the effect of markup is largely negligible (0.0033). This result, which may seem strange at first sight, is actually compatible with the model of Kaplan and Zoch (2020) which show that that whether an increase in the markup leads to an increase or a decrease in the labor share depends on the share of N-type labor in the economy.[71] Indeed, when a sufficiently large fraction of labor income compensates N-type activities, the established and negative co-movement can be reversed.[72] The diagnostic statistics do not indicate problems with the specification.[73] Table 10 presents the same results with a breakdown at the level two of NACE classification (from C10 to C33) for manufacturing. Note that in this case the elasticity of substitution is slightly higher than the average for the whole economy (roughly 1.02), with some subsectors like for instance (C16) - Manufacture of wood and of products of wood and cork, except furniture and (C18) - Printing and reproduction of recorded media and which reach values of respectively 1.26 and 1.31. Further, in the case of manufacturing the effects of the markup is strong and an increase of 1% lead to a reduction of the labor share of 0.48 percentage points.

[70] (A) – Agriculture and forestry; (D) - Electricity, gas, steam and air conditioning supply; (G) - Wholesale, retail trade, repair of motor vehicles; (J) - Information and communication; (M) - Professional, scientific and technical activities; (R) – Arts and entertainment.

[71] In models that abstract from the expansionary role of labor, markup and the labor share always move in opposite directions.

[72] For instance, if all workers perform production activities, then a higher markup leads to a decrease in the labor share. However, if enough workers perform expansionary activities, then a higher markup can lead to an increase in the labor share. This should be of some interest for policymakers since it would mean that the impact of markups depend on the composition of the labor force.

[73] We have tried different estimations with variations in the set of instruments, which are however not shown for brevity since we obtained in all the cases very similar results.

Code	Sector name	lk	t-ratio	- σkl (-0.39)	- σkl (-0.50)	ltfp	markup_dlw~tl	dlE
A	Agriculture, forestry and fishing	0.31	(9.54)	-1.07	-1.08	-0.08	-0.09	-0.02
B	Mining and quarrying	-1.65	(-3.43)	-0.73	-0.66	0.37	-0.32	0.01
C	Manufacturing	0.08	(4.86)	-1.02	-1.02	0.05	-0.48	-0.01
D	Electricity, gas, steam and air conditioning supply	-0.07	(-0.44)	-0.99	-0.99	-0.32	0.00	-0.01
E	Water supply; Sewerage, waste management	0.75	(3.55)	-1.18	-1.23	0.97	-0.57	-0.01
F	Construction	-0.17	(-1.31)	-0.95	-0.94	2.06	-0.70	0.01
G	Wholesale and retail trade; Repair of mothor vehicles	-0.35	(-9.08)	-0.91	-0.88	-0.09	-0.34	0.01
H	Transportation and storage	0.03	(0.52)	-1.01	-1.01	0.15	-0.24	0.02
I	Accomodation and food service activities	-0.49	(-5.05)	-0.86	-0.82	1.53	-0.81	-0.02
J	Information and communication	-0.19	(-5.24)	-0.96	-0.95	-0.32	-0.18	-0.01
K	Financial and insurance activities	-0.08	(-0.68)	-0.98	-0.98	0.75	0.00	0.02
L	Real estate activities	0.02	(0.02)	-1.00	-1.01	1.47	-0.39	0.01
M	Professional, scientific and technical activities	-0.16	(-3.08)	-0.96	-0.95	-0.56	0.00	0.02
N	Administrative and support service activities	-0.47	(-5.04)	-0.85	-0.81	1.02	-0.42	0.01
O	Public administration and defence; Compulsory social security	0.24	(1.53)	-1.08	-1.10	1.82	-1.07	-0.01
P	Education	-0.05	(-0.74)	-0.98	-0.98	2.22	-1.54	0.00
Q	Human health and social work activities	0.33	(8.77)	-1.11	-1.14	0.45	-0.82	0.01
R	Arts, entertainment and recreation	0.17	(2.88)	-1.04	-1.06	-0.04	-0.50	-0.02
S	Other service activities	0.31	(2.65)	-1.09	-1.12	0.26	-0.69	0.01
ALL	Whole economy	-0.03	(-4.21)	-0.99	-1.01	-0.15	0.00	0.00

Table 9 - Estimation of labor share equation. Dependent variable: $lnLS_{it}$

Note: No. of observations: 3,296,042 (Agriculture, forestry and fishing - 97,377; Mining and quarrying - 13,249; Manufacturing - 848,415; Electricity, gas, steam and air conditioning supply - 2,472 Water supply, Sewerage, waste management - 38,573; Construction - 324,038; Wholesale and retail trade, Repair of motor vehicles - 951,841; Transportation and storage - 193,493; Accommodation and food service activities - 144,411; Information and communication - 101,097; Financial and insurance activities - 163,971; Real estate activities - 77,998; Agriculture, forestry and fishing - 114,189; Administrative and support service activities - 111,648; Public administration and defense, Compulsory social security - 19,744; Education - 4,923; Human health and social work activities - 35,751; Arts, entertainment and recreation - 32,307; Other service activities - 20,468.

Method: Panel regression with Fixed-effects (FE) model. Instruments for levels of log(k), log (TFP), markup, ΔE: lagged first differences. t-statistics based on standard errors clustered by firm in parenthesis. *Additional control variables:* year dummies. *Period of estimation:* 2011-2019.

Code	Sector name	lk	t-ratio	- σkl (-0.39)	- σkl (-0.50)	ltfp	markup_dlw~tl	dlE
C10-C12	Manufacture of food products and beverages	0.12	(1.73)	-1.03	-1.03	0.542	-0.723	-0.01
C13-C15	Manufacture of textiles, wearing apparel and leather products	-0.10	(-0.99)	-0.98	-0.97	1.52	-0.74	-0.01
C16	Manufacture of wood and of products of wood and cork, except furniture	0.79	(4.31)	-1.20	-1.26	1.32	-0.73	0.01
C17	Manufacture of paper and paper products	0.38	(1.36)	-1.08	-1.10	1.59	-0.73	-0.01
C18	Printing and reproduction of recorded media	0.88	(2.45)	-1.25	-1.31	2.49	-0.92	0.01
C19	Manufacture of coke and refined petroleum products	0.07	(0.13)	-1.01	-1.01	-0.16	-0.13	-0.46
C20	Manufacture of chemicals and chemical products	-0.02	(-0.11)	-1.00	-0.99	1.22	-0.62	0.00
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	-0.43	(-0.71)	-0.91	-0.89	1.22	-0.53	-0.05
C22	Manufacture of rubber and plastic products	0.42	(3.20)	-1.10	-1.13	1.12	-0.59	0.01
C23	Manufacture of other non-metallic mineral products	0.14	(3.95)	-1.03	-1.04	0.17	-0.93	-0.01
C24	Manufacture of basic metals	0.27	(0.99)	-1.08	-1.10	1.47	-0.78	0.02
C25	Manufacture of fabricated metal products, except machinery and equipment	0.22	(2.19)	-1.06	-1.08	1.93	-0.78	0.01
C26	Manufacture of computer, electronic and optical products	0.16	(1.13)	-1.04	-1.05	1.25	-0.96	0.00
C27	Manufacture of electrical equipment	-0.41	(-1.57)	-0.89	-0.86	1.82	-0.79	0.01
C28	Manufacture of machinery and equipment n.e.c.	0.22	(1.60)	-1.06	-1.08	1.83	-0.75	0.00
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.03	(0.24)	-1.01	-1.01	0.19	-0.88	0.01
C30	Manufacture of other transport equipment	0.24	(0.82)	-1.06	-1.08	1.03	-0.68	0.02
C31_C32	Manufacture of furniture	-0.28	(-2.23)	-0.93	-0.91	1.13	-1.01	-0.02
C33	Repair and installation of machinery and equipment	-0.44	(-2.36)	-0.87	-0.83	2.29	-0.81	0.04
C	Manufacturing	0.08	(4.99)	-1.02	-1.02	0.05	-0.48	-0.01

Table 10 - Estimation of labor share equation (Manufacture breakdown at NACE level 2). Dependent variable: $lnLS_{it}$

Note: No. of observations: 688,566 (Manufacture of food products and beverages - 118,235; Manufacture of textiles, wearing apparel and leather - 87,988; Manufacture of wood and of products of wood, except furniture - 31,692; Manufacture of paper products - 19,771; Printing and reproduction of recorded media - 2,341; Manufacture of coke and refined petroleum - 1,914; Manufacture of chemicals products - 33,545; Manufacture of basic pharmaceutical products - 6,739; Manufacture of rubber and plastic products - 5,311; Manufacture of other non-metallic mineral products - 41,091; Manufacture of basic metals - 19,315; Manufacture of fabricated metal products, except machinery and equipment - 156,575; Manufacture of computer, electronic and optical products - 22,809; Manufacture of electrical equipment - 30,418; Manufacture of machinery and equipment n.e.c. - 919; Manufacture of motor vehicles, trailers and semi-trailers - 19,519; Manufacture of other transport equipment - 8,478; Manufacture of furniture - 49,205; Repair and installation of machinery and equipment - 32,701. *Method:* Panel regression with Fixed-effects (FE) model.

Setting aside sectoral heterogeneity for a moment and returning to the estimates for the whole economy, we obtained the following results (t-ratios in parentheses).

$$\begin{aligned} lnLS_{it} = &\underbrace{-0.340}_{(-6.46)} \underbrace{-0.0301}_{(-4.21)}\ lnk_{it} \underbrace{-0.152}_{(-8.73)}\ lnTFP_{it} \\ &+ \underbrace{0.000598}_{(1.21)}\ \mu \underbrace{-0.00102}_{(1.21)}\ ln\Delta E \end{aligned} \tag{12}$$

The coefficient for the capital-output ratio (-0.030) implies, for a value of $\eta = -0.50$ an average capital-labor elasticity of 1.02, which is not very far from the Cobb-Douglas value of 1 at the 1% level. This result lies in between those found by other researchers. On the one hand, there is a long tradition of literature finding elasticities significantly below 1, from 0.30 (Lucas, 1969) to 0.76 (Kalt, 1978). In their pioneering article, Arrow et al. (1961) find that σ_{KL} is below 0.6 in the United States over the period from 1909 to 1949. Later, studies for the aggregate US economy have also documented gross complementarity between labor and capital (Antras, 2004; Klump et al., 2012). Further, the hypothesis that the elasticity of substitution is below unity is also supported by empirical evidence at the sectoral (Young, 2013; Herrendorf et al., 2015; Chirinko and Mallick, 2017) and firm level (Barnes et al., 2008). On the other hand, more recently, research exploiting cross-country variation provide contrasting estimates of σ_{KL}. For instance, using a panel for 82 countries over 30 years, Duffy and Papageorgiou (2000) find that the elasticity of substitution is on average greater than one. Similarly, empirical evidence provided by Karabarbounis and Neiman (2014) implies that σ is about 1.25. This leaves a lot of open questions and a puzzle which seems to be unsolved. And it is worth noting that this is a matter of primary importance for both the theories closely related to the elasticity of substitution (let us think at all the implications for growth models for instance) and that of income distribution. Our estimates in Table 9 are in line with the results in these two sets of studies, which are however not readily comparable to ours, since they use aggregate data for many countries, rather than firm-level data for European countries as we do. Moreover, our computed elasticities depend on positing an external value for the elasticity of the labor demand (the parameter η), so that we cannot provide direct estimates of σ_{KL}. The value of the elasticity of substitution turns out to be crucial in understanding the recent broadly documented trends in factor shares. Indeed, within neoclassical theory, the recent decline in the labor share cannot be associated with physical capital accumulation when labor and capital are gross complementary, i.e., $\sigma < 1$ and hence, if this is the case, it is possible to assume that net labor-augmenting technical progress has played a major role in determining recent trends in the factor shares (Mućk, 2017). On the other hand, under gross substitutability, factor-augmenting technical progress is the dominant process that explains the direction of recent trends in factor shares. This is exactly the pivot on which Piketty's theory of the rising in capital share hinges and that allow him to explain the simultaneous increase in capital/income ratio and capital share (Piketty, 2014).

At this point we would like to draw attention on the most important point of the paper. Given that the model suggests potential non-linearities in the elasticity of the labor share with respect to the capital-output ratio and given that we find both positive and negative coefficients in our specification with industry and year dummies, we tried to capture this effect and hence a possible (and probable) more complex relationship between k and the LS. For this purpose, we employed a third-degree polynomial by adding a term in the squared and cubic log capital-labor ratio and interactions among control variables. As explained in Section 5, the exact influence in terms of magnitude of the variables involved with the interactions cannot be assessed unless their marginal effects are computed with a specific marginal analysis. This latter allows us to compute meaningful marginal effects and confidence intervals with a plot that shows how the conditional marginal effect of one term on another changes across levels of the moderators. However, as shown by Hainmueller et al. (2019) ideally, to compute the marginal effect of a variable (let say Y) at a given value of the moderator, let say X_0, there needs to be enough observations whose X values are close to X_0 and variation in the key independent variable, Y, at X_0. Otherwise, it would mean that the conditional estimates of marginal effects are based on extrapolation of the functional form to an area where there is only scarce data and therefore the estimates of effects are weak (King and Zeng, 2006).[74] For these reasons we abstain from such considerations. Nevertheless, even without going into the latter dynamic and without in any way restricting the validity or the extent of our results, this estimation permits us to examine the impact of the capital-output ratio on the labor share from a more flexible empirical framework. The cubic function which we use to capture the relationship, allow the effect of the independent variable (k) on the dependent variable (the LS) to change. As the value of k increases (or decreases), the impact of the dependent variable may increase or decrease. This means that effect on the LS of a change in k depends on the value of k - i.e., the marginal effect of k is not constant. In this case, a simple linear regression would be mis-specified: the functional form would be wrong and the estimator of the effect of k on the LS would be biased. Table 11 presents our estimations of the non-linear model.

[74] Hainmueller et al., 2019 show that this error is common in empirical analysis. Typically, studies report conditional marginal effect estimates for the entire range of the moderator which often includes large intervals where there are no or very few observations.

Code	Sector name	Const	lk	t-ratio	lk^2	t-ratio	lk^3	t-ratio	f'(lk)=0	f'(k)=0
A	Agriculture, forestry and fishing	-0.684	0.263	(10.58)	0.137	(16.33)	-0.012	(-8.95)	-0.866	0.421
B	Mining and quarrying	-3.064	-0.386	(-0.94)	0.134	(5.18)	-0.012	(-3.07)	1.961	7.109
C	Manufacturing	-1.392	0.248	(9.18)	0.080	(5.32)	-0.004	(-1.31)	-1.393	0.248
D	Electricity, gas, steam and air conditioning supply	-19.490	0.017	(0.08)	0.145	(7.38)	-0.010	(-4.22)	-0.057	0.945
E	Water supply; Sewerage, waste management	-1.838	-0.063	(-0.44)	0.151	(10.01)	-0.015	(-4.71)	0.215	1.240
F	Construction	2.086	-1.541	(-12.77)	0.086	(7.22)	-0.004	(-2.04)	NA	NA
G	Wholesale and retail trade; Repair of mothor vehicles	-1.340	-0.530	(-12.65)	0.108	(5.77)	-0.010	(-2.84)	NA	NA
H	Transportation and storage	-4.206	-0.222	(-4.76)	0.068	(9.57)	0.001	(0.40)	1.588	4.892
I	Accomodation and food service activities	-1.049	-0.247	(-2.75)	0.082	(7.78)	-0.005	(-1.21)	1.764	5.835
J	Information and communication	0.200	-0.438	(-10.45)	0.064	(14.72)	-0.002	(-1.36)	4.160	64.083
K	Financial and insurance activities	-9.020	-0.056	(-0.69)	0.085	(11.28)	-0.003	(-3.46)	0.334	1.397
L	Real estate activities	-12.550	-0.847	(-5.19)	0.107	(12.23)	-0.007	(-3.33)	NA	NA
M	Professional, scientific and technical activities	-4.381	-0.199	(-2.07)	0.104	(11.89)	-0.006	(-3.01)	1.058	2.882
N	Administrative and support service activities	-2.743	-0.431	(-4.31)	0.070	(16.27)	-0.003	(-1.76)	4.334	76.263
O	Public administration and defence	-2.245	-0.186	(-1.36)	0.046	(8.04)	0.002	(0.83)	1.818	6.162
P	Education	3.299	-0.299	(-2.86)	0.097	(13.07)	-0.001	(-0.51)	1.591	4.910
Q	Human health and social work activities	1.328	0.070	(3.71)	0.038	(9.39)	0.003	(1.73)	-1.066	0.344
R	Arts, entertainment and recreation	-0.844	0.080	(1.56)	0.101	(13.26)	-0.005	(-3.01)	-0.384	0.681
S	Other service activities	-1.040	0.316	(2.31)	0.080	(10.86)	-0.001	(-0.48)	-1.896	0.150
ALL	Whole economy	-0.699	-0.124	(-9.68)	0.083	(17.02)	-0.003	(-3.14)	0.775	2.170

Table 11 - Estimation of labor share equation with interactions (non-linear hypothesis). Dependent variable: $lnLS_{it}$

Note: No. of observations: 2,297,406 (Agriculture, forestry and fishing – 65,221; Mining and quarrying – 8,759; Manufacturing – 623,899; Electricity, gas, steam and air conditioning supply – 16,529 Water supply, Sewerage, waste management – 27,550; Construction – 208,390; Wholesale and retail trade, Repair of motor vehicles – 666,532 Transportation and storage – 136,893; Accommodation and food service activities – 93,954; Information and communication – 68,363; Financial and insurance activities – 74,084; Real estate activities – 50,710; Agriculture, forestry and fishing – 75,766; Administrative and support service activities – 73,643; Public administration and defense, Compulsory social security – 13.046; Education – 34,563; Human health and social work activities – 24,803; Arts, entertainment and recreation – 20,659; Other service activities – 13,994.

Method: Panel regression with Fixed-effects (FE) model and interactions. *Note:* Fixed effect model. t-statistics based on standard errors clustered by firm in parenthesis. *Additional control variables:* year dummies; all possible interaction terms between log (TFP), markup, ΔE. *Period of estimation:* 2011-2019.

The reference model, which is the one in Bentolila and Saint-Paul (2003), here is upgraded to include a non-linear effect of the capital-output ratio, interactions and more controls. From the estimation for the 28 countries of the European Union (Tables 9 and 10), we can conclude that the main drivers of the labor share are the capital-output ratio (significant at 1% confidence levels in all the industries considered), the TFP and the markup. In addition, we can draw important considerations on how these technological/institutional factors affect the relationship of the LS with k. Either the capital-output ratio and the TFP enter the equation with a positive/negative sign, and we would take this as reflecting complementarity/sustainability between capital and labor in these industries (i.e., respectively a $|\sigma| >$ or < 1), together with a negative influence of technical change and market power on the labor share. A standard story. To this base-run model we add interaction and non-linear terms for the capital-output ratio. Notably the coincidence for k turned out to be significant for the whole economy and for many of the industries considered (all the industries at the 1% for the quadratic term and all but 6 for the cubic at 5%).[75] The estimation is conducted with a panel regression model and fixed effects. As explained in Section 5 and briefly summarized here, the influence of the variables involved in the interactions cannot be assessed nor is it relevant to the conclusions of the paper. On the other hand, the non-linear relationship between k and LS here estimated gives us new important insights on how the interacting terms for k and other factors affect the labor share in these countries. The curve for the aggregate economy is shown in Figure 16.

[75] More exactly, we found p-values <0.01 for: (A) Agriculture, forestry and fishing; (C) Manufacturing; (D) Electricity, gas, steam and air conditioning supply; (E) Water supply, sewerage and waste management; (H) Transportation and storage; (I) Accommodation and food service activities; (J) Information and communication; (K) Financial and insurance activities; (L) Real estate activities. While p-values <0.05 for (B) Mining and quarrying; (F) Construction; (G) Wholesale and retail trade; (M) Professional, scientific and technical activities; (R) Arts, entertainment and recreation.

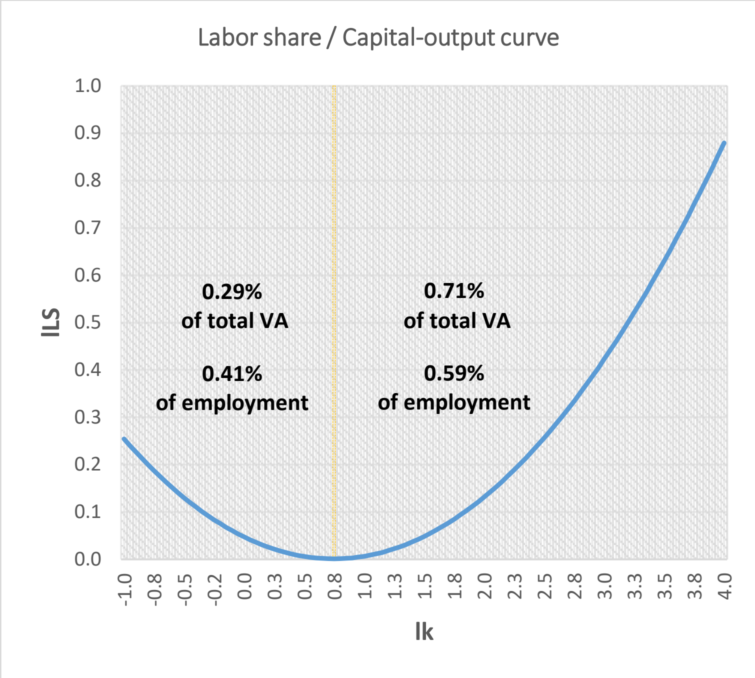


Figure 16 - The labor share/capital-output curve for the aggregate economy.

Source: Authors' calculation on AMADEUS data.

Now the effect k on the LS is no more constant, nor it is the elasticity of substitution. Even if we do not assume that capital per unit of output and σ_{KL} are linked together through any specific functional form, this eventuality is consistent with all the literature on endogenous (and variable) elasticity of factor substitution. In the VES frameworks the elasticity of factor substitution interacts with the level of economic activity, and from this perspective we can actually say that the literature which provides empirical validity to the usefulness of VES production technology predates a lot from the recent growth in the research on labor income shares.[76] Just to mention a few of these works, for instance, Revankar (1972) assumed that σ_{KL} varies with the capital-output ratio around the intercept term of unity; Duffy and Papageorgiou (2000) show that σ_{KL} increases as the economy grows; Miyagawa and Papageorgiou (2007) built a static model where σ_{KL} in each period is endogenously determined by the existing endowments of capital and labor and their sectoral allocation.[77] Here we are able to reconcile all these different findings of the literature and shed

[76] The standard CES production function assumes: (i) the existence of a relationship between the value added per unit of work and the wage rate independent of changes in capital stock; and (ii) the elasticity of substitution between input factors as a constant (though not unitary) along the isoquant. However, both assumptions appear unrealistic in the presence of an upward trend in the capital-labor ratio, as documented by many studies. (Acemoglu and Guerrieri 2008).

[77] Most of the studies (Sato and Hoffman, 1968; Meyer and Kadiwala, 1974; Kazi, 1980) reject CD and CES model specifications in favor of the VES. On the other hand, Lovell (1973), Tsang (1976) and Zellner and Ryu (1998) provide evidence that in certain industries the CES model perform better compared to VES.

more light on the connections between these two different strands. More specifically, the elasticity of substitution is lower than one in the first part of the curve (i.e., capital and labor are gross complements for low levels of k) and hence an increase in k contributes to a decrease in the labor share. Then the curve reaches a minimum, which we estimate for $\frac{\partial lnLS}{\partial lnk} = 0$, corresponding roughly to a $lk = 0{,}77$ or $k = 2.17$. In this point, and only in this point the labor share is perfectly independent of the capital-output ratio (i.e., the Cobb-Douglass case). On the other hand, for higher levels of the capital-output ratio (i.e., capital and labor are gross substitutes for high levels of k) the elasticity of substitution becomes greater than one and a higher capital intensity has a negative effect on the labor share as the capital price goes down. This is known as "accumulation view." This classification suggests a consistent and statistically significant role that capital-output ratio plays in explaining the variation of the LS over time and across sectors, but even more so suggests that more careful attention must be paid in the modeling choice.

What is more interesting to note from our point of view is that despite the predominance of the economy is operating on the right side of the curve, a significant proportion of firms is on the left side. Indeed, within our sample we have that the share of the latter amounts to 29.5% of the Value Added and as much as 41% of the total Employment which is equal to roughly 37% of the firms in the sample. Further these shares turn out to be even more relevant in some sectors of the economy, i.e., Education (82.38%); Human health and social work activities (78.09%); Public administration and defense (72.53%); Administrative and support service activities (69.97%); Other service activities (62.56%); Accommodation and food service activities (61.61%); Arts, entertainment and recreation (55.09%). Even if the latter industries account for only 7.80% of the total value added in the economy, firms with low levels of capital intensity have not negligible shares and are also present in the biggest industries since they constitute roughly 23.45% of the total observations in Manufacturing, 24.82% in Real estate activities and 19.70% in Financial and insurance activities.

On average (Table 12 and Figure 17), firms on the left side of the curve, are characterized by an average capital-output ratio of roughly 1.39 have, as expected, higher labor shares (0.76), lower TFPs (4.00), lower labor productivities (0.61), lower markups (1.38) and a lower size in terms of value added per employee (48.80). On the other hand, firms on the right side of the curve are characterized by an average capital-output ratio of roughly 4.76 and have, as expected, lower labor shares (0.55), higher TFPs (4.11), higher labor productivities (0.88), higher markups (1.62) and a higher value added per employee (80.77).

Firms with lk<0.77							
Code	k	LS	tfp	m	LP	E	VA
A	1.58	0.66	2.74	1.02	0.47	46.81	1465.42
B	1.48	0.42	4.3	1.31	0.88	77.65	8132.23
C	1.63	0.67	3.78	1.39	0.72	111.28	6533.79
D	1.65	0.39	5.48	1.25	0.98	116.64	15000.00
E	1.43	0.75	4.17	1.23	0.47	131.07	5462.04
F	1.44	0.82	3.75	1.3	0.56	50.15	2571.10
G	1.6	0.71	3.74	1.51	0.64	82.11	4128.69
H	1.39	0.8	3.45	1.49	0.52	139.97	6269.76
I	1.22	0.83	3.68	1.41	0.32	107.2	2962.97
J	1.34	0.73	3.31	1.29	0.8	147.25	11200.00
K	1.37	0.76	4.67	1.3	0.64	753.38	32100.00
L	1.43	0.78	4.92	1.54	0.64	673.81	39700.00
M	1.29	0.79	4.2	1.33	0.68	136.03	7402.40
N	0.78	0.9	4.03	1.36	0.35	320.63	9209.65
O	1	0.88	4.55	1.06	0.44	72.73	2852.21
P	1.32	0.88	4.29	1.01	0.52	271.65	13000.00
Q	1.01	0.91	1.42	1.1	0.34	177.42	5600.62
R	1.28	0.69	3.28	1.45	0.67	68.55	4667.28
S	1.24	0.81	3.67	1.34	0.54	142.21	6567.37
Total	1.39	0.76	4	1.38	0.61	153.47	7489.25

Firms with lk>0.77							
Code	k	LS	tfp	m	LP	E	VA
A	5	0.52	2.57	1.25	0.62	34.92	1400.28
B	4.84	0.42	3.23	1.58	0.92	119.46	12200.00
C	4.39	0.58	3.56	1.57	0.96	129.38	10800.00
D	7.04	0.35	4.51	1.78	1.33	283.79	52600.00
E	5.69	0.57	4.5	1.59	0.77	126.94	8288.02
F	5.04	0.69	3.64	1.43	0.67	43.75	2342.64
G	4.6	0.65	3.94	1.55	0.68	48.45	2537.33
H	5.68	0.61	3.63	1.57	0.75	129.24	9295.41
I	4.95	0.6	3.81	1.47	0.5	52.41	2010.87
J	4.04	0.46	4.2	1.72	1.21	193.95	27300.00
K	5.38	0.49	4.5	1.52	0.87	225.37	20200.00
L	4.43	0.57	4.71	1.86	0.84	1337.87	113000.00
M	4.05	0.53	4.29	1.46	0.93	96.74	9131.11
N	4.37	0.6	4.22	1.62	0.78	112.56	7888.77
O	3.84	0.77	4.58	1.16	0.5	67.19	2326.77
P	3.3	0.75	4.29	1.02	0.54	110.73	5133.76
Q	3.65	0.75	1.61	1.31	0.44	147.51	5807.76
R	4.27	0.58	3.27	1.53	0.72	55.64	3348.54
S	4.51	0.65	3.78	1.5	0.75	98.95	6156.7
Total	4.76	0.55	4.11	1.62	0.88	116.8	9434.37

All							
Code	k	LS	tfp	m	LP	E	VA
A	4.48	0.54	2.59	1.21	0.6	36.71	1410.09
B	4.54	0.42	3.33	1.53	0.91	112.79	11600.00
C	3.78	0.60	3.61	1.53	0.91	123.3	9357.39
D	6.99	0.35	4.52	1.77	1.33	276.07	50900.00
E	4.76	0.61	4.43	1.5	0.71	128.22	7411.80
F	3.58	0.74	3.68	1.38	0.62	46.25	2431.75
G	3.74	0.67	3.88	1.54	0.67	55.33	2862.51
H	3.76	0.69	3.55	1.53	0.64	134.77	7735.10
I	2.69	0.74	3.74	1.43	0.39	80.97	2507.24
J	3.03	0.56	3.87	1.49	0.97	165.55	17500.00
K	4.63	0.54	4.53	1.47	0.82	295.98	21800.00
L	3.7	0.62	4.77	1.76	0.79	1016.58	77400.00
M	2.89	0.64	4.25	1.39	0.82	115.79	8292.74
N	1.81	0.81	4.09	1.43	0.47	251.17	8768.69
O	1.76	0.85	4.56	1.09	0.45	70.97	2685.59
P	1.67	0.85	4.29	1.02	0.52	215.24	10200.00
Q	1.58	0.88	1.46	1.15	0.36	171.05	5644.73
R	2.68	0.64	3.27	1.49	0.69	61.68	3965.88
S	2.42	0.75	3.71	1.39	0.61	125.35	6407.36
Total	3.8	0.61	4.08	1.54	0.8	129.48	8761.65

Table 12 - Summary statistics (labor share, TFP, markup, labor productivity and VA) by sector and for lk > or < 0.77.

Source: Authors' calculation on AMADEUS data.

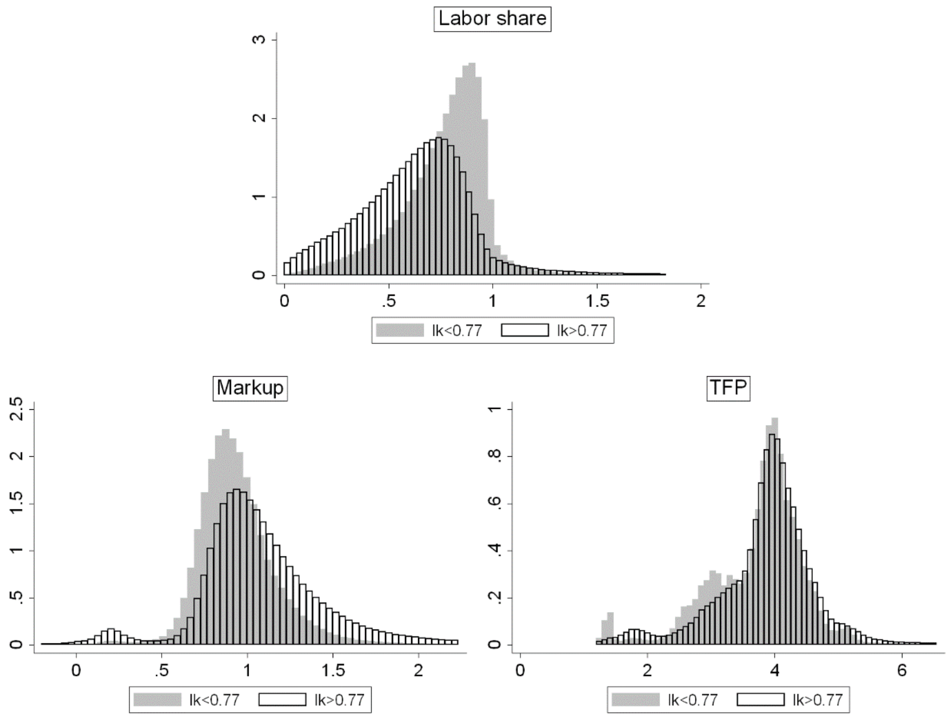


Figure 17 - Distribution of the labor share, markup and TFP for the aggregate economy (lk > or < 0.77).

Source: Authors' calculation on AMADEUS data.

If we look at different industries within their relevant range for lk (as calculated in Table A12) we have also a lot of heterogeneity in the behavior of the curves. The logarithm of capital-output ranges from a lower bound of -1.77 (i.e. a capital-output ratio of 0.17) in the Public administration and in general values below -1.30 in services (Human health and social work activities; Administrative and support service activities; Other service activities; Arts, entertainment and Education) to values above -0.60 (i.e. a capital-output ratio of 0.54) in Manufacturing; Water supply, sewerage and waste management; Agriculture, forestry and fishing; Wholesale, retail trade and repair of motor vehicles; Mining and quarrying; Electricity, gas, steam and air conditioning supply. The standard deviation is lower for the upper bounds which on the other hand can be as low as 2.3/2.5 (i.e., a k of roughly 12) in services and as high as 2.70/2.75 (i.e., a k of roughly 15) in Construction; Mining and quarrying; Agriculture, forestry and fishing; Electricity, gas, steam and air conditioning supply.

Indeed, what we observe at an aggregate level (Figure 18) is the result of specific firm and sectoral behaviors that - even if with some similarities - behave in very different ways (Figure A9 in Appendix A).

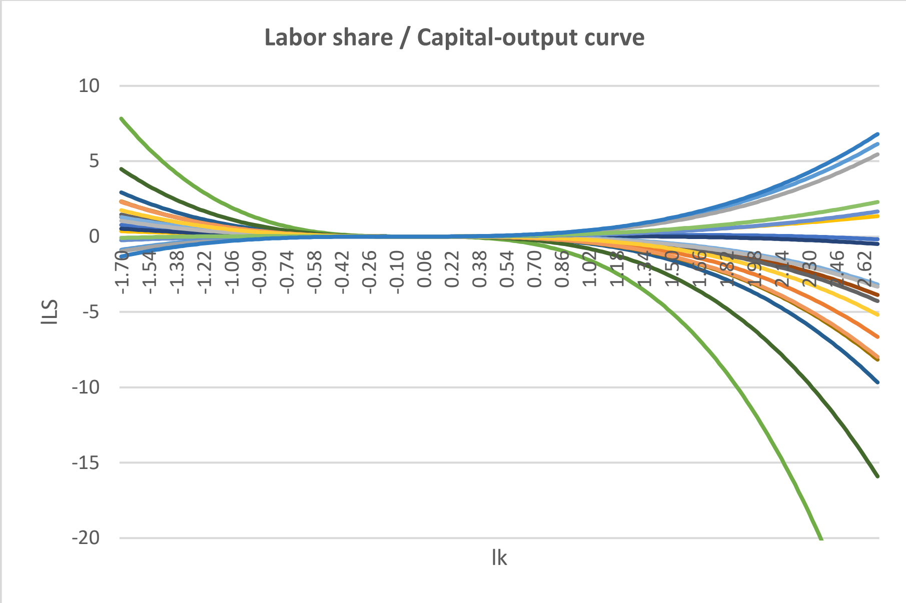


Figure 18 - The labor share/capital-output curve by industry.

Source: Authors' calculation on AMADEUS data.

From an aggregate perspective, Figure 18 show us that while in some sectors the relationship between the labor share and the capital-output ratio is monotonically decreasing in k - meaning that an increase in k always reduce the labor share and σ is higher than 1 - such as (G) Wholesale retail trade, (H) Transportation and storage, (J) Information and communication; in others, the same relationship it is strictly increasing in k - meaning that an increase in k always raise the labor share and hence σ is lower than 1 - (C) Manufacturing; (D) Electricity, gas and steam. Finally, there are some sectors, namely (E) Water supply, sewerage, waste management and (K) Financial and insurance activities which are neither characterized by a monotonically decreasing nor increasing relationship. And it is precisely this difference in the dynamics of various industries - which can eventually be traced down to micro-elasticities - that overall characterizes the complex behavior observed in the economy. In addition, such a classification would also be a simplification, since not in all industries the ascent/descent path along the curve takes place at the same speed. Finally, it is worth nothing that in all the cases for intermediate k-values, the curve is virtually flat and the upward pressures on the LS starts only behind a certain threshold. Indeed, for the range of lk which goes from -0.30 (i.e., a k of roughly 0.74) to 0.32 (i.e., a k of roughly 1.37) increases in k do not increase nor decrease the LS (with changes below 1%).

7. Conclusions and further research

The structural decline of the labor share is now a generally accepted phenomenon. Rapid technological progress (Bassanini and Manfredi, 2012), the globalization of trade and capital (Guscina, 2006; Elsby et al., 2013), product and labor market institutions (Azmat et al., 2012), market concentration (Autor et al., 2020), the bargaining power of labor and unemployment have all been proposed as key factors for this fall. The crucial parameter through which the effects on the labor share operates is the elasticity of substitution between capital and labor (Bentolila and Saint-Paul, 2003). In this paper we propose a reassessment of the role played by these driving forces in a more flexible empirical framework than the one usually followed by the literature. We start by challenging the results obtained by Bentolila and Saint-Paul (2003) who claim and demonstrate the existence of a one-for-one relationship between the labor share and the capital-output ratio, the so-called share-capital schedule. First, we replicate their estimated models with firm level data to create partially comparable estimates and correctly identify shift factors. At this purpose, to test the performance of the model empirically, we employed data on a panel of 19 industries in 28 European countries, over the period 2011-2019 and estimate the relationship between the labor share and the capital-output ratio while controlling for variables intended to capture some of the factors mentioned above. Our focus is mainly focus is on TFP and Markup. We found that for what concerns factors which can shifts the $LS - k$ curve and cause deviations from it, TPF plays a major role, while deviations from marginal cost pricing such as changes in markups, labor adjustment costs, and changes in workers' bargaining power are in a certain sense less important for the aggregate economy. However, it is always worth remembering that a great heterogeneity is present in the data, and so we found Markups to be very important in services (Human health and social work activities; Accommodation and food service activities; Other service activities), but also Construction and Water supply, sewerage and waste management.

We also uncover several issues that may increase the extent their findings for what concerns the behavior of the LS along the $LS - k$ curve. This is the reason why we conduct the same analysis with critical changes in the empirical methodology. First, we use first level observations; second, we introduce cross-section effects; but more importantly we estimate the model with multiplicative interaction and a non-linear term for k. We find a significant relationship between the two key variables, i.e., evidence of nonlinear movements along the schedule. These changes cause the capital-output ratio to cease being a critical driving force of the labor share which operates in just one direction and gives life to a flexible framework that consistently with the data makes the effects of k on the LS depending on the range of k in which a firm is operating. This finding is very important and supports the increasing number of studies that have recently introduced into distribution theory variable elasticity of substitution (VES) framework as an alternative to the CES model to analyze movements in the labor income share and their connection with the elasticity of substitution. Movements along the curve capture changes in factor prices such as wage pushes and changes in real interest rates, as well as the contribution of labor-augmenting technical progress. We found that for low levels of the capital-output ratio firms usually have higher labor shares, and the elasticity of substitution is greater than 1, meaning that an increase in k lead to a decrease of the LS. On the other hand, when k is above a certain threshold and firms have usually lower labor share, the pressures exerted by an increase in k on the labor share is upward. The simple framework presented here then aggregates sector and the overall impact can be traced down to micro-elasticities, as they propagate through the structure of the economy. Therefore, beyond this result, we also uncover relevant differences in the determinants of the labor share at the industry level. In our baseline model, all the firms have only two factors of productions. Hence, further research should be primarily aimed at disaggregating these results for different types of labor (i.e., skilled/non-skilled) and different types of capital (i.e., tangible and intangible) - since this last distinction would be expected to originate different degrees of factor substitution and therefore affect the relationship. Another interesting experiment might also involve a more in-depth investigation of the role of public capital. Indeed, a lot of studies found evidence against perfect substitutability between public and private capital, and different types of public capital are known to have varying degrees of contributions to economic growth, especially in different stages of economic development (An et al., 2019). In order to do this, we might introduce in the model some forms of interaction between private and public capital that have been recognized by the literature as extremely important (Bucci and Del Bo, 2012). Given available data, these analyses are only feasible for a small number of OECD economies, which is therefore the natural next step of this research.

Appendix A: additional charts and tables

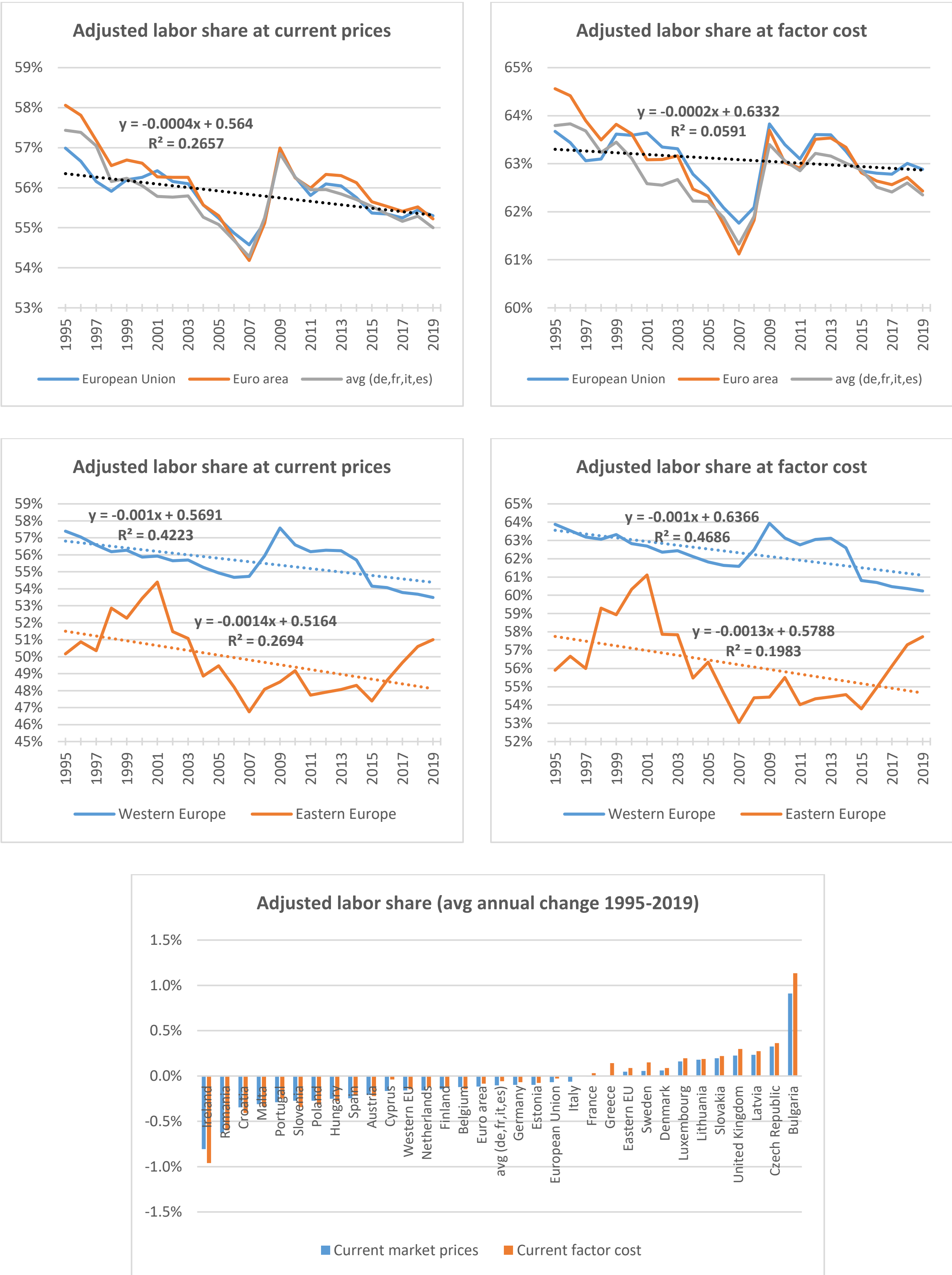
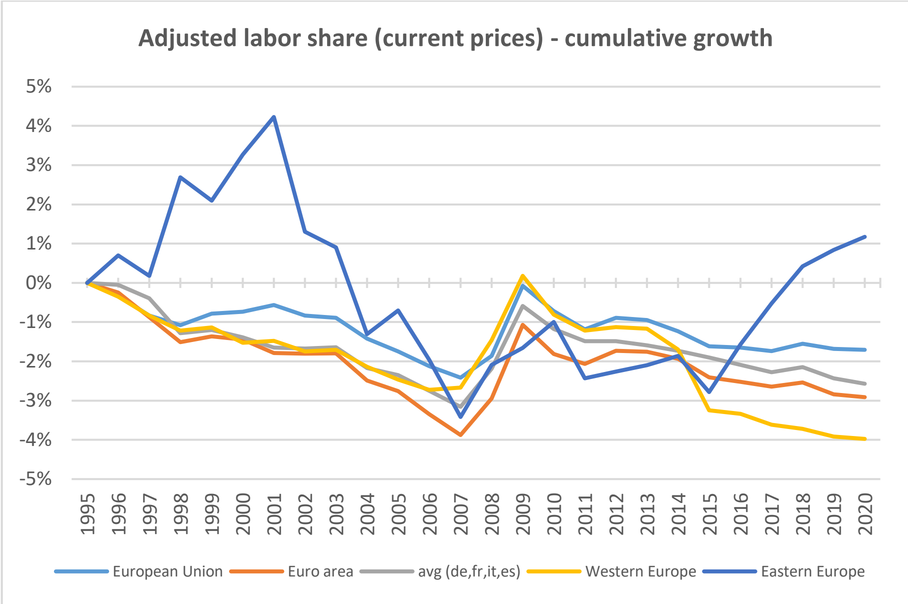


Figure A1 - Labor share at current market prices and factor cost in the EU28. *Source:* Authors' calculation on AMECO.



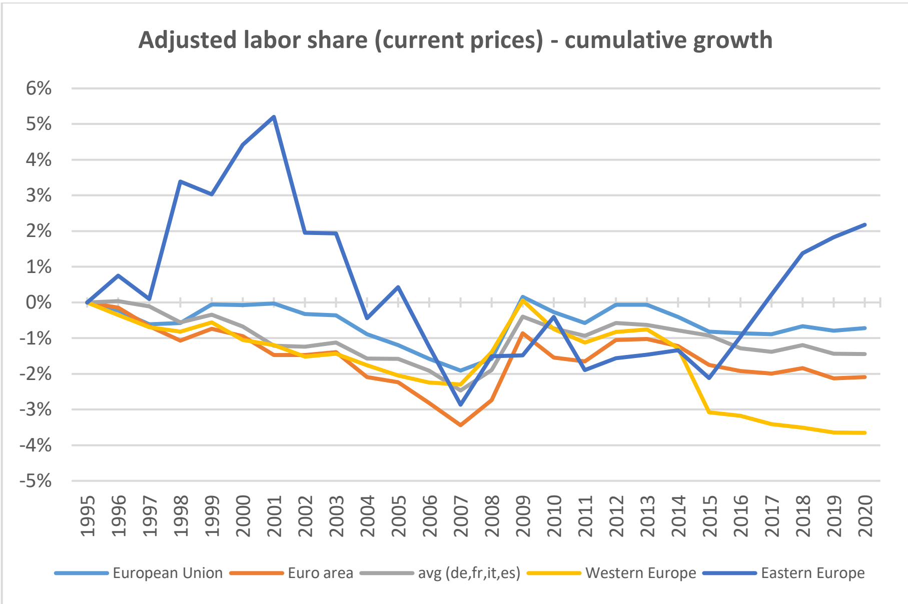


Figure A2 - The labor share at current market prices and current factor cost in the EU28 (cumulative growth).

Note: The fall of the labor share has affected both developing and developed countries of the EU. However, recently (in the last 5 years) while developing countries have recovered, developed countries have continued to decline. When measured at factor cost, the labor share declines from an average of 64 per cent to 61 per cent in the European Union. *Source:* Authors' calculation on AMECO data.

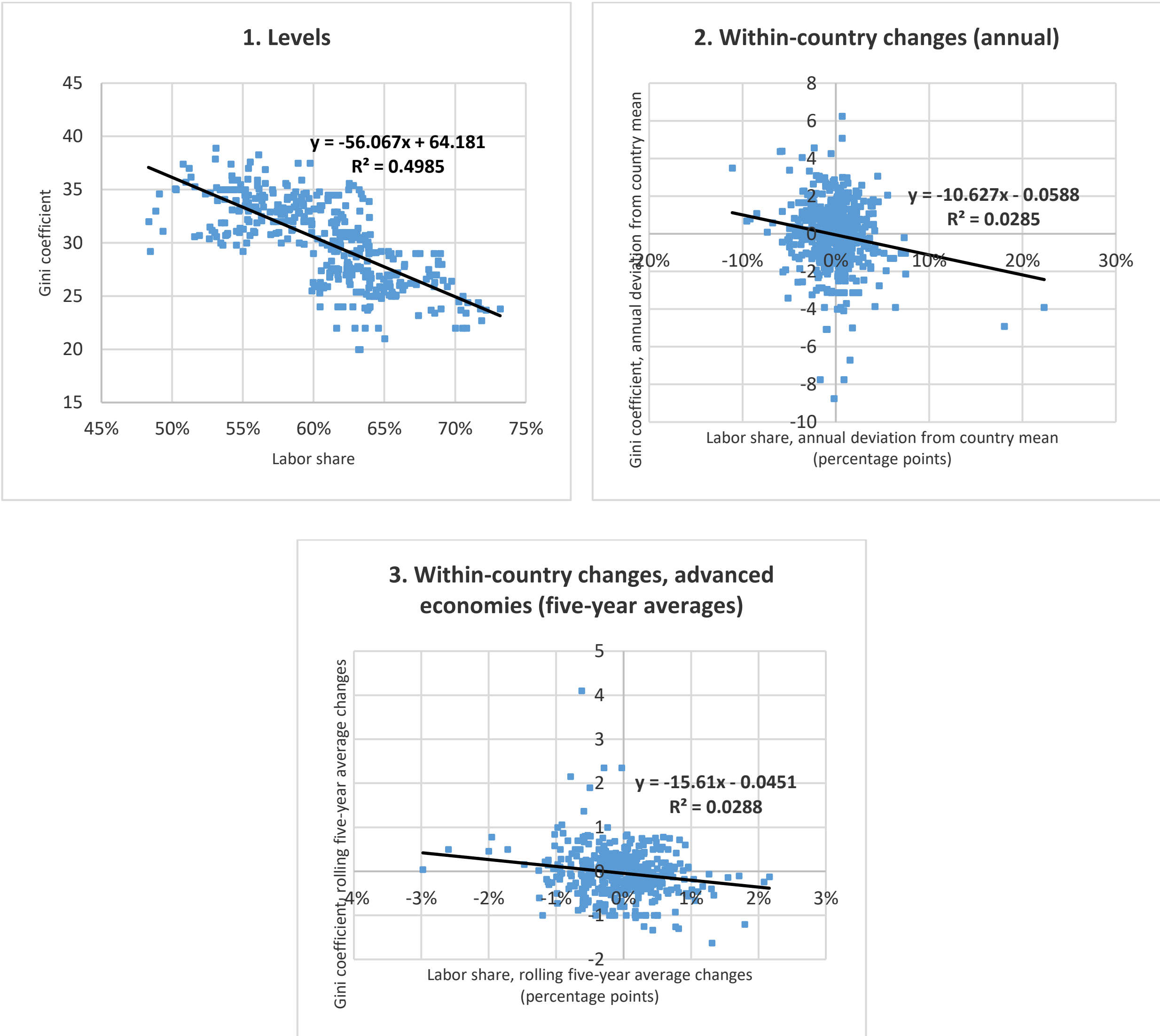


Figure A3 - Labor shares and income inequality.

Note: Lower labor shares are associated with higher income inequality (measured by Gini coefficients) both across countries and over time within countries. *Source:* Authors' calculation on AMECO and OECD data.

Industry	Within sectors	Between sectors	Total change
Ireland	-0.53%	-0.54%	-1.07%
Romania	0.02%	-0.62%	-0.60%
Slovenia	-0.34%	-0.16%	-0.50%
Croatia	-0.46%	0.02%	-0.44%
Poland	-0.08%	-0.31%	-0.40%
Hungary	-0.28%	-0.03%	-0.31%
Portugal	-0.10%	-0.14%	-0.24%
Austria	-0.07%	-0.09%	-0.17%
Spain	-0.08%	-0.08%	-0.16%
Finland	-0.15%	0.00%	-0.15%
Cyprus	-0.01%	-0.12%	-0.13%
Netherlands	-0.22%	0.10%	-0.12%
Belgium	-0.18%	0.08%	-0.10%
EA19	-0.02%	-0.06%	-0.08%
EU28	0.00%	-0.07%	-0.07%
Germany	-0.04%	-0.01%	-0.05%
Italy	0.06%	-0.10%	-0.05%
Denmark	-0.03%	0.02%	-0.01%
Estonia	0.04%	-0.01%	0.03%
France	0.09%	-0.04%	0.05%
Sweden	-0.06%	0.12%	0.05%
Luxembourg	0.06%	0.06%	0.11%
Slovakia	0.06%	0.09%	0.14%
United Kingdom	0.10%	0.11%	0.21%
Czechia	0.29%	-0.07%	0.22%
Lithuania	0.33%	-0.10%	0.23%
Greece	0.34%	-0.10%	0.24%
Latvia	0.42%	-0.16%	0.26%
Bulgaria	0.84%	0.23%	1.07%
Mean	0.0001%	-0.0692%	-0.0691%
Standard Deviation	0.0027	0.0018	0.0036

Table A1 - Shift-share decomposition of the labor share, breaking down between and within-industry effects.

Note: 1995-2019. *Source:* Authors' calculation on AMADEUS data.

Code	Industry	Within firms	Between firms	Total change
D	Electricity, gas, steam and air conditioning supply	-1.74%	1.40%	-0.35%
J	Information and communication	-0.20%	0.12%	-0.08%
R	Arts, entertainment and recreation	-0.14%	-0.30%	-0.44%
N	Administrative and support service activities	-0.02%	0.08%	0.06%
E	Water supply; Sewerage, waste management	-0.02%	0.42%	0.40%
A	Agriculture, forestry and fishing	-0.02%	0.23%	0.21%
I	Accomodation and food service activities	-0.01%	-0.10%	-0.11%
O	Public administration and defence	-0.01%	-0.09%	-0.10%
P	Education	-0.01%	-0.22%	-0.23%
C	Manufacturing	-0.01%	-0.01%	-0.01%
B	Mining and quarrying	0.00%	-0.30%	-0.30%
S	Other service activities	0.01%	0.00%	0.02%
L	Real estate activities	0.02%	0.04%	0.06%
F	Construction	0.03%	-0.11%	-0.08%
H	Transportation and storage	0.03%	0.14%	0.17%
K	Financial and insurance activities	0.03%	-0.39%	-0.36%
M	Professional, scientific and technical activities	0.11%	-0.25%	-0.14%
Q	Human health and social work activities	0.29%	-0.03%	0.26%
G	Wholesale and retail trade; Repair of mothor vehicles	0.71%	-0.84%	-0.13%
Mean		-0.05%	-0.01%	-0.06%
Standard Deviation		0.005	0.004	0.002

Table A2 - Shift-share decomposition of the labor share at the firm-level (2011-2019).

Source: Authors’ calculation on AMADEUS data.

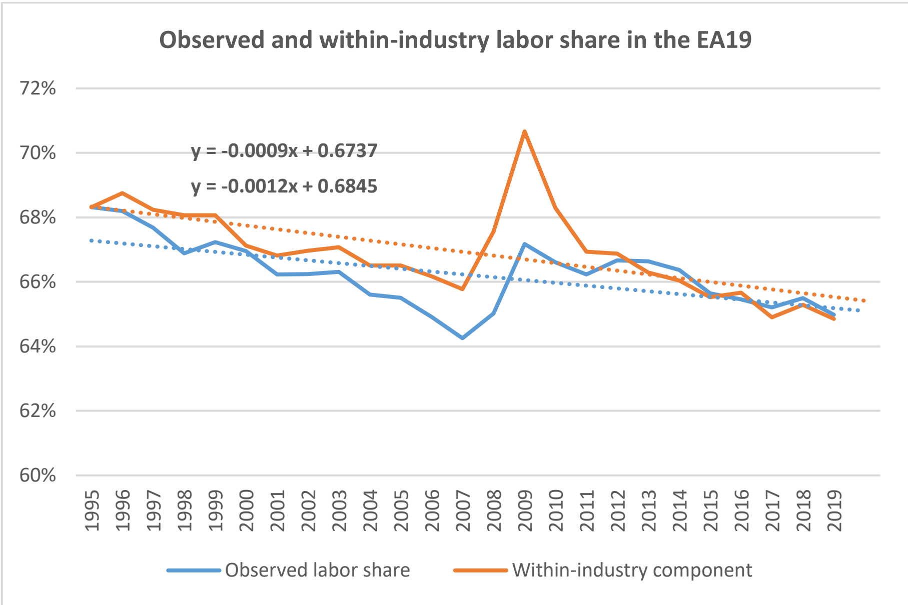


Figure A4 - Observed and within-industry aggregate labor income share in the Euro Area (EA).

Note: 1995-2019. *Source:* Authors' calculation on AMECO and OECD data.

f	AT	BE	DE	DK	ES	FR	IE	IT	PL	SE	Total
A	2.146	2.479	2.684	3.408	2.450	2.817	2.145	2.135	2.547	4.157	2.593
B	4.753	4.225	3.873	1.654	4.210	3.182	4.271	4.368	4.354	4.421	3.333
C	4.064	4.469	2.978	4.074	4.123	3.822	4.547	4.122	4.081	4.233	3.611
D	5.027	5.142	4.920	5.275	5.679	3.520	5.229	5.228	5.231	5.318	4.523
E	4.464	4.747	4.681	4.337	3.798	4.337	4.429	4.680	4.885	4.315	4.431
F	3.315	3.766	3.296	3.512	3.447	3.751	3.927	3.800	4.104	3.783	3.679
G	3.992	4.104	3.696	3.688	3.871	3.801	3.855	3.903	4.135	4.184	3.884
H	3.763	3.716	3.434	3.791	3.447	3.613	4.514	3.475	3.494	3.742	3.550
I	3.966	3.866	3.699	3.921	3.749	3.798	3.961	3.583	4.102	3.914	3.741
J	4.646	4.024	3.363	3.938	4.288	4.018	3.826	3.887	4.413	3.794	3.868
K	4.603	5.120	4.880	4.366	4.539	3.914	4.427	4.857	5.473	5.083	4.533
L	5.110	5.348	4.820	4.969	5.084	4.464	4.654	5.095	5.050	5.132	4.765
M	4.371	4.657	4.311	4.073	4.493	3.809	4.712	4.637	4.422	4.583	4.251
N	4.176	4.319	4.079	4.611	3.765	4.111	4.415	4.134	4.234	4.125	4.087
O	4.724	4.689	4.574	4.852	4.572	4.642	4.755	4.456	4.501	4.645	4.557
P	4.264	4.741	4.257	4.466	4.346	4.424	4.410	4.304	4.216	4.417	4.289
Q	1.263	1.422	1.447	1.855	1.444	1.598	1.394	1.518	1.328	1.473	1.474
R	2.736	3.882	3.116	3.715	3.170	3.126	3.567	3.342	3.006	3.644	3.274
S	3.815	3.777	3.659	4.353	3.838	3.626	3.832	3.686	3.940	4.264	3.713
Total	4.441	4.389	3.780	4.137	4.238	4.039	4.513	4.236	4.210	4.539	4.077

Table A3 - Descriptive statistics of the TFP by industry and country.

Note: relevant period 2011-2019. TFP: Total Factor Productivity (index). Translog specification. N. of observations by industry are reported in table A13 - Appendix C. *Source:* Author’s calculation on AMADEUS data.

f	AT	BE	DE	DK	ES	FR	IE	IT	PL	SE	Total
A	1.512	1.193	1.156	1.109	1.199	1.182	1.050	1.070	1.430	1.599	1.208
B	1.239	1.750	1.849	1.736	1.345	1.569	1.341	1.296	1.510	1.600	1.526
C	1.564	1.483	1.697	1.588	1.368	1.403	1.625	1.399	1.555	1.404	1.528
D	1.742	1.816	1.742	1.600	1.678	2.019	1.541	1.661	1.274	1.793	1.769
E	1.583	1.615	1.692	1.280	1.527	1.507	1.544	1.419	1.363	1.604	1.497
F	1.574	1.449	1.612	1.525	1.352	1.321	1.591	1.302	1.416	1.423	1.375
G	1.619	1.573	1.702	1.728	1.478	1.524	1.713	1.459	1.551	1.534	1.538
H	1.767	1.375	1.849	1.325	1.295	1.480	1.525	1.451	1.447	1.375	1.528
I	1.420	1.309	1.440	1.241	1.408	1.729	1.431	1.262	1.436	1.404	1.434
J	1.263	1.328	1.670	1.480	1.240	1.634	1.599	1.350	1.184	1.282	1.487
K	1.420	1.415	1.323	1.439	1.567	1.640	1.510	1.439	0.846	1.245	1.466
L	1.845	1.428	1.733	1.579	1.553	1.954	1.835	1.597	1.000	1.399	1.759
M	1.181	1.381	1.528	1.391	1.233	1.452	1.351	1.276	1.250	1.301	1.393
N	1.326	1.388	1.607	1.549	1.425	1.409	1.650	1.310	1.129	1.391	1.425
O	0.961	1.045	1.185	1.315	1.049	1.064	1.094	0.947	1.280	1.150	1.086
P	1.059	1.357	1.018	0.945	0.990	0.946	1.108	1.012	0.892	1.134	1.016
Q	1.074	1.118	1.107	1.665	1.139	1.305	1.399	1.059	1.107	1.216	1.150
R	1.889	1.532	1.574	1.663	1.466	1.410	1.594	1.441	1.608	1.588	1.489
S	1.542	1.415	1.409	1.401	1.400	1.425	1.558	1.306	1.281	1.161	1.391
Total	1.624	1.467	1.636	1.518	1.414	1.663	1.746	1.413	1.424	1.385	1.539

Table A4 - Descriptive statistics of Markups by industry and country.

Note: 2011-2019. Translog specification. N. of observations by industry are reported in Table A13 - Appendix C.

Source: Author’s calculation on AMADEUS data.

	Labor share (LS)									Capital-output ratio (k)								
Percentiles	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1%	0.073	0.074	0.070	0.071	0.067	0.068	0.069	0.071	0.068	0.382	0.388	0.385	0.380	0.377	0.374	0.363	0.352	0.355
5%	0.209	0.211	0.211	0.210	0.206	0.209	0.208	0.210	0.208	0.737	0.753	0.747	0.734	0.723	0.715	0.703	0.682	0.685
10%	0.317	0.326	0.325	0.322	0.317	0.319	0.317	0.318	0.317	1.025	1.053	1.046	1.023	1.004	0.999	0.990	0.967	0.967
25%	0.513	0.525	0.527	0.522	0.516	0.516	0.514	0.513	0.513	1.706	1.750	1.742	1.694	1.656	1.661	1.655	1.631	1.618
50%	0.699	0.711	0.713	0.710	0.704	0.703	0.703	0.703	0.703	2.898	2.991	2.975	2.876	2.798	2.796	2.781	2.747	2.712
75%	0.840	0.849	0.849	0.847	0.843	0.843	0.844	0.845	0.844	4.919	5.074	5.064	4.907	4.777	4.736	4.701	4.643	4.590
90%	0.940	0.949	0.948	0.943	0.938	0.938	0.938	0.939	0.936	7.949	8.170	8.197	8.002	7.808	7.755	7.694	7.607	7.561
95%	1.013	1.037	1.029	1.010	0.995	0.992	0.992	0.993	0.981	10.388	10.634	10.632	10.438	10.255	10.227	10.145	10.073	10.025
99%	1.377	1.421	1.412	1.384	1.352	1.348	1.336	1.347	1.326	14.498	14.569	14.572	14.476	14.407	14.399	14.416	14.370	14.343
Mean	0.615	0.604	0.614	0.611	0.623	0.615	0.611	0.604	0.598	3.847	3.875	3.904	3.823	3.812	3.756	3.686	3.818	3.949
Smallest	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.667	-2.699	-5.048	-7.008	-7.112	-6.601	-8.884	-5.750	-6.227
Largest	1.832	1.832	1.832	1.832	1.832	1.832	1.832	1.832	1.832	16.296	16.296	16.296	16.297	16.297	16.296	16.296	16.297	16.298
Stdandard Deviation	0.256	0.248	0.247	0.236	0.228	0.228	0.231	0.239	0.247	2.552	2.558	2.644	2.492	2.657	2.639	2.547	2.520	2.450

Table A5 - Labor share and capital-output ratio's percentiles by year.

Note: 2011-2019. *Source:* Authors' calculation on AMADEUS data.

	Labor share (weighted avg)									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change (%)
Small	60.72%	59.72%	61.01%	60.74%	60.23%	59.77%	59.11%	59.74%	59.37%	-1.35%
Medium	65.26%	64.88%	65.17%	64.37%	64.28%	64.52%	63.50%	63.85%	63.47%	-1.79%
Big	60.70%	59.85%	60.90%	60.67%	62.29%	61.24%	60.98%	59.91%	60.96%	0.26%
Standard Deviation	0.026	0.030	0.024	0.021	0.020	0.024	0.022	0.023	0.021	0.011
Total (weighted avg)	62.23%	61.48%	62.36%	61.93%	62.27%	61.84%	61.20%	61.17%	61.27%	-0.96%
	sVA (share in value-added)									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change (%)
Small	7.47%	8.33%	8.41%	8.11%	7.98%	7.89%	7.99%	8.56%	8.32%	0.85%
Medium	11.44%	11.29%	11.60%	11.42%	11.65%	11.94%	12.26%	12.33%	12.40%	0.96%
Big	81.10%	80.39%	80.00%	80.46%	80.37%	80.17%	79.76%	79.11%	79.28%	-1.82%

Table A6 - Labor shares and shares of value-added by year and firm size.

Note: 2011-2019. *Source:* Authors' calculation on AMADEUS data.

	Labor share (weighted avg)									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change (%)
LP	82.22%	83.39%	79.28%	78.81%	78.38%	75.99%	79.45%	85.95%	80.92%	-1.30%
MP	68.75%	67.42%	69.31%	68.49%	68.23%	67.26%	67.37%	67.10%	67.02%	-1.73%
HP	29.38%	30.21%	30.62%	31.22%	33.59%	35.69%	34.50%	34.27%	34.04%	4.66%
Standard Deviation	0.2745	0.2729	0.2570	0.2503	0.2348	0.2120	0.2326	0.2615	0.2408	0.0357
Total (weighted avg)	60.12%	60.34%	59.74%	59.51%	60.07%	59.65%	60.44%	62.44%	60.66%	0.54%
	sVA (share in value-added)									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change (%)
LP	0.32%	0.33%	0.33%	0.30%	0.28%	0.33%	0.29%	0.37%	0.33%	0.01%
MP	80.47%	80.50%	79.87%	79.70%	79.32%	79.17%	79.01%	78.07%	78.08%	-2.39%
HP	19.21%	19.17%	19.80%	20.00%	20.40%	20.50%	20.70%	21.56%	21.59%	2.38%

Table A7 - Labor share and share of value-added by year and productivity class.

Note: 2011-2019. *Source:* Authors' calculation on AMADEUS data.

Code	Sector name	log(k)	log(TFP)	Markup	ΔE	N. obs
A	Agriculture, forestry and fishing	-0.006 (-2.45)	-0.080 (-11.55)	-0.093 (-139.27)	-0.021 (-1.81)	73,941
B	Mining and quarrying	0.128 (20.48)	0.372 (4.77)	-0.323 (-52.75)	0.012 (0.42)	9,925
C	Manufacturing	0.006 (9.01)	0.052 (30.02)	-0.484 (-372.29)	-0.006 (-2.16)	662,015
D	Electricity, gas, steam and air conditioning supply	-0.017 (-1.35)	-0.322 (-4.09)	0.000 (14.49)	-0.007 (-0.16)	18,276
E	Water supply; Sewerage, waste management	-0.027 (-7.90)	0.970 (31.90)	-0.568 (-100.84)	-0.012 (-0.41)	29,365
F	Construction	-0.057 (-59.27)	1.953 (113.68)	-0.619 (-240.32)	0.015 (3.44)	238,267
G	Wholesale and retail trade; Repair of motor vehicles	-0.048 (-64.13)	-0.163 (-34.39)	-0.271 (-220.16)	0.013 (4.48)	719,367
H	Transportation and storage	-0.114 (-86.99)	0.154 (21.51)	-0.239 (-103.96)	0.017 (3.58)	146,307
I	Accomodation and food service activities	0.030 (21.73)	1.529 (79.67)	-0.807 (-181.70)	-0.016 (-0.68)	105,435
J	Information and communication	-0.074 (-37.46)	-0.323 (-49.41)	-0.174 (-78.53)	-0.007 (-0.98)	74,619
K	Financial and insurance activities	-0.182 (-64.47)	0.766 (40.37)	0.002 (72.99)	0.017 (1.00)	112,630
L	Real estate activities	-0.117 (-58.08)	1.250 (47.50)	-0.306 (-80.89)	0.008 (1.07)	56,387
M	Professional, scientific and technical activities	-0.154 (-65.35)	-0.558 (-46.35)	-0.001 (-22.51)	0.024 (2.22)	83,428
N	Administrative and support service activities	-0.122 (-104.64)	1.017 (61.17)	-0.419 (-83.49)	0.005 (0.92)	81,066
O	Public administration and defence; Compulsory social security	-0.018 (-6.62)	1.809 (48.42)	-1.066 (-63.38)	-0.008 (-0.72)	14,317
P	Education	0.005 (2.35)	2.218 (97.35)	-1.538 (-105.62)	0.004 (0.44)	37,125
Q	Human health and social work activities	-0.069 (-52.17)	0.450 (24.39)	-0.822 (-82.28)	0.005 (0.90)	27,145
R	Arts, entertainment and recreation	-0.036 (-10.31)	-0.042 (-3.14)	-0.499 (-80.81)	-0.026 (-1.98)	23,606
S	Other service activities	-0.031 (-9.63)	0.260 (11.24)	-0.686 (-75.47)	0.009 (0.57)	15,179
ALL	Whole economy	-0.133 (-348.99)	-0.152 (-82.83)	0.001 (99.48)	-0.001 (-0.21)	2,528,400

Table A8 - Estimation of labor share equation. Dependent variable: $lnLS_{it}$

Note: No IV estimation. *Source:* Authors' calculation on AMADEUS data.

Code	Sector name	log(k)	log(TFP)	Markup	ΔE	N. obs
C10-C12	Manufacture of food products and beverages	0.091	0.541	-0.722	-0.008	91,307
		(53.87)	(34.38)	(-21.82)	(-1.54)	
C13-C15	Manufacture of textiles, wearing apparel and leather products	0.012	1.524	-0.735	-0.007	68,454
		(7.09)	(65.19)	(-124.42)	(-0.75)	
C16	Manufacture of wood and of products of wood and cork, except furniture	0.096	1.324	-0.725	0.006	24,352
		(27.13)	(32.49)	(-86.98)	(0.62)	
C17	Manufacture of paper and paper products	0.107	1.593	-0.728	-0.010	15,678
		(22.21)	(39.59)	(-80.79)	(-0.90)	
C18	Printing and reproduction of recorded media	0.074	2.491	-0.919	0.015	18,255
		(17.63)	(39.81)	(-65.51)	(0.81)	
C19	Manufacture of coke and refined petroleum products	-0.026	-0.137	-0.127	-0.458	1,528
		(-1.40)	(-1.12)	(-16.62)	(-5.67)	
C20	Manufacture of chemicals and chemical products	0.170	1.216	-0.620	-0.004	26,468
		(40.68)	(32.61)	(-94.17)	(-0.34)	
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.130	1.234	-0.531	-0.049	5,268
		(12.89)	(11.49)	(-28.88)	(-1.83)	
C22	Manufacture of rubber and plastic products	0.131	1.122	-0.588	0.007	41,863
		(43.28)	(47.69)	(-123.80)	(0.66)	
C23	Manufacture of other non-metallic mineral products	0.090	0.169	-0.933	-0.008	31,712
		(29.98)	(18.42)	(-113.20)	(-0.44)	
C24	Manufacture of basic metals	0.110	1.467	-0.782	0.016	15,231
		(22.66)	(31.60)	(-65.93)	(0.92)	
C25	Manufacture of fabricated metal products, except machinery and equipment	0.067	1.930	-0.783	0.007	122,870
		(44.08)	(100.37)	(-176.39)	(1.34)	
C26	Manufacture of computer, electronic and optical products	0.089	1.251	-0.963	-0.003	17,693
		(20.59)	(27.18)	(-62.54)	(-0.20)	
C27	Manufacture of electrical equipment	0.088	1.816	-0.788	0.015	23,946
		(22.46)	(38.43)	(-72.51)	(1.16)	
C28	Manufacture of machinery and equipment n.e.c.	0.087	1.830	-0.750	0.001	72,909
		(40.37)	(78.31)	(-118.93)	(0.03)	
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.177	0.189	-0.873	0.006	15,053
		(40.59)	(5.61)	(-81.29)	(0.37)	
C30	Manufacture of other transport equipment	0.081	1.027	-0.678	0.016	6,467
		(13.63)	(15.01)	(-39.24)	(0.75)	
C31_C32	Manufacture of furniture	0.119	1.132	-1.010	-0.017	38,395
		(48.06)	(35.60)	(-117.21)	(-1.61)	
C33	Repair and installation of machinery and equipment	-0.053	2.293	-0.814	0.043	24,566
		(-18.33)	(42.12)	(-43.40)	(3.31)	
C	Manufacturing	0.006	0.052	-0.484	-0.006	662,015
		(9.01)	(30.02)	(-372.29)	(-2.16)	

Table A9 - Labor share and capital-output ratio's percentiles by year (2011-2019).

Note: No IV estimation. *Source:* Authors' calculation on AMADEUS data.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	ALL
	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS
dmtl	-0.0998***	-0.220***	-0.288***	0.00316	-0.184***	-0.259***	-0.281***	-0.0683	-0.0767***	-0.233***	0.000162***	0.0107	-0.0734*	-0.0373	-0.216***	-0.0620	-0.459***	-0.0602	-0.223***	-0.0000382
	(-5.11)	(-7.63)	(-56.56)	(1.15)	(-9.21)	(-10.51)	(-7.77)	(-1.30)	(-5.81)	(-6.88)	(5.44)	(0.76)	(-2.47)	(-1.66)	(-4.36)	(-1.57)	(-11.93)	(-1.40)	(-8.70)	(-0.31)
2012.year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
2013.year	0.00750	-0.0357*	-0.00971***	-0.0219	-0.00544	-0.0113***	-0.0145***	-0.0190***	-0.0279***	-0.00651	-0.0111*	-0.00897*	-0.0114**	-0.0102***	-0.000976	-0.00725*	0.000766	-0.00293	-0.0116	-0.0168***
	(1.58)	(-2.58)	(-10.01)	(-1.84)	(-1.10)	(-5.10)	(-9.19)	(-7.33)	(-9.15)	(-1.68)	(-2.18)	(-2.26)	(-3.00)	(-3.70)	(-0.17)	(-1.97)	(0.25)	(-0.32)	(-1.76)	(-27.89)
2014.year	-0.000918	-0.0315*	-0.0138***	0.00644	-0.0126*	-0.0148***	-0.0183***	-0.0230***	-0.0339***	-0.0157***	-0.0239***	-0.0216***	-0.0286***	-0.0120***	-0.00354	-0.00989**	-0.00177	-0.0284**	-0.0154*	-0.0265***
	(-0.20)	(-2.40)	(-15.05)	(0.64)	(-2.49)	(-6.22)	(-8.06)	(-8.82)	(-11.62)	(-3.73)	(-4.39)	(-6.18)	(-7.16)	(-4.58)	(-0.64)	(-2.85)	(-0.60)	(-2.75)	(-2.44)	(-45.22)
2015.year	0.0102*	-0.0335**	-0.00652***	-0.0198	-0.00555	-0.0128***	-0.0124***	-0.0227***	-0.0324***	-0.0130**	-0.0237***	-0.0209***	-0.0229***	-0.0125***	0.000989	-0.000139	0.00142	-0.0273**	-0.0164*	-0.0220***
	(2.27)	(-2.64)	(-7.41)	(-1.60)	(-1.14)	(-5.08)	(-5.41)	(-8.01)	(-11.38)	(-3.18)	(-3.95)	(-5.75)	(-5.28)	(-4.75)	(0.19)	(-0.04)	(0.47)	(-2.62)	(-2.53)	(-37.85)
2016.year	0.00565	-0.00892	-0.00474***	-0.0304*	-0.0206***	-0.00220	-0.00570**	-0.00120	-0.0153***	-0.00490	-0.0228***	-0.0136***	-0.00773*	-0.00513*	0.00115	0.00247	0.00199	0.00412	-0.00484	-0.0124***
	(1.26)	(-0.77)	(-5.45)	(-2.00)	(-4.13)	(-1.02)	(-3.20)	(-0.55)	(-5.47)	(-1.29)	(-4.17)	(-3.81)	(-2.10)	(-2.03)	(0.21)	(0.71)	(0.68)	(0.46)	(-0.84)	(-21.91)
2017.year	0.0141***	-0.0193	-0.00316***	-0.0347	-0.0123*	-0.00782**	-0.00264	0.00110	-0.0111***	-0.00543	-0.0171**	-0.0158***	-0.0152***	-0.00903***	0.00358	0.00264	0.00411	-0.00559	-0.00172	-0.0121***
	(3.35)	(-1.45)	(-3.70)	(-1.51)	(-2.50)	(-3.27)	(-1.47)	(0.53)	(-4.06)	(-1.46)	(-3.01)	(-4.21)	(-3.93)	(-3.49)	(0.68)	(0.78)	(1.46)	(-0.61)	(-0.30)	(-21.31)
2018.year	0.0202***	-0.00193	0.00176*	-0.00858	-0.00818	-0.00420	-0.0000165	0.00690**	-0.000163	-0.000636	-0.00293	-0.00502	-0.0106**	-0.00765**	-0.0000170	0.00260	0.00947**	0.0199*	0.00127	-0.00626***
	(4.57)	(-0.16)	(2.05)	(-0.46)	(-1.70)	(-1.65)	(-0.01)	(3.06)	(-0.06)	(-0.17)	(-0.53)	(-1.28)	(-2.68)	(-2.91)	(-0.00)	(0.72)	(3.25)	(2.13)	(0.20)	(-11.12)
2019.year	0.00988	-0.0362	0.0163**	0.00440	0.0370	-0.00739	0.00757	0.00641	0.0187	-0.0145	0.00371	0.0126	0.00995	-0.00645	-0.00949	-0.0208	0.0133	0.113*	-0.0352	0.0000207
	(0.80)	(-1.08)	(2.82)	(0.21)	(1.62)	(-0.84)	(1.21)	(0.71)	(1.67)	(-1.20)	(0.18)	(0.98)	(0.75)	(-0.47)	(-0.76)	(-0.40)	(0.88)	(2.14)	(-0.66)	(0.01)
_cons	-0.0184***	0.00374	0.00500***	-0.00765	0.00880*	0.00540**	0.00632***	0.0103***	0.0111***	-0.00310	-0.0133***	0.00618*	0.00562*	0.00839***	-0.00117	0.000955	0.000553	-0.0140	0.00615	0.00965***
	(-5.48)	(0.40)	(7.66)	(-0.73)	(2.45)	(3.09)	(4.60)	(6.01)	(5.07)	(-1.06)	(-3.53)	(2.37)	(1.96)	(4.33)	(-0.31)	(0.38)	(0.25)	(-1.91)	(1.34)	(22.91)
N	56291	9288	651173	13831	28367	229331	700461	130657	103407	72008	100519	53876	77130	78182	14225	36843	27061	21871	14866	2419436

Table A10 - Industry-Level regressions of changes in the labor share on changes in markup.

Note: * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	ALL
	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS	dLS
dmcd	-0.110***	-0.277***	-0.346***	-0.0264*	-0.270***	-0.185***	-0.236***	-0.164***	-0.206***	-0.213***	-0.000555***	-0.0311	-0.0203	-0.241***	-0.400***	-0.208***	-0.451***	-0.131***	-0.227***	-0.00320
	(-5.25)	(-7.81)	(-57.78)	(-2.29)	(-14.76)	(-8.95)	(-9.86)	(-3.76)	(-18.09)	(-3.95)	(-4.74)	(-1.89)	(-1.87)	(-9.01)	(-14.80)	(-10.73)	(-14.52)	(-3.56)	(-4.76)	(-1.88)
2012.year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
2013.year	0.00758	-0.0375**	-0.00895***	-0.0222	-0.00443	-0.0128***	-0.0171***	-0.0155***	-0.0238***	-0.00675	-0.0110*	-0.00841*	-0.0120**	-0.00864**	-0.00402	-0.00413	0.000857	-0.000844	-0.0109	-0.0167***
	(1.59)	(-2.73)	(-9.26)	(-1.87)	(-0.91)	(-5.89)	(-13.94)	(-5.84)	(-7.89)	(-1.74)	(-2.17)	(-2.12)	(-3.17)	(-3.19)	(-0.70)	(-1.14)	(0.28)	(-0.09)	(-1.66)	(-27.74)
2014.year	-0.000880	-0.0342**	-0.0133***	0.00586	-0.0111*	-0.0196***	-0.0238***	-0.0196***	-0.0286***	-0.0174***	-0.0240***	-0.0207***	-0.0311***	-0.00818**	-0.00239	-0.00574	-0.00234	-0.0249*	-0.0152*	-0.0264***
	(-0.19)	(-2.62)	(-14.64)	(0.59)	(-2.22)	(-8.93)	(-16.28)	(-7.20)	(-9.98)	(-3.99)	(-4.39)	(-5.94)	(-8.20)	(-3.17)	(-0.44)	(-1.68)	(-0.81)	(-2.57)	(-2.39)	(-44.87)
2015.year	0.0101*	-0.0370**	-0.00664***	-0.0190	-0.00384	-0.0209***	-0.0185***	-0.0179***	-0.0268***	-0.0151***	-0.0237***	-0.0203***	-0.0254***	-0.00827**	-0.000416	0.00313	0.000759	-0.0248*	-0.0167*	-0.0219***
	(2.25)	(-2.94)	(-7.58)	(-1.53)	(-0.80)	(-9.47)	(-12.51)	(-6.26)	(-9.64)	(-3.57)	(-3.94)	(-5.55)	(-6.13)	(-3.22)	(-0.08)	(0.93)	(0.25)	(-2.57)	(-2.54)	(-37.48)
2016.year	0.00588	-0.0106	-0.00497***	-0.0300*	-0.0185***	-0.00589**	-0.0105***	-0.000604	-0.0118***	-0.00699	-0.0228***	-0.0125***	-0.00973**	-0.00184	0.00146	0.00526	0.000858	0.00527	-0.00485	-0.0123***
	(1.31)	(-0.92)	(-5.74)	(-1.98)	(-3.77)	(-2.87)	(-9.03)	(-0.28)	(-4.32)	(-1.81)	(-4.16)	(-3.52)	(-2.73)	(-0.74)	(0.28)	(1.52)	(0.30)	(0.61)	(-0.85)	(-21.73)
2017.year	0.0144***	-0.0236	-0.00286***	-0.0336	-0.0103*	-0.0136***	-0.00643***	0.00241	-0.00727**	-0.00627	-0.0171**	-0.0146***	-0.0177***	-0.00340	0.00287	0.00597	0.00386	-0.00300	-0.000785	-0.0120***
	(3.42)	(-1.80)	(-3.37)	(-1.46)	(-2.13)	(-6.37)	(-5.25)	(1.15)	(-2.73)	(-1.63)	(-3.01)	(-3.91)	(-4.77)	(-1.33)	(0.55)	(1.77)	(1.39)	(-0.35)	(-0.14)	(-21.06)
2018.year	0.0202***	-0.00457	0.00242**	-0.00708	-0.00637	-0.0102***	-0.00209	0.00807***	0.00201	-0.00192	-0.00290	-0.00377	-0.0124**	-0.00208	0.00280	0.00721*	0.0106***	0.0234**	0.00303	-0.00616***
	(4.57)	(-0.38)	(2.84)	(-0.38)	(-1.33)	(-4.58)	(-1.68)	(3.65)	(0.76)	(-0.47)	(-0.53)	(-0.96)	(-3.28)	(-0.80)	(0.54)	(2.01)	(3.66)	(2.59)	(0.49)	(-10.90)
2019.year	0.00951	-0.0497	0.0181**	0.00663	0.0382	-0.0137	0.00139	0.0167	0.0255*	-0.0173	0.00377	0.0144	0.00821	0.00774	-0.0162	-0.00655	0.00948	0.117*	-0.0388	0.000162
	(0.77)	(-1.61)	(3.14)	(0.32)	(1.71)	(-1.57)	(0.24)	(1.76)	(2.29)	(-1.42)	(0.18)	(1.12)	(0.61)	(0.56)	(-1.29)	(-0.13)	(0.65)	(2.21)	(-0.80)	(0.05)
_cons	-0.0189***	0.00483	0.00209**	-0.00929	0.00483	0.00659***	0.00594***	0.00504*	0.00642**	-0.00361	-0.0133***	0.00501	0.00692*	0.00234	-0.00377	-0.00392	-0.000763	-0.0181*	0.00354	0.00953***
	(-5.60)	(0.52)	(3.17)	(-0.88)	(1.35)	(3.85)	(4.97)	(2.24)	(2.95)	(-1.11)	(-3.54)	(1.89)	(2.51)	(1.19)	(-1.00)	(-1.54)	(-0.34)	(-2.55)	(0.77)	(22.36)
N	56291	9288	651173	13831	28367	229331	700461	130657	103407	72008	100519	53876	77130	78182	14225	36843	27061	21871	14866	2419436

Table A10 - Industry-Level regressions of changes in the labor share on changes in markup.

Note: * p ≤ 0.10, ** p ≤ 0.05, *** p ≤ 0.01.

Relevant ranges for lk																			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1%	-0.53	-0.24	-0.63	0.03	-0.61	-0.80	-0.28	-1.02	-1.12	-1.31	-0.75	-1.14	-0.96	-1.63	-1.77	-1.35	-1.64	-1.27	-1.45
5%	0.20	0.30	-0.02	0.76	-0.08	-0.27	0.22	-0.44	-0.63	-0.68	-0.03	-0.62	-0.48	-1.18	-1.09	-0.77	-1.15	-0.65	-0.80
10%	0.53	0.56	0.23	1.05	0.18	-0.01	0.46	-0.15	-0.39	-0.40	0.33	-0.33	-0.21	-0.94	-0.73	-0.47	-0.85	-0.34	-0.47
25%	0.97	0.94	0.62	1.39	0.62	0.42	0.86	0.28	0.05	0.04	0.94	0.17	0.24	-0.45	-0.23	0.00	-0.39	0.18	0.02
50%	1.42	1.39	1.03	1.74	1.13	0.92	1.31	0.73	0.65	0.54	1.68	0.73	0.77	0.24	0.35	0.49	0.10	0.79	0.54
75%	1.91	1.87	1.46	2.11	1.64	1.48	1.76	1.23	1.41	1.09	2.32	1.39	1.33	0.99	0.94	1.00	0.66	1.42	1.08
90%	2.33	2.29	1.89	2.42	2.07	2.04	2.16	1.75	2.05	1.67	2.60	2.02	1.89	1.63	1.49	1.49	1.18	1.99	1.64
95%	2.53	2.49	2.15	2.57	2.32	2.36	2.38	2.07	2.34	2.02	2.69	2.34	2.21	2.01	1.88	1.79	1.54	2.30	1.97
99%	2.73	2.72	2.56	2.74	2.65	2.69	2.67	2.56	2.68	2.55	2.77	2.68	2.63	2.56	2.48	2.35	2.29	2.66	2.53
Mean	1.41	1.39	1.04	1.72	1.12	0.96	1.30	0.76	0.74	0.58	1.56	0.78	0.80	0.30	0.36	0.50	0.15	0.80	0.55
Smallest	-3.47	-2.69	-8.58	-3.45	-2.93	-6.57	-5.71	-8.25	-4.63	-6.43	-3.47	-3.09	-3.90	-4.49	-6.49	-4.39	-3.07	-3.53	-3.41
Largest	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.78	2.79	2.79	2.79	2.79
Standard Deviation	0.71	0.67	0.66	0.56	0.73	0.78	0.65	0.75	0.91	0.82	0.88	0.88	0.80	0.98	0.89	0.77	0.81	0.89	0.83
Variance	0.50	0.45	0.43	0.32	0.53	0.61	0.43	0.56	0.83	0.67	0.78	0.77	0.64	0.96	0.79	0.60	0.65	0.80	0.69
Skewness	-0.47	-0.24	-0.13	-0.83	-0.16	0.08	-0.19	0.02	0.16	0.06	-0.62	0.08	0.07	0.21	-0.05	-0.02	0.23	-0.10	-0.02
Kurtosis	3.63	3.09	3.52	5.32	2.80	2.85	2.98	3.44	2.45	3.42	2.77	2.61	2.84	2.50	3.38	3.21	3.24	2.76	3.22

Table A12 - Relevant ranges for k in different sectors of the economy.

Note: 2011-2019. *Source:* Authors' calculation on AMADEUS data.

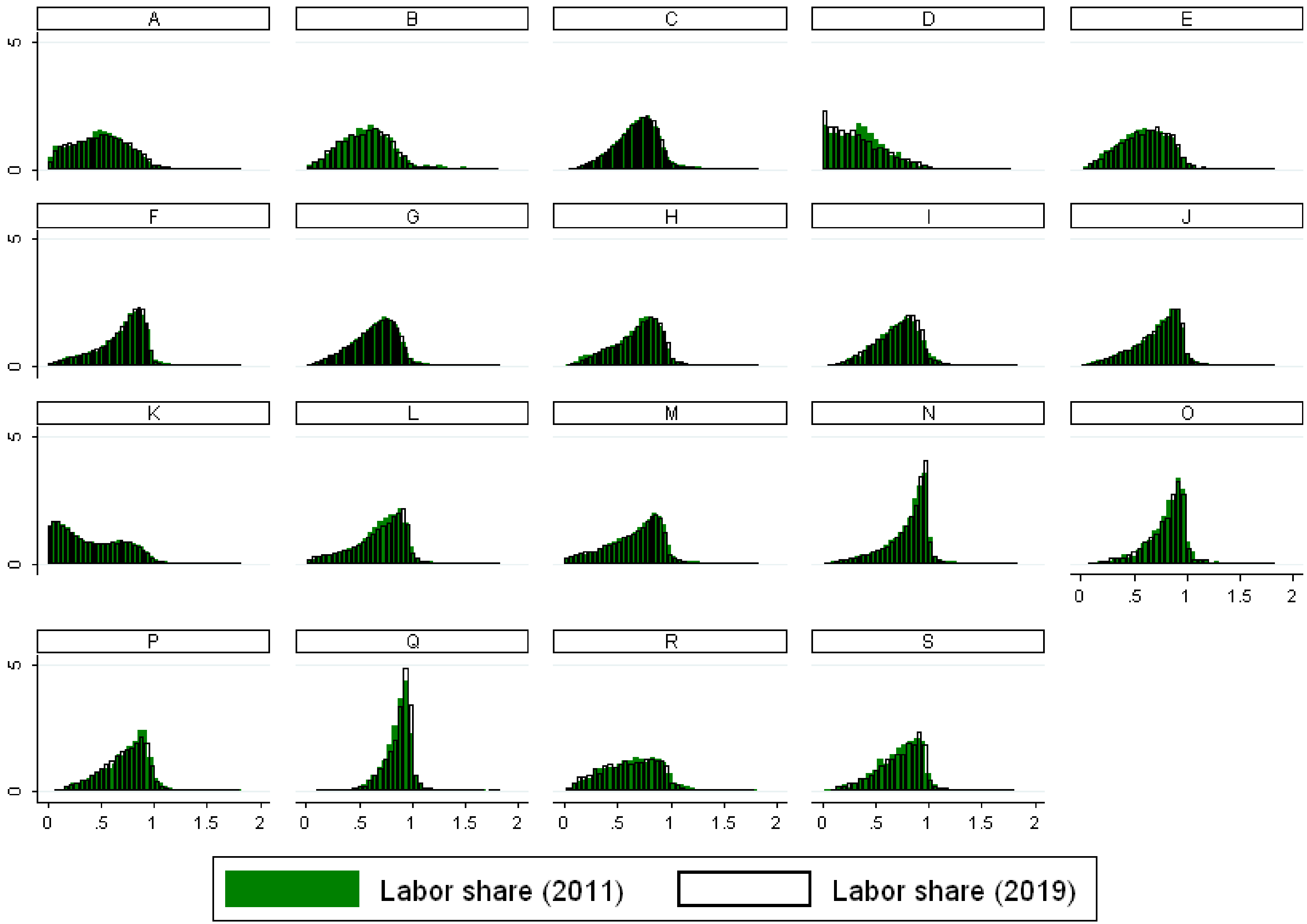


Figure A5 - Labor share's distribution by industry, 2011 and 2019.

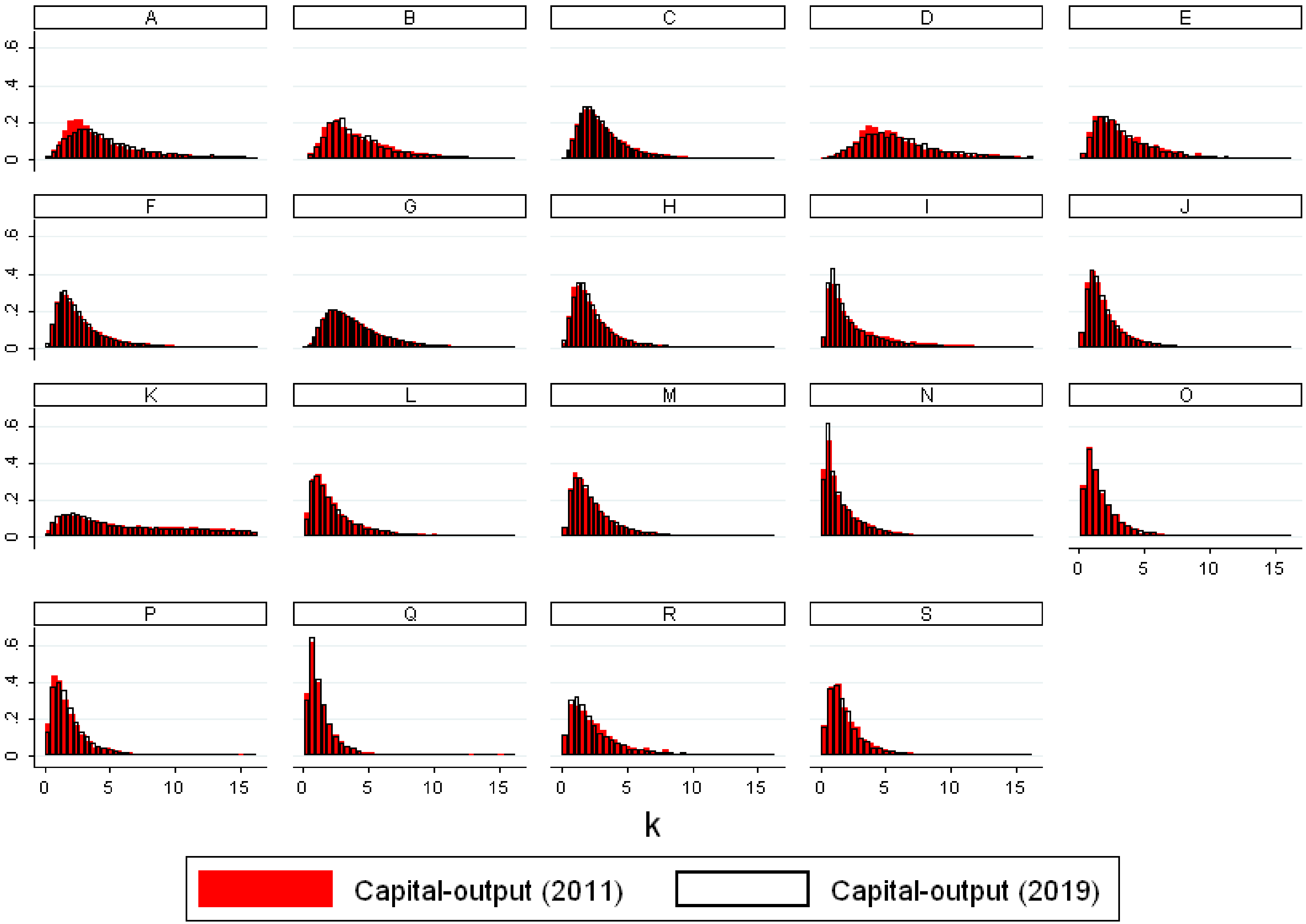


Figure A6 - Capital-output ratio's distribution by industry, 2011 and 2019.

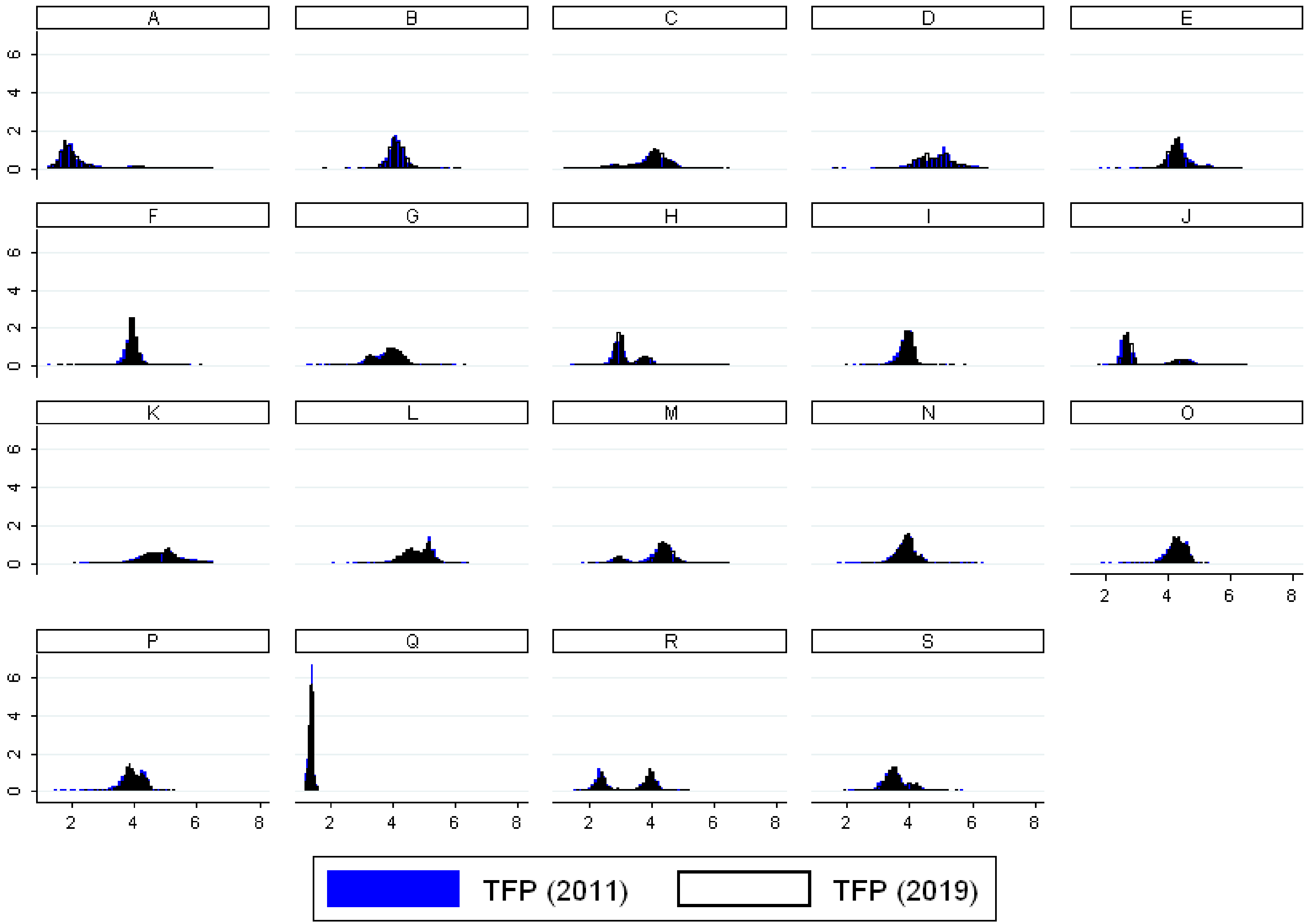


Figure A7 - TFP's distribution by industry (Translog specification), 2011 and 2019.

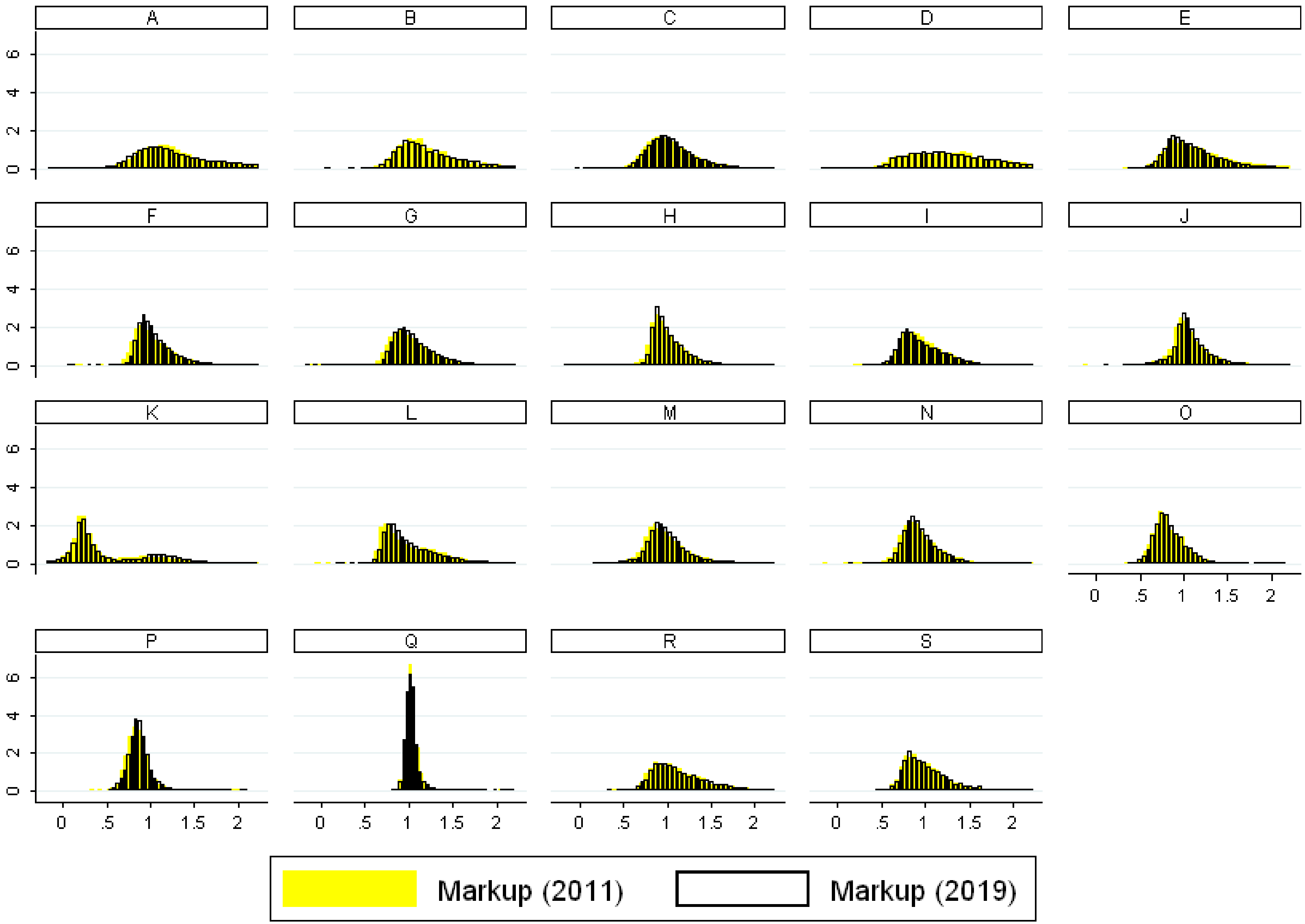


Figure A8 - Markup's distribution by industry (Translog specification), 2011 and 2019.

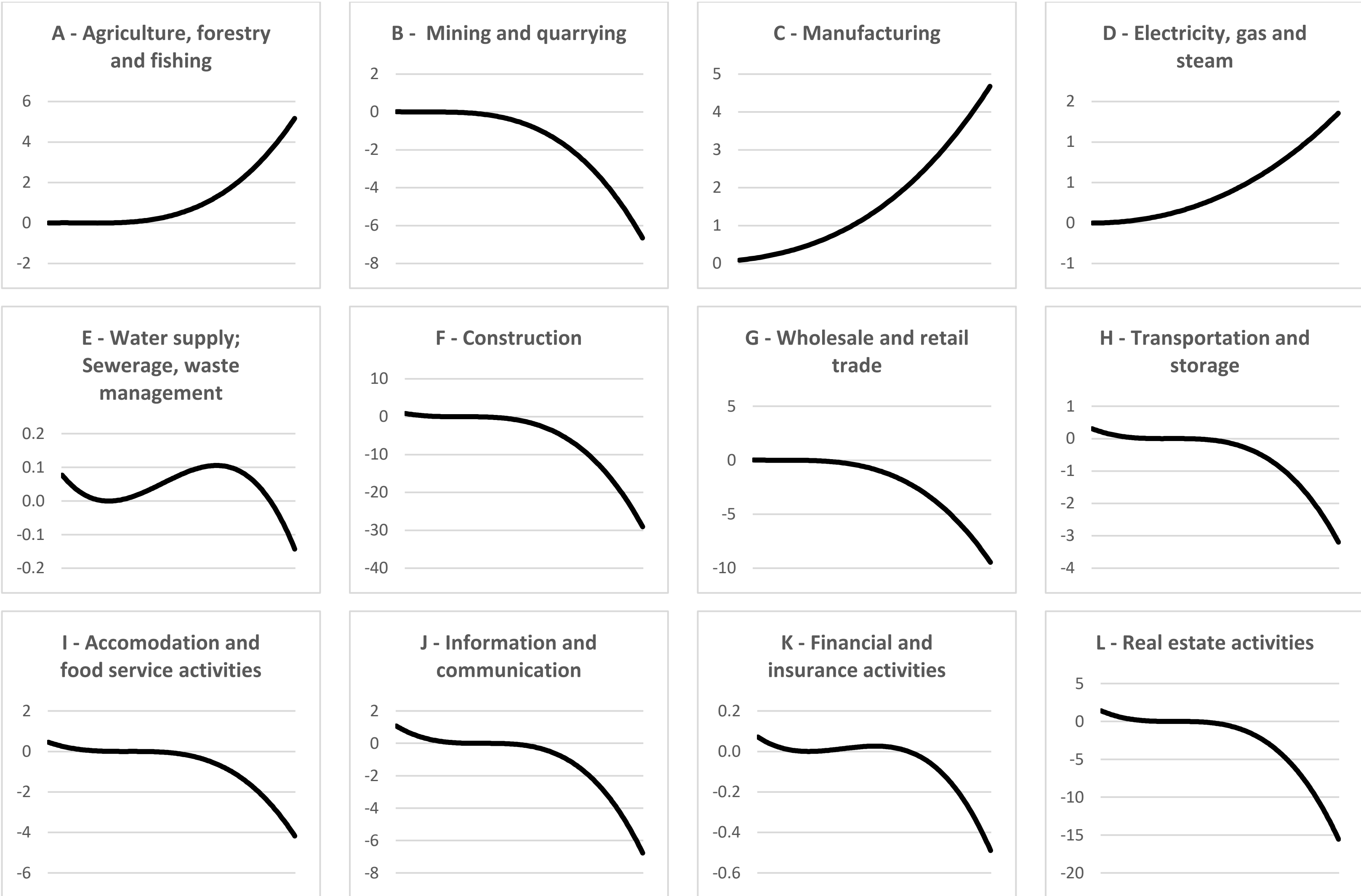


Figure A9 (A-L) - The labor share/capital-output curve by industry.

Source: Authors' calculation on AMADEUS data.

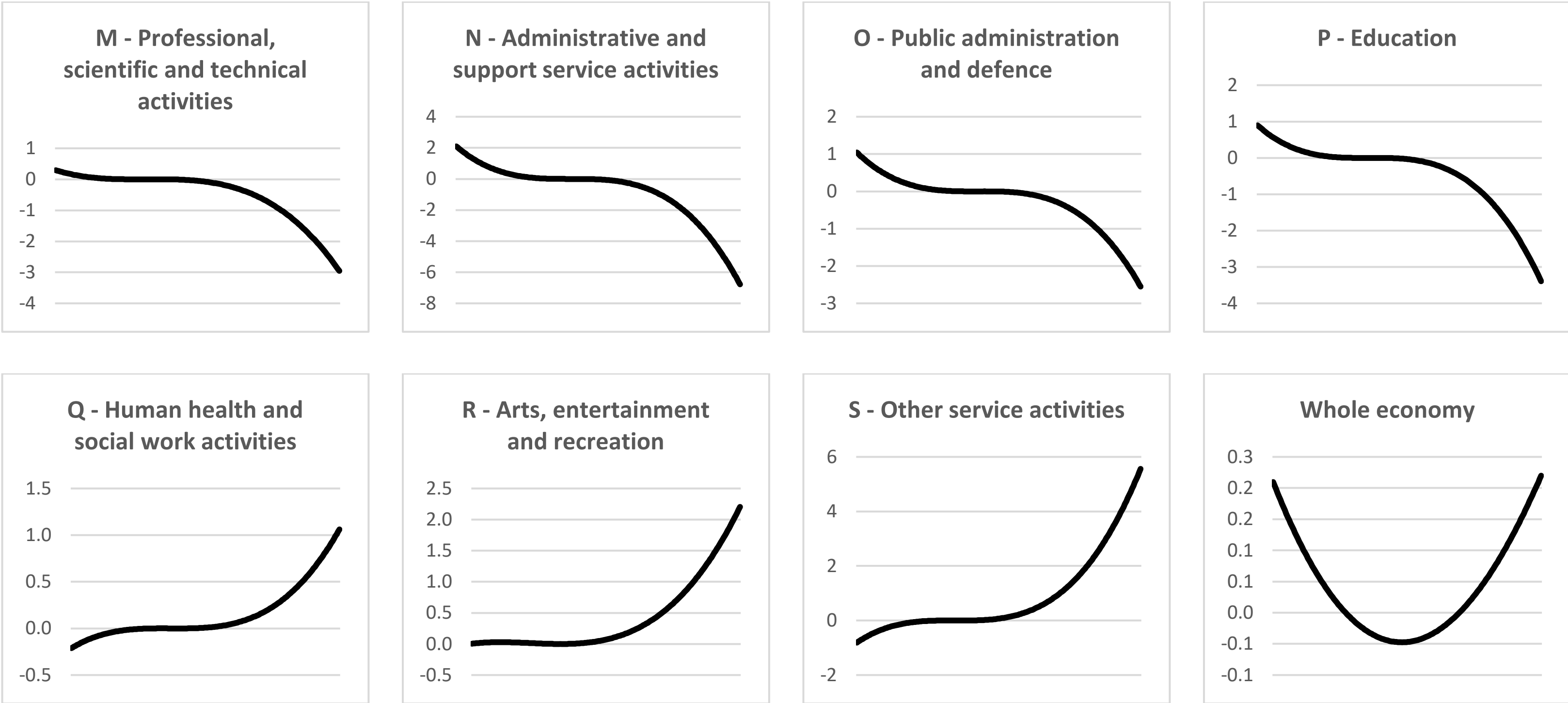


Figure A9 (M-S) - The labor share/capital-output curve by industry.

Source: Authors' calculation on AMADEUS data.

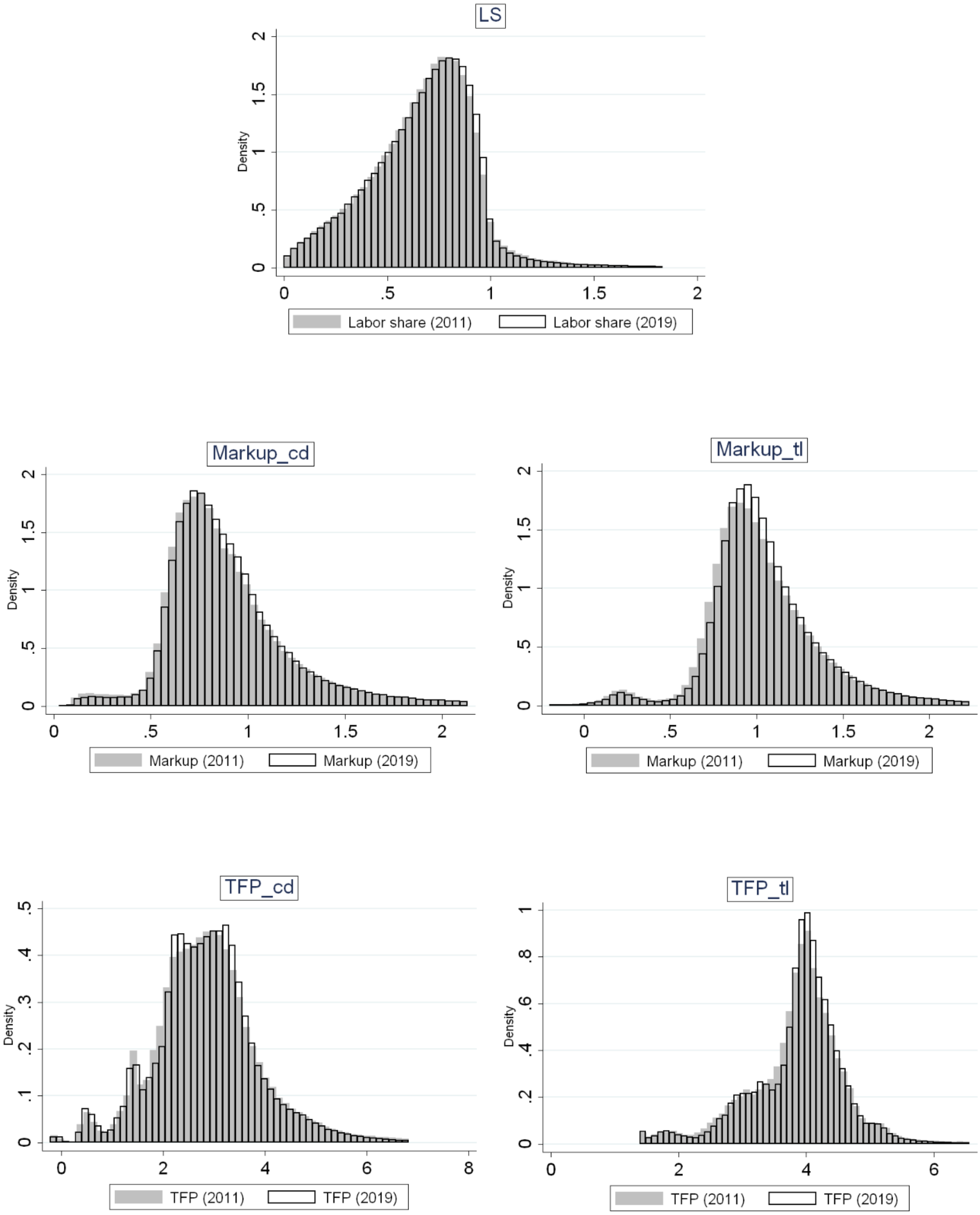


Figure A10 - The labor share, capital-output ratio, markup and TFP distributions (2011/2019).

Note: the suffixes _tl and _cd refers respectively to the Translog and the Cobb-douglas specifications.

Source: Authors' calculation on AMADEUS data.

Appendix B: mathematical appendix

(i) Derivation of the formulas employed in the shift-share analysis

Starting from the definition of labor share we can write the following identity:

$$Labor\ Share_t = LS_t = \frac{Labor\ cost_t}{Value\ Added_t} = \frac{W_t L_t}{Y_t} = \frac{W_t L_t}{Pc_t L_t} \frac{Pc_t}{Pva_t} \frac{L_t}{Y_t} = \frac{w_t}{y_t} p_t \qquad \text{A1}$$

Where:

- W_t = nominal unit labor cost;
- L_t = number of workers (employees and self-employed);
- Y_t = value added;
- Pc_t = consumption prices index (CPI);
- Pva_t = production price index (VA deflator).

If we set the real compensation of employees per person employed as $w_t = W_t/Pc_t$; labor productivity (value added per worker) as $y_t = Y_t/L_t$ and the relative prices as $p_t = Pc_t/Pva_t$ we obtain the last synthetic expression of the LS on the right side of A1. Since the economy of a country is made up of several sectors, the aggregate labor share can be written as a weighted average of individual industries' labor shares:

$$LS = \sum_i s_i \frac{w_i}{y_i} \qquad \text{A2}$$

Where: s_i is the weight of sector i in total value-added. The shift-share analysis allows us to decompose changes in the aggregate labor share into changes of that variable within industries and structural changes in industry composition. In our case a standard *shift share decomposition* can be written as:

$$\Delta LS = (LS_t - LS_{t-1}) = \underbrace{\sum_i \bar{s}_i (ls_{it} - ls_{it-1})}_{within-industry} + \underbrace{\sum_i (s_{it} - s_{it-1})\, \overline{ls}_i}_{between-industry} \qquad \text{A3}$$

Where: LS_t and ls_{it} represent respectively the aggregate and industry labor shares; s_{it} is the share of industry i in terms of (nominal) value added and a bar over the letter represents the average of the variable between the initial and final period. The first term on the right-hand side is a weighted average of within-industry changes (the so-called *withing component*) while the last term represents the contribution of sectoral reallocation (the so-called *between component*). Equation A3 is exactly equation (1) in the main text of the paper.

Note that the evolution of the labor share in each industry can also be linked to the different evolution of real wages, labor productivity and relative prices. Using logarithmic approximations, we can rewrite A1 as:

$$\Delta LS = \Delta \frac{w}{y} p$$

Or:

$$ln\left(\frac{LS_t}{LS_{t-1}}\right) = ln\left(\frac{W_t}{W_{t-1}}\right) - ln\left(\frac{y_t}{y_{t-1}}\right) + ln\left(\frac{p_t}{p_{t-1}}\right) \qquad \text{A4}$$

A4 tells us that the total (%) change in the aggregate labor share LS can be decomposed into the % growth of aggregate real wage W (deflated with the consumer price index P) minus the % growth in labor productivity Y (deflated with the value added deflator D) plus the % change in the relative price of consumption goods with respect to domestic output.[203] Using the formulation in A3, the labor share of A4 can be decomposed in order to shed some light on the relative contributions of wages, productivity and prices to within-industry and between-industry variations.

$$ln\frac{W_t}{W_{t-1}} \cong \sum_i \bar{h}_i ln\left(\frac{w_{it}}{w_{it-1}}\right) + \sum_i \bar{h}_i ln\frac{w_{it}}{w_{it-1}}\left(\frac{\bar{w}_i - \bar{W}}{\bar{W}}\right) + \sum_i (h_{it} - h_{it-1})\left(\frac{\bar{w}_i}{\bar{W}}\right) \qquad \text{A5}$$

$$ln\frac{Y_t}{Y_{t-1}} \cong \underbrace{\sum_i \bar{h}_i ln\left(\frac{y_{it}}{y_{it-1}}\right)}_{within-ndustry} + \underbrace{\sum_i \bar{h}_i ln\frac{y_{it}}{y_{it-1}}\left(\frac{\bar{y}_i - \bar{Y}}{\bar{Y}}\right)}_{convergence/divergence} + \underbrace{\sum_i (h_{it} - h_{it-1})\left(\frac{\bar{y}_i}{\bar{Y}}\right)}_{between-industry} \qquad \text{A6}$$

Where: lowercase letters represent industry-level variables, h_i is the share of industry i in total hours worked; Y_t and y_{it} (i.e. the labor productivity at the aggregate and industry level) as for real

[203] From now on, to simplify the notation Y and W will always refer to their real values (unless otherwise indicated) and the use of uppercase and lowercase letters will serve to differentiate the whole economy and individual sectors respectively.

wages (W_t and w_t) are both deflated by the aggregate value-added deflator to preserve additivity.[204] The first term on the right-hand side of A5/A6 represents a weighted average of within-industry wage (productivity) growth rates. The second one captures the contribution to aggregate wage (productivity) growth of the covariance of wage/productivity levels and growth (i.e., the larger is the wage [productivity] growth in high wage/productivity industries and the larger is the aggregate wage [productivity] growth), the so-called convergence/divergence component. The third term on the right-hand side captures the structural reallocation to or against high-wage (productivity) industries (i.e., the between component A3). From A6, after some manipulations (and considering of the price dynamics) we obtain:

$$ln\frac{Y_t}{Y_{t-1}} \cong \sum_i \bar{h}_i ln\left(\frac{y_{it}}{y_{it-1}}\right) + \sum_i \bar{h}_i ln\frac{y_{it}}{y_{it-1}}\left(\frac{\bar{y}_i - \bar{Y}}{\bar{Y}}\right) + \sum_i (h_{it} - h_{it-1})\left(\frac{\bar{y}_i}{\bar{Y}}\right) + \sum_i \bar{h}_i ln\frac{\frac{d_{it}}{D_t}}{\frac{d_{it-1}}{D_{t-1}}} + \sum_i \bar{h}_i ln\frac{\frac{d_{it}}{D_t}}{\frac{d_{it-1}}{D_{t-1}}}\left(\frac{\bar{y}_i - \bar{Y}}{\bar{Y}}\right) \qquad \text{A6}$$

Where: D_t and d_{it} are respectively the value-added deflator of the aggregate economy and industry i. Noting that that the sum of the industry shares is equal to 1 $\left(i.e.\ \sum_i \bar{h}_i = 1\right)$ and therefore $\sum_i \bar{h}_i\bar{y}_i \cong \bar{Y}$, we have:

$$ln\frac{Y_t}{Y_{t-1}} - ln\frac{\frac{P_t}{D_t}}{\frac{P_{t-1}}{D_{t-1}}} \cong \sum_i \bar{h}_i ln\left(\frac{y_{it}}{y_{it-1}}\right) + \sum_i \bar{h}_i ln\frac{y_{it}}{y_{it-1}}\left(\frac{\bar{y}_i - \bar{Y}}{\bar{Y}}\right) + \sum_i (h_{it} - h_{it-1})\left(\frac{\bar{y}_i}{\bar{Y}}\right) + \sum_i \bar{h}_i ln\frac{\frac{d_{it}}{P_t}}{\frac{d_{it-1}}{P_{t-1}}} + \sum_i \bar{h}_i ln\frac{\frac{d_{it}}{P_t}}{\frac{d_{it-1}}{P_{t-1}}}\left(\frac{\bar{y}_i - \bar{Y}}{\bar{Y}}\right) \qquad \text{A7}$$

Combining the results in A4, A5 and A7 implies that the aggregate percentage changes in the labor share can be decomposed as follows:

[204] Note that the formulas derived here are exact (=) for growth rates and only approximated (≈) for log differences.

$$\log\frac{LS_t}{LS_{t-1}} \cong \underbrace{\left[\sum_i \bar{h}_i ln\left(\frac{w_{it}}{w_{it-1}}\right) + \sum_i \bar{h}_i ln\frac{w_{it}}{w_{it-1}}\left(\frac{\bar{w}_i - \bar{W}}{\bar{W}}\right) + \sum_i (h_{it} - h_{it-1})\left(\frac{\bar{w}_i}{\bar{W}}\right)\right]}_{real\ wage\ effect} - \underbrace{\left[\sum_i \bar{h}_i ln\left(\frac{y_{it}}{y_{it-1}}\right) + \sum_i \bar{h}_i ln\frac{y_{it}}{y_{it-1}}\left(\frac{\bar{y}_i - \bar{Y}}{\bar{Y}}\right) + \sum_i (h_{it} - h_{it-1})\left(\frac{\bar{y}_i}{\bar{Y}}\right)\right]}_{labor\ productivity} - \underbrace{\left[\sum_i \bar{h}_i ln\frac{\frac{d_{it}}{P_t}}{\frac{d_{it-1}}{P_{t-1}}} + \sum_i \bar{h}_i ln\frac{\frac{d_{it}}{P_t}}{\frac{d_{it-1}}{P_{t-1}}}\left(\frac{\bar{y}_i - \bar{Y}}{\bar{Y}}\right)\right] + \left[ln\frac{\frac{D_{it}}{P_t}}{\frac{D_{it-1}}{P_{t-1}}}\sum_i \bar{h}_i\left(\frac{\bar{y}_i - \bar{Y}}{\bar{Y}}\right)\right]}_{price\ dynamics} \quad \text{A8}$$

The first term in brackets on the right-hand side of A8 represents the real wage effect that can be decomposed into a (i) within, (ii) convergence/divergence and (iii) between component; the second term represents a productivity effect that can be decomposed as well into the same components of real wages; the third term represents a relative price effect that can be decomposed into (i) within-industry changes of value added prices with respect to the consumption deflator and a (ii) convergence/divergence term which has a negative contribution to the labor share dynamics if industries with high value added per hour worked have the largest growth in relative prices. Finally, the last term represents a residual, which should be in practice very small. Re-arranging the terms in A8 we obtain:

$$\Delta LS = \log\frac{LS_t}{LS_{t-1}} \cong \left[\sum_i \bar{h}_i\left(ln\frac{w_{it}}{w_{it-1}} - ln\frac{y_{it}}{y_{it-1}}\right)\right] + \left[\sum_i \bar{h}_i ln\frac{w_{it}}{w_{it-1}}\left(\frac{\bar{w}_i - \bar{W}}{\bar{W}}\right) - \sum_i \bar{h}_i ln\frac{y_{it}}{y_{it-1}}\left(\frac{\bar{y}_i - \bar{Y}}{\bar{Y}}\right)\right] + \left[\sum_i \bar{h}_i ln\frac{\frac{P_t}{d_{it}}}{\frac{P_{t-1}}{d_{it-1}}} - \sum_i \bar{h}_i ln\frac{\frac{P_t}{d_{it}}}{\frac{P_{t-1}}{d_{it-1}}}\left(\frac{\bar{y}_i - \bar{Y}}{\bar{Y}}\right) + res\right] + \sum_i (h_{it} - h_{it-1})\left(\frac{\bar{w}_i}{\bar{W}} - \frac{\bar{y}_i}{\bar{Y}}\right) \quad \text{A9}$$

Which is exactly equation (3) in the main text of the paper (with res indicating the small residual term of A9). The term in the first bracket represents the contribution to the evolution of the aggregate labor share of the average relative *within-industry* growth of real wages with respect to productivity. The second term captures the contribution of *convergence/divergence* in real wages and labor productivity. Real wages provide a bigger contribution to the percentage change of the labor share when they grow faster in industries characterized by above-average wages; on the other hand, when productivity grow faster in industries with high-productivities, this inevitably reduce the labor share. The third term represents the *relative price effect*, which when positive, means that, on average, the consumption deflator is growing faster than the output deflator. Finally, the last term captures the reallocation of labor from (to) industries that are relatively higher in wages (productivity), e.g., the *between component*.

(ii) Derivation of the $LS - k$ curve

Consider a firm indexed by i. Assume it has a constant return to scale (CRS), differentiable production function by which output, Y_i, is produced with two factors of production, capital, K_i, and labor, L_i. Assume there is labor-augmenting technical progress, which we write as B_i: $Yi = F(K_i, B_i L_i)$. Then, under the assumption that labor is paid its marginal product, there exists a unique function f such that:

$$LS_i = f(k_i) \qquad \text{A10}$$

Where: $LS_i = w_i L_i / p_i Y_i$ is the labor share in industry i, with w_i denoting the wage and p_i the product price. Finally, $k_i = K_i / Y_i$ is the capital-output ratio. Since the production function has the property of CRS and therefore when inputs are increased by a certain amount, the output increases by exactly the same amount, we can exploit this property to rewrite the production function in the following way (by dividing all the inputs by K and multiplying Y for the same amount): $Yi = K_i f(1, B_i L_i / K_i)$. If we call $B_i L_i / K_i = l_i$, we can write $Yi = K_i f(l_i)$. In equilibrium, remembering that ($MPL = w$) and exploiting the chain rule to compute the first derivative of the production function we have:

$$B_i f'(l_i) = \frac{w_i}{p_i} \qquad \text{A11}$$

This implies that the labor share (by definition $LS_i = w_i L_i / p_i Y_i$) is equal to:

$$LS_i = \frac{w_i L_i}{p_i Y_i} = \frac{B_i L_i f'(l_i)}{K_i f(l_i)} = \frac{l_i f'(l_i)}{f(l_i)} \qquad \text{A12}$$

Since $Yi = K_i f(l_i)$, the capital-output ratio is equal to:

$$k_i = \frac{K_i}{Y_i} = \frac{1}{f(l_i)} \qquad \text{A13}$$

Since $f(\cdot)$ is monotonic, equation A13 defines a one-to-one relationship between l_i and k_i. Indeed, we can rewrite A13 as $f(l_i) = \frac{1}{k_i}$ and then (if we call the new function h):

$$l_i = h(k_i) = f^{-1}\left(\frac{1}{k_i}\right) \qquad \text{A14}$$

Substituting A14 into A12, we find that:

$$LS_i = \frac{l_i f'(l_i)}{f(l_i)} = k_i h(k_i) f'[h(k_i)] \qquad \text{A15}$$

Equation A15 establish a stable relationship between the LS_i and k_i which is independent of the functional form of the production function.[205] This is unaffected by changes in factor prices or labor-augmenting technical progress. The response of the labor share to the capital-output ratio is related to the elasticity of substitution between labor and capital. The latter is defined as:

$$\sigma_i = \frac{d(K_i/L_i)/K_i/L_i}{d(MRS_i)/MRS_i} = \frac{d(K_i/L_i)}{d(MRS_i)} \frac{MRS_i}{K_i/L_i}$$

Where: K_i/L_i is the cost-minimizing input mix and $MRS_i = r_i/w_i$ the relative cost of capital. By applying this formula to the expression in A10 we have that the marginal products of labor (MPL_i) and capital (MPK_i) are:

$$MPL_i = B_i f'(l_i) \qquad \text{A16}$$

[205] Equation (5) on pag. 5 in the original paper of Bentolila and Saint-Paul (2003).

And

$$MPK_i = f(l_i) - K_i f'(l_i)\frac{B_i L_i}{{K_i}^2} = f(l_i) - l_i f'(l_i) \quad \text{A17}$$

So, we get the MRS_i dividing MPK_i by MPL_i and since in equilibrium each factor is paid its marginal product, we have:

$$\frac{r_i}{w_i} = \frac{f(l_i) - l_i f'(l_i)}{B_i f'(l_i)} \quad \text{A18}$$

Taking the derivative of r_i/w_i with respect to l_i:

$$\frac{d(r_i/w_i)}{d(l_i)} = \frac{\{f'(l_i) - [f'(l_i) + l_i f''(l_i)]\}B_i f'(l_i) - B_i f''(l_i)[f(l_i) - l_i f'(l_i)]}{[B_i f'(l_i)]^2}$$

$$\frac{d(r_i/w_i)}{d(l_i)} = \frac{f''(l_i)f(l_i)}{[B_i f'(l_i)]^2} \quad \text{A19}$$

Note that $l_i = \frac{B_i}{(K_i/L_i)}$ so:

$$\frac{d(l_i)}{d(K_i/L_i)} = -\frac{B_i}{(K_i/L_i)^2} = \frac{l_i}{(K_i/L_i)} \quad \text{A20}$$

Using the chain rule and substituting A19 and A20 we have:

$$\frac{d(r_i/w_i)}{d(K_i/L_i)} = \frac{d(r_i/w_i)}{d(l_i)}\frac{d(l_i)}{d(K_i/L_i)} = \frac{l_i f''(l_i)f(l_i)}{(K_i/L_i)B_i[f'(l_i)]^2} \quad \text{A21}$$

And by the inverse function theorem we get:

$$\frac{d(K_i/L_i)}{d(r_i/w_i)} = \frac{(K_i/L_i)B_i[f'(l_i)]^2}{l_i f''(l_i)f(l_i)} \quad \text{A22}$$

Finally, by multiplying A18 and A22 and dividing by (K_i/L_i) we conclude that:

$$\sigma_i = \frac{d(K_i/L_i)}{d(r_i/w_i)}\frac{r_i/w_i}{K_i/L_i} = \frac{(K_i/L_i)B_i[f'(l_i)]^2}{l_i f''(l_i)f(l_i)}\frac{f(l_i) - l_i f'(l_i)}{(K_i/L_i)B_i f'(l_i)}$$

$$\sigma_i = \frac{f'(l_i)[f(l_i) - l_i f'(l_i)]}{l_i f''(l_i) f(l_i)} = \frac{f(l_i)}{l_i f''(l_i)}\left[1 - \frac{l_i f'(l_i)}{f(l_i)}\right] \quad \text{A23}$$

(iii) Estimation of TFP and Markup at the firm level

The markup is commonly defined as the price of output divided by the marginal cost (i.e., the ability of a firm to set a price which is above its marginal costs). Measuring markups is notoriously a hard task for economists since marginal cost data are not readily available. Three distinct approaches have been developed to measure markups. (i) The first approach, the so called "accounting approach" relies on directly observable gross (or net) margins of profits. (ii) The second approach, developed within the boundaries of the Industrial Organization, is based on the specification of a specific demand system that provides the price-elasticity of demand (Berry et al., 1995). Then, putting together the recovered information with the hypothesis about firms' competition, provides markups measures through the first order condition associated with the optimal pricing. (iii) Here, following De Loecker et al. (2020) we rely on a third approach, the production approach. This approach is based on the insight of Hall (1988) to estimate markups from the firm's cost minimization decision. Hall (1988) used industry aggregates, De Loecker and Warzynski (2012) recently proposes to estimate firm level markups. The method uses information from the firm's financial statements and the advantage is that it does not require any assumptions on demand and on competition patterns of firms. Markups are obtained by exploiting cost minimization of a variable input of production.

Consider an economy with N firms, indexed by $i = 1, \ldots, N$. Firms are heterogeneous in terms of their productivity (A_{it}) and production technology $Y_{it}(\cdot)$.[206] In each period t, firm i minimizes the contemporaneous cost of production given the production function:

$$Y_{it} = Y_{it}(A_{it}, V_{it}, K_{it}) \quad \text{A24}$$

[206] The expression to compute markups is derived from a general firm-specific production technology. The only requirement is the production function to be twice differentiable.

Where: $V = (V^1, \ldots, V^j)$ is a vector which contains all the variable inputs of production (including labor, intermediate inputs and raw materials)[207]; K_{it} is the capital stock and A_{it} is productivity. The key assumption is that within one period (a year in our data), variable inputs adjust without friction, whereas the fixed input (i.e., capital) is subject to adjustment costs and other frictions.[208] We can write the Lagrangian objective function associated with the firm's cost minimization problem in the following way:

$$\mathrm{L}(V_{it}, K_{it}, \lambda_{it}) = P^{VI}{}_{it} V_{it} + r_{it} K_{it} + F_{it} - \lambda_{it}(Y(\cdot) - \bar{Y}_{it}) \qquad \text{A25}$$

Where:

- P^{VI} is the price of the variable input;
- r_{it} is the user cost of capital;
- F_{it} is the fixed cost;
- $Y(\cdot)$ is the general technology of production;
- $\bar{Y}_{it}$ is a scalar and λ is the Lagrange multiplier.

If variable input prices are given to the firm. The first order condition with respect to the variable input V, is then given by:

$$\frac{\partial L_{it}}{\partial V_{it}} = P^{VI}{}_{it} - \lambda_{it} \frac{\partial Y(\cdot)}{\partial V_{it}} = 0 \qquad \text{A26}$$

Multiplying all terms in A26 by $\left(\frac{V_{it}}{Y_{it}}\right)$, and rearranging yields an expression for the output elasticity of input V:

$$\frac{\partial L_{it}}{\partial V_{it}} = \frac{P^{VI}{}_{it} V_{it}}{Y_{it}} - \lambda_{it} \frac{\partial Y(\cdot)}{\partial V_{it}} \frac{V_{it}}{Y_{it}} = 0$$

[207] In the implementation we use information on a bundle of variable inputs, and not the individual inputs, however, in the exposition we treat the vector L as a scalar.

[208] The conditional statement refers to the fact that it affects the factors of production that are dynamically chosen. E.g. if capital faces adjustment costs or simply time to build, the firm chooses variable inputs to minimize cost, given the level of capital that was set in the previous period.

$$\frac{P^{VI}{}_{it}V_{it}}{Y_{it}} - \lambda_{it}\frac{\partial Y(\cdot)}{\partial V_{it}}\frac{V_{it}}{Y_{it}} = \frac{P^{VI}{}_{it}V_{it}}{Y_{it}} - \lambda_{it}\theta^{v}{}_{it} = 0$$

$$\frac{P^{VI}{}_{it}V_{it}}{Y_{it}} = \lambda_{it}\alpha^{V}{}_{it}$$

$$\alpha^{V}{}_{it} = \frac{1}{\lambda_{it}}\frac{P^{VI}{}_{it}V_{it}}{Y_{it}} \qquad \text{A27}$$

i.e., the Lagrange multiplier λ is itself a direct measure of marginal cost. Therefore, since we define the markup as price to marginal cost ratio $\left(\mu_{it} = \frac{P_{it}}{\lambda_{it}}\right)$, where P is the output price. Substituting this expression for the markup into A27, we obtain a simple expression for the markup:

$$\lambda_{it} = \frac{P_{it}}{\mu_{it}}$$

$$\alpha^{V}{}_{it} = \frac{\mu_{it}}{P_{it}}\frac{P^{VI}{}_{it}V_{it}}{Y_{it}}$$

$$\mu_{it} = \alpha^{V}{}_{it}\frac{P_{it}Y_{it}}{P^{VI}{}_{it}V_{it}} = \alpha^{V}{}_{it}\left(\frac{P^{V}{}_{it}V_{it}}{P_{it}Y_{it}}\right)^{-1} \qquad \text{A28}$$

The markup derived in this way does not rely on the specification of any demand system. Note that with this approach to markup estimation, there are in principle multiple first order conditions (one for each of the variable input in production) that yield to an expression for the markup. However, regardless of which variable input of production is used, there are two key ingredients needed in order to measure the markup: (i) the revenue share of the variable input, $\frac{P^{V}{}_{it}V_{it}}{P_{it}Q_{it}}$, and (ii) the output elasticity of the variable input, $\alpha^{V}{}_{it}$. Therefore, the marginal cost of production is derived from a single variable input in production, without imposing any particular substitution elasticity with respect to other inputs in production (variable or fixed) or returns to scale. The only crucial component that we need for the estimation is the output elasticity of a variable input of production ($\alpha^{V}{}_{it}$). While the production approach to markup estimation, described in De Loecker and Warzynski (2012) does not restrict the output elasticity, when implementing this procedure, the estimation of this latter parameter is dependent on a specific production function, and assumptions of underlying producer behavior which are all necessary in order to identify and estimate the elasticity from the data. To this purpose we estimate a parametric Translog production function for each firm-year using recent techniques that consider the well-known potential biases discussed in the literature. This implies that $f(\cdot)$ is approximated by a second-order polynomial where all (logged) inputs, (logged) inputs squared, and interaction terms between all (logged) inputs are included. More specifically the Translog production technology with Hicks-neutral productivity employed as a production function on the value added takes the following form:

$$y_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_{ll} l^2{}_{it} + \beta_{kk} k^2{}_{it} + \beta_{lk} l_{it} k_{it} + \omega_{it} + \varepsilon_{it} \qquad \text{A29}$$

Where: all variables are in logs, y_{it} is value added of production, l_{it} and k_{it} denote labor and capital, respectively, and the βs are parameters. Total factor productivity (the TFP) is captured by ω and ε is the error term containing unanticipated shocks to the producer and measurement error. To allow for industry differences in the production technology parameters, we do the estimation procedure separately for 19 broad industry groups.[209] We measure value added with firm revenue less expenditures on material inputs, labor with the number of employees, and capital with the book value of tangible assets. Unfortunately, we observe neither physical quantities nor firm-level prices. Therefore, we deflate all variables with available industry specific price indices.[210] For robustness, we experimented also alternative specifications of the production function, including a Cobb-Douglas specification.

[209] These are the one-digit NACE industries from A to S.

[210] While the use of deflation is clearly inferior, De Loecker and Warzynski (2012) show that it affects only the level of the markup estimates, and not the correlation between markups and firm-level characteristics.

Appendix C: data appendix

(i) Data sources and definition of variables

The variables we use in the estimation are constructed from AMADEUS - Bureau Van Dijk database. AMADEUS is a database of comparable financial information for public and private companies across Europe. It covers the period 2011-19, with disaggregated data on a sufficient scale for all the variables employed. On the other hand, deflators used to compute the real value of the variables are obtained from the National accounts aggregates by industry (up to NACE A*64) of Eurostat (nama_10_a64). The variables we use are as follows (original AMADEUS variables are denoted by their full name in parentheses):

- E = Number of employees (key financial & employees);
- CE = Compensation of employees, at current prices, thousand Euro (Costs of employees);[211]
- YN= Value added at market prices, current prices, thousand Euro (Added Value) ;
- YR = Value added at market prices, 2010 prices, thousand Euro;
- Def= Price index (implicit deflator), 2010=100, euro (PD10_EUR);
- KT = Gross (tangible) capital stock at market prices, current prices, thousand Euro (Tangible fixed assets);
- KINT = Gross (intangible) capital stock at market prices, current prices, thousand Euro (Intangible fixed assets);
- DA = Depreciation & Amortization, current prices, thousand Euro;
- K = (KT+KINT)-DA;
- Capital-output ratio: k = K/YN;
- Labor share: LS = (CE/E)/YN;
- TFP(CD) = TFP computed with the Cobb-Douglass specification;
- TFP(TL) = TFP computed with the Translog specification;
- MARKUP(CD) = Markup computed with the Cobb-Douglass specification;
- MARKUP(TL) = Markup computed with the Translog specification.

The sectoral breakdown we follow refers to the statistical classification of economic activities in the European Community, commonly referred to as NACE and used distinguishes between 21 industries at the level 1 of disaggregation (identified by alphabetical letters A to U). The number of observations available for the econometric estimation by country and industry are shown in Tables A13 and A14.

[211] Like in the national accounts, total compensation of employees reported by individual firms includes non-wage expenses, such as pension and health insurance expenses, as well as social security contributions.

NACE	N. of firms	lk<0.77	lk>0.77	% total
A	19582	3217	16365	2.73%
B	2696	485	2211	0.38%
C	160960	59548	101412	22.48%
D	5548	287	5261	0.77%
E	7823	2549	5274	1.09%
F	72792	30952	41840	10.17%
G	199583	46422	153161	27.87%
H	41054	22252	18802	5.73%
I	33865	19144	14721	4.73%
J	22763	14024	8739	3.18%
K	43298	5915	37383	6.05%
L	18756	8952	9804	2.62%
M	26232	13140	13092	3.66%
N	26613	18099	8514	3.72%
O	4588	3244	1344	0.64%
P	10327	6937	3390	1.44%
Q	7521	5948	1573	1.05%
R	7415	3603	3812	1.04%
S	4656	2941	1715	0.65%
T	18	16	2	0.00%
U	4	2	2	0.00%
Total	716094	267677	448417	100%

Table A13 - Number of unique firms by industry.

Source: Authors' calculation on AMECO data.

NACE	N. of obs	lk<0.77	lk>0.77	% total
A	97377	14664	82713	2.90%
B	13249	2113	11136	0.39%
C	848415	284927	563488	25.23%
D	24720	1142	23578	0.74%
E	38573	11960	26613	1.15%
F	324038	126389	197649	9.64%
G	951841	194500	757341	28.31%
H	193493	99783	93710	5.75%
I	144411	75287	69124	4.29%
J	101097	61486	39611	3.01%
K	163971	21929	142042	4.88%
L	77998	37737	40261	2.32%
M	114189	55378	58811	3.40%
N	111648	74376	37272	3.32%
O	19744	13483	6261	0.59%
P	49230	31974	17256	1.46%
Q	35751	28138	7613	1.06%
R	32307	15124	17183	0.96%
S	20468	12493	7975	0.61%
T	69	66	3	0.00%
U	8	6	2	0.00%
Total	3362597	1162955	2199642	100%

Table A14 - Number of observations by industry.

Source: Authors' calculation on AMECO data.

References

Acemoglu, D., and Guerrieri, V. (2008). Capital deepening and nonbalanced economic growth. *Journal of political Economy 116.3*, 467-498.

Acemoglu, D., and Restrepo, P. (2018). The race between man and machine: Implications of technology for growth, factor shares, and employment. *American Economic Review 108.6*, 1488-1542.

Adrjan, P. (2018). The mightier, the stingier: Firms' market power, capital intensity, and the labor share of income. *Munich Personal RePEc Archive*.

Aghion, P., Caroli, E., and Garcia-Penalosa, C. (1999). Inequality and economic growth: the perspective of the new growth theories. *Journal of Economic literature 37.4*, 1615-1660.

Aiken, L. S., West, S. G., and Reno, R. R. (1991). Multiple regression: Testing and interpreting interactions. *Sage*.

Alvarez-Cuadrado, F., Van Long, N., and Poschke, M. (2018). Capital-labor substitution, structural change and the labor income share. *Journal of Economic Dynamics and Control 87*, 206-231.

An, Z., Kangur, A., and Papageorgiou, C. (2019). On the substitution of private and public capital in production. *European Economic Review 118,* 296-311.

Antras, P. (2004). Is the US aggregate production function Cobb-Douglas? New estimates of the elasticity of substitution. *The BE Journal of Macroeconomics 4.1*.

Aradanaz-Badia, A., Awano, G., and Wales, P. (2017). *Understanding firms in the bottom 10% of the labour productivity distribution in Great Britain:"the laggards", 2003 to 2015*. Retrieved from London.

Arpaia, A., Pérez, E., and Pichelmann, K. (2009). Understanding labour income share dynamics in Europe. *European Commission Economic Papers 379 | May*.

Arrow, K. J., et al., e. (1961). Capital-labor substitution and economic efficiency. *The review of Economics and Statistics*, 225-250.

Atkinson, A. B. (2009). Factor shares: the principal problem of political economy? *Oxford Review of Economic Policy 25.1*, 3-16.

Autor, D. H., and Dorn, D. (2013). The growth of low-skill service jobs and the polarization of the US labor market. *American Economic Review 103.5*, 1553-97.

Autor, D. H., Dorn, D., and Hanson, G. H. (2016). The China shock: Learning from labor-market adjustment to large changes in trade. *Annual Review of Economics 8*, 205-240.

Autor, D., et al., e. (2017). A note on the effect of rising trade exposure on the 2016 presidential election. *Appendix to "Importing Political Polarization"*.

Autor, D., et al., e. (2020). The Fall of the Labor Share and the Rise of Superstar Firms. *The Quarterly Journal of Economics 135.2*, 645-709.

Azmat, G., Manning, A., and Van Reenen, J. (2012). Privatization and the decline of labour's share: international evidence from network industries. *Economica 79.315*, 470-492.

Baldwin, R. (2016). *The great convergence.* Harvard University Press.

Barnes, S. N., Price, S., and Barriel, M. (2008). The elasticity of substitution: evidence from a UK firm-level data set. *Bank of England - Working Paper No. 348*.

Bassanini, A., and Duval, R. (2009). Unemployment, institutions, and reform complementarities: re-assessing the aggregate evidence for OECD countries. *Oxford Review of Economic Policy 25.1*, 40-59.

Bassanini, A., and Manfredi, T. (2012). Capital's grabbing hand? A cross-country/cross-industry analysis of the decline of the labour share. *OECD Social, Employment and Migration Working Papers*.

Bauer, A., and Boussard, J. (2019). Market Power and Labor Share. *[Pouvoir de marché et part du travail]. No. hal-02353137*.

Bell, B. D., and Van Reenen, J. (2013). Extreme wage inequality: pay at the very top. *American economic review 103.3*, 153-57.

Bellocchi, A. (2020). Variable Elasticity of Substitution, imperfect competition and the decline of the labor shares.

Benjamin, B., and Demougin, D. (2010). Declining labor shares and bargaining power: An institutional explanation. *Journal of Macroeconomics 32.1*, 443-456.

Bentolila, S., and Saint-Paul, G. (2003). Explaining movements in the labor share. *The BE Journal of Macroeconomics 3.1*.

Berg, A. G., and Ostry, J. D. (2017). Inequality and unsustainable growth: Two sides of the same coin? *IMF Economic Review 65.4*, 792-815.

Berkowitz, D., Ma, H., and Nishioka, S. (2017). Does Capital-Labor Substitution or Do Institutions Explain Declining Labor Shares? *University of Pittsburgh*.

Berry, S., Levinsohn, J., and Pakes, A. (1995). Automobile prices in market equilibrium. *Econometrica: Journal of the Econometric Society*, 841-890.

Blanchard, O. J., Nordhaus, W. D., and S. Phelps, E. (1997). The medium run. *Brookings Papers on Economic Activity 1997.2*, 89-158.

Blanchard, O., and Giavazzi, F. (2003). Macroeconomic effects of regulation and deregulation in goods and labor markets. *The Quarterly journal of economics 118.3*, 879-907.

Böckerman, P., and Maliranta, M. (2012). Globalization, creative destruction, and labour share change: evidence on the determinants and mechanisms from longitudinal plant-level data. *Oxford Economic Papers 64.2*, 259-280.

Boldrin, M., and Horvath, M. (1995). Labor contracts and business cycles. *Journal of Political Economy 103.5*, 972-1004.

Brambor, T., Clark, W. R., and Golder, M. (2006). Understanding interaction models: Improving empirical analyses. *Political analysis 14.1*, 63-82.

Braumoeller, B. F. (2004). Hypothesis testing and multiplicative interaction terms. *International organization*, 807-820.

Bridgman, B. (2018). Is labor's loss capital's gain? Gross versus net labor shares. *Macroeconomic Dynamics 22.8* , 2070-2087.

Bucci, A., and Del Bo, C. (2012). On the interaction between public and private capital in economic growth. *Journal of Economics 106.2*: 133-152.

Burke, J., and Epstein, G. (2001). Threat effects and the internationalization of production. *PERI Working Papers*: 29.

Caballero, R. J., and Hammour, M. L. (1998). Improper churn: Social costs and macroeconomic consequences. *No. w6717. National bureau of economic research*.

Castaneda, A., Dıaz-Giménez, J., and Rıos-Rull. J.-V. (1998) Exploring the income distribution business cycle dynamics. *Journal of Monetary economics 42.1*, 93-130.

Charpe, M. (2011). The labour share of income: Determinants and potentialcontribution to exiting the financial crisis. *World of Work Report*, 55-74.

Charpe, M., Bridji, S., and McAdam, P. (2019). Labor share and growth in vthe long run. *ECB Working Paper Series No 2251 / March 20*.

Chirinko, R. S., and Mallick, D. (2017). The substitution elasticity, factor shares, and the low-frequency panel model. *American Economic Journal: Macroeconomics 9.4*, 225-53.

Choi, S., and Rios-Rull, J.-V. (2009). Understanding the dynamics of labor share: The role of noncompetitive factor prices. *Annals of Economics and Statistics/Annales d'Economie et de Statistique*, 251-277.

Costinot, A., and Rodríguez-Clare, A. (2014). Trade theory with numbers: Quantifying the consequences of globalization. *Handbook of international economics. Vol. 4. Elsevier*, 197-261.

Cournède, B., Denk, O., and Garda, P. (2016). Effects of flexibility-enhancing reforms on employment transitions. *OECD Economics Department Working Papers*.

Dall'Aglio, V., Magnani, M., and Marchini, P. L. (2015). A Firm-level Analysis of the Italian Labor Share. *Rivista Internazionale di Scienze Sociali*, 179-210.

Dao, M., Das, M., Koczan, Z., and Lian, W. (2017). Why is Labor Receiving a Smaller Share of Global Income? Theory and Empirical Evidence. *IMF Working Paper*.

De La Grandville, O. (1989). In quest of the Slutsky diamond. *The American Economic Review*, 468-481.

De Loecker, J., and Warzynski, F. (2012). Markups and firm-level export status. *American economic review 102.6*, 2437-71.

De Loecker, J., Eeckhout, J., and Unger, G. (2020). The rise of market power and the macroeconomic implications. *The Quarterly Journal of Economics 135.2*, 561-644.

De Serres, A., Scarpetta, S., and De La Maisonneuve, C. (2002). Sectoral shifts in Europe and the United States: how they affect aggregate labour shares and the properties of wage equations. *OECD Economics Department No. 326*.

Dimova, D. (2019). The Structural Determinants of the Labor Share in Europe. *International Monetary Fund*.

Donaldson, D. (2015). The gains from market integration. *Economics 7.1*, 619-647.

Driver, C., and Muñoz-Bugarin, J. (2010). Capital investment and unemployment in Europe: Neutrality or not? *Journal of Macroeconomics 32.1*, 492-496.

Duffy, J., and Papageorgiou, C. (2000). A cross-country empirical investigation of the aggregate production function specification. *Journal of Economic Growth 5.1*, 87-120.

Eden, Maya, and Gaggl, P. (2015). *Do poor countries really need more IT? the role of relative prices and industrial composition*. The World Bank.

Elsby, M. W., Hobijn, B., and Şahin, A. (2013). The decline of the US labor share. *Brookings Papers on Economic Activity 2013.2* , 1-63.

Espinosa, M. P., and Rhee, C. (1989). Efficient wage bargaining as a repeated game. *The Quarterly Journal of Economics 104.3*, 565-588.

European Commission (EC). (2007). The labour income share in the European Union. *Employment in Europe 2007, Directorate-General for Employment, Social Affairs and Equal Opportunities (Brussels)*, 237-72.

Fajgelbaum, P. D., and Khandelwal, A. K. (2016). Measuring the unequal gains from trade. *The Quarterly Journal of Economics 131.3*, 1113-1180.

Fanti, L. (2015). Union-firm bargaining agenda: Right-to-manage or efficient bargaining. *Economics Bulletin 35.2*, 936-948.

Fichtenbaum, R. (2011). Do unions affect labor share of income: Evidence using panel data. *American Journal of Economics and Sociology 70.3*, 784-810.

Garrido Ruiz, C. (2005). Are factor shares constant? An empirical assessment from a new perspective. *Working paper available at http://www.eco.uc3m.es*.

Gollin, D. (2002). Getting income shares right. *Journal of political Economy 110.2*, 458-474.

Gomme, P., and Greenwood, J. (1995). On the cyclical allocation of risk. *Journal of Economic dynamics and control* 19.1-2, 91-124.

Goos, M., Manning, A., and Salomons, A. (2014). Explaining job polarization: Routine-biased technological change and offshoring. *American economic review 104.8*, 2509-26.

Grossman, G. M., and al., e. (2017). The productivity slowdown and the declining labor share: A neoclassical exploration. *No. w23853. National Bureau of Economic Research*.

Growiec, J, McAdam, P., and Mućk, J. (2018). Endogenous labor share cycles: Theory and evidence. *Journal of Economic Dynamics and Control 87*, 74-93.

Guerriero, M., and Sen, K. (2012). What determines the share of labour in national income? A cross-country analysis. *IZA Discussion Papers 6643. Institute for the Study of Labor (IZA)*.

Guscina, A. (2006). Effects of Globalization on Labors Share in National Income. *IMF Working Paper, 06/294, Washington, DC*.

Hainmueller, J., Mummolo, J., and Xu, Y. (2019). How much should we trust estimates from multiplicative interaction models? Simple tools to improve empirical practice. *Political Analysis 27.2*, 163-192.

Hall, R. E. (1988). The relation between price and marginal cost in US industry. *Journal of political Economy 96.5*, 921-947.

Hamermesh, D. S., and Pfann, G. A. (1996). Adjustment costs in factor demand. *Journal of Economic Literature 34.3*, 1264-1292.

Harrison, A. (2005). Has globalization eroded labor share? Some cross-country evidence. *Munich Personal RePEc Archive.*

Herrendorf, B., Herrington, C., and Valentinyi, A. (2015). Sectoral technology and structural transformation. *American Economic Journal: Macroeconomics 7.4*, 104-33.

Hwang, D., and Lee, B. (2015). Wage share and corporate policies in personnel management in Korea: A firm-level study. *ILO, mimeo*.

Ibarra, C. A., and Ros, J. (2017). The decline of the labour share in Mexico: 1990-2015. *No. 2017/183. WIDER Working Paper*.

International Labor Organization (ILO). (2012). Global Wage Report 2012/13: Wages and Equitable Growth.

International Labor Organization (ILO). (2015). Global Wage Report 2014/15. *Inclusive Labour Markets, Labour Relations and Working Conditions Branch (INWORK)*.

International Labour Organization Organisation for Economic Co-operation and Development. (2012). The Labour Share in G20 Economies. *Report prepared for the G20 Employment Working Group*.

International Monetary Fund (IMF). (2007). The globalization of labor. *World Economic Outlook, April 2007: Spillovers and cycles in the world economy (Washington, DC)*, 161-92.

International Monetary Fund (IMF). (2017). Understanding the Downward Trend in Labor Income Shares. *World Economic Outlook: Gaining Momentum?*, 121-172.

Jayadev, A. (2007). Capital account openness and the labour share of income. *Cambridge Journal of Economics 31.3*, 423-443.

Kaldor, N. (1961). *Capital accumulation and economic growth. The theory of capital.* London: Palgrave Macmillan.

Kalt, J. P. (1978). Technological change and factor substitution in the United States: 1929-1967. *International Economic Review*, 761-775.

Kaplan, G., and Zoch, P. (2020). Markups, Labor Market Inequality and the Nature of Work. *No. w26800. National Bureau of Economic Research*.

Karabarbounis, L., and Neiman, B. (2014). The global decline of the labor share. *The Quarterly journal of economics 129.1*, 61-103.

Karagiannis, G., Palivos, T., and Papageorgiou, C. (2005). Variable elasticity of substitution and economic growth: theory and evidence. In *New trends in macroeconomics* (p. 21-37). Berlin, Heidelberg: Springer.

Kazi, U. A. (1980). The variable elasticity of substitution production function: a case study for Indian manufacturing industries. *Oxford Economic Papers 32.1*, 163-175.

Kehrig, M., and Vincent, N. (2018). The micro-level anatomy of the labor share decline. *No. w25275. National Bureau of Economic Research*.

King, G., and Zeng, L. (2006). The dangers of extreme counterfactuals. *Political Analysis 14.2*, 131-159.

Klump, R., McAdam, P., and Willman, A. (2012). The normalized CES production function: theory and empirics. *Journal of Economic Surveys 26.5*, 769-799.

Knoblach, M., and Stöckl, F. (2019). What determines the elasticity of substitution between capital and labor? A literature review. *CEPIE Working Paper. No. 01/19*.

Koh, D., Santaeulalia-Llopis, and Raul Zheng, Y. (2019). Labor share decline and intellectual property products capital. *Working Paper*.

Krueger, A. B. (1999). Measuring labor's share. *American Economic Review 89.2*, 45-51.

Kohler, K. A. (2019). The impact of financialisation on the wage share: a theoretical clarification and empirical test. *Cambridge Journal of Economics 43.4*, 937-974.

Krusell, P., Ohanian, L., and Ríos-Rull, J. (2000). Capital-skill complementarity and inequality: A macroeconomic analysis. *Econometrica 68.5*, 1029-1053.

Lawless, M., and Whelan, K. T. (2011). Understanding the dynamics of labor shares and inflation. *Journal of Macroeconomics 33.2*, 121-136.

Layard, R., et al., e. (2005). Unemployment: macroeconomic performance and the labour market. *Oxford University Press.*

León-Ledesma, M. A., McAdam, P., and Willman, A. (2015). Production technology estimates and balanced growth. *Oxford Bulletin of Economics and Statistics 77.1*, 40-65.

Lichter, A., Peichl, A. and Siegloch, S. (2015). The own-wage elasticity of labor demand: A meta-regression analysis. *European Economic Review 80*, 94-119.

Lovell, C. K. (1973). Estimation and prediction with CES and VES production functions. *International Economic Review*, 676-692.

Lucas, R. E. (1969). Labor-capital substitution in US manufacturing. *The taxation of income from capital*, 223-274.

McDonald, I. M., and Solow, R. M. (1984). Union wage policies: Reply." *The American Economic Review 74.4*, 759-761.

Meyer, R. A., and Kadiyala, K. R. (1974). Linear and nonlinear estimation of production functions. *Southern Economic Journal*, 463-472.

Miyagiwa, K., and Papageorgiou, C. (2007). Endogenous aggregate elasticity of substitution. *Journal of Economic Dynamics and Control 31.9*, 2899-2919.

Mrázová, M., and Neary, J. P. (2017). Not so demanding: Demand structure and firm behavior. *American Economic Review 107.12*, 3835-74.

Mućk, J. (2017). Elasticity of substitution between labor and capital: robust evidence from developed economies. *Narodowy Bank Polski. Education & Publishing Department*.

Nayar, N. P., Flaaen, A., and Boehm, C. (2015). Input Linkages and the Transmission of Shocks: Firm-Level Evidence from the 2011 Tohoku Earthquake. *2015 Meeting Papers. No. 383. Society for Economic Dynamics*.

Nekarda, C. J., and Ramey, V. A. (2013). The cyclical behavior of the price-cost markup. *No. w19099. National Bureau of Economic Research*.

Oberfield, E., and Raval, D. (2014). Micro data and macro technology. *No. w20452. National Bureau of Economic Research*.

Ollivaud, P., Guillemette, Y., and Turner, D. (2016). Links between Weak Investment and the Slowdown in Productivity and Potential Output Growth across the OECD. *OECD Economics Department Working Papers, Organisation for Economic Co-operation and Development, Paris.*

Organisation for Economic Co-operation and Development (OECD). (2012). "Labour Losing to Capital", Supporting Material for Chapter 3 of the 2012 OECD Employment Outlook. *OECD Publishing*.

Organisation for Economic Co-operation and Development (OECD). (2012). *Employment Outlook, Paris*.

Pak, M., and Schwellnus, C. (2019). Labour share developments over the past two decades: The role of public policies. *OECD Economics Department Working Papers.*

Palivos, T. (2008). Comment on "σ: The long and short of it" . *Journal of Macroeconomics 30.2*, 687-690.

Paul, S. (2019). A Skeptical Note on the Role of Constant Elasticity of Substitution in Labor Income Share Dynamics. *ADBI Working Paper Series*.

Paul, S. (2019). Labor Income Share Dynamics with Variable Elasticity of Substitution. *IZA DP No. 12418*.

Perugini, C., Vecchi, M., and Venturini, F. (2017). Globalisation and the decline of the labour share: A microeconomic perspective. *Economic Systems 41.4*, 524-536.

Peters, J. (2008). Labour market deregulation and the decline of labour power in North America and Western Europe. *Policy and Society 27.1*, 83-98.

Pierce, J. R., and Schott, P. K. (2016). The surprisingly swift decline of US manufacturing employment. *American Economic Review 106.7*, 1632-62.

Piketty, T. (2014). *Capital in the 21st Century.* Harvard University Press.

Piketty, T., and Zucman, G. (2014). Capital is back: Wealth-income ratios in rich countries 1700-2010. *The Quarterly Journal of Economics 129.3*, 1255-1310.

Raurich, X., Sala, H., and Sorolla, V. (2012). Factor shares, the price markup, and the elasticity of substitution between capital and labor. *Journal of Macroeconomics 34.1*, 181-198.

Raval, D. R. (2019). The micro elasticity of substitution and non-neutral technology. *The RAND Journal of Economics 50.1*, 147-167.

Revankar, N. S. (1971). A class of variable elasticity of substitution production functions. *Econometrica: Journal of the Econometric Society*, 61-71.

Ricardo, D. (1911). *On the principles of political economy.* London: J. Murray.

Rodriguez, F., and Jayadev, A. (2010). The declining labor share of income. *Journal of Globalization and Development 3.2*, 1-18.

Rotemberg, J. J., and Woodford, M. (1999). The cyclical behavior of prices and costs. *Handbook of macroeconomics 1*, 1051-1135.

Ruiz, C. G. (2005). Are factor shares constant? An empirical assessment from a new perspective. *Working paper uc3m*.

Sala, H., and Trivín, P. (2014). The decline of the labor income share: a reappraisal of the driving forces. *XXXIX Symposium of Spanish Economic Association, Palma de Mallorca, Spain*.

Sato, R., and Hoffman, R. F. (1968). Production functions with variable elasticity of factor substitution: some analysis and testing. *The Review of Economics and Statistics*, 453-460.

Schneider, D. (2011). The labor share: A review of theory and evidence. *No. 2011-069. SFB 649 discussion paper*.

Smith, M. (2019). Capitalists in the Twenty-first Century. *The Quarterly Journal of Economics 134.4*, 1675-1745.

Stock, J. H., and Watson, M. W. (2018). *Introduction to Econometrics.* Pearson Series in Economics.

Stockhammer, E. (2017). Determinants of the wage share: a panel analysis of advanced and developing economies. *British Journal of Industrial Relations 55.1*, 3-33.

Suchanek, L. (2009). Labour shares and the role of capital and labour market imperfections. *No. 2009-2. Bank of Canada Discussion Paper*.

Torrini, R. (2005). Profit share and returns on capital stock in Italy: the role of privatisations behind the rise of the 1990s. *NoCentre for Economic Performance, London School of Economics and Political Science*.

Torrini, R. (2016). Labour, profit and housing rent shares in Italian GDP: long-run trends and recent patterns. *Questioni di Economia e Finanza (Occasional Papers). N. 318*.

Tsang, H. H. (1976). A generalized model for the CES-VES family of production function. *Metroeconomica 28.1-2-3*, 107-118.

Vogel, T. (2007). Union wage compression in a Right-to-Manage model. *No. 2007, 009. SFB 649 discussion paper*.

Wacziarg, R., and Welch, K. H. (2008). Trade liberalization and growth: New evidence. *The World Bank Economic Review 22.2*, 187-231.

Weil, D. (2014). *The fissured workplace.* Harvard University Press.

Wolff, E. N. (2017). Household Wealth Trends in the United States, 1962 to 2016: Has Middle Class Wealth Recovered? *No. w24085. National Bureau of Economic Research*.

Young, A. T. (2013). US elasticities of substitution and factor augmentation at the industry level. *Macroeconomic Dynamics 17*, 861-897.

Zellner, A., and Ryu, H. (1998). Alternative functional forms for production, cost and returns to scale functions. *Journal of Applied Econometrics 13.2*, 101-127.

Chapter 4: Macroeconomic implications of a changing income distribution

Alessandro Bellocchi[1]

Abstract

Recent economic research highlights the macroeconomic dimension of income distribution, but currently, no comprehensive theory has yet emerged in the field. In this paper, we introduce new elements into a standard macroeconomic growth model and develop a Post-Keynesian model which allows us to acquire valuable insights on the macroeconomic effects of a changing income distribution. We find, analytically, that: (i) income distribution matters mostly in the medium run; (ii) real wage restraint policies along with less restrictive labor market legislation can depress capital accumulation and growth; (iii) a decline in EPL may reduce the equilibrium unemployment. However, this latter result is obtained at the expenses of both demand and productivity growth. This means that the jobs created are not only of low productivity but also low-paid. Turning to the empirical part of the paper we tested the predictions of the model by estimating the impact of a change in labor share on economic growth in a sample of 20 OECD countries. We analyzed the interaction among different economies and calculate the global effects of a simultaneous decline. At the national level, a decrease in the labor share leads to lower growth in Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain and Sweden; whereas it stimulates growth in Australia, Canada, Ireland, United Kingdom and the United States. However, a simultaneous decline in all these countries has a negative impact on global growth. Finally, we turn our attention to the long-run dynamics of the model by means of a structural vector autoregression (VAR). We focus on the relationship between labor productivity, employment, effective demand, capital accumulation, income distribution and labor market regulation. The VAR model composed as follows is estimated for France, Germany, Italy, Spain, the UK and the USA. We find that employment is demand-led, and that income distribution may influence either demand or employment. Finally, technological progress affects income distribution as well as employment. The policy conclusions of the paper shed light on the limits of international competitiveness strategies based on wage competition in an integrated global economy.

Keywords: Income distribution, Capital accumulation, Economic growth, Vector autoregression (VAR).

[1] Department of Economics, Society and Politics (DESP); University of Urbino Carlo Bo, Italy. e-mail: alessandro.bellocchi@uniurb.it.

1. Introduction

National income is the sum of all disposable income for residents of a given country each year. The division of national income between labor and capital is usually defined "functional income distribution". The labor income share (or more simply the labor share) is the part of national income allocated to labor compensation, while the capital share is the part of national income that goes to remunerate capital.[2] Labor shares have been considered relatively stable for a long period of time and hence attracted little attention from either academia or economic policy discussions. Indeed, they used to fluctuate between 68% and 72% before 1980. However, in recent years, a growing and consistent body of empirical evidence suggests that labor shares have witnessed a secular downward trend with important and negative consequences for the aggregate economy. For instance, in a scenario characterized by declining labor shares, improvements in macroeconomic indicators would not necessarily translate into improvements in the personal condition of households (Atkinson, 2009). Data show that over time and across countries, a higher capital share is associated with higher personal inequality (Piketty, 2013; Piketty and Zucman, 2014; Karabarbounis and Neiman, 2014). From a theoretical point of view, at least until the 1980s, a stable labor share was considered by economists as a “stylized fact” of economic growth (Kaldor, 1961).[3] In recent decades, however, this conventional wisdom has been challenged. This happened along with a polarization of personal income distribution that took place in either developed or developing countries. The labor shares reached their lowest level of the past half century just before the global financial crisis of 2008 and have not recovered since then. If we look to the data we have, for example, that over the period from 1980 to 2019 the share of labor compensation in national income declined in 29 out of 40 (33 if we measure it at current prices instead of factor cost) advanced countries for which data is available, and the median (adjusted) labor share of national income across these countries fell from 68 per cent to 60 per cent (-0.13% a year) and from 61% to

[2] The labor share is calculated as the ratio of total compensation of employees (wages and salaries before taxes, as well as employers' social contributions) over a product/income aggregate, such as the GDP. However, in this form the labor share is likely to be a lower bound of the real one, since the total compensation of employees in national accounts do not include the part of income generated by the self-employed. This latter is recorded under "Mixed Income" and its attribution to either labor or capital is unclear due to the fact that reflects both the return on labor and capital investment. The most common solution to the problem and the one adopted in this paper consist in assuming that the wage rate of the self-employed is equal to the average wage of a normal employee.

[3] These empirical findings date back to the early 20th century, when Arthur Bowley first observed such regularity in British data from the 19th and 20th centuries and formulated the so-called “Bowley's Law”. Later on, Paul Douglas made a similar finding regarding the labor share in the US, and developed together with Charles Cobb, the Cobb-Douglas production function, which imply a constant functional distribution of income. Keynes described this constancy as “a bit of a miracle” (Keynes, 1939) and Solow questioned the reliability of the empirical evidence (Solow, 1958).

53% (-0.14%) (Figure 1 - panel b).[4] Interestingly, over the past two decades, the negative trend has been observed both in recession-hit advanced economies such as Ireland, Portugal and Spain, and in economically prosperous ones such as Germany and the Netherlands. Some of the developing western EU countries, i.e., Estonia, Hungary, Latvia and Lithuania experienced a decline in 2009-15 and are now on the rebound. In contrast, other new member states such as Croatia, Poland and Romania have now returned to their 2002 levels.[5] A more recent OECD calculation finds that the average (adjusted) labor share in G20 countries went down by about 0.3 percent a year between 1980 and the late 1990s. Similar trends have been observed by other international agencies (IMF, 2017; EC, 2019; ILO, 2019). It is worth noting that this coincided in time with the introduction of neoliberal policy reforms since the early 80s (Figure 1 - panels a and b) where, with this latter expression we refer to all market-oriented reform policies - like for instance the elimination of price controls, the deregulation of capital markets, the lowering of barriers to trade and capital movements. These actions were understood as an attempt to modernize the economy aiming to stimulate private investment and exports, with the expectation of generating a more stable economic growth and more jobs. In this context, scholars of the Post-Keynesian literature argue that financialization and Neoliberalism represented an important driver for the fall of the aggregate labor share (Hein, 2015; Barradas, 2019). Tree main channels have been identified. (i) The first one involves a change in the sectorial composition of economies, through growth in the financial sector and a reduction in government activity. This channel and more generally the reallocation of value added between sectors has been extensively analyzed in the second paper of this thesis (Bellocchi, 2020). (ii) The second channel is related to the emergence of a corporate governance model primarily oriented towards shareholder value. (iii) Finally, a last one concerns the deterioration of the collective bargaining power exerted by trade unions. As a result, several empirical studies have emerged in recent years to assess the relationship these tendencies and aggregate labor shares. Most of these studies derive and estimate labor share equations, finding statistical evidence that Neoliberalism and financialization have largely contributed to its decline (Cohen and Angel Centeno, 2006; Hermann, 2007; Kristal 2010; Amable at al., 2011; Dünhaupt 2013; Stockhammer at al., 2015; Appel and Orenstein, 2016; Köhler et al., 2018).

[4] A number of international institutions provide estimates on labor shares. The annual macroeconomic database (AMECO) of the European Commission) includes a dataset based on National Accounts on the adjusted labor shares for 48 countries of the world. The labor share is calculated as the compensation of employees over GDP (total economy) multiplied by total employment. From the two published series - market prices and factor costs - the long-term downward trend is quite evident, Figure 1. AMECO calculates the adjusted labor share with GDP at market prices as well as with GDP at current factor cost (i.e. minus taxes and plus subsidies). According to Guerriero (2019) the latter is more significant, since taxes do not represent any kind of return to capital or labor.

[5] The only exception is Bulgaria whose labor share has been on an upward trend.

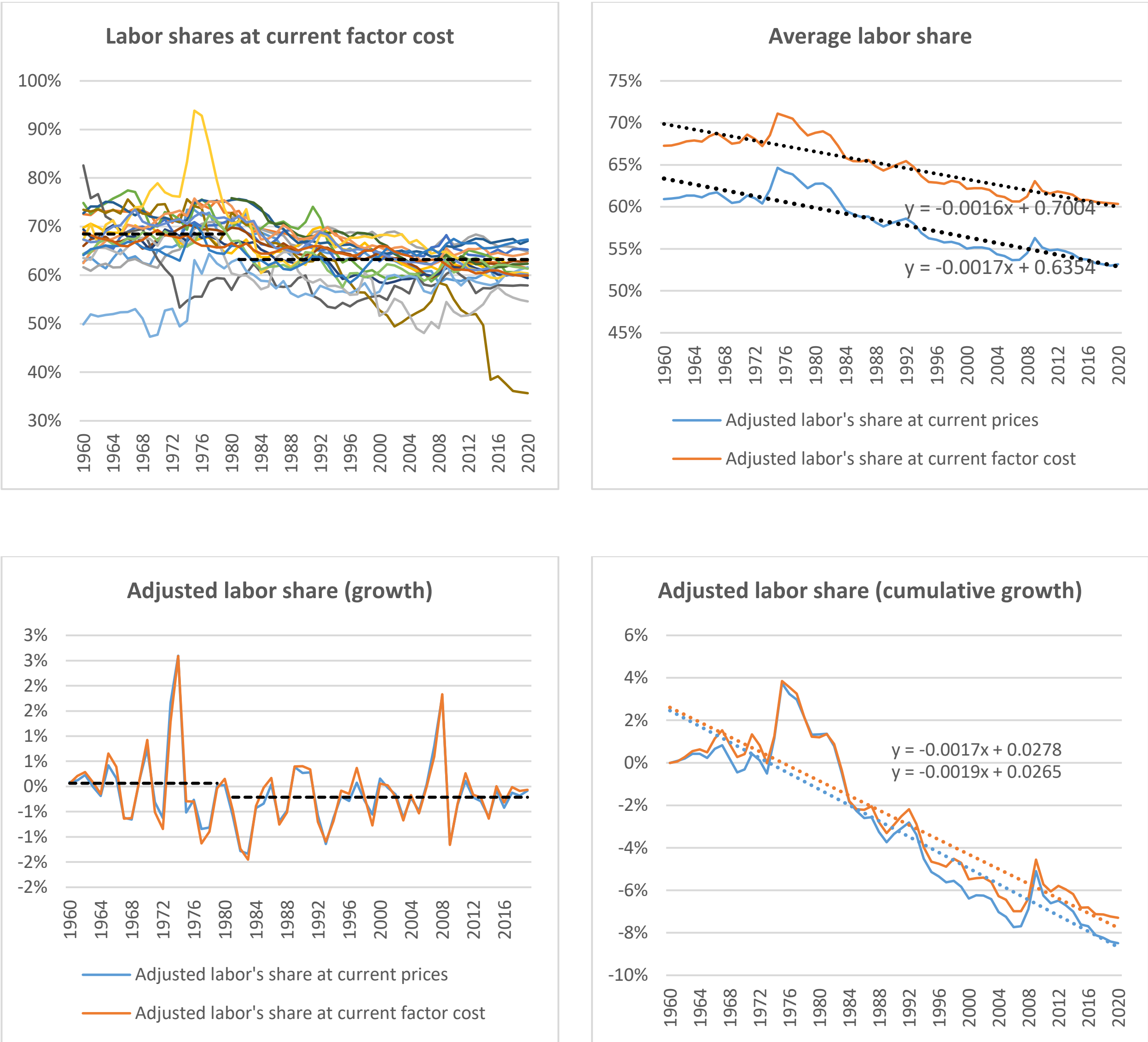


Figure 1 - The evolution of the adjusted labor share (and its growth) in 20 OECD countries (1960-2020).

Source: Author's calculation on AMECO data.[6]

[6] The countries considered here and in the rest of the paper are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom and the United States. To compute cross-country averages, observations are weighted according to the real GDP of single countries.

	Adjusted labor share (at current prices)				Adjusted labor share (at current factor cost)			
	1960	2019	var (%)	coverage	1960	2019	var (%)	coverage
Australia	59.92%	51.97%	-7.95%	1970-2019	65.00%	58.01%	-6.99%	1970-2019
Austria	63.87%	54.26%	-9.61%	1960-2019	72.56%	61.88%	-10.68%	1960-2019
Belgium	55.57%	59.73%	4.16%	1960-2019	61.65%	66.47%	4.82%	1960-2019
Bulgaria	38.79%	58.23%	19.44%	1995-2019	42.05%	66.25%	24.20%	1995-2019
Canada	61.87%	55.27%	-6.60%	1960-2019	69.51%	62.31%	-7.21%	1960-2019
Croatia	59.85%	52.74%	-7.11%	1995-2019	71.93%	64.25%	-7.68%	1995-2019
Cyprus	53.33%	48.86%	-4.47%	1995-2019	59.28%	57.76%	-1.52%	1995-2019
Czechia	42.20%	50.23%	8.04%	1993-2019	47.15%	55.62%	8.47%	1993-2019
Denmark	57.30%	55.91%	-1.39%	1960-2019	64.34%	65.20%	0.86%	1960-2019
Estonia	52.21%	54.43%	2.22%	1993-2019	59.12%	62.82%	3.70%	1993-2019
Finland	67.05%	52.74%	-14.32%	1960-2019	74.89%	60.44%	-14.45%	1960-2019
France	62.29%	58.28%	-4.01%	1960-2019	72.73%	67.42%	-5.30%	1960-2019
Germany	59.27%	56.89%	-2.38%	1960-2019	65.98%	63.00%	-2.98%	1960-2019
Greece	75.41%	49.59%	-25.82%	1960-2019	82.59%	57.92%	-24.67%	1960-2019
Hungary	54.24%	48.17%	-6.07%	1995-2019	63.87%	57.39%	-6.47%	1995-2019
Iceland	59.82%	58.28%	-1.55%	1970-2019	72.04%	67.52%	-4.52%	1970-2019
Ireland	64.74%	34.30%	-30.44%	1960-2019	73.50%	36.94%	-36.56%	1960-2019
Italy	67.79%	52.79%	-15.00%	1960-2019	76.94%	60.54%	-16.40%	1960-2019
Japan	72.17%	57.92%	-14.25%	1980-2019	75.86%	62.82%	-13.04%	1980-2019
Korea	86.81%	61.04%	-25.77%	1970-2019	95.72%	66.45%	-29.27%	1970-2019
Latvia	35.22%	53.55%	18.33%	1992-2019	37.14%	60.72%	23.58%	1992-2019
Lithuania	39.08%	50.60%	11.52%	1993-2019	41.90%	56.67%	14.76%	1993-2019
Luxembourg	48.02%	53.42%	5.40%	1960-2019	49.88%	59.85%	9.97%	1960-2019
Malta	52.38%	45.86%	-6.52%	1992-2019	60.40%	51.87%	-8.53%	1992-2019
Mexico	37.94%	35.52%	-2.42%	1995-2019	39.64%	38.23%	-1.41%	1995-2019
Netherlands	58.15%	57.27%	-0.88%	1960-2019	62.47%	64.19%	1.72%	1960-2019
New Zealand	55.37%	52.31%	-3.07%	1986-2019	62.23%	58.07%	-4.16%	1986-2019
North Macedonia	63.61%	45.57%	-18.04%	1997-2019	73.41%	49.39%	-24.02%	1997-2019
Norway	58.01%	49.27%	-8.74%	1960-2019	63.51%	54.88%	-8.63%	1960-2019
Poland	62.83%	49.00%	-13.83%	1992-2019	70.13%	56.34%	-13.79%	1992-2019
Portugal	64.14%	52.12%	-12.03%	1960-2019	67.27%	60.82%	-6.45%	1960-2019
Romania	82.52%	52.50%	-30.02%	1990-2019	82.40%	57.90%	-24.50%	1990-2019
Slovakia	42.56%	47.42%	4.86%	1995-2019	47.06%	52.80%	5.74%	1995-2019
Slovenia	67.52%	61.16%	-6.36%	1995-2019	77.61%	70.21%	-7.40%	1995-2019
Spain	61.36%	53.89%	-7.47%	1960-2019	67.36%	60.21%	-7.15%	1960-2019
Sweden	52.13%	49.45%	-2.68%	1960-2019	64.39%	62.44%	-1.94%	1960-2019
Switzerland	63.94%	64.52%	0.57%	1991-2019	65.22%	66.33%	1.11%	1991-2019
Turkey	55.46%	47.38%	-8.08%	1988-2019	58.57%	52.49%	-6.07%	1988-2019
United Kingdom	63.94%	58.19%	-5.75%	1960-2019	64.14%	66.67%	2.53%	1960-2019
United States	63.17%	56.51%	-6.66%	1960-2019	68.66%	60.54%	-8.13%	1960-2019
Mean	58.55%	52.68%	-5.87%		64.75%	59.54%	-5.21%	
Standard Deviation	0.112	0.061	0.111		0.124	0.07	0.125	

Table 1 - The labor share at current prices and factor cost in 40 OECD countries 1960/2019 (levels and % change).

Source: Author's calculation on AMECO data.

	Adjusted labor share (at current prices)				Adjusted labor share (at current factor cost)			
	1960-1980	1980-2019	1960-2019	coverage	1960-1980	1980-2019	1960-2019	coverage
Australia	NA	-11.38%	-11.38%	1970-2019	NA	-6.99%	-6.99%	1970-2019
Austria	0.01%	-9.84%	-9.83%	1960-2019	0.25%	-11.34%	-11.08%	1960-2019
Belgium	10.23%	-5.72%	4.51%	1960-2019	10.19%	-4.98%	5.21%	1960-2019
Bulgaria	NA	NA	20.11%	1995-2019	NA	NA	24.58%	1995-2019
Canada	-3.28%	-2.61%	-5.89%	1960-2019	-5.27%	-1.93%	-7.21%	1960-2019
Croatia	NA	NA	-6.17%	1995-2019	NA	NA	-6.89%	1995-2019
Cyprus	NA	NA	-3.68%	1995-2019	NA	NA	-0.97%	1995-2019
Czechia	NA	NA	8.81%	1993-2019	NA	NA	7.51%	1993-2019
Denmark	4.00%	-5.13%	-1.13%	1960-2019	7.17%	-6.20%	0.96%	1960-2019
Estonia	NA	NA	2.71%	1993-2019	NA	NA	4.43%	1993-2019
Finland	-4.23%	-9.29%	-13.52%	1960-2019	-5.16%	-8.48%	-13.64%	1960-2019
France	3.57%	-8.78%	-5.21%	1960-2019	2.74%	-8.73%	-6.00%	1960-2019
Germany	4.95%	-6.72%	-1.78%	1960-2019	3.78%	-6.11%	-2.32%	1960-2019
Greece	-22.43%	-3.33%	-25.76%	1960-2019	-25.65%	0.12%	-25.53%	1960-2019
Hungary	NA	NA	-5.69%	1995-2019	NA	NA	-6.03%	1995-2019
Iceland	NA	1.84%	-2.64%	1970-2019	NA	-2.13%	-5.73%	1970-2019
Ireland	2.08%	-32.58%	-30.50%	1960-2019	-0.67%	-35.93%	-36.61%	1960-2019
Italy	-4.17%	-10.87%	-15.04%	1960-2019	-9.73%	-6.73%	-16.46%	1960-2019
Japan	NA	-14.02%	-14.02%	1980-2019	NA	-5.97%	-5.97%	1980-2019
Korea	NA	-21.41%	-24.89%	1970-2019	NA	-29.27%	-29.27%	1970-2019
Latvia	NA	NA	18.73%	1992-2019	NA	NA	24.38%	1992-2019
Lithuania	NA	NA	12.65%	1993-2019	NA	NA	15.93%	1993-2019
Luxembourg	11.07%	-4.42%	6.64%	1960-2019	12.86%	-1.60%	11.26%	1960-2019
Malta	NA	NA	-8.17%	1992-2019	NA	NA	-9.64%	1992-2019
Mexico	NA	NA	-0.56%	1995-2019	NA	NA	-1.41%	1995-2019
Netherlands	10.56%	-11.26%	-0.70%	1960-2019	11.75%	-9.39%	2.36%	1960-2019
New Zealand	NA	NA	-3.44%	1986-2019	NA	NA	-4.16%	1986-2019
North Macedonia	NA	NA	-18.41%	1997-2019	NA	NA	-22.54%	1997-2019
Norway	-3.44%	-5.91%	-9.34%	1960-2019	-3.14%	-6.06%	-9.20%	1960-2019
Poland	NA	NA	-11.93%	1992-2019	NA	NA	-11.36%	1992-2019
Portugal	3.17%	-15.19%	-12.02%	1960-2019	3.35%	-9.64%	-6.29%	1960-2019
Romania	NA	NA	-26.35%	1990-2019	NA	NA	-20.46%	1990-2019
Slovakia	NA	NA	5.93%	1995-2019	NA	NA	6.94%	1995-2019
Slovenia	NA	NA	-5.32%	1995-2019	NA	NA	-6.33%	1995-2019
Spain	5.05%	-12.13%	-7.09%	1960-2019	3.79%	-10.52%	-6.73%	1960-2019
Sweden	3.22%	-5.76%	-2.54%	1960-2019	2.60%	-4.50%	-1.89%	1960-2019
Switzerland	NA	NA	-0.51%	1991-2019	NA	NA	0.03%	1991-2019
Turkey	NA	NA	-8.88%	1988-2019	NA	NA	-6.83%	1988-2019
United Kingdom	-4.05%	-0.94%	-4.99%	1960-2019	1.93%	1.52%	3.45%	1960-2019
United States	-1.14%	-5.35%	-6.48%	1960-2019	-2.20%	-5.72%	-7.92%	1960-2019
Mean	2.02%	-10.29%	-8.28%		2.12%	-9.63%	-7.52%	
Standard Deviation	0.084	0.072	0.110		0.099	0.094	0.126	

Table 2 - The labor share at current prices and factor cost in 40 OECD countries (% total change over the period).

Source: Author's calculation on AMECO data.

Figure 1 (panels a-d) and Tables 1-2[7] show the evolution of the labor share (for the whole economy) in 40 selected OECD countries from 1960 to 2018. Cyprus, Denmark, Mexico, the Netherlands, Sweden, Switzerland and the UK exhibits the closest approximation to the "stylized facts of economic growth" suggested by Kaldor, with the labor shares experiencing large, short-run fluctuations around a stable level. On the other hand, in the US there are significant short-run fluctuations around an apparent downward trend, with the labor share becoming virtually flat in the 1980s. Japan experienced a sharp rise, slowing down considerably after 1975. Finally, the picture for Continental Europe is hump-shaped, with the labor shares going up and down. However, country experiences are highly heterogeneous: in Germany and France the labor share peaked in the early 1980s, while in other countries like Italy, the Netherlands, and Spain it does so in the mid-1970s. From a cross-country perspective, it is striking to see that these large differences exist even across countries that are relatively similar from a technological point of view. As evidenced by the standard deviation, the labor share has not converged among them during the 80s (since its value has increased). In 2018, some countries like Belgium, France and the UK showed labor shares around 70%, while others like Spain, Germany or Italy had more modest values around 60%. Figure 1 (panels b, c and d) further shows that during the deepest years of the global economic crisis the long-term downward trends paused or slightly reversed to resume its decline again after 2009. This reflects the fact that wages are less volatile than profits during financial crisis. Indeed, as the OECD states: "In times of economic downturn, the decline in the labor share has usually stopped, to subsequently resume following the recovery. The recent economic slump and subsequent (sluggish) recovery have not followed a different pattern" (OECD, 2012). This countercyclical behavior of labor shares in advanced economies has been well documented (Gomme and Greenwood, 1995; Rotemberg and Woodford, 1999, OECD, 2012; IMF, 2017).[8] Trends in labor shares are to a large extent driven by the joint evolution of average wages and labor productivity. To see this, recall that a firm's total labor cost is simply the product of the number of hours worked in the firm (L) and the average gross hourly labor cost (W). Gross hourly labor costs include not only wages and salaries per hour, but

[7] In Tables 1 and 2, together with the base group of 20 countries analyzed in the paper, another 20 OECD countries are reported for comparison (when data was available), namely Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Iceland, Korea, Latvia, Lithuania, Malta, Mexico, New Zealand, North Macedonia, Poland, Romania, Slovakia, Slovenia, Switzerland and Turkey.

[8] During recessions, profits are the component that most often contribute to the decline in aggregate income, causing an increase in the labor share. During the recoveries, although all components of the GDP increase, profits recover quite strongly in most economies, leading to a decline in the labor share. In Europe, the behavior of the labor share during the recent recovery seems very similar to what took place during other recoveries between 1980 and 2006: with profits that increased strongly relative to labor income. In contrast, the recent recovery in the US appears quite unusual from an historical perspective and more similar to an average European recovery, with a strong recover in profits relative to labor income. One explanation could be that the fear of workers of an increase in long-term unemployment has led to more subdued wages relative to labor productivity growth during the recent recovery.

also paid vacations, direct labor taxes, social security contributions, and other benefits paid by employers on behalf of their workers - which in many European countries can be nearly equal to the net pay received by the worker (EC, 2015). Therefore, a country's aggregate unit labor cost is computed in the same way. It is simply the ratio of total labor costs WL - also called the wage bill - to the total real output, i.e., the real GDP Y:

$$NULC = \frac{wage\ bill}{real\ GDP} = \frac{WL}{Y} \tag{1}$$

Nominal unit labor costs must be distinguished from the real labor cost of producing a unit of real GDP or, equivalently, the ratio of the nominal wage bill to nominal GDP.

$$RULC = \frac{NULC}{nominal\ GDP} = \frac{wage\ bill}{nominal\ GDP} = \frac{WL}{PY} \tag{2}$$

The real unit labor costs measure the share of GDP (PY) that goes to labor (WL). Therefore, one should note that the labor share remains constant when workers get their appropriate or "fair" share of productivity gains. To see this, note that the labor share can be rewritten as $(W/P)(Y/L)$. Using the differentiation rule (i.e., differentiating eq. 2 with respect to time), the percentage increase in the labor share can be rewritten as:

$$\frac{\Delta LS}{LS} = \frac{\Delta(W/P)}{W/P} - \frac{\Delta(Y/L)}{Y/L} \tag{3}$$

Or in other words:

$$\dot{LS} = \dot{w} - \dot{y} \tag{4}$$

Where the "dot" over a variable indicates the derivative of the variable with respect to time, i.e., $\dot{LS} = \frac{dLS}{dt}$; $\dot{w} = \frac{dw}{dt}$ and $\dot{y} = \frac{dy}{dt}$. Equation 4 states that when real wages grow at the same rate of labor productivity, real unit labor costs remain constant. To put it another way, when productivity is rising, real wages can increase at the same rate without raising production costs. On the other hand, in most cases, when average wages increase more rapidly than average labor productivity, the labor share increases. Conversely, when average wage growth is slower than labor productivity growth, the share of labor tends to decrease. The result of this process is that an increasing fraction of productivity gains has been going to capital over time. And since capital is more concentrated than labor at the upper end of its distribution, the decrease in the share of labor income is also likely to increase inequalities (Jacobson and Occhino, 2012; Lawrence et al., 2012; Piketty, 2013; Abdih and Danninger, 2017). However, the interpretation of this relationship may become more difficult if the share of wages in total compensation changes over time, or if different deflators (i.e., consumption, value added or the consumer price index) are used to deflate respectively wages and GDP per worker. Nonetheless, the ILO (2014) has shown that in several countries where labor shares declined, wage growth significantly lagged productivity growth, even when different deflators are employed or if total compensation is employed instead of the tightest notion of wages. Because many large economies, including France, Germany, Italy, Spain, the UK, United States and Japan, have seen wage growth lagging productivity growth, labor productivity has exceeded real average wage growth in a group of 9 advanced G20 economies for which data is available since 1980 (Figure 2, panels a-d).

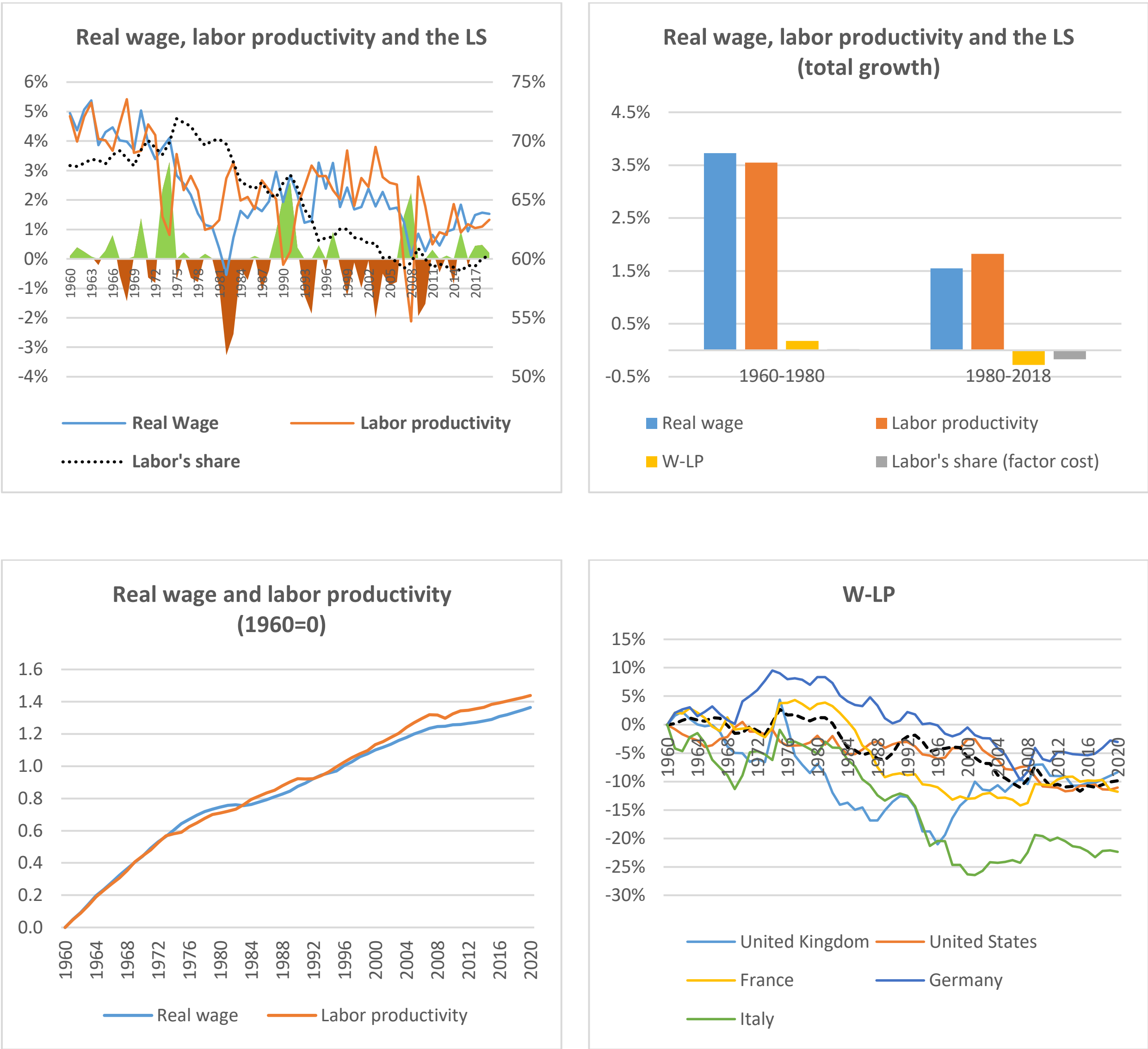


Figure 2 - Evolution of real wages, labor productivity and the labor share in 20 advanced OECD economies.

Note: 1960-2018. *Source:* Author's calculation on AMECO data.[9]

[9] The countries considered are: Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Mexico, Netherlands, New Zealand, North Macedonia, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States. To compute cross-country averages, observations are weighted by real GDP of single countries.

	1960-1980				1980-2019			
	Real Wage	Labor productivity	Labor share	W-LP	Real Wage	Labor productivity	Labor share	W-LP
Australia	2.09%	1.43%	0.89%	0.66%	0.78%	1.21%	-0.51%	-0.43%
Austria	3.99%	4.00%	0.03%	-0.01%	0.89%	1.32%	-0.42%	-0.43%
Belgium	4.68%	3.80%	0.78%	0.89%	1.05%	1.14%	-0.17%	-0.09%
Bulgaria	NA	NA	NA	NA	4.27%	2.53%	1.96%	1.74%
Canada	1.55%	1.83%	-0.38%	-0.27%	0.79%	0.94%	-0.06%	-0.15%
Croatia	NA	NA	NA	NA	1.43%	1.85%	-0.37%	-0.42%
Cyprus	NA	NA	NA	NA	0.72%	0.99%	-0.04%	-0.27%
Czechia	NA	NA	NA	NA	3.06%	2.33%	0.68%	0.73%
Denmark	3.00%	2.65%	0.54%	0.35%	1.09%	1.31%	-0.21%	-0.22%
Estonia	NA	NA	NA	NA	4.29%	4.11%	0.34%	0.18%
Finland	3.76%	4.07%	-0.31%	-0.31%	1.39%	1.76%	-0.30%	-0.37%
France	4.34%	4.16%	0.19%	0.18%	0.89%	1.25%	-0.30%	-0.36%
Germany	3.83%	3.42%	0.29%	0.42%	0.72%	0.99%	-0.22%	-0.27%
Greece	4.78%	6.68%	-1.77%	-1.91%	0.26%	0.48%	0.04%	-0.22%
Hungary	NA	NA	NA	NA	1.44%	1.87%	-0.38%	-0.43%
Iceland	2.92%	2.65%	-0.46%	0.26%	1.58%	1.43%	0.06%	0.15%
Ireland	4.17%	4.00%	0.01%	0.18%	1.73%	3.38%	-1.59%	-1.66%
Italy	4.43%	4.69%	-0.66%	-0.26%	0.42%	0.86%	-0.26%	-0.43%
Japan	NA	6.16%	NA	NA	0.96%	1.52%	-0.44%	-0.56%
Korea	5.06%	5.46%	-0.06%	-0.40%	3.44%	4.27%	-0.94%	-0.82%
Latvia	NA	NA	NA	NA	6.24%	2.78%	2.38%	3.46%
Lithuania	NA	NA	NA	NA	5.24%	2.39%	1.31%	2.85%
Luxembourg	3.26%	2.18%	1.36%	1.08%	0.82%	1.03%	-0.03%	-0.21%
Malta	NA	NA	NA	NA	1.41%	2.01%	-0.67%	-0.60%
Mexico	NA	NA	NA	NA	-0.41%	0.46%	-0.12%	-0.87%
Netherlands	3.95%	3.09%	0.88%	0.86%	0.74%	1.16%	-0.32%	-0.42%
New Zealand	NA	1.01%	NA	NA	0.77%	1.11%	-0.22%	-0.33%
North Macedonia	NA	3.21%	NA	NA	-0.26%	1.40%	-1.44%	-1.67%
Norway	2.94%	NA	-0.22%	NA	1.05%	3.92%	-0.18%	-2.86%
Poland	NA	5.26%	NA	NA	3.50%	1.76%	-0.60%	1.74%
Portugal	5.54%	NA	0.39%	NA	1.14%	3.83%	-0.33%	-2.69%
Romania	NA	NA	NA	NA	2.91%	3.83%	-0.48%	-0.91%
Slovakia	NA	NA	NA	NA	3.83%	3.29%	0.58%	0.54%
Slovenia	NA	NA	NA	NA	1.82%	2.17%	-0.33%	-0.35%
Spain	5.89%	5.46%	0.29%	0.43%	0.71%	1.15%	-0.39%	-0.44%
Sweden	2.92%	2.62%	0.22%	0.31%	1.32%	1.63%	-0.15%	-0.30%
Switzerland	NA	2.20%	NA	NA	0.82%	0.48%	0.01%	0.34%
Turkey	NA	3.43%	NA	NA	2.37%	2.95%	-0.11%	-0.58%
United Kingdom	2.00%	2.35%	0.18%	-0.34%	1.45%	1.51%	0.07%	-0.06%
United States	1.61%	1.71%	-0.16%	-0.10%	1.26%	1.51%	-0.22%	-0.25%
Mean	3.65%	3.50%	0.10%	0.11%	1.70%	1.90%	-0.11%	-0.20%
Standard Deviation	0.012	0.015	0.007	0.007	0.015	0.011	0.007	0.012

Table 3 - Evolution of wages, labor productivity and the labor share (growth) in 40 advanced OECD economies.

Note: 1960-2018. *Source:* Author's calculation on AMECO data.

What stands out from Figure 2 and Table 3 is that in most of the advanced countries for which data is available, the aggregate growth of real wages was significantly slower than that of aggregate productivity even considering of the evolution of relative prices, and hence considering the decline of labor share. This does not necessarily imply that the slower growth of average real wages relative to aggregate productivity is common to all sectors of the economy. Indeed, in many countries, real wages grew faster than productivity in several industries and less than productivity in others. However, shift-share analysis based on comparable data for 28 European Countries and 20 industries in the private sector of the economy, suggests that reallocation of factors across broad industries has generally not been significant in driving and determining labor share trends (OECD, 2012). Another study of the ILO found that while shifts in the composition of the economy were a key factor in many developing countries, in advanced economies most of the fall in the labor share was the result of falling shares within industries (ILO, 2014). As pointed out by Autor et al. (2020) and Bellocchi et al. (2020), in several cases, the decline in labor share has been due to between-firm reallocation rather than to a decline in the unweighted average labor share within firms; and the between-firm reallocation component of the decline is greater in sectors characterized by a strong increase in market concentration (Dorn and al., 2017). Though, in these countries, the labor share decreased on average within industries because labor productivity used to grow faster than wages in industries (and firms) characterized by high productivity, thus raising the average growth of productivity above that of wages (see McKinsey, 2019 for the USA and the IMF, 2019 for Europe).

A number of studies that have documented a decline in the labor income share since the 1980s have also tried to understand its causes.[10] The reasons for the decline are complex, but two main hypotheses have been put forward: (i) the *technological change hypothesis* which posits that the labor share declined due to capital augmenting technological progress or an increase in the capital intensity of production (Bentolila and Saint-Paul 2003; Lawless and Whelan, 2011; Piketty and Zucman, 2014; Karabarbounis and Neiman 2014). (ii) The *bargaining power hypothesis* which, on the other hand, attributes the decline in the labor share to a decline in the bargaining power of labor, induced by changes in government policy, labor market institutions, globalization or

[10] The reasons for the fall in the aggregate labor shares have recently been the subject of a growing amount of theoretical and empirical literature that have tried to decompose the effects of technology, globalization, and changes in labor market institutions (Harrison, 2005; European Commission, 2007; Rodriguez and Jayadev, 2010; Stockhammer, 2011; ILO/IILS, 2011; OECD, 2012; IMF, 2019; Bellocchi, 2020).

financialization (Blanchard and Giavazzi, 2003; Bassanini and Duval, 2009; Guerriero and Sen, 2012; Elsby et al., 2013; O'Mahony et al., 2019).[11]

Bentolila and Saint-Paul (2003) showed that when technological progress is capital-augmenting, labor shares will always decrease for a given level of the capital-output ratio, while capital accumulation reduces the labor share by causing a movement along a decreasing schedule. Bellocchi et al. (2020) reinforced the framework by demonstrating that overall, the effect of capital accumulation on the labor share depends on the elasticity of substitution and therefore on the point along the (nonlinear) $LS - k$ curve on which the individual companies are operating. Capital intensity is included in the models to capture the extent of factor endowment (Harrison, 2005; Stockhammer, 2009) while other indicators, like for instance TFP, information and communication technologies (ICT) or capital stock to capture the extent of biased technological change (Jaumotte and Tytell, 2007). The relationship between capital intensity and labor share depends on the elasticity of substitution (Hicks, 1932; Robinson, 1933; Harrison 2005, European Commission, 2007) and the nature surroundings technological progress. An increase in the capital-output ratio results in a higher labor share, if these two inputs are complementary. When the elasticity of substitution is low, it is not easy to substitute capital stock for labor, implying higher labor shares too. On the contrary, the labor share will decrease when capital intensity rises, if the two inputs are relatively substitutable (Figure 3 - panel b). In other words, if a production process is highly automated and requires little labor input, then under certain conditions, a higher proportion of the value added produced by firms may be allocated to compensate the suppliers of capital. Whether the labor share is higher or lower for firms that employ more capital relative to labor is therefore an empirical question. Recent important works by Karabarbounis and Neiman (2014), Piketty (2014) and Piketty and Zucman (2014) have linked the decline in the labor share of income over the past 20 years to a secular decrease in the relative price of investment and a secular increase in the K/Y ratio, respectively (Figure 3 - panel a). For the explanation provided it is crucial that the elasticity of substitution is greater than one.

[11] The importance of these factors differs across countries along three lines: (i) the relevance of labor market institutions which depends in part on the bargaining regime. For instance, union density is likely to have a prominent role in countries with highly coordinated bargaining regimes, while bargaining coverage and social government expenditure is more important in a decentralized bargaining environments; (ii) the effect of globalization on the labor share depends on whether market or cost seeking activities dominate, which is likely to vary by country and industry; (iii) the effect of technology might differ depending on the structure of the economy, the type of goods the country specializes, as well as across high and low-skilled sectors.

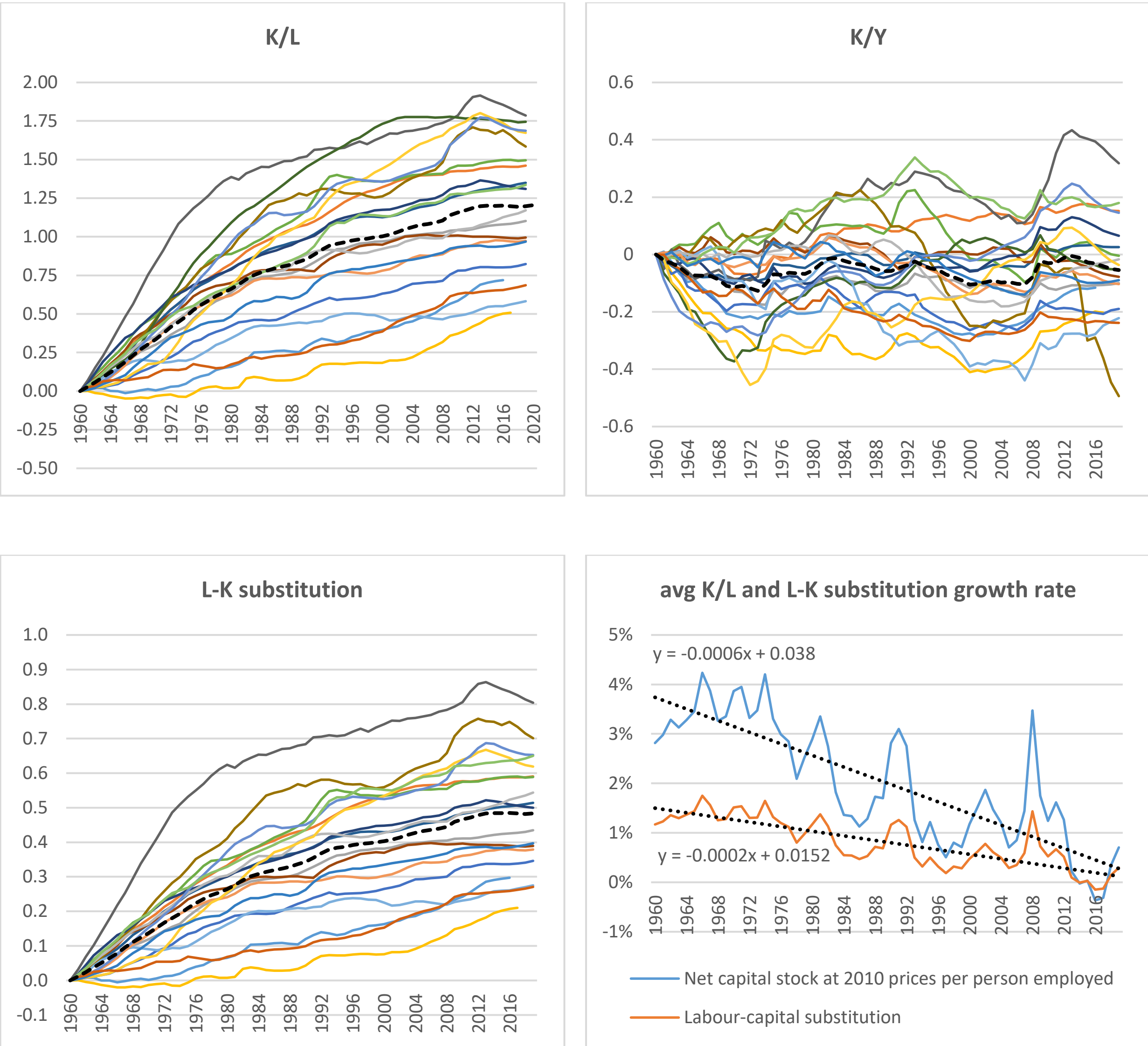


Figure 3 - Capital intensity K/L growth (cumulative), capital-output ratio K/Y growth (cumulative), labor-capital L-K substitution growth (cumulative), average K/L and labor-capital substitution growth rate.

Source: Author's calculation on AMECO data.

As will be clearer in the next sections, here it is argued that the developments concerning the distribution of income are only partly associated with technical progress, markups and changes in the composition of output, and that the essential force that has driven its evolution (and dispersion) over the long run is a change in economic policies and the institutional and legal environment over the last forty years. The current idea is that actual unemployment on the labor market emerges from the refusal of unemployed workers to accept a lower wage, which corresponds to their marginal productivity. Therefore, there are high and rigid real wages caused by over-regulation, employment protection legislation and, more generally, all measures aimed at reducing income inequalities and protecting workers from non-insurable labor market risks. As socially commendable as the intentions behind these regulatory interventions are, it has been argued that their macroeconomic impact is the strengthening of wage bargaining for trade unions, the increase in real wage costs (compared to labor productivity), the reduction of real wage flexibility, the increase in unemployment (especially for the less skilled) and eventually the weakness of the overall macroeconomic framework.[12] In terms of macroeconomic policies the key implication of this framework is that governments and central banks should not seek to promote full employment, as any effort to push the unemployment rate below a critical threshold (i.e. the NAIRU) would generate an acceleration of inflation. It is exactly for this reason that there is a constant conflict - trade-off - between growth and equity, especially now that competition in the market has become more intense as a result of globalization. However, recently, the financial crisis that started in 2007 has at least questioned the claim that a policy of real wage moderation, accompanied by an increasing flexibility in the labor market, as well as labor institutions and laws more favorable to employers, would ultimately result in a stable economy, a more dynamic economic system and sustained economic growth.

On the other hand, there is an increasing awareness that the decline in the labor share has meant: (i) a major shift in income distribution at the expense of labor; (ii) an increasing polarization in the distribution of personal income. In several countries in the past decades, we have witnessed to a combination of falling labor shares and a polarization of personal income distribution (Jacobson

[12] It is worth remembering Keynes' criticism of the second postulate of the classical theory of employment which is deemed to exclude - a priori - the possibility of involuntary unemployment. However, it is not unrealistic to believe that there may be no forces tending to lower the real wage when there is an excess supply of labor (De Angelis, 2000; Taylor, 2010). The only way workers could respond would be by cutting the money wage (since actual wage bargains are made in terms of money). However, these cuts cannot lead to a fall in real wages, because wages in money are such a large part of production costs; as a result, prices will fall, keeping real wages constant and leaving the economy with involuntary unemployment. Things can also get worse, because wage and price deflation increase the real interest rate and the debt service which can further discourage investment and consumption.

and Occhino, 2012; Francese, 2015; Milanovic, 2016; Das, 2018). These last issues are particularly important because the financial crisis has pushed many economies into a deep recession which is still going on today, thus further weakening the ability of workers to resist attempts to lower their wages, with the consequence, at the aggregate level, of further reducing the labor share.

The idea that wages are an important element of the economic system has a long tradition. It was first put forward in the reformist visions within the workers' movements and found its fortune in the 19th century economy under the name of "underconsumption theories". Within the Marxist tradition, the latter have been discussed as problems in the realization of profits. Then, they received another boost following the endorsement by Keynes. In his theory of effective demand, excessive saving rates along with weak investment rates, were at the core of depressed economies. More recently, in the academic debate, Post-Keynesian economists revived the topic with a focus on the relationship between the distribution of income and effective demand. Indeed, the standard objection to the consideration of problems related to the lack of effective demand, is that the long-run growth of an economy is ultimately determined by supply-side factors, such as the growth rate of the labor force and the growth rate of labor productivity. While supporters of the so-called "endogenous growth theory" recognize that investment in human capital or R&D may end up changing the potential growth rate, they usually reject the idea that current growth rates may have an influence as well. However, nowadays, it no longer seems so impossible to believe - just thing at the long-term growth forecasts of many industrialized countries that have been constantly revised downwards following the crisis - that weak aggregate demand still has an no impact on potential growth.[13] This explains why it is worth focusing also on the income distribution determinants of aggregate demand.

Here we want to provide a theoretical and empirical assessment of the effects of the undergoing redistribution of income on growth and employment both at the national and global level. Much of the existent literature on income distribution and economic growth employs inequality measures and a microeconomic approach. Further, mainstream macroeconomic models emphasize the supply side rather than the demand side of the economy since demand will always follow supply (by relying on the so-called Say's law). With a different approach, we follow a recent trend which try to study the relationship between income distribution and macroeconomic outcomes, as suggested in (Krugman, 2009; Galbraith, 2012; Stiglitz, 2012; Storm and Naastepad,

[13] As Dray and Thirlwall (2011) put it, “it makes little economic sense to think of growth as supply constrained if, within limits, demand can create its own supply”.

2012 and Reich, 2013) - among others. Little attention has been paid to factor shares in recent decades. Part of the reason is that factor shares used to be constant in the post-war era and this constancy became a stylized fact that was not worth further discussion. For instance, the most famous macroeconomic growth model, which rely on the Cobb-Douglas production is characterized by constant factor shares. Indeed, with perfect competition and constant returns to scale (CRS), income distribution is irrelevant to the growth process (Bertola et al., 2006). For this reason, issues of production and distribution have almost always been treated separately from economists and little progress has been made in the macroeconomics of income distribution over the last 40 years. At present time, no standard model has yet appeared. But, most importantly, existing models treat wage merely as a component of cost for firms, hence neglecting its role as a source of aggregate demand. On the contrary, Post-Keynesian/Kaleckian models reflect the dual role of wages in affecting both costs and demand.[14] This means that, while they accept the direct positive effects of higher profits on investment and net exports highlighted by mainstream models, they also consider a negative effect on consumption. Indeed, in these models, consumption is expected to decrease when the labor share decreases, since the marginal propensity to consume of capitalists is lower than that of wage earners. Further, since internal funds are an important source of finance for firms, it is argued that profits may positively influence investment. Therefore, a higher profitability (and hence a lower labor share) is expected to stimulate investment for a given level of aggregate demand. Finally, for a given level of domestic and foreign demand, net exports will depend negatively on unit labor costs.[15] To sum up, when this is the relevant framework the total effect of a decrease in the labor share on aggregate demand depends on the relative elasticities of consumption, investment and net exports to changes in the distribution of income. Whether the negative effect of lower wages on consumption or the positive effect on investment and net exports prevail is essentially an empirical question.

We start by summarizing the effects of a change in the labor share of national income on aggregate demand in a panel of 20 advanced OCED countries for which data is available over a sufficiently long period of time. These countries together constitute more than 80% of the global GDP. In this way we can develop an updated global map of wage-led demand economies, where consumption is more sensitive to distribution than investment and where domestic demand represents a significant part of aggregate demand as opposed to profit-led ones, where the

[14] As developed by (Rowthorn, 1981; Dutt, 1984; Blecker, 1989; Bhaduri and Marglin, 1990).

[15] Which are by definition closely related to the labor share, since $LS = wL/Y$.

responsiveness of investment to profits is stronger and foreign trade is an important part of the economy (as it is in the case of small open economies). Then, we make a step forward by moving beyond the nation-wide unit of analysis and discuss the overall effect of these changes in income distribution based on each country's joint responses to changes not only in national income distribution but also in the labor shares of their trading partners; this in turn affects import prices and foreign demand for each country. Indeed, neoliberal policies were implemented simultaneously in many developed and developing countries and redistribution policies for the benefit of capital (in all its forms) did not occur separately. As a result, decreasing labor costs have become a crucial issue for international competitiveness and this has inevitably had spill-over effects on other countries seeking to maintain their competitive position in global markets. Hence, from this perspective, the crucial question we ask ourselves is what happens to the global demand, when there is a simultaneous decline in the aggregate labor shares in all the major developed economies.

Finally, we investigate the long run relationship between effective demand, income distribution and unemployment. Kelekian (or Post-Keynesian) models differ fundamentally from neoclassicals in how they perceive the interaction between goods and labor market. While for the former unemployment is the result of a lack of demand in the goods markets, for the latter, unemployment is mainly a phenomenon originating in the labor market itself. Since there always exists a real wage which would clear the labor market, unemployment will rise if the real wage is too high, often because of frictions caused by governments, labor unions or insiders.[16] At this purpose, we estimate a macroeconomic model by means of a structural vector autoregression (VAR) approach. The VAR consists of six variables, namely capital accumulation, aggregate demand, the labor share, employment protection legislation[17], unemployment and labor productivity. In VAR methodology, each dependent variable is regressed on the lagged values of all the other variables in the system. The model is estimated for France, Germany, Italy, Spain, UK and the USA. The time period under investigation ranges from 1983 to 2018. This last part of the analysis allows us to address the following crucial questions: (i) Is unemployment also driven by goods market's variables? (ii) What is the effect of a change in the distribution of income or labor market regulation on accumulation? (iii) Does technological progress increase the unemployment? In addition to these Post-Keynesian questions, two rather general neoclassical issues are investigated: (iv) does an increase in wages cause unemployment? (v) Does an increase in wages lead to a substitution effect

[16] Needless to say, the different forms of neoclassical theory are more sophisticated and sometimes can give different results.
[17] Proxied either by means of a relative measure of the EPL (relative EPL) and the Incidence of Temporary Employment (ITE).

in terms of capital for labor? [18] The policy conclusions of the analysis shed light on the potential limits of international competitiveness strategies based on wage reduction in a highly integrated global economy and indicate the possibilities of correcting global imbalances through coordinated macroeconomic policy with a central role for aggregate demand.

The rest of the paper is organized as follows: Section 2 present the theoretical framework; Section 3 the Post-Keynesian model employed in the empirical analysis; Section 4 shows the empirical findings and discuss the econometric methods and various data issues; Section 5 estimates the structural VAR Model to investigate the long run dynamics of the economy; Finally, Section 6 concludes by providing some policy implications.

2. Theoretical framework

The relationship between income distribution and growth was at the center of the economic debate in classical economics, but with the Neoclassical revolution of the 20th century, it has been largely set aside. Indeed, within a neoclassical model of perfect competition income distribution is assumed to be regulated by the marginal productivity of each factor. In this framework, wages for various jobs are determined by the market forces of supply and demand. However, such a mechanical way of determining wages and the distribution of income is at odds with a world where monopsony, imperfect competition, economic and social powers are part of the game. In this case, very often labor market forces do not produce an optimal result and there is room for modifying the current distribution of income. Income distribution is the outcome of complex social and economic processes, which the government can directly influence through tax policy, social policy or by changing labor market legislation. Following the nomenclature introduced by Bowles and Boyer (1995) we define as "pro-capital" distributive policies those that eventually lead to a long-term decline in the share of labor in national income and as "pro-labor" distributive policies those that lead to an increase in the share of labor (Stockhammer, 2013). Pro-capital distributive policies usually claim to promote labor market flexibility, rather than increasing capital income and include all the measures that weaken collective bargaining (for instance by allowing exceptions to bargaining coverage), labor unions (by changing the strike laws) and employment protection legislation, as well as minimum wage measures. Ultimately, the effect of pro-capital policies is a

[18] The focus of this work is on the Post-Keynesian model and neoclassical topics will only be discussed in passing.

strong moderation in the growth of real wages. Then there are also measures that affect the secondary distribution of income in favor of profit earners, such as exempting capital gains from income taxation, or reducing corporate income taxes. In contrast, the main objective of pro-labor policies is that of strengthening the welfare state, labor market institutions, labor unions, and the ability of workers to engage in collective bargaining (e.g., by extending the reach of bargaining agreements to non-unionized firms and workers). These are associated with increased unemployment benefits, higher minimum wages relative to the median wage, as well as reductions in wage dispersion (Bowles and Boyer, 1988; Wallerstein, 1990; Navarro, 1998; Hassel and Ebbinghaus, 2000; Johnston and Hancké, 2009). Ceteris paribus, pro-labor distributional policies have the effect of increasing the labor share in the long run, as real wages tend to grow in line or exceed labor productivity. On the other hand, with pro-capital distributional policy, real wages will not grow as fast as labor productivity. Of course, there are also other structural factors that influence the distribution of income, such as technological change, globalization, financialization and financial deregulation. As recognized by literature (see Growiec, 2012; Siegenthaler and Stucki, 2015 and Bellocchi, 2020 for a more extensive review), these factors have recently played an important role, but we will not get into them in this stage, since they would shift the focus from the main points addressed by this paper and do not change or affect the implications of the model.

The best way to analyze the relationship between income distribution and economic growth is by asking the following question: "if income distribution is shifting in favor of capital or labor, what is the effect of such a shift on the overall economic performance?". For instance, if income distribution in each country is shifting in favor of profit earners, does this by itself has positive or negative effects on aggregate demand in the short run, on the growth rate of aggregate demand in the long run, or on the growth rate of labor productivity? If the answer is positive and indeed the shift towards profits has a favorable impact on the economy, we can say that the economy is profit-led. If it is negative, and the shift towards profits has a negative impact on the economy, then the economy is *wage-led*. All these cases are summarized in Table 4.

		Overall impact on the economy	
		Positive	*Negative*
Change in the aggregate income distribution	*An increase in the labor share*	Wage-led	Profit-led
	An increase in the profit share	Profit-led	Wage-led

Table 4 - Definition of profit-led and wage-led economies.

Source: Author's own compilation.

Whether an economy operates under a profit-led or a wage-led demand scheme is strictly connected with the structure of the economy itself (Stockhammer and Onaran, 2013; Blecker, 2016). Indeed, it depends in part on the existing structure of income distribution in that country, but also on various behavioral components of its economic agents, such as the propensity to consume out of wage and profit earners, the sensitivity of entrepreneurs to variations in sales and profit margins, the sensitivity of importers and exporters to relative costs, real exchange rates, and variations in foreign demand, as well as the relative dimension of various components of aggregate demand. In other words, while the nature of an economy depends on the intrinsic differences in terms of economic structures and institutions, and hence can be influenced by different forms of government policy, the nature of the economy is not a choice variable for economic policy but is rather determined by the overall social and institutional environment. Between the two sets of highlighted distributional policies and regimes, four different combinations are possible. When pro-labor policies are carried out in a wage-led economy, this will eventually result in a *wage-led growth* process. On the other hand, when pro-capital policies are carried out in a profit-led economy, this will eventually result in a *profit-led growth* process. In these two cases distributive policies and economic structures are consistent with each other. However, when pro-labor policies are carried out in a profit-led economy or when pro-capital policies are carried out in a wage-led economy, the result is an inevitable stagnation. This happens because inconsistent policies and distribution regimes lead to unstable growth patterns, since growth must rely on external stimulation (Table 5).

		Distributive policies	
		Pro-labor	*Pro-capital*
Nature of the economy	*Wage-led*	Wage-led growth (1)	Stagnation or unstable growth (2)
	Profit-led	Stagnation or unstable growth (3)	Profit-led growth (4)

Table 5 - Different types of growth patterns.

Source: Author's own compilation.

The fourth cell in Table 5 (pro-capital policies in a profit-led economy) reflects the neoliberal ideology. It builds on the idea of a trickle-down process where increasing profits lead to a virtuous cycle of higher growth that is ultimately beneficial also to labor. If this is the case, policies more favorable to profit earners and employers translate into a general improvement of the macroeconomic performance. The average worker will benefit from wage cuts and tougher working conditions as higher profit margins induce entrepreneurs to invest in more numerous machines and a more productive capacity, so that rewards of the production activity will eventually also reach workers, in the form of higher employment rates and a higher purchasing power (Arndt, 1983; Holt and Greenwood, 2012). In contrast, the first cell (pro-labor policies in a wage-led economy) represents the situation which has prevailed in the post-war era (for a more in-depth discussion, see Marglin and Schor, 1990). The fast expansion of the welfare state in advanced economies led to a golden age of growth which was favorable to both workers and entrepreneurs with rising real wages that generated large increases in labor productivity and profits until the early 1980s. The second cell (pro-labor policies in a profit-led economy) is the scenario outlined by neoliberals if social reforms were implemented again. In this situation, any attempt to raise the compensation of workers or the labor share inevitably leads to a slowdown of the economy. The third cell (pro-capital policies in a wage-led economy) is the picture that describes the effects of modern neoliberalism, where in several countries four decades of redistributive policies in favor of capital have led to a general increase in economic inequalities and poor economic performance (Ostry et al., 2014; Stiglitz, 2015; Stiglitz, 2016). To circumvent the slow growth, this latter form of neoliberalism has been accompanied by a strong reliance on an inflated financial sector and external demand (export-led and debt-led growth), which in many cases has generated further economic and financial instability (Palley, 2012; Hein and Mundt, 2013; Disoska, 2016). Before taking further steps, it is worth examining what factors determine whether an economy is wage-led or profit-led.

To determine whether an economy operates under a wage-led demand scheme or in a profit-led one, we need to estimate the impact of a change in the labor share on the components of aggregate demand (i.e., the relative elasticities of C, I, G and NX). As we have already stressed, in general, we will say that an economy is wage-led when an increase in the labor share (or alternatively a decrease in the profit share) leads to an increase in the sum of the components of aggregate demand; and we will say that an economy is profit-led when an increase in the profit share (or a decrease in the labor share) leads to an increase in the sum of the components of aggregate demand.[19] Let us begin with the effect of an (exogenous) increase in the labor share (or equivalently an increase in real wages with a constant labor productivity) on aggregate private consumption. In this case, if the propensities to consume out of profits and wages are the same, that change would have no impact on consumption, which is the standard assumption in standard macroeconomic models. On the other hand, if the propensity to consume out of salary earners is higher than the propensity to consume out of profit earners, then a shift in income distribution towards wages would lead to an increase in consumption demand. Indeed, a redistribution of income towards a higher labor share gives rise to an increase in consumption expenditure since wage workers spend a greater portion of income than profit earners. In a similar way, a decrease in wage dispersion, which increases the share of income of the lower deciles of the distribution would lead to the same result. All these arguments are at the center of underconsumption theories in modern Kelekian models which highlight the detrimental impact of higher profit shares on aggregate demand (Dutt, 1987; Allgoewer, 2002; King, 2012). They are also supported by empirical evidence, which found the propensities to save out of profit recipients to be much higher than those to save out of wages and which also show that the propensities to save of the richest deciles are higher, as one would expect, than those of the poorest deciles (Carrol et al., 2017; Fisher et al., 2020). The positive effects of a higher labor share on consumption expenditure and aggregate demand may, however, be reversed by the negative effects of a higher labor share on private investments. Kelekian economists usually support the idea that future (expected) profitability depends on past profitability, and hence on sales, thus believing that investments should not be significantly affected by an increase in the labor share (Richardson and Romilly, 2008; Łaski and Walther, 2015). On the other hand, a large group of Marxists argue that expected profitability depends on the profit share in national income, or in other words, on the profit margin of firms, i.e.,

[19] The first three components of aggregate demand (consumption, investment and government expenditure) are the domestic components of aggregate demand. Thus, this will allow us to make a distinction between "domestic" demand regimes and "total" demand regimes.

the profit rate that firms expect to obtain on their capital stock with a standard employment of the production capacity (Lavoie et al., 2004; Goldstein, 2009; Roberts, 2017). If this is the case, since higher real wages, ceteris paribus, imply lower profit margins and lower profitability, it means that an increase in the labor share would lead to a downward shift of the investment function.[20] This version of the Kelekian model is also known as the Post-Kelekian model of growth and distribution.

	Nature of aggregate demand	
	Wage-led	*Profit-led*
Structure of the economy	• The propensity to consume of wage earners is significantly higher than that of profit; • Investments not very sensitive to changes in profitability; • Relatively closed economy, characterized by a low elasticity for the price of net export and import income.	• Small difference in the propensity to consume of wages and profit earners; • Investments very sensitive to changes in profitability; • Open economy, characterized by a high elasticity for the price of net export and import income.
Other factors	Other sources of aggregate demand: • Government fiscal and monetary policies; • Financial factors; • Exchange rates and changes in world demand.	

Table 6 - Structure of the economy: wage-led and profit-led aggregate demands.

Source: Author's own compilation.

Table 6 summarizes all the various factors that determine whether the structure of an economy is wage-led or profit-led. Of course, there are many other factors besides income distribution which determine the level of aggregate demand (let us think at monetary policy, fiscal policy, different shocks which can affect the economy, changes in real exchange rates, changes in the growth rate of world GDP, etc.) (Afonso, et al., 2010; Stockhammer, 2013; Dunhaupt, 2013). For most year-to-year variations, income distribution is likely to have little influence in determining aggregate demand, with other forces playing a more important role. Nevertheless, if there are continuous and long-term structural changes as they occurred in the last 40 years, these will end up having a considerable

[20] Similar formalizations for the investment function were adopted by Bhaduri (1990), Kurz (1991), Taylor (1991) and Blecker (2002).

impact. What we have discussed so far are the domestic components of aggregate demand. However, it is usually claimed that an increase in real wages or the labor share may negatively affect the trade balance. Further, this latter effect is thought to be particularly significant in small open economies characterized by high net export price elasticities. Therefore, we must also consider the net effect of an increase in the labor share on foreign flows. Blecker (1989), Vandille (2002), Fajgelbaumy et al. (2011) and Onaran et al. (2016) have extensively analyzed the possible effects of changes in unit labor costs on net exports. An increase in real wages, without a simultaneous increase in prices, would inevitably lead to a reduction in profit margins, thus making the export of some products no more profitable. On the other hand, if prices are pushed up, the same products may no longer be competitive on international markets. This has some important consequences. It means that an economy which is domestically profit-led will not necessarily be profit-led overall. Adding international trade to the picture certainly adds some additional constraints, since the favorable domestic impact of an increase in the labor share may be eventually overturned once considering the adverse effect on net exports. The possibility of a conflict between a redistribution towards labor and maintaining a competitive position in international markets reduces the possibility for a peacefully balanced equilibrium favorable to workers and capitalists.[21] Besides, there is a second delicate point in the case of an open economy, which is the possibility of a so-called "fallacy of composition" which is particular likely to happen when an economy is characterized by a wage-led domestic demand.[22] Actually, in this case, a situation in which competitive wage cuts are jointly carried out in all the countries of the world can potentially undermine the position of workers everywhere. Real wages would be reduced if markups are flexible, but at the same time, employment would not increase if the competitive gains offset each other (Taylor, 1991; Hein and Vogel, 2008; Uxó et al., 2014). This means that while each individual country can boost its exports to sustain aggregate demand, not all the countries can follow the same strategy simultaneously. The world economy is a closed economy. It is therefore essential to look at the domestic effects and the total effects individually. The domestic component includes only the effects on consumption and investment and should be interpreted as a scenario where the labor share shock affects all trading partners simultaneously. One can think of it as the result of a change in the global labor share.

[21] If the negative impact of a higher labor share on profitability is small, there is not necessarily a contrast between the interests of capital owners and workers in an economy with overcapacity and hence it is possible to increase real wages and employment on the one hand and profits on the other along a positive growth path. However, this conclusion must be revised in an open economy.

[22] A fallacy of composition arises when it is inferred something for the whole population from the fact that it is true for a part it.

Following the methodology introduced by Storm and Naastepad (2013), the key variable that we employ to model the supply side of the economy is labor productivity. We will say that productivity is profit-led if an increase in real wages deters firms from doing productivity raising capital investments and, therefore, the growth rate of productivity slows down (there is a slowdown in embodied technological progress) (Boucekkine et al., 2003). On the other hand, however, higher real wages may provide an incentive for firms to increase investments and productivity in order to maintain competitiveness o to improve workers' contribution and commitment to the production process (McLaughlin, 2009; Calcagnini et al., 2018; Bellocchi et al., 2020).[23] This is the so-called "efficiency wage hypothesis" (Yellen, 1995; Cheng et al., 2004; Van Biesebroeck, 2014).[24] The main features of the two regimes are presented in Table 7.

		Nature of labor productivity
Structure of the Economy	*Wage-led*	• Real wage growth has a positive effect on labor effort and productivity raising investments. • Higher real wage growth or a higher labor share boost productivity growth.
	Profit-led	• Real wage growth restraint translates into productivity raising investment. • Higher real wage growth or a higher labor share are linked with a slower productivity growth.

Table 7 - Structure of the economy: wage-led and profit-led labor productivity.

Source: Author's own compilation.

Higher real wages lead firms to invest in more capital-intensive technologies, which, under the standard assumptions of a neoclassical production function, eventually result in a higher labor productivity. We should, however, also consider indirect demand effects, as in Post-Keynesian models (see for instance Setterfield and Cornwall, 2002; Ricoy, 2004; Davanzati, 2019), to assess whether productivity is overall wage-led or profit-led. Kaldor's followers have long claimed that

[23] This is due to the increased motivation of workers and, in developing countries, to the improvement of workers' health status.

[24] The efficiency wage hypothesis argues that wages are formed in a way that is not market-clearing. Specifically, managers may have an incentive to pay their employees more than the market-clearing wage in order to increase their productivity or efficiency, or reduce costs associated with employee's turnover. This happens especially in industries where the costs of replacing labor are high. Increased labor productivity or lower costs can pay off the higher wages.

supply-side growth is endogenous, thus colliding in part with mainstream theories of endogenous growth. This is also known as the "Kaldor-Verdoorn law", for which there is a substantial amount of empirical evidence (McCombie, 2002; Millemaci and Ofria, 2014; Deleidi et al., 2018) and the formal origins of which can be dated back to Kaldor's (1957) technical progress function. The "Kaldor-Verdoorn relationship"[25] claims that there is a positive causal link between the growth rate of GDP and the growth rate of labor productivity (and even the growth rate of the labor force). In other words, demand-led growth has an impact on the supply components of growth (Leòn-Ledesma and Thirlwall, 2002; Dray and Thirlwall, 2011). What does this imply for the assessment of the nature of labor productivity? Suppose that there is an increase in the labor share or in the growth rate of real wages. As argued before, the partial effect on productivity growth is likely to be positive. In the case of a wage-led demand the indirect "Kaldor-Verdoorn" effect will reinforce the direct productivity effect. Hence, the total productivity effect will always be positive, and we will always have a total wage-led productivity. If on the other hand the demand is profit-led, an increase in the labor share or in the growth rate of real wages will generate a decrease in the growth rate of the economy. The "Kaldor-Verdoorn" effect would hence translate this decrease into a decrease in the growth rate of labor productivity. However, this indirect negative effect caused by increasing real wages may be blown away by the direct positive productivity effect, assuming a wage-led partial productivity.[26]

Nature of aggregate demand	Partial productivity effect (1)	Indirect productivity effect (Kaldor-Verdoorn) (2)	Total productivity effect (1+2)
Wage-led	Positive	Positive	Positive
Profit-led	Positive	Negative	Positive or negative

Table 8 - Total productivity effect of an increase in the labor share, when the partial productivity nature is wage-led.

Source: Author's own compilation.

The last consideration to be made concerns the possibility of a feedback from productivity growth to economic activity or growth. Thus, what happens on the productivity side as result of a change in the distribution of income could have an additional indirect effect on demand. More precisely, the

[25] The "Kaldor-Verdoorn" law argue that in the long run labor productivity generally grows proportionally to the square root of output. According to the law, faster growth in output increases productivity due to IRS. Verdoorn (1949) argued that "in the long run a change in the volume of production, say about 10%, tends to be associated with an average increase in labor productivity of 4.5%." A Verdoorn coefficient close to 0.5 (0.48) was found in subsequent estimations of the law.

[26] This has been empirically verified in OECD countries by Storm and Naastepad (2012) and Hein and Tarassow (2010).

feedback from productivity growth to production growth may turn a presumed profit-led economy into a wage-led one, while, as shown by Lavoie and Stockhammer (2013) the opposite is impossible. This happens when the effects of an increase in the labor share on productivity are substantial, and when the positive effects of productivity growth on aggregate demand outweigh the weak negative effects of a higher labor share (Hein, 2015).

3. The model

To set up our model we build on Bhaduri (2008), Naastepad and Storm (2013) and Guarini (2016). We organize our ideas on growth and employment in a demand-led growth model that allows for systemic diversity. The model integrates Neo-Keleckian growth theory (where the interaction between growth and distribution plays a key role, but technological change is often neglected) with Neo-Kaldorian growth theory (in which long-run growth is determined by endogenous technological change, but there is no discussion on the impact of income distribution). The focus is on the structural differences in growth patterns between countries. For this reason, issues related to economic cycles are left out of the analysis. The model is composed of two curves. The first one is a "labor *productivity schedule - LPS*", which encapsulates the technological dynamics and specifies how labor productivity gains are obtained; the second one is an "aggregate *demand schedule - ADS*", which specifies how productivity gains for a given real wage growth may affect aggregate demand growth. Finally, to close the model there is a "*labor market schedule - LMS*", which describes how real wage growth is influenced by unemployment, productivity growth, and extent of labor market regulation. When everything is stable the result is a provisional equilibrium and not long-run equilibrium in a strictly neoclassical sense since we are not assuming that real wage growth equals labor productivity growth (keeping income distribution constant). This is done in the next section where we derive the steady state long run equilibrium.

3.1 Labor productivity schedule (LPS)

The supply side of the economy is modeled in terms of a "labor *productivity schedule*" which represents a description of how aggregate productivity growth is influenced by the key variables which affect its behavior: real GDP (or output) growth $\dot{Y}$, real wage growth $\dot{w}$, the growth of the capital-labor ratio $\dot{k}$ and labor market regulation z (where a dot over the variable denotes its growth rate). In the conventional Neoclassical approach, it is assumed that labor productivity growth is exogenous, meaning that productivity does not change in response to demand growth, real wage growth, changes in the capital-labor ratios or shifts in the social relations of production (which are strictly connected with the nature of labor market regulation). However, labor productivity is likely to change in response to demand growth and the capital-labor ratio, especially in terms of capital accumulation, because investment embodies part of the technological progress (Kaldor 1957/1966). Productivity may also change when real wage change, because of induced labor-saving technological change (Marx-biased technological change *à la* Foley, 2019). And finally, productivity may be influenced by the social relations of production. Productivity growth increase if the relationship between employees and firm becomes more cooperative and workers feel more secure and fairly treated (Gordon, 1996; Buchele and Christiansen 1999; Giacalone and Jurkiewicz, 2003). All this can be summarized in the following equation: [27]

$$\dot{y} = \beta_0 + \beta_1 \dot{Y} + \beta_2 \dot{w} + \beta_3 z + \beta_4 \dot{k} \qquad \beta_0, \beta_2, \beta_3, \beta_4 > 0;\ 0 < \beta_1 < 1 \tag{5}$$

Where:

- β_1 measures the impact of demand determined output growth on labor productivity growth, which for instance may be due to the fact that aggregate production exhibits Increasing Returns to Scale - IRS (Kaldor 1966; McCombie et al., 2002; Millemaci and Ofria, 2014).[28]
- β_2 reflects the degree of wage-led technological progress. It captures the extent to which a higher labor cost induces firms to intensify research for the possibility of introducing new productivity-enhancing techniques (Duménil and Lévy 2010; Tavani 2012; Foley, 2019).[29]
- β_3 indicates the extent to which the nature of the regulation in force in the labor market (through its impact on the social relations of production) influences labor productivity growth. We assume that $\beta_3 > 0$; that is, the more regulated the labor market, the higher the rate of labor productivity growth. This is in line with the hypothesis that pro-worker labor market regulation improves labor productivity by enhancing workers' motivation and stimulating investment in human capital (Autor et al., 2007; Lisi, 2013; Henrekson, 2020).

[27] Equation (1) can be derived from a Variable-elasticity-of-substitution (VES) production function (as we show in the Mathematical Appendix to this paper - Derivation of the LPS).

[28] Formally, a production function $F(K, L)$ is defined to have IRS if (for any constant a greater than 1) $F(aK, aL) > aF(K, L)$.

[29] From a neoclassical perspective, β_2 is simply the elasticity of capital-labor substitution (see Appendix A - Derivation of the LPS).

- β_4 captures the fact that investments contribute simultaneously to aggregate demand, the capital stock, and average productivity, because they embody new and more productive vintages of capital (Kaldor, 1957). Here, exactly like in the work of Nicholas Kaldor which posited the existence of a "technical progress" function we have a direct relationship between per capita investment (and hence the capital stock) and per capita output (see also Kaldor and Mirrlees, 1962; McCombie and Spreafico, 2015; Schlicht, 2016).[30]

Figure 4 presents the productivity schedule in the $(\dot{y}, \dot{Y})$ plane where output growth $\dot{Y}$ is measured on the vertical axis and labor productivity growth $\dot{y}$ on the horizontal axis. The curve is upward sloping with a slope coefficient of $(1/\beta_1)$. A rise in real wage growth, the capital-labor ratio or alternatively a shift to more extensive and stricter labor market regulation (a higher z), will shift the productivity schedule downward to the right (PR_1), as illustrated in the graph. The same rate of output growth is now associated with a higher rate of labor productivity growth, the increase being due to induced technological progress. Contrariwise, a decline in real wage growth, the capital-labor ratio or a decline in z will shift the productivity curve upward to the left.

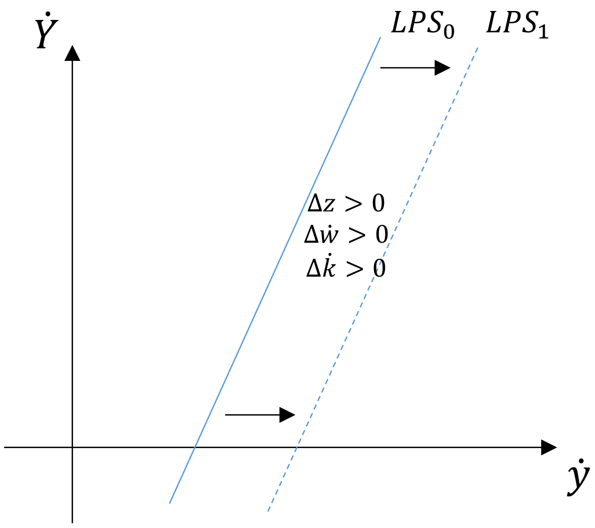


Figure 4 - The labor productivity schedule (LPS).

Source: Author's own elaboration.

[30] Kaldor (1957) and Kaldor and Mirrlees (1962) argued that the rate of productivity growth, as well as that of technical progress itself, is endogenous to the growth rate of investment per worker. However, technical progress is due in part to improvements in human capital. In this case, these latter can occur through a worker's experience with new machines such as Kaldor's learning-by-doing and Myrdal's cumulative causation approach. As Kaldor and Mirrlees (1962, p.176) state "[…] that machines of each vintage are of constant physical efficiency during their lifetime, so that the growth of productivity in the economy is interlay due to the infusion of new machines into the system through gross investment. A technical progress function makes the annual rates of growth of productivity per worker operating on new equipment a function of the rate of growth of investment per worker a constant rate of investment per worker overtime will itself increase productivity per worker".

3.2 Aggregate demand schedule (ADS)

Following the national accounting convention, aggregate production (or output) Y is determined by effective demand as follows:

$$Y = C + I + G + X - Q \tag{6}$$

Where: C is aggregate private consumption, G is public current expenditure, I is aggregate investment, X is national exports, and Q is national imports; all variables are measured at constant prices. Before presenting the structural equations determining C, I, X, and Q, it is convenient to define the real labor cost per unit of output or the real labor share as follows:

$$c = \left(\frac{W}{P}\right) y^{-1} = wy^{-1} \tag{7}$$

Where: W is the nominal wage (per hour of work) and P is the aggregate price level. We assume that the real wage $w = (W/P)$ is fixed at any point in time, from institutions and a history of bargaining. Later, we make use of equation (7) expressed in growth rates as follows:

$$\dot{c} = \frac{\Delta c}{c} = (\dot{w} - \dot{y}) \tag{8}$$

The growth of unit labor cost depends (positively) on the growth of real wage and (negatively) on the growth of labor productivity. From equation (7), and for a given level of labor productivity y, it follows that there exists a negative relationship between the real wage rate and the profit share. To see this, note that the profit share π is equal to 1 minus the labor share:

$$\pi = 1 - \frac{w}{y} = (1 - c) \tag{9}$$

Expressed in growth rates, this gives:

$$\dot{\pi} = \frac{\Delta\pi}{\pi} = \frac{-\Delta c}{1-c} = \frac{-\Delta c}{\pi} = -1\frac{\Delta c}{\pi} = -\frac{c}{\pi}\frac{\Delta c}{c} = -\theta(\dot{w} - \dot{y}) \tag{10}$$

Where $\theta = (c/\pi) = \frac{c}{(1-c)} > 0$. Equation (10) shows that profit share growth will decline as a result of real wage growth in excess of labor productivity growth.

Consumption demand is a function of labor and capital income. We assume income-class specific consumption behaviors. Denoting with s the propensity to save and using the subscripts w and π to refer respectively to income from wages and profits we have that wage-earners consume

$(1 - s_w)$ of their income, while capitalists' average consumption propensity equals $(1 - s_\pi)$. It is also assumed that wage earners save at a rate that is lower than the savings rate of profits recipients $(s_w < s_\pi)$ because of the retention of a significant portion of profits by corporations. Accordingly, the consumption function can be written as:

$$C = (1 - s_W)wy^{-1}\mathrm{Y} + (1 - s_\pi)\pi\mathrm{Y} - \mathrm{T}$$
$$= [(1 - s_W)\mathrm{c} + (1 - s_\pi)(1 - \mathrm{c})]\mathrm{Y} - \mathrm{T} \tag{11}$$

Where T is the aggregate payment of direct taxes.

Import demand is a linear function of output and the real exchange rate:

$$\mathrm{Q} = \zeta Y \tag{12}$$

where ζ is the average import propensity. Substituting equations (11) and (12) into (6) and rearranging, we get the following expression for Y:

$$Y = \frac{(G-T)+I+X}{[1-(1-s_W)\mathrm{c}-(1-s_\pi)(1-\mathrm{c})+\zeta]} = \mu^{-1}(G^* + I + X) \tag{13}$$

We define $G^* = (G - T)$ as government current expenditure minus direct tax payments (which is the government's budget deficit). Note that $\mu^{-1} = 1/[1 - (1 - s_W)\mathrm{c} - (1 - s_\pi)(1 - \mathrm{c}) + \zeta]$ is the Keynesian multiplier $(\mu^{-1} > 1)$, the magnitude of which depends, through c, on the distribution of income and in particular on real wage and labor productivity. Totally differentiating (13),[31] dividing through by Y, and rearranging, we get the following expression for demand-led output growth:

$$\dot{Y} = -\dot{\mu} + \psi_g\dot{G}^* + \psi_i\dot{I} + \psi_x\dot{X} \tag{14}$$

Where ψ_g, ψ_i, and ψ_x are the multiplier-adjusted shares in GDP of net government expenditure, investment, and exports, respectively. The multiplier is endogenous, because any change in the labor share directly affects its denominator μ, which equals $[s_\pi - c(s_\pi - s_W) + \zeta]$. We can derive its growth rate as a function of unit labor cost growth as follows:

$$\dot{\mu} = -\frac{c}{\mu}(s_\pi - s_w)\dot{c} = \xi(s_\pi - s_w)(\dot{w} - \dot{y}) \tag{15}$$

[31] For more details on the differentiation of eq. 9, see Appendix A - Total differentiation of eq. (9) in the main text.

Where ξ represents the fraction (c/μ). Therefore, the denominator of the multiplier will decrease (and thus the multiplier will become larger) when the labor share increases. At this point, we need to specify investment $(\dot{I})$ and export demand growth $(\dot{X})$ to close the model.

Following Bhaduri and Marglin (1990) and Taylor (1991/2004), we assume that *the growth rate of investments* $\dot{I}$ depends positively on the growth rates of π and Y and negatively on the real interest rate (or the user cost of capital) r:

$$\dot{I} = f_0\dot{b} + f_1\dot{\pi} + f_2\dot{Y} - f_3 r \qquad f_0, f_1, f_2, f_3 > 0 \tag{16}$$

Where b represents autonomous factors which have an influence on investment decisions (the so-called "animal spirits" of entrepreneurs in the Keynesian framework).[32] Coefficient f_1 is the elasticity of investment with respect to the profit share; the positive effect on investment of π can be justified by referring to the use by firms of corporate retained profits for mitigating financial constraints on investments, or else by thinking of π as the expected rate of return on new investment (assuming that expected profits equal actual profits). Finally, f_2 is the accelerative component, that is, the effect of output growth on the demand for new capital equipment, and f_3 is the elasticity of investment with respect to the real interest rate r.

Next, we turn to *exports* X, which we assume to be a negative function of relative unit labor cost and a positive function of exogenous (or autonomous) exports x_0:

$$X = x_0 c^{-\varepsilon_1} \tag{17}$$

Where ε_0 is the elasticity of exports with respect to world demand, and ε_1 is the elasticity of the volume of exports to a change in the (relative) real unit labor cost. Linearizing (17) in growth rates:

$$\dot{X} = \dot{x}_0 - \varepsilon_1\dot{c} \tag{18}$$

The substitution of equations $(15), (16)$, and (18) into (14) yields the following reduced-form equation for aggregate demand:[33]

$$\dot{Y} = \frac{\psi_i f_0\dot{b} + \psi_g\dot{G}^* + \psi_x\dot{x}_0 - \psi_i f_3 r}{(1-\psi_i f_2)} + \frac{[\xi(s_\pi - s_w) + \psi_x\varepsilon_1 + \psi_i f_1\theta]}{(1-\psi_i f_2)}(\dot{w} - \dot{y}) \tag{19}$$

[32] Apart from instability due to speculation, there is instability due to the characteristics of human nature that much of our positive activities depend on spontaneous optimism (an impulse to action rather than inaction) rather than a weighted average of benefits multiplied by probabilities (Keynes, 1936).

[33] Note that for equation (19) to be economically meaningful, we must assume that $[1-\psi_i f_2] > 0$, that is, the accelerator elasticity has to fall within the range $0 \le f_2 < (1/\psi_i)$.

Demand-led output growth therefore depends on five factors:

i. The growth of autonomous investment $\dot{b}$.

ii. The growth of net public current expenditure $\dot{G}^*$.

iii. The growth of autonomous exports $\dot{x}_0$.

iv. The real interest rate r.

v. The growth of real unit labor cost $\dot{c} = (\dot{w} - \dot{y})$.

While the impact on output growth of *(i)* autonomous investment, *(ii)* government expenditure and *(iii)* export is positive; that of *(iv)* the real interest rate is negative and that of *(v)* real unit labor cost (i.e., the labor share) is ambiguous. This happens because any excess of real wage growth over labor productivity (i.e., $\dot{c} > 0$ or $\dot{w} > \dot{y}$) has two opposite effects on output growth. On the one hand, it reduces investment growth (via the profit share elasticity f_2) and export growth (via the export cost elasticity ε_1), and consequently slows down output growth. On the other hand, it increases the size of the multiplier, because it entails a redistribution of income from profits toward wages and a consequent decrease in the aggregate saving propensity (since $s_w < s_\pi$). The sign of the derivative of output growth with respect to unit labor cost growth $(d\dot{Y}/d\dot{c})$ which we get from equation (19), will be positive under the following condition:

$$D = \frac{d\dot{Y}}{d\dot{c}} = \frac{[\xi(s_\pi - s_w) - \psi_i f_1 \theta - \psi_x \varepsilon_1]}{(1 - \psi_i f_2)^2} > 0 \tag{20}$$

If:

$$(s_\pi - s_w) > \frac{I}{\pi Y} f_1 + \frac{X}{cY} \varepsilon_1 \tag{21}$$

If (21) is satisfied (i.e., $D > 0$), real wage growth in excess of productivity growth will raise output growth - demand, and the economy is wage-led. Alternatively, demand is profit-led when $D < 0$. In this case, a higher labor share growth reduces demand and output growth because the consequent fall in profits and investments as well as exports is larger than the increase in consumption. We can simplify the notation by assuming that Θ represents all autonomous influences on output growth (including the negative impact of a higher real interest rate):

$$\Theta = \frac{\psi_i f_0 \dot{b} + \psi_g \dot{G}^* + \psi_x \dot{x}_0 - \psi_i f_3 r}{(1 - \psi_i f_2)} \tag{22}$$

The nature of demand can then be expressed as the following function of real wage, productivity and autonomous demand growth:

$$\dot{Y} = \dot{\Theta} + D[\dot{w} - \dot{y}] \quad (23)$$

Figure 5 presents the aggregate demand schedule in the $(\dot{y}, \dot{Y})$ plane. Panels a and b show respectively a wage-led and a profit-led economy. Wage-led demand is downward sloping in the $(\dot{y}, \dot{Y})$ plane, with a slope coefficient of D. The reason is that faster labor productivity (at a given rate of real wage growth) redistributes income from labor, which has a lower saving rate, to capital, which has a higher saving rate (see equation 11); in other words, it raises the profit share. This in turn reduces consumption growth, and the fall in consumption is larger in absolute terms than the rise in investment and export growth induced by higher profits and a lower unit labor cost. Therefore, output growth declines. In contrast, profit-led demand is upward-sloping because faster productivity growth stimulates output (since a higher productivity reduces unit labor costs hence stimulating investments and exports). Figure 5 also illustrates what happens when there is a rise in real wage growth, or alternatively a shift to more extensive labor market regulation (a higher z). The wage-led demand will shift upward, reflecting the fact that the same rate of labor productivity growth is now associated with higher wage-led output growth. The profit-led demand, in contrast, will shift downward and higher real wage growth reduces profit-led output growth for a constant rate of increase in productivity.

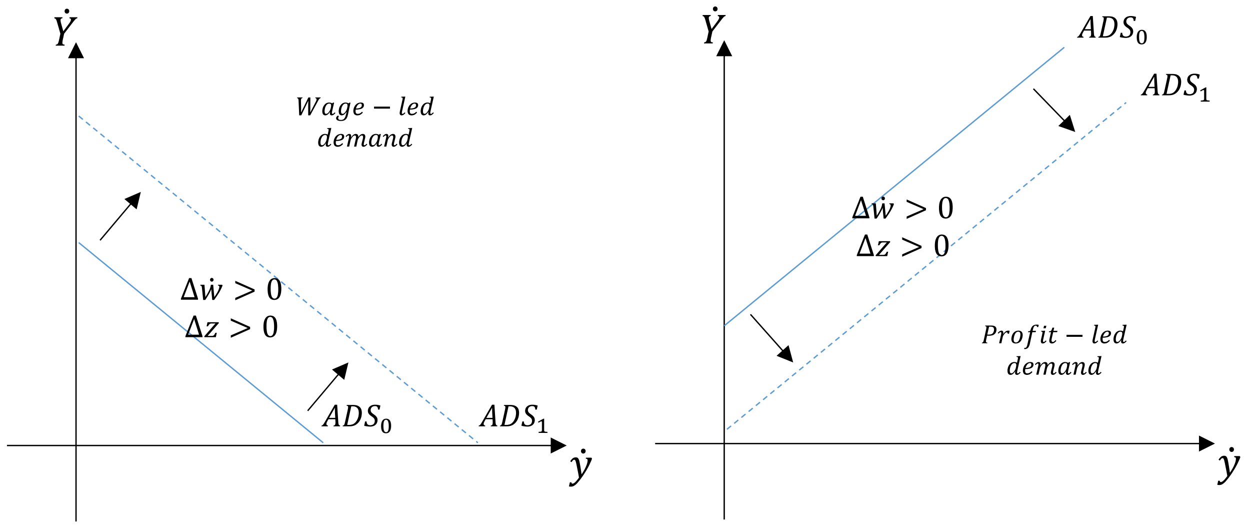


Figure 5 - The nature of aggregate demand.

Source: Author's own elaboration.

3.3 Labor market schedule (LMS)

Employment growth (i.e., labor demand growth) $\dot{L}$ is equal to:

$$\dot{L} = \left[\dot{Y} - \dot{y}\right] \tag{24}$$

Using the productivity equation (5), we can express $\dot{L}$ as a function of output growth:

$$\dot{L} = \left[\dot{Y}(1-\beta_1) - \beta_0 - \beta_2\dot{w} - \beta_3 z - \beta_4\dot{k}\right] \tag{25}$$

Unemployment u, in turn, is a negative function of employment growth (assuming an exogenous growth of the labor supply):

$$u = f(\dot{L}) = \Omega - \gamma\dot{L} \tag{26}$$

Finally, in line with the standard macroeconomic approach to wage bargaining, we assume that:

$$\dot{w} = \alpha_0 - \alpha_1 u + \alpha_2\dot{y} + \alpha_3 z \qquad \alpha_0, \alpha_2, \alpha_3 > 0 \tag{27}$$

Where coefficient α_1 reflects the negative impact on the real wage of a rise in unemployment - a higher unemployment rate weakens the bargaining power of workers and they are forced to accept a lower real wage; coefficient α_2 represents the extent to which labor productivity growth is reflected in real wage bargaining - in compliance with recent econometric evidence, α_2 is statistically significantly smaller than unity (Nunziata, 2005; Carter, 2007; Mergulhão and Pereira, 2019); finally a higher z reflects workers strengthened bargaining position, which increases the real wage growth demanded by workers for a given unemployment rate: hence $\alpha_3 > 0$.

3.4 Steady state equilibrium

Let us for the moment ignore equation (27) and assume that real wage growth is exogenously determined as the outcome of institutionalized negotiation and a bargaining history between trade unions and employers' associations. Combining equations (5), (23) and (25) we can solve for the equilibrium rates of output $\dot{Y}$, labor productivity growth $\dot{y}$ and employment growth $\dot{L}$:

$$\begin{aligned}\dot{Y} &= \frac{\Theta - \beta_0 D}{(1+\beta_1 D)} + \dot{w}\frac{D(1-\beta_2)}{(1+\beta_1 D)} - \frac{\beta_3 D}{(1+\beta_1 D)}z - \frac{\beta_4 D}{(1+\beta_1 D)}\dot{k} \\ &= \bar{\Theta} + \Xi\dot{\mathrm{w}} - \Phi\mathrm{z} - \varpi\dot{\mathrm{k}}\end{aligned} \tag{28}$$

$$\dot{y} = \beta_0 + \beta_1\bar{\Theta} + [\beta_1\Xi + \beta_2]\dot{\mathrm{w}} + [\beta_3 - \beta_1\Phi]\mathrm{z} + \dot{\mathrm{k}}[\beta_4 - \beta_1\varpi] \quad (29)$$

$$\dot{L} = -\beta_0 + (1-\beta_1)\bar{\Theta} + [(1-\beta_1)\Xi - \beta_2]\dot{\mathrm{w}} - [(1-\beta_1)\Phi + \beta_3]z - [(1-\beta_1)\varpi + \beta_4]\dot{\mathrm{k}} \quad (30)$$

Where:

$$\bar{\Theta} = \frac{\Theta - \beta_0 D}{1+\beta_1 D}, \Xi = \frac{(1-\beta_2)D}{1+\beta_1 D}, \Phi = \frac{\beta_3 D}{1+\beta_1 D}, \varpi = \frac{\beta_4 D}{(1+\beta_1 D)}$$

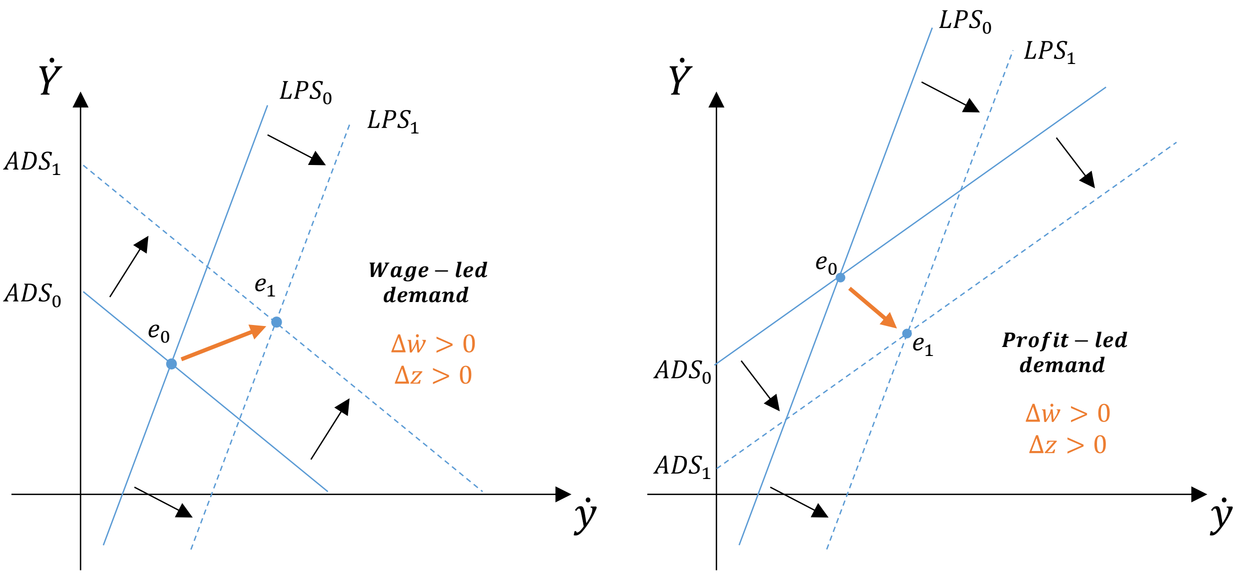


Figure 6 - Short run equilibrium in a wage/profit-led economy.[34]

Source: Author's own elaboration.

These equilibrium expressions can be employed to analyze how output, productivity, and employment growth are affected by changes in real wage growth ($\Delta\dot{w}$) and labor market regulation (Δz). Let us consider the effects of real wage restraint policies (i.e., a reduction of real wage growth). From equation (28), we derive the total impact of the decline in real wage growth on equilibrium output growth as follows:

$$\frac{d\dot{Y}}{d\dot{w}} = \frac{(1-\beta_2)D}{1+\beta_1 D} \quad (31)$$

[34] The different effect of an increase in real wages (or labor market regulation) in the two different regimes. Indeed, when we do not assume that the economy is profit-led (panel a instead of panel b) there may be potential beneficial effects of labor regulation, such as the fact that more regulation can lead to faster technological change for labor saving and faster productivity growth.

Note that $1/(1+\beta_1 D)$ represents an endogenous technology multiplier that captures the process of cumulative causation implied by the Kaldor-Verdoorn effect. It follows from the stability condition of the model that the denominator $1/(1+\beta_1 D)$ of equation (31) is positive. Accordingly, the sign of $(d\dot{Y}/d\dot{w})$ depends on whether the numerator is positive or negative. In the case of a wage-led economy (i.e., $D > 0$), the numerator will be positive only if $0 \leq \beta_2 < 1$, that is, the elasticity of productivity growth with respect to real wage growth (wage-cost-induced technological progress) is smaller than unity. In this case, lower real wage growth unambiguously lowers output growth (Bhaduri and Marglin, 1990).[35] It must further be noted, however, that if $\beta_2 \rightarrow 1$, $(d\dot{Y}/d\dot{w}) \rightarrow 0$, that is, the impact on output growth of reduced real wage growth becomes smaller and eventually vanishes.[36] In the same way, turning to equation (29), we have an overview of the impact of reduced real wage growth on equilibrium productivity growth when demand is wage-led:

$$\frac{d\dot{y}}{d\dot{w}} = \beta_2 + \beta_1 \frac{d\dot{Y}}{d\dot{w}} = \frac{\beta_2 + \beta_1 D}{1 + D\beta_1} \tag{32}$$

A reduction in real wage growth has direct and indirect effects on productivity growth. The direct effect is a decline in productivity growth by $\beta_2 \Delta\dot{w}$; a permanently lower rate of wage growth reduces the incentive for firms to invest in labor-saving technological progress. The indirect effect is equal to the variation in long-run demand growth, caused by the decrease in real wage growth $(dY/d\dot{w})$ multiplied by the Kaldor-Verdoorn coefficient β_1. If the economy is wage-led, $(d\dot{y}/d\dot{w})$ is always positive, because $D > 0$; consequently, reduced real wage growth always depresses long-run productivity growth both directly (providing less incentive for firms to improve technology) and indirectly (by reducing demand, which in turn reduces productivity growth via β_1). In this case, any attempt to restore firm's profitability by cutting real wage growth ends up with a drop in both production and productivity growth and eventually results in declining profits. It follows, on the other hand, that a higher real wage growth may raise growth, productivity, and total profits (Figure 6 - panel a). Despite a higher real wage and a lower profit share, capitalists can still make higher total profits if they recoup on volumes what they lose on the profit margin per unit of sale.

---

[35] Such a regime is one in which demand and growth are sufficiently depressed that an increase in the labor share has a net positive impact on demand and production. Wage growth is therefore only possible in a stagnant regime. There are two types of stagnant regimes: "cooperative stagnationist" and "conflictual stagnationist". While in the first case a decrease in the profit share results in an increase in the profit rate, in the second case a lower profit share increases capacity utilization but does not increase the profit rate (Bhaduri and Marglin 1990).

[36] The reason is simple: if wage growth declines, and if, as a result, labor productivity growth declines in the same proportion (which is what happens when β_2 is close to unity), then from equation (4) unit labor cost growth v does not change much, and hence output growth does not change much.

Similar are the effects of labor market regulation. If we assume that $\alpha_0 = \alpha_1 = \alpha_2 = 0$ in equation (27), real wage growth becomes a function of regulation only (i.e., $\dot{w} = \alpha_3 z$). Labor market deregulation is operationalized through a decline in z. This has two effects. First, real wage growth will decline. Second, from equation (5), we can see that less regulation reduces pressures on firms to economize on labor cost, and hence productivity growth declines as well. To determine the impact of a decline in z on output growth, we substitute the new equation for real wage growth into equation (28) and totally differentiate the resulting equation with respect to z as follows:

$$\frac{d\dot{Y}}{dz} = \frac{\alpha_3(1-\beta_2)D - \beta_3 D}{1 + D\beta_1} \tag{33}$$

The sign of $\frac{d\dot{Y}}{dz}$ is ambiguous and depends on the nature of aggregate demand. If demand is wage-led $(i.e. D > 0)$, $\frac{d\dot{Y}}{dz} > 0$ if $\alpha_3 > \alpha_3\beta_2 + \beta_3$, that is, the decline in real wage growth due to a decline in z is larger than the corresponding decline in labor productivity growth. When real wage growth declines more than productivity, unit labor cost growth (or labor share growth) declines as in equation (8). A less strict labor market regulation, in other words, is not positive for wage-led growth, because it reduces the labor share by (directly and indirectly) depressing labor productivity growth. In contrast, if $\alpha_3 < \alpha_3\beta_2 + \beta_3$, a reduction of z will raise output growth even in a wage-led economy. This happens because now the decline in z raises the labor share, which is positive for growth, since wage growth declines less than productivity growth. The same holds true for the productivity growth effects. The impact of a decline in z on productivity growth is determined by substituting equation for real wage growth into (29) and totally differentiating with respect to z:

$$\frac{d\dot{y}}{dz} = \frac{\alpha_3\beta_2 + \alpha_3\beta_1 D + \beta_3}{1 + D\beta_1} \tag{34}$$

Because the denominator is positive (by assumption), the sign of $(\frac{d\dot{y}}{dz})$ depends on the sign of the numerator. If the economy is wage-led, the numerator is positive, and, as a result, productivity growth always declines due to labor market deregulation, because depressing wage growth leads to a less rapid technological change.

What happens to employment? From equations (31) and (32), we derive the employment growth effect of reduced real wage growth:

$$\frac{d\dot{L}}{d\dot{w}} = \frac{d\dot{Y}}{d\dot{w}} - \frac{d\dot{y}}{d\dot{w}} = \frac{(1 - \beta_1 - \beta_2)D - \beta_2}{1 + D\beta_1} \tag{35}$$

The total impact of reduced real wage growth on employment growth is the result of three effects:

(i) Employment growth declines due to a decrease in output growth;

(ii) Employment growth rise due to the direct decline in labor productivity growth;

(iii) Employment growth rise because labor productivity growth falls via β_1.

The sign of $(d\dot{L}/d\dot{w})$ depends on the magnitude of each of these effects, hence, employment growth may rise or fall in response to the fall in real wage growth. Formally, if $(d\dot{L}/d\dot{w}) > 0$, then $D > \beta_2(1 - \beta_1 - \beta_2)$ which means that the decline in employment induced by a lower wage growth must be larger than the rise in employment caused by a slower productivity growth (also resulting from a lower real wage growth). Under wage-led demand $(D > 0)$, this condition is always met if we assume absent wage-cost-induced technological progress $(\beta_2 = 0)$ and hence, lower real wage growth results in lower employment growth.[37] The picture changes when $\beta_2 > 0$. For high values of β_1 and especially β_2, the sign of $(d\dot{L}/d\dot{w})$ becomes negative and a decline in real wage growth may lead to a rise in employment growth, because of its negative impact on induced labor-saving technological progress and productivity and the positive effect on demand. To sum up, in a wage-led system the employment effect of increased real wage growth is ambiguous. Moderate wage growth leads to moderate output growth while at the same time hinders labor productivity growth. The result in this case could be increased employment growth and a lower unemployment rate, but this is achieved by depressing productivity growth rather than by raising profitability and output.

In view of the diversity in the responses of output and productivity growth, it should not come as a surprise that also the impact of labor market legislation on employment growth is equally ambiguous and subject to the nature of the ADS. From equation (25), it follows that:

$$\frac{d\dot{L}}{dz} > 0 \; if \; \frac{d\dot{Y}}{dz} > \frac{d\dot{y}}{dz} \tag{36}$$

If the decline in output growth due to a lower z is larger than the decline in labor productivity growth, the growth rate of employment will fall. The left-hand side of (36) gives the impact of a change in z on output growth, the right-hand side the corresponding change in productivity growth. Remembering (33) and (34), if $D > 0$, the right-hand side is positive, meaning that productivity growth will fall in response to a decline in z. The left-hand side can be positive or negative. If $\alpha_3 >$

[37] In contrast to what Keynes called the second postulate of classical employment theory.

$\alpha_3\beta_2 + \beta_3$, the left-hand side is positive, and hence a decline in z reduces $\dot{Y}$. If the decline in $\dot{Y}$ is larger than the decline in $\dot{y}$, employment growth will fall in response to deregulation - Figure 7, panel b. However, even if $\alpha_3 > \alpha_3\beta_2 + \beta_3$, employment growth under wage-led demand rises due to a reduced z, because productivity growth declines more than output growth. Nevertheless, in this latter case new employment is the result of technology stagnation - Figure 7, panel c).

When demand is profit-led (i.e., $D < 0$). The impact on output growth of a decline in real wage growth is given by equation (31). The numerator of (31) will be negative if $0 \leq \beta_2 < 1$. Hence, a fall in real wage growth increases output growth. What happens to productivity growth in the profit-led case? Equation (32) tell us that when $D < 0$ the numerator can be positive, negative or zero, depending on the size of the coefficients. If $0 \leq \beta_2 < -\beta_1 D$, the numerator is negative and a decline in real wage growth raises productivity growth, because the wage-cost-induced productivity growth decline is more than offset by the increase in productivity growth due to higher demand growth (through the coefficient β_1). This is the case in which real wage growth restraint raises both output and productivity growth. But if $\beta_2 > -\beta_1 D$, then $(d\dot{y}/d\dot{w})$ is positive and lower wage growth leads to reduced productivity growth, even though output growth increases. Employment growth will increase due to lower real wage growth. In the profit-led case, as can be seen from equation (35), real wage restraint is necessary to raise employment growth and reduce unemployment. The effect of wage restraints on productivity growth and technological dynamism is not clear and may be negative if coefficient C is small and coefficient β_2 is large. In this case, unemployment would decline because of a falling productivity growth with a stagnant output.

Similarly, if we consider the effect of labor regulation when the demand is profit-led $(i.e. D < 0)$, from equation (33) we have that $\frac{d\dot{Y}}{dz} < 0$ if $\alpha_3 > \alpha_3\beta_2 + \beta_3$ that is, output growth will rise if z is reduced, because real wage growth declines more than productivity growth, which means that income is being redistributed from wages to profits, and the consequent increase of the profit share raises output. However, if $\alpha_3 < \alpha_3\beta_2 + \beta_3$, a reduction of z reduces output growth - since now the profit share declines due to the deregulation. When demand is profit-led also the sign of $(\frac{d\dot{y}}{dz})$ becomes ambiguous. We can see that the numerator is positive only if $\alpha_3\beta_2 + \beta_3 > -\alpha_3\beta_1 D$; in this case, the decline in z reduces productivity growth, because the effect on productivity growth of higher output growth due to lower real wage growth is more than offset by the depressing effect due to a reduced rate of technological progress. Accordingly, the impact on productivity growth of less stricter labor market regulation can be positive or negative.

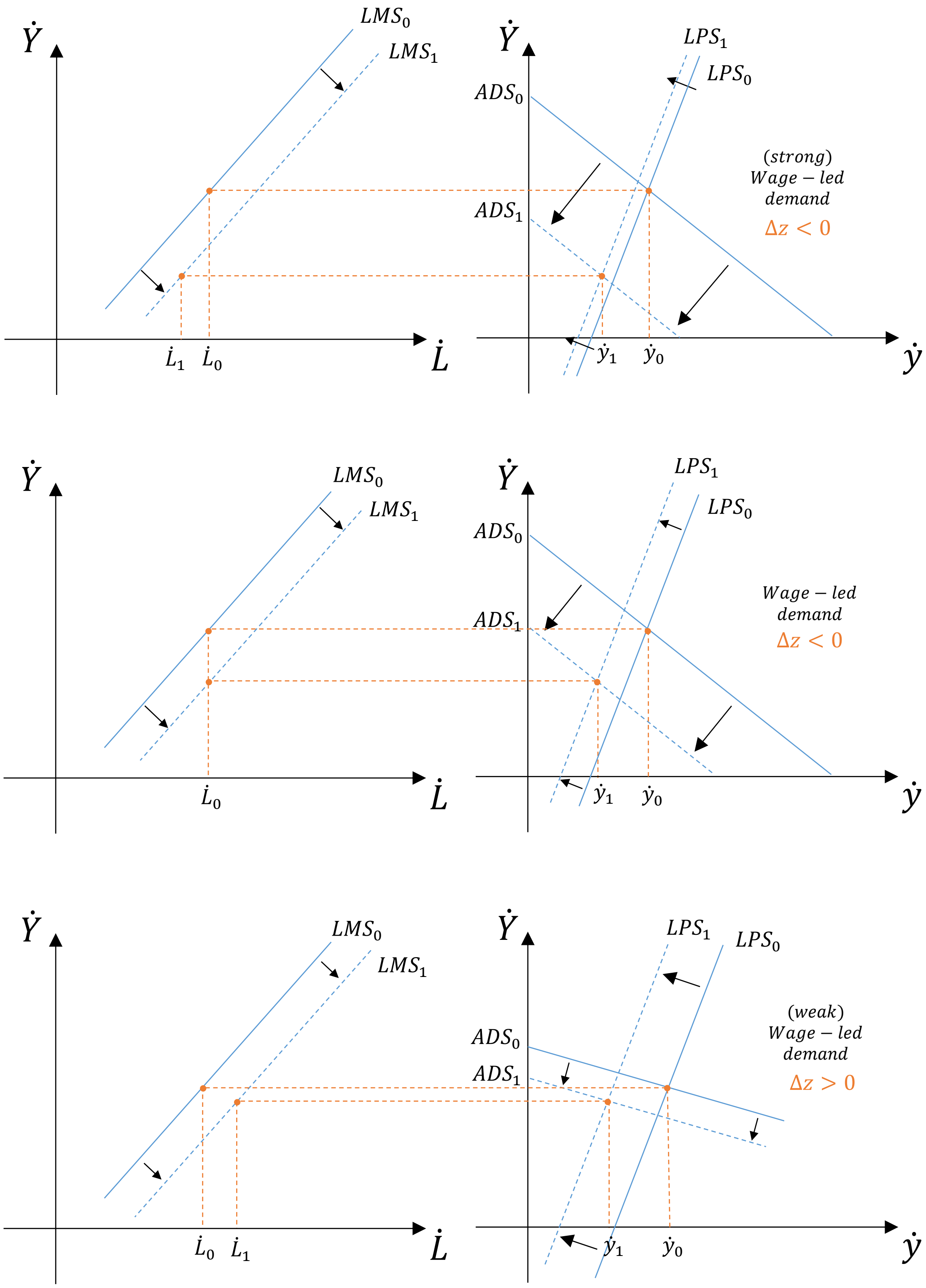
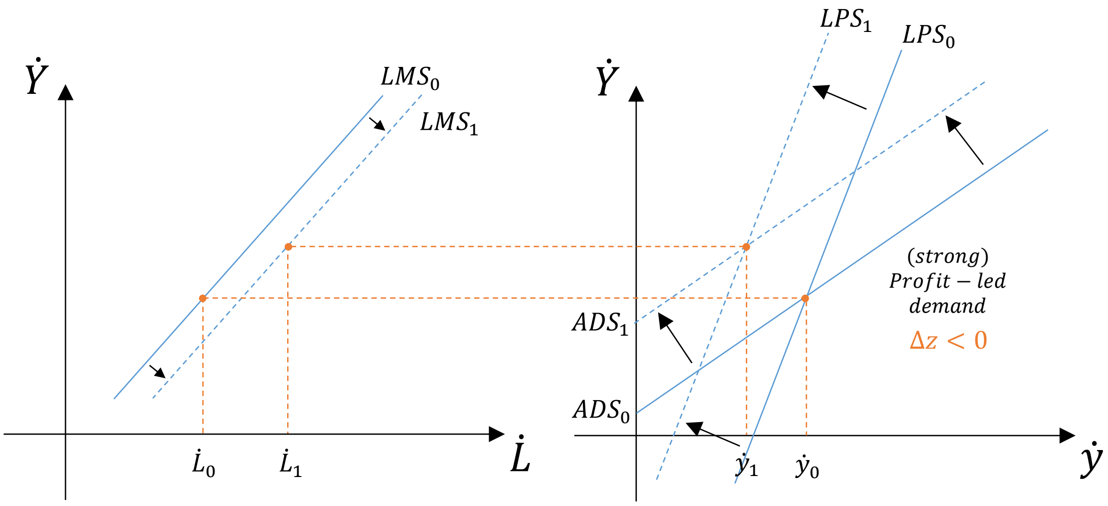
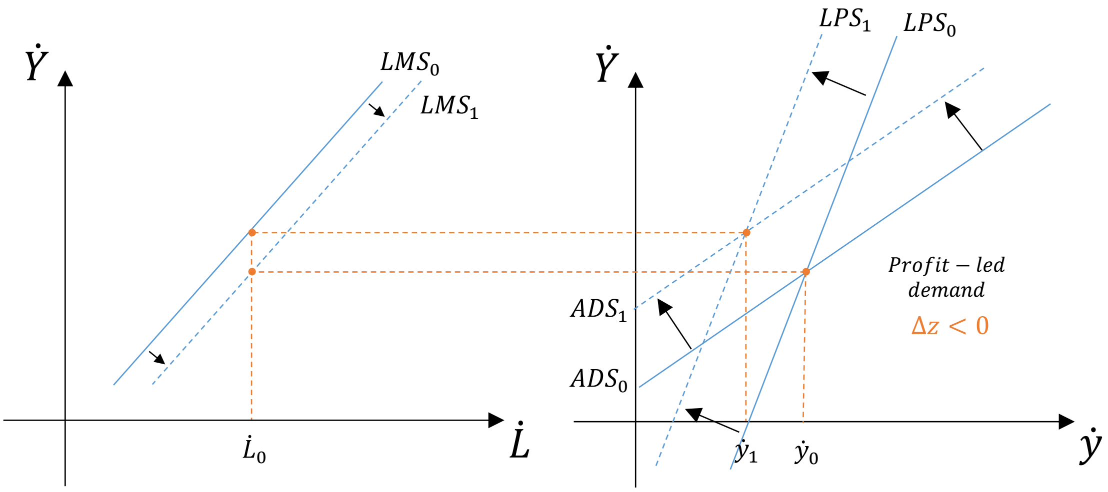


Figure 7 - Effects of a decrease in z in a wage-led ADS.

Note: The arrows indicate shifts in the demand, productivity, and employment curves caused by a decline in real wage growth, which is in turn due to a weakening of the bargaining power of workers caused by labor market deregulation (a decline in z). The intersection of the productivity and demand schedules determine the equilibrium rates of labor productivity growth $\dot{y}$ and output growth $\dot{Y}$. The (dynamic) stability conditions require that the slope of the productivity curve exceed the slope of the demand curve.





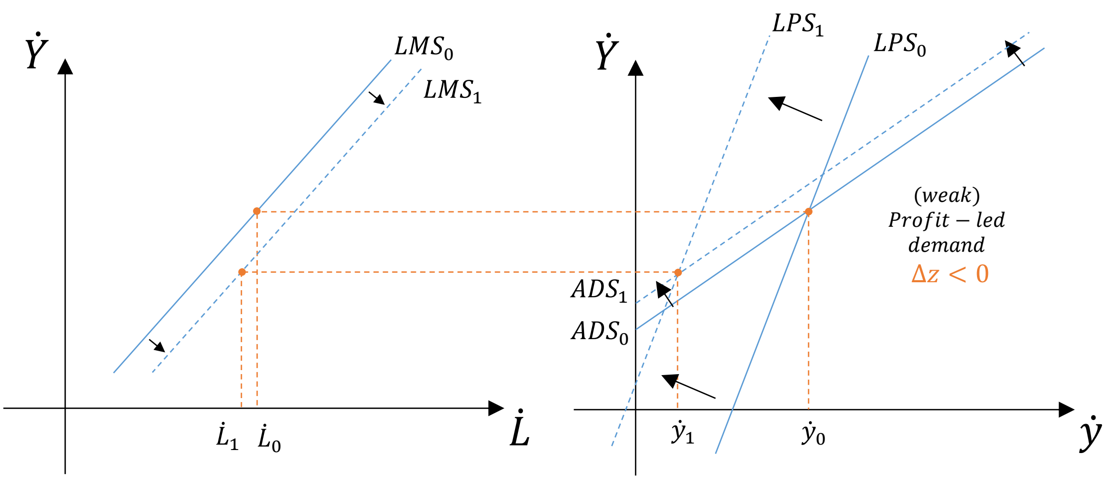


Figure 8 - Effects of a decrease in z in a profit-led ADS.

Note: The arrows indicate shifts in the demand, productivity, and employment curves caused by a decline in real wage growth, which is in turn due to a weakening of the bargaining power of workers caused by labor market deregulation (a decline in z). The intersection of the productivity and demand schedules determine the equilibrium rates of labor productivity growth $\dot{y}$ and output growth $\dot{Y}$. The (dynamic) stability conditions require that the slope of the productivity curve exceed the slope of the demand curve.

3.5 Long-run equilibrium

The main implication of the model is that standard macroeconomic theory that provides policies of real wage restraint and labor market deregulation may end up depressing capital accumulation and economic growth, slowing down productivity growth, and thus hindering technological progress without significantly reducing unemployment (Vergeer and Kleinknecht, 2010; Kleinknecht et al., 2014; Vergeer et al., 2012; Dutt et al., 2015). These effects are more likely to occur in wage-led economies but may - under some circumstances - reduce productivity growth also in profit-led systems (see Figure 8 - panel c). However, while this analysis yields important insights on the different macro adjustments to labor market reforms, the steady-state growth paths analyzed in the previous paragraph do not represent a real long-run equilibrium, since it is not assumed that both the rate of unemployment and the rate of inflation are constant, or - alternatively - that the wage-profit distribution is constant.[38] Hence, these latter imply an ever-changing (accelerating or decelerating) inflation and a constantly shifting (growing or declining) labor and profit share. This is realistic in the medium run: data for OECD countries show, for instance, that the profit share has continuously increased during 1963-1996 (Carter 2007). Similar are the results of Bassanini and Manfredi (2014) which analyzed data from 20 business-sector industries in 25 OECD countries for up to 28 years to document a constant decline of the labor share and Guerriero (2019) which compile a global dataset of the labor income share across 151 economies for all or part of the period 1970-2015 to show that contrary to the traditional assumption of stable factor shares there is evidence of considerable heterogeneity across economies and variability over time. However, in some other studies, at least for some countries over longer periods of time, the data show otherwise. Marquetti (2004), for instance, finds a roughly constant labor or profit share for the US economy over the last 130-years. Long-run equilibrium is therefore generally defined by imposing the condition that inflation is constant or that income distribution between wages and profits is constant. Gallardo et al. (2019) show that when "harmonized", non-housing labor share remained almost stable across all major economies except the US, where the labor share still declines, primarily due to a fall in manufacturing. Therefore, the unemployment rate will also be constant,

[38] Typically, we assume that in the long run an economy is characterized by balanced growth and thus that factor shares are ultimately constant - this arises either from the assumption that production is Cobb Douglas or that technical progress is labor-augmenting. Moreover, there should be no relationship between the labor share and the growth rate of the economy. This can be seen under a unitary elasticity where the income share of labor is a technological constant. Turning to the empirical literature, however, we know that for many economies the case for a unitary elasticity is weak, as it is the presumption that technical progress is neutral.

and this explains the NAIRU, which is the unemployment rate at which inflation is constant,[39] because inflation is fully anticipated and various claims on income by workers and firms are consistent with each other (Gordon R. J., 1997; Atkeson and Ohanian, 2001).

In this paragraph we impose this long-run equilibrium condition on the model to identify the determinants of equilibrium unemployment. What emerges is a more general model that allows aggregate demand, investment, and demand-induced technological progress to play a major role in determining the NAIRU. The main implications are: (i) that aggregate demand has long-run effects on unemployment and (ii) that labor market deregulation is not always effective in reducing unemployment. The determination of the equilibrium includes an analysis of accumulation and the evolution of technological progress over time. Specifically, in a situation where for instance a positive demand shock take place and causes unemployment to fall below its natural rate, additional demand is considered to have a positive impact (through the coefficient β_1) on productivity. And there is also the possibility that the higher real wage growth induces higher labor productivity growth (along the lines of *Hicks*) or capital accumulation (*a la* Kaldor). The result is that equilibrium unemployment will change once the system is perturbed out of equilibrium, and it is no longer clear what the new equilibrium will be. In this respect, changes and equilibriums are highly path-dependent - with the NAIRU acting as an attractor. Because of this, demand and demand policy have long-run, permanent effects. To see this, recall the three basic equations of the model: the LPS (5), the ADS (23), and the real wage equation (27):

$$\dot{y} = \beta_0 + \beta_1\dot{Y} + \beta_2\dot{w} + \beta_3 z + \beta_4\dot{k}$$
$$\dot{Y} = \Theta + D[\dot{w} - \dot{y}]$$
$$\dot{w} = \alpha_0 - \alpha_1 u + \alpha_2\dot{y} + \alpha_3 z$$

This is a system of three equations in four unknowns: labor productivity growth $(\dot{y})$, real GDP growth $(\dot{Y})$, real wage growth (w), and the unemployment rate (u). It means that an additional restriction needs to be imposed in order to close the system. As already stated, we assume that in the long run real wages must grow at the same rate of labor productivity, so that:

$$\dot{w} = \dot{y} \qquad (37)$$

[39] According to standard macroeconomic theory, as unemployment increases, inflation should decrease. If the economy does not go well, inflation tends to decrease, as firms cannot raise prices due to a lack of demand. If the demand for a product decreases, the price of the product drops because fewer consumers want the product, and this results in a price cut by firms to stimulate demand. The NAIRU is the level of unemployment that the economy must reach before prices start to fall. On the contrary, if unemployment falls below the NAIRU (i.e. the economy is doing well), inflation should increase. If the economy goes well for many years, companies can raise prices to meet demand. In addition, the demand for consumer goods increases and this demand causes inflationary pressures. Therefore, the NAIRU represents also the lowest level of unemployment that can exist before inflation starts to rise.

Condition (37) is the condition for long-run equilibrium, which implies that both inflation and the distribution of income across wages and profits are constant. Using equation (37) and equation (22), eq. (23) gives us the reduced-form expression for long-run equilibrium income growth $(\dot{Y})$:

$$\dot{Y}^* = \frac{\psi_i f_0 \dot{b} + \psi_g \dot{G}^* + \psi_x x_0 - \psi_i f_3 r}{(1 - \psi_i f_2)} \tag{38}$$

Interestingly, the nature of aggregate demand, while is of crucial importance in the medium run, turns out to be irrelevant for long-run income growth; this is not surprising, however, since we are keeping the distribution of income between wages and profits constant with restriction (37). Long-run growth thus depends on autonomous investment and export growth ($\dot{b}$ and $\dot{x}_0$), the growth of net public expenditure $\dot{G}^*$ (the fiscal policy), and the real interest rate r (the monetary policy). Substituting equations (37) and (38) into the LPS we can derive the reduced-form expression for equilibrium labor productivity growth $\dot{y}^*$:

$$\begin{aligned}\dot{y} = \frac{\beta_0}{(1-\beta_2)} + \frac{\beta_1}{(1-\beta_2)}\left[\frac{\psi_i f_0 \dot{b} + \psi_g \dot{G}^* + \psi_x \dot{x}_0 - \psi_i f_3 r}{(1-\psi_i f_2)}\right] \\ + \frac{\beta_3}{(1-\beta_2)} z + \frac{\beta_4}{(1-\beta_2)} \dot{k}\end{aligned} \tag{39}$$

Provided that $\beta_1 > 0$, i.e., that the Kaldor-Verdoorn coefficient is positive, long-run productivity depends positively on the growth of autonomous demand and negatively on the real interest rate (further assuming that $(1-\beta_2) < 0$). In addition, if β_3 is > 0, any rise in the extent of labor market regulation (captured by a rise in z) will raise productivity growth through the process of labor-saving technological progress. Finally, if $\beta_4 > 0$ also capital accumulation has a positive impact on long-run labor productivity. Turning to the labor market, by combining equations (37) and (27) we can derive the equilibrium unemployment rate u^*. Substituting (39) into it finally gives the following reduced-form expression for u^*:

$$\begin{aligned}u^* = \frac{(1-\beta_2)\alpha_0 - (1-\alpha_2)\beta_0}{(1-\beta_2)\alpha_1} \\ - \left[\frac{(1-\alpha_2)\beta_1}{(1-\beta_2)\alpha_1}\right] \frac{\psi_i f_0 \dot{b} + \psi_g \dot{G}^* + \psi_x \dot{x}_0 - \psi_i f_3 r}{(1-\psi_i f_2)} \\ + \left[\frac{(1-\beta_2)\alpha_3 - (1-\alpha_2)\beta_3}{(1-\beta_2)\alpha_1}\right] z - \left[\frac{(1-\alpha_2)\beta_4}{(1-\beta_2)\alpha_1}\right] \dot{k}\end{aligned} \tag{40}$$

Two insights follow directly from equation (40). (i) First, demand factors $\dot{b}$, $\dot{G}^*$, $\dot{x}_0$, and variations in the real interest rate Δr can have permanent effects on equilibrium unemployment. If $0 < \alpha_1 < 1$, $0 < \beta_1 < 1$, and $0 \leq \beta_2 < 1$, it follows that an increase in the growth rate of autonomous investment, net public expenditure, and exports will permanently reduce equilibrium unemployment, while a rise in the real interest rate will reduce u^* by depressing investments:

$$\frac{\partial u^*}{\partial \dot{G}^*} = \left[\frac{(1-\alpha_2)\beta_1}{\alpha_1(1-\beta_2)}\right]\frac{\psi_g}{(1-\psi_i f_2)} < 0 \tag{41}$$

$$\frac{\partial u^*}{\partial \dot{c}_0} = \left[\frac{(1-\alpha_2)\beta_1}{\alpha_1(1-\beta_2)}\right]\frac{\psi_x}{(1-\psi_i f_2)} < 0 \tag{42}$$

$$\frac{\partial u^*}{\partial r} = \left[\frac{(1-\alpha_2)\beta_1}{\alpha_1(1-\beta_2)}\right]\frac{\psi_i f_3}{(1-\psi_i f_2)} > 0 \tag{43}$$

As we can see from the system of derivatives in $(41)-(43)$, changes in aggregate demand by means of fiscal and/or monetary policy causes the natural rate of unemployment to change over time. On the other hand, here, the inflationary impact of demand expansions is at least partly mitigated because it leads to faster productivity growth; hence output growth, wage growth, and employment growth can be increased permanently without raising inflation. From equation (40), it follows that the sign of the impact on equilibrium unemployment of an increase in z is ambiguous while that of $\dot{k}$ is unambiguously negative. Increased regulation leads to higher equilibrium unemployment only if:

$$\frac{\partial u^*}{\partial z} = \frac{\alpha_3(1-\beta_2)-(1-\alpha_2)\beta_3}{(1-\beta_2)\alpha_1} > 0 \tag{44}$$

This contrasts with what happens in standard macroeconomic models where generally it is assumed that equilibrium productivity growth is exogenous and consequently, possible influences of productivity growth on unemployment are treated as due to exogenous productivity shocks. In terms of LPS, this requires that the coefficient β_1 is zero (i.e.,

demand growth does not affect labor productivity growth) and that the coefficient of wage-led technological progress β_2 is equal to unity (which in terms of a neoclassical production function means an elasticity of capital-labor substitution equal to one) (Uzawa, 1962). By assuming that β_2 is equal to unity, capital intensity growth and real wage growth will vary one-to-one in the short run.

As a result, if actual unemployment declines and the real wage rate increases, firms will substitute labor for capital until the loss of jobs on the installed capital stock is equal to the additional jobs created by the new equipment (and u^* remains unchanged). From restriction (37), it follows that w^* must adjust to the exogenously given growth rate of labor productivity. Given these assumptions (i.e., $\beta_1 = 0$, $\beta_2 = 1$), equilibrium productivity and real wage growth and equilibrium unemployment u^* are determined. This leaves equilibrium demand growth to be determined, with the latter which must be consistent with u^* and a stable inflation. Finally, the effect of technological progress on labor productivity is always positive (in terms of a standard model it raises the price setting curve without affecting the wage setting), and consequently the equilibrium unemployment rate is always reduced.

$$\frac{\partial y^*}{\partial \dot{k}} = \frac{\beta_4}{(1-\beta_2)} > 0 \qquad (45)$$

$$\frac{\partial u^*}{\partial \dot{k}} = -\frac{\beta_4(1-\alpha_2)}{\alpha_1(1-\beta_2)} < 0 \qquad (46)$$

4. An empirical investigation in a selection of 20 OECD countries

In this section we employ aggregate data from 20 OECD countries to empirically evaluate the theoretical model presented in Section 3. We start by investigating four broad stylized facts concerning the aggregate dynamic of labor productivity growth.[40] The core argument of our discussion is that labor productivity growth is influenced by income distribution, aggregate demand, the capital-labor ratio and the social relations of production.[41] Any change in the wage or profit rate, any change in aggregate demand or capacity utilization, or any reform of labor market regulation affects productivity, and this, in turn, necessarily influences unemployment. These stylized facts are expressed in terms of a labor *productivity schedule (LPS)* as follows:[42]

$$\dot{y} = \beta_0 + \beta_1\dot{Y} + \beta_2\dot{w} + \beta_3 z + \beta_4\dot{k} \qquad \beta_0, \beta_2, \beta_3, \beta_4 > 0;\ 0 < \beta_1 < 1$$

[40] Nicholas Kaldor argued that theory construction should begin with a summary of relevant facts, but because the "facts, as recorded by statisticians, are always subject to numerous snags and qualifications" he suggested that theorists "should be free to start off with a stylized view of the facts - i.e. concentrate on broad tendencies, ignoring individual detail" (Kaldor 1965).

[41] Aggregate labor productivity growth is the core variable for the supply-side of our model. Labor productivity is a comprehensive output measure of technological change and reflects the joint influence of many factors, including embodied and disembodied technological progress, changes in the sectoral employment structure, organizational reform, and human capital formation.

[42] As shown in the Mathematical Appendix A - Derivation of the productivity curve, this latter equation can be derived from a general VES production function and states that labor productivity growth depends on capital intensity growth and real GDP growth.

Where $\dot{Y}$ is real GDP (or output) growth, $\dot{w}$ is real wage growth, $\dot{k}$ is the growth of capital-labor ratio and z is an index of labor market regulation. Our hypothesis, to be empirically tested here, is that the coefficients are positive and statistically significant, that is, $\beta_1, \beta_2, \beta_3, \beta_4 > 0$. Before entering the empirical part of the work, it is worth taking a closer look to the determinants of the LPS. Then we present empirical evidence on the evolution of labor productivity for a panel of twenty OECD countries over the period 1985-2013. There are four different key factor which affect the evolution of labor productivity:

1. *The Kaldor-Verdoorn effect.*[43] Higher output growth raises labor productivity growth by a factor of β_1 in equation (5). Verdoorn's formulation dates to 1949. In 1966, Nicholas Kaldor formulated his own law, which has since become known as the Kaldor-Verdoorn law. According to Kaldor, an increase in aggregate demand leads to a chain of reactions from firms that ultimately increase in labor productivity. A key role is played by the following factors: (i) economies of scale; (ii) learning-by-doing; (iii) productive specialization towards exports; (iv) the endogeneity of technical progress through the accumulation of capital; (v) cumulative causation processes (Angeriz, et al., 2008; Millemaci and Ofria, 2014). Verdoorn first observed the association, finding a coefficient β_1 of about 0.45 (Verdoorn, 1949). Kaldor (1966) reported a more reasonable coefficient of about 0.5. McCombie et al. (2002) have reviewed more than eighty empirical studies on the Kaldor-Verdoorn effect from 1949 and 2001, finding that the Kaldor-Verdoorn effect is confirmed in most of the cases, irrespective of the differences in econometric methods and data employed. The effect is statistically significant for cross-section estimations across countries or regions and for specific industries, but also in time-series econometric studies on single countries or regions (Castiglione, 2011; Fazio et al., 2013; Magacho, 2016; Deleidi et al., 2018). In contrast to these results, it has been claimed that reasoning in terms of demand rather than supply (i.e., the Solow model) as a crucial factor determining the rate of accumulation could be misleading in understanding causality.[44] The Kaldor-Verdoorn effect, in this sense, may reflect the fact that faster growth in productivity induce, via its effect on relative costs and prices, a faster growth of demand, and not the other way around. However, this is not fully

[43] Kaldor's (1966) inaugural address at Cambridge University and Kaldor (1972) are excellent expositions of the Kaldor-Verdoorn effect. The older work by Allyn Young (1928) on the importance of increasing scale returns is also relevant.

[44] Verdoorn's law differs from "the usual hypothesis […] that the growth of productivity is mainly to be explained by the progress of knowledge in science and technology", as it typically is in neoclassical models of growth. Verdoorn's law is associated with cumulative causation models of growth, in which demand rather than supply determine the pace of accumulation.

convincing and as Kaldor explains, the alternative hypothesis is not specified. If the growth rate of productivity in each industry and country is an autonomous factor, we need some hypothesis to explain it. The usual one is that the growth of productivity relates to the progress of knowledge in science and technology. But in that case how it is possible to explain the large differences in each industry over the same period in different countries? This hypothesis denies the existence of increasing returns which are an important feature for the manufacturing industry (Park and K. Ryu., 2006; Anguo et al., 2011; Chen, 2011). Moreover, since this is not enough to argue that productivity growth is autonomous, it is also necessary to make the additional hypothesis that differences in productivity growth rates between industries and sectors are fully reflected in the movement of relative prices and that the price-elasticity of demand for the products of any industry is greater than unity. None of these hypotheses have been subject to econometric validation (Kaldor 1966).

2. *Induced labor-saving technological progress.* Our second hypothesis is that changes in factor prices influence the type and direction of technological progress; in particular, high real wages induce labor-saving innovations and higher labor productivity growth, that is, $\beta_2 > 0$. The idea is generally credited to Hicks, but the concept of wage-cost-induced technological change has even older roots, going back to Marx (Duménil and Lévy 2010).[45] In Marx, labor-saving technological progress is the only mechanism that guarantees the reproduction of a positive economic surplus and a growing reserve army, necessary to keep real wages constant in a growing system. For this reason, in times of excessive labor demand and declining profits, the application of labor saving innovations will be accelerated, with negative consequences on the bargaining power of workers.[46] These insights opened an empirical debate on the implications of variations in relative factor price for the rate and direction of technological change, especially at the industry level, which came back to the forefront in the late 1990s as part of renewed interest in economic growth and endogenous technological change (Ruttan 1997). For instance, Foley (2019) developed a microeconomic model of induced technological change in which labor productivity growth is a positive function of the labor share. Similarly, Bhaduri (2008) and Tavani (2009) provide micro

[45] Hicks wrote in his Theory of Wages (1932): "a change in the relative prices of factors of production is itself an incentive to innovation and to inventions of a particular type, directed at economizing the use of a factor which has become relatively expensive".

[46] Hicks and Marx insights initially received little attention. During the 1960s and 1970s, however, they triggered an important debate, which addressed possible reasons for the apparent stability of the labor share in a scenario characterized by the presence of rapidly rising real wages.

foundations on the hypothesis of induced innovation. Empirically, there is strong evidence that real wage growth and labor productivity growth are cointegrated in the long run (Bellocchi et al., 2020). Marquetti (2004) found a one-to-one relationship between wage and productivity growth for the US economy over the last 130-years, which in terms of LPS would mean that $\beta_2 = 1$ and the labor share is constant. Brida et al. (2010), Sethi and Kaur (2013), De Souza (2017) and Bellocchi et al. (2020) also test for Granger causality, with the important finding of unidirectional causality from real wages to labor productivity. However, over shorter periods of time, the association is less strong. Finally, using data for 15 OECD countries over the period from 1980 to 1996, Carter (2007) finds that β_2 takes a value of about 0.4/0.5. Evidence for nineteen OECD economies provided by Rowthorn (1999) suggests that β_2 may even be lower, varying between 0.2 and 0.3. Thus, we expect that β_2 is positive but below unity.

3. *The social relations of production.*[47] We assume that $\beta_3 > 0$, which, if true, would mean that labor productivity growth, on average, is higher in economies having regulated and coordinated labor markets than in countries characterized by deregulated and flexible ones. Usually, in macroeconomic model the social organization of production and labor relations can affect technology only through their direct impact on production costs of firms, not through workers' motivation and effort since the latter is supposed to depend only on the monetary incentive as a compensation for the disutility of working. This means that workers are not supposed to worry about the non-monetary dimensions of the productive system, and they are supposed to maintain their work intensity in front of whatever form of technological/organizational change is introduced in the workplace, provided that their real wage is not negatively affected.[48] It is acknowledged that labor market regulation is a cost for firms, because it raises labor costs and reduces their flexibility to adjust the workforce.

[47] David Gordon's (1996) is a great exposition on how the social relations of production influence productivity growth, macro performance and social welfare. Lorenz (1992) presents an historically supported argument that as organizational flexibility increases, labor management relations become more cooperative; his comparative analysis based on how computer-numerical-control machine tools were introduced in high-trust Germany (with the cooperation of workers) and low-trust Britain (with much worker opposition) is of particular relevance. Buchele and Christiansen (1999) made a careful statistical evaluation of the impact of labor relations on OECD productivity growth. Peter Auer (2007) and Faggio and Nickell (2007) provide a useful overview of contemporary cross-national differences in the social relations of production.

[48] As Richard Sennett (1998) states: "At a certain point, routine becomes self-destructive, because human beings lose control over their own efforts lack of control over work time means people go dead mentally". Adam Smith in his Wealth of Nations argues: "In the progress of the division of labor, the employment of the far greater part of those who live by labor…comes to be confined to a few very simple operations. The man whose whole life is spent in performing a few simple operations has no occasion to exert his understanding, or to exercise his invention in finding out expedients for removing difficulties which never occur. He loses the habit of such exertion, and generally becomes as stupid and ignorant as it is possible for a human creature to become" (Smith, 1776).

Further, regulation may lead to increased wage pressures from employed "insiders" whose bargaining position is strengthened by the interventions (Lindbeck and Snower, 2001). However, it is often overlooked that regulation may also positively affect firm's behavior, because of its direct impact on workers' motivation, effort, and work intensity (De Spiegelaere et al., 2014). Remarkably, few studies on productivity growth payed attention to the effects of labor relations. The OECD Employment Outlook (2007) reviews this literature and concludes that: "Evidence on the productivity growth effects of labor market reforms do not loom large in the existing empirical literature and hence more research is needed". However, recently the gap has been partially filled, revealing that ceteris paribus, regulation has a positive and significant impact on labor productivity growth.[49] This is the result of two contrasting effects. (i) On the one hand, as explained above, labor market regulation rises labor costs. The increase in labor costs, in turn, increases labor productivity growth by stimulating capital deepening, increasing the share of high-skilled workers in the labor force, encouraging capital-intensive sectors, and promoting labor-saving technological change (Boeri et al., 2007; Bassanini et al., 2009; Calcagnini et al., 2018; Bellocchi et al., 2020). This conclusion is linked to the Swedish debate on solidarity bargaining, in which it was argued that nationwide wage settlements, would drive inefficient firms out of the market and sustain structural change, increasing the aggregate productivity growth (Rehn, 1952; Lundberg, 1985; Haucap and Wey, 2004). (ii) On the other hand, however, since higher labor costs reduce the expected return on innovation, it may slow down technological investments and hence reduce TFP and labor productivity growth (Malcomson, 1997; Bartelsman, 2000). These two and opposite effects presumably cancel each other out, in which case productivity growth is not strongly influenced by changes in labor market interventions. In terms of LPS, this would mean that β_3 is zero or negligibly small. Nevertheless, there is enough studies on the effects of work organization on productivity, all of which conclude that productivity is higher in firms characterized by more involvement of workers in production activities, participation in decisional processes and a fair sharing of profits. [50] The social organization of

[49] In recent literature, despite some mechanisms that could give rise to a positive link between flexibilization of the labor market and productivity (e.g. a higher EPL could decrease productivity by hindering the reallocation of workers and jobs across industries and firms or reducing workers effort), a number of mechanisms may suggest a positive relationship between EPL and productivity (e.g. a higher EPL may provide insurance and promote specific investments and may make firms more selective in choosing their workers). For instance, Blanchard and Landier (2002) and Cahuc and Postel-Vinay (2002) model of temporary contracts as policies that adversely affect wage setting and can generate higher unemployment and lower productivity.

[50] Recall this example by David Gordon: "Imagine two workers in the same industry, working in firms with comparable technology. One works in a firm with top-down management, little job security, stagnant wages, no participation in organizing production. The

production has a strong impact on the way in which a specific technology is employed and, consequently, on labor productivity. Therefore, in this perspective, productivity improvements depend on the cooperation of workers, their tacit knowledge and ideas, which will be denied if workers feel their jobs at risk.[51] Hence, in regulated production systems, workers are more accommodating towards the introduction of automation that increases productivity, possibly participating positively in planning and implementation activities, because their job security reduces the fear of technological layoffs and a fair share of the increases in productivity. Hence, we expect β_3 to be positive.[52]

4. *The capital-labor ratio*. Kaldor (1957) added an additional explanation of the positive association between demand growth (as the cause) and productivity growth (as the consequence). It is based on the so-called "technical progress function",[53] according to which the direction of technical change is determined by the rate of capital deepening. This has to do with the fact that new investments generally embody the latest, most modern technology, making the newly installed machines more productive than older vintages of capital stock. If demand growth leads to investment growth, this will modernize the capital stock of a country (at the margin) and raise average worker productivity. The initial technical progress function was a dynamic production relationship, relating the growth of productivity to the growth of the capital-labor ratio. The specification changed in Kaldor and Mirrlees (1962) to a vintage approach, but the basic insights remained largely the same. In a way that anticipated neoclassical endogenous growth theories, Kaldor argued that the growth of capital per worker induces technical change but at a diminishing rate. It embodies the idea that capital accumulation and technical progress occur jointly. The same idea has been taken up (and acknowledged) by Arrow (1962). It has resurfaced in some more recent AK theories

---

other works in a firm with a much less bureaucratic structure, job security, rapid wage growth - particularly when productivity improves - and the opportunity to participate in decisions about the organization of work. It seems likely that the second worker will make a much more commitment to the progress and future of the enterprise" (Gordon, 2006).

[51] Marx analyzed the interaction between technology and the social relations of production. His conclusion is that technology is determined and transformed by the system of social relations (Braverman, 1974).

[52] Nickell and Layard (1999) state: "There is no reason to be surprised that employment protection shows up with a positive coefficient in productivity regressions".

[53] Consider a closed economy with two factors of production, labor (L) and capital (K). Denote output by Y and labor productivity by y. The development of labor productivity over time depends on the amount of capital employed per worker k. The more the capital-labor ratio increases, the more labor productivity increases, but also without capital deepening, labor productivity would increase somewhat. The "technical progress function" formalizes this idea. It gives the growth rate of labor productivity as a positive function of capital deepening. Denoting time derivatives by a dot and growth rates by a hat, the growth rate of labor productivity is $\hat{y} = \frac{1}{y}\frac{dy}{dt}$ and the rate of capital deepening is $\hat{k} = \widehat{\left(\frac{K}{N}\right)} = \hat{K} - \hat{N}$. The technical progress function gives $\hat{y}$ as a function of $\hat{k}$: $\hat{y} = \varphi(\hat{k})$. For $\hat{k} = 0$ (constant capital-labor ratio), the increase in labor productivity is positive and subject to diminishing returns.

that “aggregate productivity depends upon the aggregate capital stock” (Aghion and Howitt, 2009).[54] Therefore, we expect that β_4 is positive but below unity.

We study the differences in the growth rates of labor productivity per hour worked among twenty OECD economies over the period 1985-2013. This means that the number of observations is twenty-eight. This is a time frames for which reliable data on labor market regulation and macroeconomic performance are available and allow us to investigate the impact of structural variables (i.e., labor market regulatory institutions) on longer-term labor productivity growth. It is worth emphasizing that we use national data and not industry-level data because most labor market regulations (and especially the EPL) vary across countries but are identical across industries. The impact of labor market regulation should therefore be visible in aggregate (hourly) labor productivity growth. We have checked for country-specific effects by including country dummies in the panel regression, but in general we found (unless stated otherwise in the text and tables) that these country dummies were not statistically significant, which suggests that we have included all the relevant control variables. Table 9 presents the summary statistics of our database for the sample of twenty OECD countries; Data sources are listed in Appendix C - Data Sources.

[54] In contrast to Kaldor which assumes that even without capital accumulation, productivity increases over time.

	Summary statistics (1985-2013)						
	g_Y	g_y	g_w	g_k	EPL	g_EPL	Obs
Australia	3.23%	1.28%	0.90%	4.20%	0.54	71.76%	28
Austria	2.09%	1.32%	0.98%	2.17%	0.96	25.03%	28
Belgium	1.97%	1.17%	1.00%	2.95%	1.27	-8.99%	28
Canada	2.46%	0.92%	0.89%	3.49%	0.29	37.97%	28
Denmark	1.69%	1.31%	1.17%	2.92%	0.94	-7.11%	28
Finland	2.01%	1.89%	1.52%	1.58%	0.93	27.49%	28
France	1.85%	1.28%	0.94%	2.11%	1.45	46.66%	28
Germany	1.83%	1.03%	0.72%	1.82%	1.17	-30.80%	28
Greece	1.04%	0.77%	0.39%	0.30%	1.63	-20.68%	28
Ireland	5.33%	3.52%	1.67%	6.04%	0.44	65.40%	28
Italy	1.10%	0.97%	0.47%	0.52%	1.50	-19.43%	28
Japan	1.82%	1.55%	0.84%	1.47%	0.70	-8.66%	28
Luxembourg	4.25%	1.16%	1.00%	5.38%	NA	NA	28
Netherlands	2.26%	1.17%	1.00%	3.21%	0.99	16.73%	28
Norway	2.44%	1.36%	1.41%	2.39%	1.31	34.81%	28
Portugal	2.12%	1.98%	1.59%	1.97%	1.78	-17.68%	28
Spain	2.41%	1.11%	0.73%	3.32%	1.47	-12.84%	28
Sweden	2.19%	1.81%	1.74%	2.64%	1.14	-31.43%	28
United Kingdom	2.37%	1.51%	1.60%	2.06%	0.36	50.79%	28
United States	2.70%	1.60%	1.42%	3.13%	0.12	37.97%	28
Mean	2.36%	1.44%	1.10%	2.68%	1.00	0.04	
Standard Deviation	0.010	0.006	0.004	0.014	0.484	0.332	

Table 9 - Summary statistics for the key variables of the model, 1985-2013.

Note: The total number of observations for each country-variable is twenty-eight. For EPL, the first observation is in 1985 and the last one in 2013. All variables (except the EPL - for which we show the total change) are expressed in terms of average annual growth rates. *Source:* Author's calculation on AMECO data.

Qualitative aspects of industrial relations are difficult to quantify; however, we believe that these aspects are correlated with the EPL quantitative indicator. EPL is an index of employment protection legislation, designed as a multidimensional indicator of the strictness of legal protection against dismissals for permanent and temporary workers as well as the hiring of workers on temporary contracts. It covers both individual and collective dismissals. The higher this index, the more restricted a country’s employment protection legislation (OECD, 1999; Nicoletti et al., 2000).

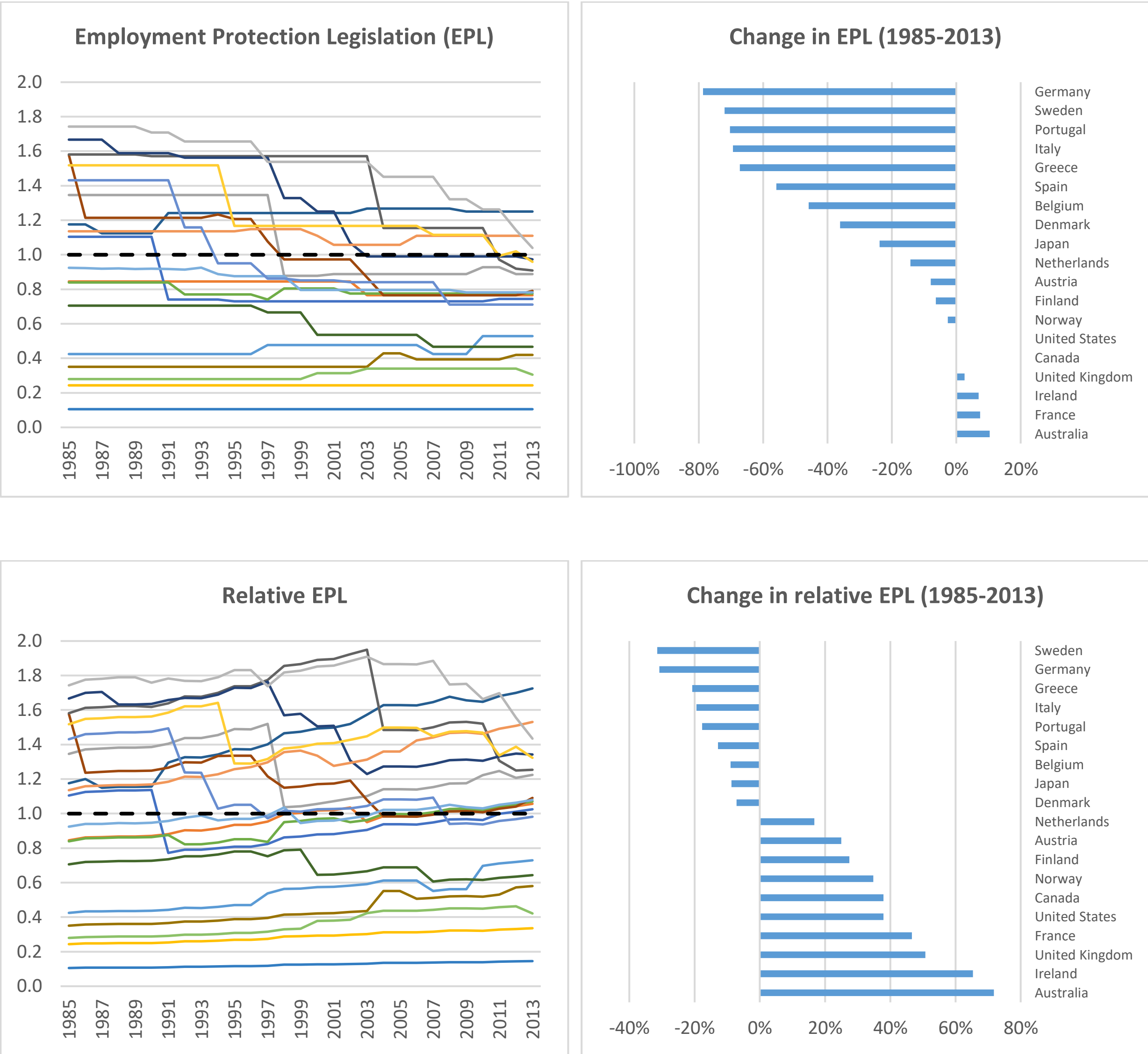


Figure 9 - Employment Protection Legislation (EPL) absolute and relative values in OECD countries (1985-2013).[55]

Source: Author's calculation on AMECO data.

Figure 9 (panels a and c) presents a graphical illustration of the evolution of labor market regulation (both in absolute and relative values), which is a defining feature of OECD labor markets. The higher the labor market regulation, the more intensively regulated is a country's labor market. Figure 9 (panels b and d) ranks the estimates of labor market regulation by country in descending order for the period from 1985 to 2013. The ranking generally confirms most observers' views that countries in southern Europe have the most regulated labor markets, followed by France, Germany, and the Scandinavian countries, while the United States, Canada, the United Kingdom, and Australia are at the opposite end of the spectrum. As can be seen by Figure 9 panels b and c, the hardest

[55] The relative EPL is calculated as the ratio between the EPL of one country and the weighted average of all other OECD countries.

deregulation took place in Germany, Sweden, Portugal and Italy. There has been little change in the ranking of countries. This is in some cases even surprising, because many OECD countries have undertaken reforms to deregulate their labor market, but in practice most of the reforms have been marginal (affecting workers on temporary contracts and not regular workers) (Boeri 2005). However, if we look at the picture in relative terms (i.e., where changes in EPL within single countries are normalized to the world average) the situation changes considerably (Figure 9 panels c and d). What stands out from the two graphs is that the biggest change occurred in Germany, which ranked fourth in the first period, when its score was above average, and eighth in the second, when its score was below average. This change is due to the reform of the German industrial relations system toward a system of "flexicurity", which combines reduced employment protection and increased social protection - especially in terms of higher unemployment benefits and active labor market policies (Keller and Seifert, 2004; Leschke et al., 2006; Auer 2007). The extent of regulation also declined (but less significantly) in Sweden, Portugal, Italy and Greece, while increased in Finland and remained unchanged in other countries of Continental Europe as well as in Japan. Finally, there has been hardly any change in the labor market regulation scores of the Anglo-Saxon countries which, however, have always had a very low level of regulation.

Table 10 presents the regression results for labor productivity. Direct estimation of the LPS did not yield robust statistical results - mainly because of problems of simultaneity, which violate the standard OLS assumptions. The simultaneity concerns both real wage growth (which affects productivity growth but is also influenced by productivity growth) and real GDP growth (which similarly is related to and at the same time determined by productivity growth). To get around these issues, we follow an indirect route and estimate the equation by means of a three-stage least squares regression (3SLS). More specifically, demand-determined real GDP growth $(\dot{Y})$ is estimated as a function of export growth $\dot{e}$, investment growth i, and the government budget $(G - T)$. Capital intensity growth $\dot{k}$ is a positive function of real wage growth (reflecting the substitution between capital and labor) $\dot{w}$ and labor market regulation EPL. Labor productivity growth $(\dot{y})$ depends positively on capital intensity growth $(\dot{k})$ and real GDP growth $(\dot{Y})$. From this three-equation system, we can recover all the coefficients of the productivity equation.

	Impact through (in percentage growth rates):						
	Const	g_Y	g_W	EPL	g_k	N	
Australia	NA	NA	NA	NA	NA	NA	NA
	-	-	-	-	-		
Austria	0.160	0.333	0.436	0.019	0.531	28	0.774
	(0.0996)*	(0.007)***	(0.0219)**	(0.0422)**	(0.0586)*		
Belgium	0.138	0.518	0.361	0.204	0.404	28	0.773
	(0.1124)	(0.024)**	(0.0054)***	(0.0008)***	(0.0479)**		
Canada	0.165	0.285	0.329	0.006	0.368	28	0.638
	(0.3284)	(0.0071)***	(0.0414)**	(0.0079)***	(0.04)**		
Denmark	0.108	0.320	0.310	-0.022	0.501	28	0.800
	(0.0549)*	(0.0095)***	(0.0208)**	(0.317)	(0.0056)***		
Finland	0.222	0.446	0.317	0.068	0.417	28	0.897
	(0.1617)	(0.0479)**	(0.0264)**	(0.0522)*	(0.0057)***		
France	0.275	0.498	0.352	0.181	0.429	28	0.915
	(0.0723)*	(0.0087)***	(0.0008)***	(0.0127)**	(0.0268)**		
Germany	0.280	0.515	0.330	0.240	0.417	28	0.861
	(0.0579)*	(0.0008)***	(0.167)	(0.2979)	(0.0049)***		
Greece	0.188	0.403	0.299	0.097	0.398	28	0.782
	(0.2926)	(0.0056)***	(0.0325)**	(0.0021)***	(0.0402)**		
Ireland	0.180	0.261	0.263	0.071	0.363	28	0.760
	(0.3278)	(0.0022)***	(0.0203)*	(0.2677)	(0.0631)*		
Italy	0.314	0.562	0.379	0.169	0.456	28	0.834
	(0.1223)	(0.0014)***	(0.0001)***	(0.0306)**	(0.0033)***		
Japan	0.062	0.496	0.498	0.236	0.515	28	0.852
	(0.1737)	(0.0279)**	(0.0482)**	(0.0061)***	(0.007)***		
Luxembourg	NA	NA	NA	NA	NA	NA	NA
	-	-	-	-	-		
Netherlands	0.255	0.443	0.418	0.142	0.479	28	0.628
	(0.2584)	(0.0061)***	(0.0241)**	(0.0856)*	(0.083)*		
Norway	0.134	0.557	0.364	0.140	0.425	28	0.371
	(0.3414)	(0.0407)**	(0.0052)***	(0.0413)**	(0.0081)***		
Portugal	0.076	0.356	0.464	0.210	0.438	28	0.864
	(0.033)**	(0.0057)***	(0.0063)***	(0.2037)	(0.0912)*		
Spain	0.194	0.390	0.357	0.160	0.493	28	0.934
	(0.2033)	(0.2294)	(0.0724)*	(0.0364)**	(0.3247)		
Sweden	0.229	0.441	0.434	0.236	0.536	28	0.843
	(0.0315)**	(0.0192)**	(0.008)***	(0.0443)**	(0.004)***		
United Kingdom	0.086	0.263	0.289	0.052	0.447	28	0.686
	(0.0732)*	(0.0351)**	(0.0176)**	(0.0663)*	(0.0414)**		
United States	0.303	0.234	0.335	0.066	0.394	28	0.887
	(0.1015)	(0.0083)***	(0.0473)**	(0.0687)*	(0.0459)**		
Panel	0.187	0.457	0.293	0.126	0.491	28	0.783
	(0.077)*	(0.0099)***	(0.0137)**	(0.0615)*	(0.0384)**		
Standard Deviation.	0.078	0.107	0.064	0.084	0.054		0.934

Table 10 - OECD productivity growth: estimation results (1983-2013).

Note: 3SLS estimation results for our three-equation system. The equations are estimated for the 20 OECD countries of our sample. Coefficients for real wage growth and the EPL index are those retrieved by estimation in the capital intensity growth equation, while GDP and capital intensity by means of the labor productivity growth equation. P-values appear in parentheses. $*$, $**$, and $***$ denote statistical significance at 10%, 5%, and 1%, respectively. In panel regression we included all statistically significant country dummies. The maximum number of dummies is 18, since they are meant to capture structural (time-invariant) country-specific effects.

We employed both the absolute and relative version of the EPL index as a standard measure for labor market regulation. Note that the number of observations is twenty-eight for single-country regressions. The explanatory power of the estimated equation is high - the adjusted R_2 lies between 0.37 and 0.93 (0.78 for the panel). All coefficients are statistically significant and have the expected signs.[56] We find that β_1 (the Kaldor-Verdoorn coefficient) takes a value (statistically significant at 1 percent) of 0.45 and can be interpreted as the percentage increase in productivity growth due to a unitary increase in output growth. The results correspond to available estimates.[57] Also, β_2 - obtained indirectly from in IV regression - is statistically significantly different from (smaller than) unity. This means that an increase in the EPL by 1 point (on a 0-2 scale) rises labor productivity growth by 0.12 percentage points - which is in line with findings by Nickell and Layard (1999), Dew-Becker and Gordon (2012), Marelli et al. (2012), Van Schaik et al. (2013) and Damiani et al. (2016). We further find that the impact of labor market regulation on capital intensity growth, is about 0.34 and statistically significantly different from zero at 1 percent (we checked that the statistical significance of the estimated coefficients does not depend on a specific country). Our estimate of the coefficient for real wage-growth-induced technological progress, namely β_3 is 0.29. This result is in line with the findings of Rowthorn (1999), Vergeer and Kleinknecht (2007) and Hein and Tarassow (2010). Finally, the coefficient for capital intensity growth β_4 takes a value of 0.49 and is statistically very significant at 1 percent, thus resembling the results of Battisti et al. (2018). This means that it is wrong to assume that labor productivity growth is not affected by labor market reforms: it is, because they influence workers' motivation, effort and intensity.[58] This point is highlighted in Figure 10, which shows that more protective labor market regulation raises wage claims (the wage-setting curve shifts to the right) as well as labor productivity levels (reflected by an upward shift of the price-setting curve). Therefore, the ultimate impact on the natural rate of

[56] Also, coefficients of the IV - not reported here - are statistically significant and positive meaning that we have obtained a plausibly instrumented estimate of real GDP growth and capital-intensity. The explanatory power is quite satisfactory for both the equations (either 0.72 and 0.80 in panel) and the coefficients have the expected signs.

[57] McCombie et al. (2002) estimates 0.3-0.6 for OECD countries (average of 80 empirical studies); Cornwall and Cornwall (2001) based on data for 16 OECD countries over the period 1960-1989 estimate 0.5; Leon-Ledesma (2002) for 18 OECD countries (1961-1995); 0.64-0.67; Angeriz et al., (2008) for Europe (1986-2002) 0.50-0.67; Hein and Tarassow (2010) 0.45-0.54 for European Countries and 0.11/0.23 respectively for the US and the UK; Alexiadis and Tsagdis (2010) for EU12 regions (1977-2005) find 0.43-0.49.

[58] Endogeneity of workers' motivation and labor productivity has been recognized in a number of macroeconomic models, especially those drawing from the efficiency-wage literature. However, the efficiency wage perspective cannot fully grasp the dimensions of the problem. Actually, the worker is seen as motivated only by monetary stimulus and labor is treated as being external to the worker itself. What is missing is that workers' motivation may be influenced by other intrinsic personal and social factors, including the social organization of the labor processes.

unemployment is not clear and may rise or fall depending on whether wage claims or productivity is affected most.

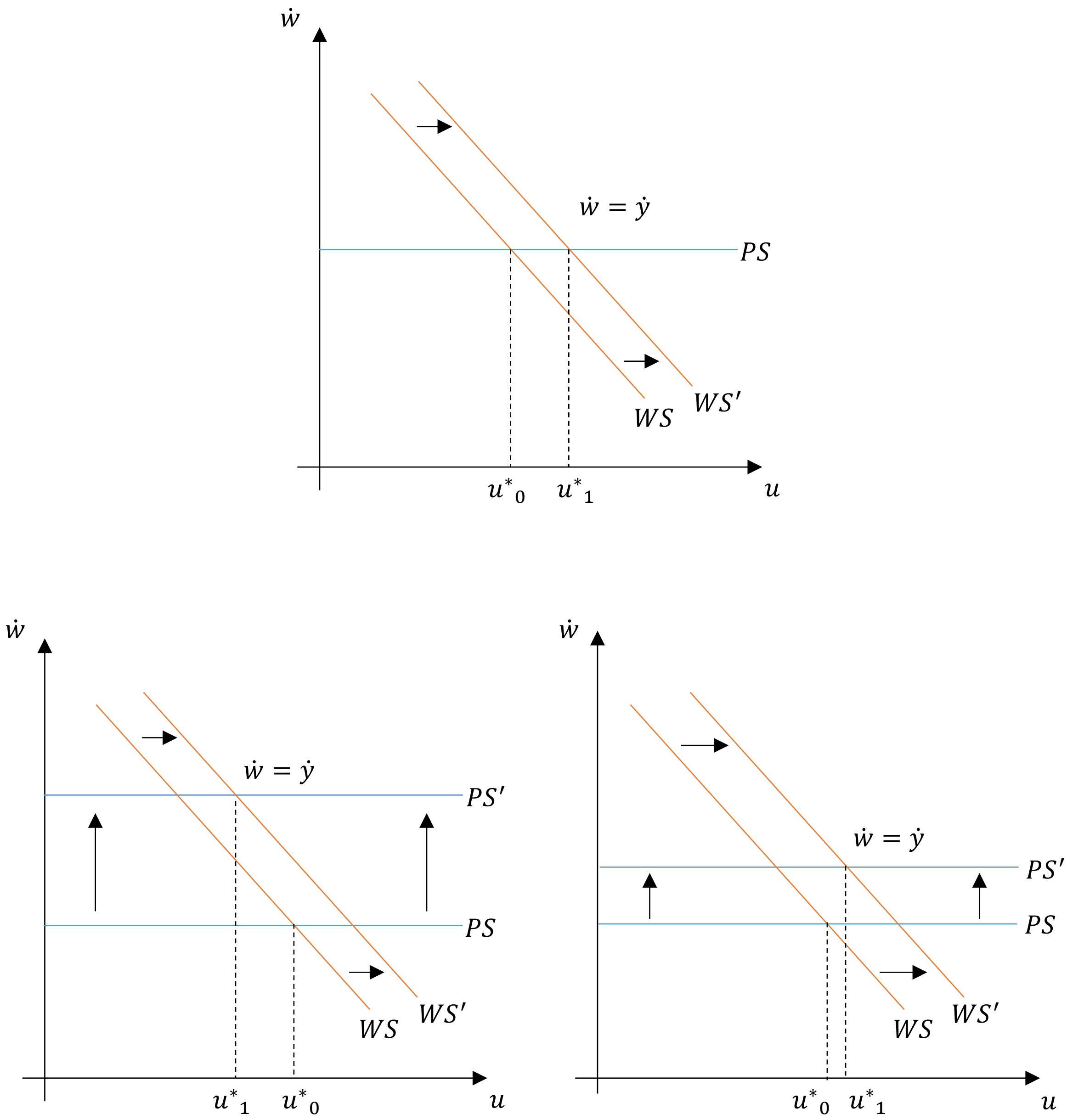


Figure 10 - Labor market regulation, productivity growth, and the equilibrium rate of unemployment.

Note: In standard macroeconomic models more labor market regulation always increases the natural rate of unemployment (NAIRU) (panel a).[59] In contrast, here, more labor market regulation and a higher real wage growth may either reduce (panel b) or raise (panel c) the NAIRU.[60] *Source:* Author's own elaboration.

[59] With more powerful unions, the system needs a higher natural rate of unemployment to stabilize inflation and bring the workers' wage demand back in line with the labor share implied by the firms' price setting. The conclusion is that an increase in labor market regulation (a higher z) creates structural unemployment. Similarly, labor market deregulation lowers the equilibrium unemployment.

[60] When the real wage rate increases - for instance, due to more extensive labor market regulation - the conventional the wage-setting curve would shift up from WS to WS'. But now, unlike what happens in standard models (panel a), the price-setting curve (PS) will also shift up because of the higher labor productivity growth, which both directly and indirectly from the increased wage rate. Therefore the final outcome is not clear: if productivity growth rises very strongly (and the PS curve shifts up considerably), the NAIRU

The second curve of the model is the *aggregate demand schedule (ADS)*. We need to find out whether, overall, aggregate demand in OECD economies is profit or wage driven. At this purpose, the first step of our empirical investigation is to determine if the distribution of income between wages and profits affects the level of savings and hence consumption. We start by noting that the standard assumption that the saving rate out of wages is smaller than the saving rate out of profit income, or $(s_W < s_\pi)$, is generally in line with available empirical evidence. Bhaduri and Marglin (1990) find an average value for $(s_\pi - s_W)$ of 0.37 for a sample of 16 OECD countries over the period 1960-1985, and the average estimate of $(s_\pi - s_W)$ for France, Germany, Japan, the UK, and the US by Bowles and Boyer (1995) is 0.46. Hein and Vogel (2008) report a statistically significant average saving differential for France, Germany, Netherlands, the UK, and the US during 1960-2005 of 0.43. Finally, Hartwig (2013) estimate the difference to be roughy 0.43 for Switzerland. Our estimates of the effect of income distribution on savings are based on a transformation of the following identity:

$$s = [s_W c + s_\pi \pi]Y \tag{46}$$

Where s are real private savings. Recalling that $c = (1 - \pi)$, we can write the aggregate saving propensity as:

$$S = \frac{S}{Y} = s_W + (s_\pi - s_W)\pi \tag{47}$$

Equation (46) summarize the empirical relationship between aggregate savings and the distribution of income under given institutional conditions. Our estimates are shown in Table 11.

falls, as in panel (b); but if the productivity response is rather weak and the upward shift of the PS curve is limited, equilibrium unemployment increases, as shown in panel (c).

	Savings propensities			
	(Sπ-Sw)	Sw	R-squared	Period
Australia	0.062	0.368	0.882	1983-2013
	(0.2486)	(0.0338)**		
Austria	0.127	0.382	0.972	1983-2013
	(0.0029)***	(0.0051)***		
Belgium	0.196	0.383	0.825	1983-2013
	(0.0043)***	(0.0296)**		
Canada	0.016	0.343	0.934	1983-2013
	(0.0535)*	(0.0014)***		
Denmark	0.051	0.528	0.913	1983-2013
	(0.0347)**	(0.0004)***		
Finland	0.045	0.530	0.900	1983-2013
	(0.0008)***	(0.0293)**		
France	0.124	0.314	0.953	1983-2013
	(0.0093)***	(0.0309)**		
Germany	0.061	0.449	0.921	1983-2013
	(0.0369)**	(0.0083)***		
Greece	0.131	0.383	0.669	1983-2013
	(0.1009)	(0.0773)*		
Ireland	0.016	0.452	0.814	1983-2013
	(0.0035)***	(0.0093)***		
Italy	0.189	0.303	0.766	1983-2013
	(0.0048)***	(0.0441)**		
Japan	0.113	0.409	0.900	1983-2013
	(0.0003)***	(0.0389)**		
Luxembourg	0.046	0.538	0.680	1983-2013
	(0.019)**	(0.1551)		
Netherlands	0.143	0.601	0.803	1983-2013
	(0.0311)**	(0.0587)*		
Norway	0.048	0.529	0.894	1983-2013
	(0.0035)***	(0.0071)***		
Portugal	0.167	0.298	0.602	1983-2013
	(0.0611)*	(0.009)***		
Spain	0.146	0.293	0.688	1983-2013
	(0.0072)***	(0.0372)**		
Sweden	0.039	0.448	0.750	1983-2013
	(0.0303)**	(0.0449)**		
United Kingdom	0.053	0.421	0.778	1983-2013
	(0.0339)**	(0.0926)*		
United States	0.118	0.231	0.693	1983-2013
	(0.0975)*	(0.0645)*		
Panel	0.095	0.410	0.857	1983-2013
	(0.0041)***	(0.0419)**		
Standard Deviation	0.057	0.099		

Table 11 – Estimated savings propensities: 20 OECD economies.

Note: (a). The period of estimation is 1983-2013. The dependent variable is gross domestic savings divided by gross domestic product (at factor cost). (b). The columns headed S_w and $(S_\pi - S_w)$ are the estimated constant and coefficient of the profit share π. (c). Figures in parentheses are p-values. $*$, $**$, and $***$ denote statistical significance at 10%, 5%, and 1%, respectively. (d). Equations for most countries are estimated using the Cochrane-Orcutt AR (1) method. The equations for Belgium, Denmark, Sweden, and the UK are estimated using ARIMA correcting for first and second order autocorrelation. (e). The equation for Germany was estimated including a dummy variable for the year 1990.

The estimated parameters are consistent with the two-propensity hypothesis that $(S_W < S_\pi)$ and the overall fit of the equation is high. Estimates of $(S_\pi - S_W)$ vary between 0.016 (in Ireland) and 0.196 (Belgium); panel estimation takes a value of $(S_\pi - S_W)$ is 0.095, which is in line with earlier estimates mentioned above. All coefficients are significant - 9 out of 20 at 1%, 6 at 5% and 3 at 10% - except those of Australia and Greece. A redistribution from profits to wages therefore leads to a significant increase in consumption demand in most OECD countries.

The second channel through which real wage growth affects aggregate demand is through profitability and investment**.** The profit-driven model of investment has generated great debate and little consensus among economists (Dosi et al., 2015). It argues that firms' investment decisions are influenced by future profits and by the firms' liquidity, both of which vary with current profits. Additionally, profitability may favorably influence the willingness of firms to build new capacity in front of uncertain product demand. Other influences on investment typically included in the models are the level of expected future demand as measured by current capacity utilization, an accelerator term and the cost of borrowing (Bowles and Boyer, 1995, Hein and Ochsen, 2003, Nikiforos and Foley, 2012). Usually, measures of expected future demand dominate other independent variables in econometric models of aggregate investment, but as pointed out in the literature review by Glyn (1997), the available evidence consistently show that profitability plays an important role, particularly in the slowing down of investment growth after 1975 (see Bhaskar and Glyn 1995). When investments are regressed on profitability alone (or with only a lagged dependent variable), profitability is almost always significant (Glyn, 1997). Recently, the profit sensitivity of investment has also been confirmed by more sophisticated studies. We estimate the investment equation with variables expressed in log, thus avoiding spurious correlations between variables with common trends. We checked that the transformation of the original level variables in growth rates stabilizes their means and variances through time (i.e., the variables are stationary), so that OLS estimation can be employed. To avoid simultaneity, the profit share π and aggregate demand Y are introduced with one-year lag. Specifically, we estimate the following investment demand function:

$$\log(I/Y) = \Xi + f_1 log\,\pi + (f_2 - 1) logY \qquad (48)$$

Where Y is the ratio of gross fixed investment to GDP. Using this ratio, we are assuming that investment and GDP normally grow together, keeping the ratio unchanged - a 1% increase in GDP growth is associated with a 1% increase in investment growth - any deviation from the trend is captured by the coefficient $(f_2 - 1)$. If $f_2 > 1$, demand growth has strong accelerator effects on investment growth; if $f_2 < 1$, the accelerator effect is weak. The results are shown in Table 12.

	Investment growth equation				
	Ξ	f1	f2	R-squared	Period
Australia	-0.388	0.504	1.584	0.924	1983-2013
	(0.0785)*	(0.0284)**	(0.0029)***		
Austria	0.931	0.479	1.173	0.647	1983-2013
	(0.2569)	(0.0055)***	(0.3226)		
Belgium	-0.147	0.633	1.030	0.79	1983-2013
	(0.266)	(0.0058)***	(0.0035)***		
Canada	0.021	0.630	1.301	0.801	1983-2013
	(0.1527)	(0.0266)**	(0.0202)**		
Denmark	0.148	0.589	1.092	0.729	1983-2013
	(0.3189)	(0.1924)	(0.0593)*		
Finland	2.192	0.365	0.542	0.919	1983-2013
	(0.0957)*	(0.0427)**	(0.0009)***		
France	1.489	0.343	1.179	0.684	1983-2013
	(0.1891)	(0.0639)*	(0.0332)**		
Germany	1.157	0.506	1.248	0.665	1983-2013
	(0.2692)	(0.0056)***	(0.0063)***		
Greece	-0.515	0.324	1.863	0.785	1983-2013
	(0.0809)*	(0.0385)**	(0.0036)***		
Ireland	0.704	0.456	1.359	0.701	1983-2013
	(0.2725)	(0.0446)**	(0.0303)**		
Italy	-0.777	0.483	1.073	0.901	1983-2013
	(0.1653)	(0.0044)***	(0.0034)***		
Japan	-0.079	0.658	1.052	0.922	1983-2013
	(0.084)*	(0.0088)***	(0.0192)**		
Luxembourg	2.063	0.634	0.752	0.629	1983-2013
	(0.2983)	(0.0678)*	(0.1201)		
Netherlands	0.681	0.522	1.276	0.643	1983-2013
	(0.0185)**	(0.046)**	(0.2758)		
Norway	0.662	0.239	1.074	0.653	1983-2013
	(0.015)**	(0.1532)	(0.0334)**		
Portugal	-0.442	0.375	2.090	0.718	1983-2013
	(0.3057)	(0.0996)*	(0.063)*		
Spain	-0.254	0.165	2.654	0.788	1983-2013
	(0.2284)	(0.005)***	(0.0245)**		
Sweden	1.942	0.166	1.799	0.809	1983-2013
	(0.0736)*	(0.0481)**	(0.0065)***		
United Kingdom	-1.041	0.484	1.275	0.779	1983-2013
	(0.2505)	(0.0045)***	(0.0223)**		
United States	-0.828	0.573	1.119	0.812	1983-2013
	(0.1974)	(0.0035)***	(0.0365)**		
Panel	0.376	0.428	1.327	0.795	1983-2013
	(0.088)*	(0.0083)***	(0.0465)**		
Standard Deviation	0.998	0.152	0.477		

Table 12 - Estimated investment growth equations: twelve OECD economies.

Note: (a). The period of estimation is 1983-2013. The dependent variable is the log of the ratio of gross fixed capital formation to GDP. Equations for Australia, Austria, Belgium, Canada, Germany, Ireland, Japan, Netherlands, Sweden and the United Kingdom are estimated using Cochrane-Orcutt AR(1). The equations for Denmark, Greece, Finland, France, Italy, Luxembourg, Portugal, Spain and the United States are estimated using ARIMA (correcting for first-and second-order autocorrelation). For Denmark we included a time dummy for the years 1964 and 1976 in the regression. (b). Figures in parentheses are p-values. ∗, ∗∗, and ∗∗∗ denote statistical significance at 10%, 5%, and 1%, respectively.

With regard to country-specific estimates, only the one of Luxembourg is rather unsatisfactory, indicating little explanatory power. However, the coefficient of the profit share is found to be statistically significant (at 10 percent) and positive, taking a value of 0.63. For other countries, the coefficients f_1 have always the expected sign and are statistically significant (8 out of 20 at the 1 percent level, 7 at 5% and 2 at 10%) made exception for Denmark, Luxembourg and Norway; the profit-investment coefficient for France and Portugal is significant only at 10 percent. The mean of country-specific profit elasticities is 0.36, while the panel estimation coefficient is 0.43 which is higher than the average estimate of 0.28 for France, Germany, Japan, the United Kingdom, and the United States for 1953-1987 by Bowles and Boyer (1995). It is about one half the estimate of 0.9 for eighteen OECD countries by Alesina et al. (2002), which appears to be on the high side compared to other cross-country studies. Our average profit sensitivity of investment is, for instance, similar to Glyn's (1997) estimate of 0.44 for 12 OECD countries during the years 1973-1992. Turning to the country-specific findings, our estimate of the profit sensitivity of investment for the UK of 0.48, which is close to Driver et al. (2005) value of 0.55-0.78 and falls within the range of values (0.17-0.85) reported by Carruth et al. (2000) and by Bond et al. (2003) (0.38-0.79). Our coefficient estimated for France is 0.34 again very close to the value of 0.22 found by Hein and Vogel (2008), but considerably higher than the 0.09 obtained by Bond et al. (2003) - who employed firm-level data for the years from 1978 to 1989. Our estimate of 0.50 for Germany is higher than the estimate (0.33) by Bowles and Boyer (1995), but lower than the estimate of 1 by Pugh (1998). Finally, our estimation for the US of 0.57, is lower than the coefficient (0.73) found by Gordon (1995). Turning to the impact on investment of demand, we find that demand growth has a significant effect on private investment growth, taking a value that is not statistically significantly different from unity for Austria and Netherlands. This can be concluded from the fact that the coefficient $(1 - f_2)$ is not statistically significantly different from zero in these regressions. Its impact is found to be slightly larger than unity in Australia, Canada, France, Germany, Greece, Ireland, Portugal, Spain, Sweden, United Kingdom and the United States; and less than proportional for Luxembourg and Finland. If $(f_2 - 1) > 0$, then a change in demand growth becomes cumulative, because it leads to higher investment growth, and therefore a second round of demand and output growth. On the other hand, if $(f_2 - 1) < 0$, the accelerator effect is less strong.

The third channel through which real wages affect aggregate demand is through relative unit labor costs. However, it is worth pointing out that this export effect can only exist at the national level, since from an aggregate perspective the world economy is closed. This implies that if we were to consider OECD countries as a whole, the export effect surely would be diminished and, as a consequence, our analysis is likely to overestimate its importance. There is a strong consensus in the literature that cost competitiveness matters for the export performance, but only modestly. Milberg and Houston (2005) analyze aggregate export growth for 17 OECD countries over the period from 1975 to 1995 concluding that relative unit labor costs are often not statistically significant in explaining variations in international competitiveness. Similar, Hein and Vogel (2008) found no effect of a variation in unit labor costs on net exports in France, Germany, the UK, and the US for the years from 1960 to 2005. A recent analysis by the European Commission (2010) concluded that German massive export growth over the period from 1999 to 2010 was almost completely due to the growth of its international markets, whereas the contribution of more competitive pricing is imperceptible. Germany specialized in products and services that emerging economies are most willing to buy - like for instance machinery, infrastructures, automobiles, etc. - and this pattern of specialization made the demand for German exports highly price-inelastic (Janssen, 2011). Not surprisingly, therefore, a complex econometric analysis of the impact of cost competitiveness using industry-level data for 14 OECD countries during 1970-1992 found a long-run elasticity of exports to cost of only −0.26 (Carlin et al., 2001). But if instead data for total manufacturing are employed, the long-run elasticity between exports and relative unit labor costs is reduced to only -0.03, insignificantly different from zero. There is no clear relationship between change in export market share and in cost competitiveness. Indeed, there seems to be a trend for countries with rising relative costs to have increased their market shares for manufacturing production (Carlin, et al., 2001). This observation may seem strange at first glance, however, Kaldor (1978) was the first to point out that countries with the best improvement in their export performance were those with the fastest cost increases.[61] The reason for the "paradox" is that there are other factors, including differences across countries in terms of technology, investment, innovation, and the nature of labor relations, which are often more important than unit labor costs.[62] To estimate the elasticity of exports and unit labor cost growth, we employ the following specification:

$$\dot{e} = e_0 wtgrowth - \varepsilon_1 \dot{c} \tag{49}$$

[61] Kaldor identified "paradoxical" results for the US, the UK, Japan, Germany and Italy. In these countries, changes in relative unit labor costs and relative export prices were found to have a positive correlation with export shares in world markets. This result stands contrast to standard trade theory, which predict a negative relationship between labor costs per unit of output and export success. The positive trend was later confirmed with models based on levels as well as changes in the respective variables (Carlin et al, 2001).

[62] As claimed by Kaldor: The customary statistical measures of "competitiveness" …are arbitrary and not an adequate indicator of a country's true competitive position… a rise in export unit values may therefore signify no more than that a country is trading "up-market," i.e. selling machinery of higher quality, while the countries with falling export values are trading "down-market" selling machinery of the more primitive kind (1978).

We do not expect to find high values for the long-run export unit labor cost elasticity ε_1. The regression results are shown in Table 13.

	Export growth equation			
	wtgrowth	$\dot{c}$	R-squared	Period
Australia	0.939 (0.288)	-0.037 (0.082)*	0.671	1983-2013
Austria	1.124 (0.025)**	-0.107 (0.0325)**	0.862	1983-2013
Belgium	1.090 (0.0041)***	-0.141 (0.0981)*	0.942	1983-2013
Canada	0.973 (0.0023)***	0.018 (0.0357)**	0.864	1983-2013
Denmark	0.814 (0.0712)*	-0.083 (0.0781)*	0.861	1983-2013
Finland	0.957 (0.0042)***	0.027 (0.0196)**	0.886	1983-2013
France	1.291 (0.0445)**	-0.051 (0.0086)***	0.846	1983-2013
Germany	0.956 (0.0029)***	-0.163 (0.0001)***	0.822	1983-2013
Greece	1.248 (0.0199)**	-0.143 (0.2917)	0.632	1983-2013
Ireland	0.873 (0.3117)	-0.147 (0.0034)***	0.775	1983-2013
Italy	1.158 (0.0009)***	-0.129 (0.0156)**	0.89	1983-2013
Japan	1.855 (0.3421)	-0.247 (0.0954)*	0.71	1983-2013
Luxembourg	1.516 (0.009)***	0.071 (0.0098)***	1.078	1983-2013
Netherlands	0.978 (0.0215)**	-0.001 (0.0054)***	0.806	1983-2013
Norway	0.933 (0.0243)**	0.002 (0.0254)**	0.791	1983-2013
Portugal	1.116 (0.007)***	-0.217 (0.1168)	0.842	1983-2013
Spain	1.339 (0.3496)	-0.158 (0.0067)***	0.764	1983-2013
Sweden	0.822 (0.0275)**	-0.130 (0.0107)**	0.824	1983-2013
United Kingdom	0.785 (0.0078)***	-0.145 (0.0965)*	0.933	1983-2013
United States	1.161 (0.0019)***	0.180 (0.0174)**	0.807	1983-2013
Panel	1.096 (0.0013)***	-0.134 (0.0265)**	0.834	1983-2013
Standard Deviation	0.262	0.105		

Table 13 - Estimated export growth equations: twelve OECD economies.

Note: (a). The period of estimation is 1983-2013. The dependent variable is the annual growth rate of real exports. Equations for all countries were estimated using Cochrane-Orcutt AR (1). The equations for Japan the United Kingdom and the United States were estimated using the one-period lagged growth rate of unit labor cost. (b). Figures in parentheses are p-values. $*$, $**$, and $***$ denote statistical significance at 10%, 5%, and 1%, respectively. (d). wtgrowth = the growth rate of the volume of world trade; $\dot{c}$ = the growth rate of relative unit labor cost.

Overall, the results are consistent with our expectations. The general fit of the equation is high (the adjusted R^2 is about 0.83 in panel regression). All coefficients are significant except those of Australia, Ireland, Japan and Spain for *wtgrowth and* Portugal, Greece for unit labor cost growth. For Belgium, Netherlands, Canada and Finland the coefficient of world trade growth *wtgrowth* takes a statistically significant value (1 percent) that is not significantly different from unity; hence, exports of these countries tend to grow in line with world trade. The elasticity of exports with respect to world trade is (statistically significantly) larger than unity for France, Italy, Japan, Spain and the United States, while it is below unity for Denmark, Ireland, Sweden and the United Kingdom - in the latter case indicating a long-run loss of world export market share. Most of the estimated coefficients of relative unit labor cost (15 out of 20) are negative. However, some of them are not significant at the 1 percent level. The mean of country-specific-elasticities is -0.08, while panel estimation is -0.134 which is close to the mean elasticity of -0.14 across 11 of the 12 country-specific elasticities obtained by Carlin et al. (2001).[63] Our results for Belgium and Germany are consistent with those of Carlin et al., and in the case of Finland, Japan, Sweden, and the UK we find a somewhat smaller (in absolute terms) cost sensitivity. Our results of low wage-cost sensitivity of exports for France, Germany, the UK, and the US are comparable with findings by Hein and Vogel (2008). Nevertheless, for Denmark and France we obtain a negative cost elasticity (rather than a positive one, as in Carlin et al.), and the US have a statistically insignificant cost elasticity - thus suggesting negligible price sensitivity of their exports.

Depending on the relative size (in absolute terms) of these three effects, the total effect of a 1 percentage point change in real wage growth may be positive or negative. This can be easily computed once parameters of the model are retrieved from estimated equations and is shown along with the partial effects on consumption, investment and export in Table 14 for each of the 20 economies in question. We find that the redistribution from profits to wages, implied by a rise in real wage growth of 1 percentage point, rises consumption growth, thereby augmenting demand growth by on average 1.05 percentage points. However, country-specific effects vary considerably (the standard deviation is 0.47). In Luxembourg and Netherlands, for example, the rise in aggregate demand growth is only of 0.34/0.48 percentage points. This below-average effect is due to the fact that of the 20 countries in our sample, Luxembourg and Netherlands are two of the most open economies to international trade - as a consequence, a large proportion of the demand stimulus,

[63] The estimates by Carlin et al. (2001) are based on countrywide regressions using data pooled across 12 major manufacturing industries during 1970-1992.

implied by the income redistribution, leaks abroad. Italy and Greece are other countries where the impact of increased real wage growth is limited (0.62 and 0.70 respectively). This is not so much due to the openness of the Italian and Greek economy as to the fact that of the twenty countries, Italy and Greece were those with the lowest labor shares at the beginning of the sample and as a result, the demand-augmenting impact of a redistribution of income is smaller than elsewhere. The impact on demand through consumption is comparatively large in Japan (more than 1.5 standard deviations above the average), Sweden, Austria and the United States and Japan: a 1 percentage point increase in real wage growth raises aggregate demand and GDP growth by respectively 1.95, 1.71, 1.70, 1.66 percentage points. For Japan and the US, these significant impacts occur mainly because the import leakages in these countries are small (their average import-to-GDP ratios is less than 10%).

	Impact through (in percentage growth rates):						
	Consumption growth (1)	Investment growth (2)	Domestic effect (1+2)	**Nature of domestic demand**	Export growth (3)	Total effect (1+2+3)	**Nature of demand**
Australia	1.198	-0.983	0.215	wage-led	-0.243	-0.028	profit-led
Austria	1.696	-1.309	0.387	wage-led	-0.198	0.189	wage-led
Belgium	0.343	-0.284	0.059	wage-led	-0.026	0.033	wage-led
Canada	1.428	-1.495	-0.067	profit-led	-0.131	-0.198	profit-led
Denmark	1.167	-0.651	0.516	wage-led	-0.06	0.457	wage-led
Finland	1.012	-0.209	0.803	wage-led	-0.16	0.644	wage-led
France	0.798	-0.489	0.309	wage-led	-0.097	0.211	wage-led
Germany	1.167	-0.946	0.221	wage-led	-0.132	0.09	wage-led
Greece	0.7	-0.397	0.304	wage-led	-0.176	0.128	wage-led
Ireland	0.974	-1.251	-0.277	profit-led	-0.312	-0.589	profit-led
Italy	0.626	-0.385	0.241	wage-led	-0.093	0.148	wage-led
Japan	1.948	-1.815	0.133	wage-led	-0.327	-0.193	profit-led
Luxembourg	0.403	-0.258	0.145	wage-led	-0.081	0.064	wage-led
Netherlands	0.481	-0.167	0.315	wage-led	-0.118	0.197	wage-led
Norway	1.089	-0.804	0.285	wage-led	-0.103	0.182	wage-led
Portugal	0.64	-0.415	0.226	wage-led	-0.221	0.005	wage-led
Spain	0.835	-0.391	0.445	wage-led	-0.213	0.231	wage-led
Sweden	1.714	-0.721	0.993	wage-led	-0.219	0.774	wage-led
United Kingdom	1.192	-1.121	0.072	wage-led	-0.186	-0.114	profit-led
United States	1.664	-1.87	-0.206	profit-led	-0.076	-0.282	profit-led
Panel	1.054	-0.758	0.256	wage-led	-0.159	0.097	wage-led
Standard Deviation	0.473	0.498	0.648		0.051	0.633	

Table 14 - The effect of an increase in real wage growth (by 1 percentage point) on aggregate demand growth. *Note:* The period of estimation is 1960-2019. *Source:* Author's estimation.[64]

[64] How do these results compare with the literature? Stockhammer et al. (2009) find the Euro Area (1960-2004) to be wage-led. Hein and Vogel's (2007) results indicate that France and Germany are wage-led (1960-2005). Bowles and Boyer (1995) find that Japan is

Real wage growth has a much larger impact on consumption and GDP growth in Spain, mainly because of the bigger income-demand accelerator effect on investments (see Table 12 above). The same applies to Portugal where the increase in consumption and aggregate demand as a result of the redistribution of income increases the demand for investments, with a further and cumulative effect on the growth of aggregate demand.

The second column of Table 14 shows that in all the countries a higher real wage growth reduces investment demand and GDP growth. On average, a rise in real wage growth (by 1 percentage point) reduces OECD demand growth by 0.75 percentage points because it reduces profitability and hence private investments. But this average hides a wide variability in the strength of this profitability-investment's growth link, as the value of the standard deviation shows (0.47). In fact, the profitability-investment's growth is found to be particularly strong in the Japan, Luxembourg, Canada, Denmark and the United States, whereas it is relatively weak in countries of continental Europe. The average impact of a 1 percentage point rise in real wage growth on demand growth through reduced profits and investment is −0.55 percentage points for the four biggest EU countries (with a standard deviation of 0.45), whereas its average impact on growth in the United Kingdom, and the United States is −1.50 percentage points. The difference between these two blocks of countries in the strength of the profitability-investment-growth reflect strong systemic differences. Profitability turns out to be less important in the bank-based financial systems of the EU, because firms in these countries fund their activities mostly from retained earnings or by long-term bank loans (Vitols, 2001; Bebenroth et al., 2009) this explains their willingness to make long-term investments and to accept lower returns on capital (Chakraborty and Ray, 2006). In contrast, profitability is more important in the stock-market-based financial systems of the United Kingdom and the United States. Firms in these countries tend to be more dependent on bond and equity markets, and the conditions under which they can obtain external funding is strongly dependent on their valuation, which in turn depends on current profitability.

Column 5 of Table 14 shows the impact of real wage growth on demand growth through its effect on cost competitiveness. Broadly confirming the results of Table 13, the cost sensitivity of exports is small, and the effects on demand growth of a 1 percentage point rise in real wage growth is roughly equal to -0.16 percentage points. Australia, Ireland, Portugal and Sweden show the

---

profit-led, and the UK is wage-led. According to Naastepad (2006) and Tavani et al. (2011), the Netherlands is wage-led. Equally in line with our results, Gordon (1995), using data for the period 1955-1988 finds the United States to be profit-led. This result is confirmed by Barbosa-Filho and Taylor (2006). In contrast, Hein and Vogel (2008) find the US to be wage-led and the Netherlands to be profit-led. However, this result depends mainly on their finding that changes in the profit share do not affect the investments.

highest sensitivity to cost competition, with demand growth declining by about 0.22/0.32 percentage points; in contrast, changes in cost competitiveness have hardly any impact on demand growth in France, Italy, United States and Belgium. The analysis of the combined effects on consumption, investment and exports gives us an indication of the nature of aggregate demand in the countries investigated. It can be seen from the last columns of Table 14 that real wage growth increase on demand is positive in Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain and Sweden; these countries therefore exhibit a wage-led aggregate demand. On the other hand, the total effect is negative in Australia, Canada, Ireland, Japan, United Kingdom and the United States, indicating that their demands are profit-led. Finally, we must remark that for some countries, notably Belgium and Portugal, the magnitude of D is close to zero. For the other countries, the magnitude of D is significantly different from zero. Therefore, increased profitability achieved by means of real wage restraint policies, in conjunction with a more general deregulation of labor market, does not always end up improving the long-run macroeconomic performance. A reduction in the growth rate of real wages reduces productivity growth, which - keeping other factors constant - raise employment, but also reduces aggregate demand growth, which eventually reduces employment growth.

5. A VAR model to investigate the long run dynamics

In this last section we investigate the relation between effective demand, income distribution and unemployment in the long run for the 6 biggest economies of our sample. Post-Keynesians differ from neoclassical economists in their perception of the interaction between the good and the labor market. While for the former, unemployment is the result of a lack of demand in the good market and hence, variables of the good market determine the behavior of the labor market; for the latter, unemployment is strictly a labor market phenomenon. Here the focus is on the model developed in Section 3 which is estimated by means of a structural vector autoregression (VAR) approach and neoclassical topics will only be discussed marginally. VAR methodology has become popular among economists since the early 1980s. Originally it was developed as an alternative to theory-based structural estimation. In a seminal paper by Sims (1980) VAR analysis was presented as an a-theoretical model because apparently does not require any restriction on the explanatory variables and is not based on any strict exogenous-endogenous distinction. Nevertheless, few economists and econometricians today would agree with a statement of this magnitude. The importance in the ordering of variables to get the impulse response functions (IRFs) significantly reduces the a-theoretical nature of the model. Later, the development of structural VARs has reconciled theory-driven modelling with the VAR approach (Sims, 1986). Over the past 20 years VAR analysis has become a standard tool in empirical research with time series. For the questions we seek to answer the VAR approach is attractive for several reasons: (i) first, it is a flexible way of modeling since it allows past values of the variables to affect present values of the same variables. Thus, it does not force a specific theoretical structure on the data - as far as past values are concerned. (ii) Second, it is a systemic approach that considers the interaction of variables. In particular, the impulse responses calculated from the VAR trace an innovation to one variable through the entire system. (iii) Third, it has interesting properties for time series. For instance, Sims et al. (1990) have shown that "the common practice of attempting to transform models to stationary form by difference or cointegration operators whenever it appears likely that the data are integrated is in many cases unnecessary". This means that all the coefficients that can be written as coefficients of an $I(0)$ variable - all other than those of constant and trend - are consistent and have standard distributions (see also Watson, 1994; Hayashi, 2000; Lütkepohl, 2005). Therefore, VAR analysis is a good way to proceed whenever there are doubts about the order of integration of variables, as is often the case with macro-economic data. However, it should come as no surprise that these benefits have a cost: (i) first, the number of variables that can be included in the VAR is limited because due to its unrestricted nature the model quickly exhausts the degrees of freedom.[65] (ii) Secondly, since it is a systemic approach that rejects the standard distinction between endogenous and exogenous variables, it is against the principles of the model to include exogenous controls. Thus, we do not control for variables other than the ones enclosed in the system, made exception for a time trend. The basic VAR consists of 6 variables, namely labor productivity, total employment, aggregate demand, net capital stock, adjusted labor share and the incidence of temporary employment (ITE) as a proxy for labor market regulation.[66]

The model is estimated for France, Germany, Italy, Spain, UK and the US. The time period under investigation ranges from 1983 to 2018. The standard VAR approach regresses all variables on their own lags and the lags of all other variables. No contemporaneous effect is treated explicitly.

$$y_t = d_t + Cy_{t-1} + v_t \qquad (49)$$

[65] In practice, VAR models with more than six variables are rarely feasible.

[66] Incidence of temporary employment - ITE - for young workers (share on total employment). It refers to standardized age group 15-24 of the OECD and captures changes in labor market regulation. Following Bellocchi et al. (2020), we assume that the higher the labor flexibility, the higher is the share of temporary workers employed in production by firms.

Where:[67]

- y_t is the vector of variables;
- d_t includes all the deterministic components (i.e., a constant and a trend);
- υ_t is the vector of innovations.

Innovations in the covariance matrix of vector υ_t will in general be simultaneously correlated. Indeed, this covariance captures the contemporaneous interactions among variables. To illustrate this, look at the following specification, which is usually called "primitive VAR" by the literature (Enders, 2015).

$$By_t = d_t + Ay_{t-1} + \varepsilon_t \tag{50}$$

In this system contemporaneous interactions are explicitly represented in the matrix B. Contrary to υ_t in (49), ε_t in (50) will not be cross correlated. However, note that $C = B^{-1}A$ and $\upsilon_t = B^{-1}\varepsilon_t$. This is exactly the reason for the cross-correlation among the errors in υ_t. Cholesky decomposition, is the standard approach employed to compute the impulse response functions (IRFs) solve this problem by triangularizing the structure of B (i.e., it orthogonalizes the error covariance matrix). This is a simple way to proceed. Note however that it inevitably imposes a specific (recursive) structure for contemporary interactions. Therefore, according to the literature, variables must be ordered by degree of exogeneity and at the purpose we follow the order given by a block exogeneity test. According to it, it is possible - in our case - to determine a unique order. This latter is further reinforced by the relationships developed in our post-Keynesian growth and distribution model. The most exogenous among the variables is the labor market legislation which is proxied by the incidence of temporary employment and determined by the policy maker together with trade unions and the overall institutional setting of each country. Then in the standard model, income distribution is also exogenously given, and its impact on effective demand is investigated (Blecker, 2002). In equilibrium, capital accumulation, consumption, and the capacity utilization rate are simultaneously determined, and this yields the economic growth rate and employment. Finally, GDP growth is considered the most endogenous variable because it is determined by both distribution and effective demand. Since we estimated VAR with labor productivity, employment, final demand and gross fixed capital formation in the growth term, the estimation does not completely correspond to the basic model. Nevertheless, we chose to employ a combination of levels for the

[67] Here for simplicity we use only one lag, whereas in the empirical estimations more lags are employed.

wage share and the incidence of temporary employment and demand components in growth rate. This is because VARs with variables in level do not generate economically interpretable results and would provide a less-robust estimation (for instance in terms of Granger causality, impulse-responses, too-long lag length, etc.). However, although we do not include the level variables, we do consider the estimation with all stationary variables, thereby avoiding spurious regression.

Structural VARs make these interactions explicit. A necessary condition for identification is that the number of non-zero elements in the B matrix must be equal to or less than $(n^2 - n)/2$. Our structural approach for the estimation of the VAR model is therefore composed of three phases. (i) First the standard VAR in eq. (49) is estimated. In this way we obtain the estimated coefficients on lagged values and errors. (ii) Then in a second step, these estimated errors are used to obtain estimates of the B matrix. (iii) Finally, impulse responses (IRFs), i.e., reactions of the system to simulated exogenous shocks for each of the endogenous variables are calculated by combining information from both the steps. The data are annual and all from AMECO and the OECD Economic Outlook databases:

- Labor productivity is the GDP at constant market prices per person employed (RVGDE);
- Employment, persons - all domestic industries (National accounts) (NETD);
- Final demand at constant prices (OUTT);
- Gross fixed capital formation at constant prices - total economy (OIGT);
- Adjusted wage share; total economy (ALCD2);
- Labor market regulation - Incidence of temporary employment (ITE).

In Figures 11 and 12 we show the evolution of the variables under investigation and, for completeness, the one of the EPL index.[68] The inspection of the figures provides information about their divergence or convergence over time. Mainly, while Italy and Spain show a strongly decreasing labor share from the beginning of the 1980s, the US and France have declined following a lighter trend and the UK show an increasing one. The labor share of Germany is the most stable over the sample, with an overall movement of just 0.05 percentage points. Further, a marked increase in the labor share is observed in France and Germany after the crisis of 2008, while Spain's labor share continued to fall at a sustained pace. Also notice that - with some exceptions for limited periods of time - labor productivity, employment, aggregate demand and the capital stock followed a

[68] For the United States, due to a lack of data in terms of ITE we employ the (relative) employment protection legislation (EPL). Note however that while ITE is available from 1983 to 2018, the use of EPL restricts the sample to a shorter period of time (1985-2013).

symmetric evolution throughout the sample and are characterized by a common trend, at least until the crisis of 2008 when, in some countries, growth came to a halt. On the other hand, some asymmetries characterize the patterns of ITE and EPL for respectively continental European and Anglo-Saxon countries. The incidence of temporary employment has grown steadily in all countries except the United Kingdom, and consistently, labor market regulation as measured by EPL has dropped everywhere except in the UK and the US.

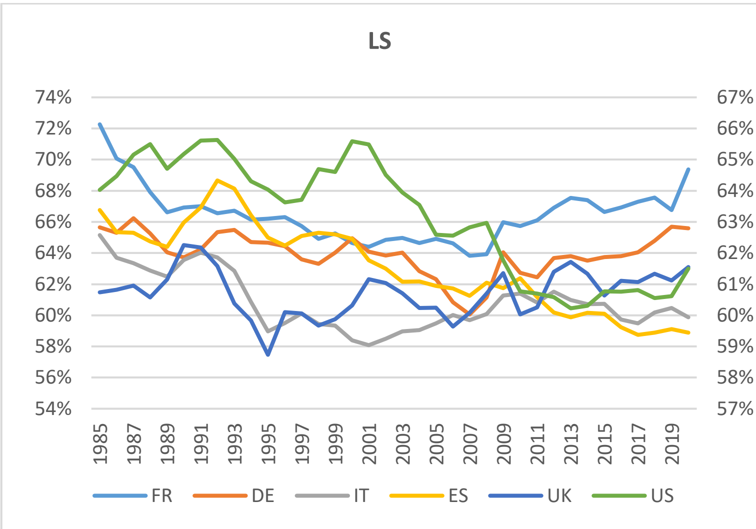


Figure 11 - Adjusted wage share (total economy).

Note: Labor shares of the European countries are represented in the main axis, that of the US on the secondary one.

Source: Author's calculation on AMECO data.

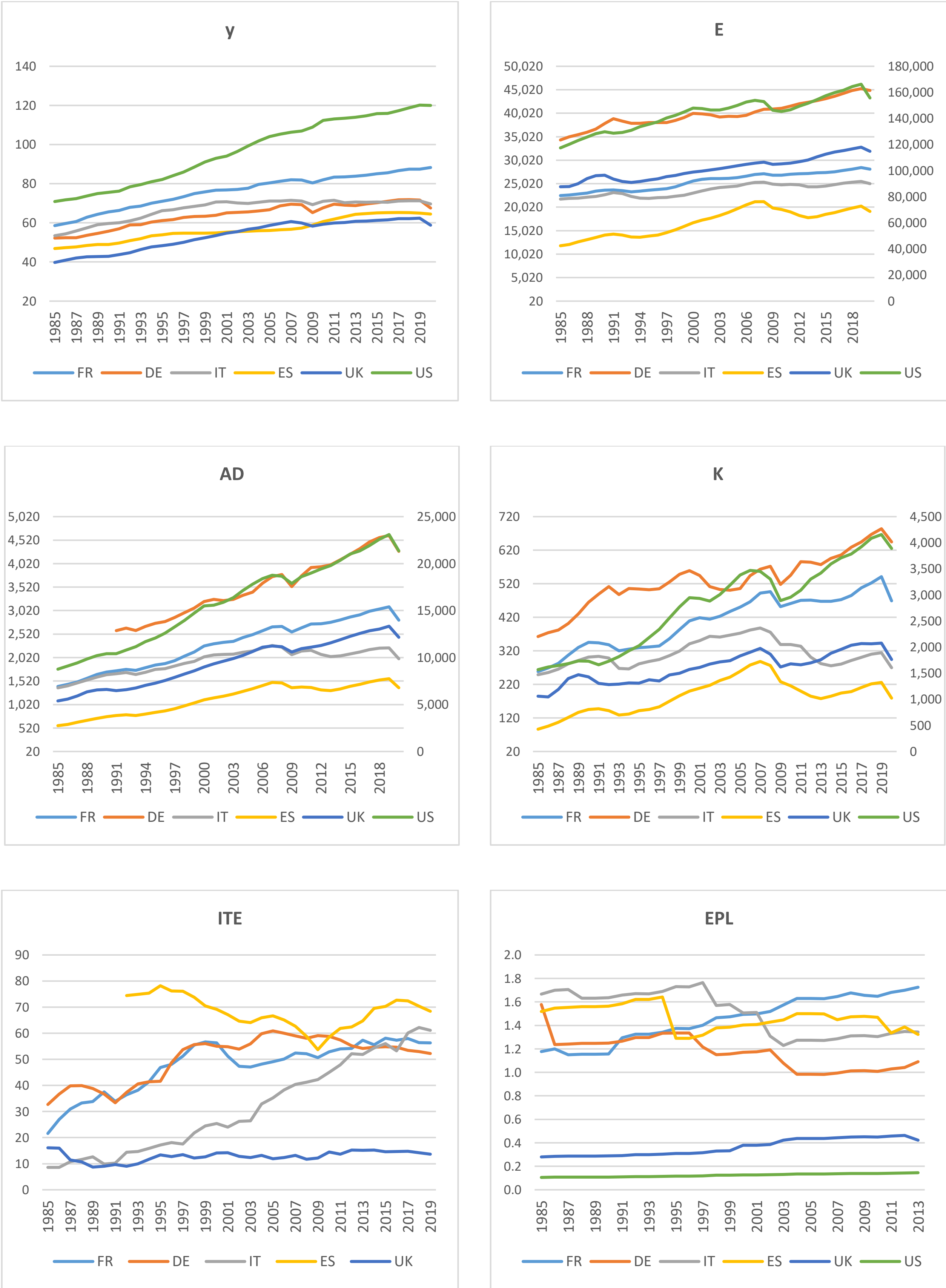


Figure 12 - Time series of the variables included in the model.

Note: Labor productivity (y), Employment (E), Final demand (AD), Capital formation (K), Labor regulation $(ITE$ and $EPL)$. All the time series start in 1985 and end in 2018 except the EPL which ends in 2013. For employment, aggregate demand and capital, US data are shown on the secondary axis. *Source:* Author's calculation on OECD and AMECO data.

Thus, the VAR consists of the six variables. A (linear) trend was added for pragmatic reasons. The trend (which is statistically significant) captures long run effects that are not appropriately captured by the variables. However, it is worth noting that it has little impact on the results. The following identical specification for contemporaneous interactions were applied to all the countries:

$$\begin{bmatrix} y \\ E \\ AD \\ K \\ LS \\ ITE \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 & 0 & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} & 0 & 0 \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} & 0 \\ b_{61} & b_{62} & b_{63} & b_{64} & b_{65} & b_{66} \end{bmatrix} \begin{bmatrix} \varepsilon_y \\ \varepsilon_E \\ \varepsilon_{AD} \\ \varepsilon_K \\ \varepsilon_{LS} \\ \varepsilon_{SPE} \end{bmatrix}$$

The VAR is estimated with one lag. Lag length tests (see Appendix B - Lag length tests) indicated that one lag would be enough. However, given that some variables may take longer than one year to respond to changes in economic conditions, it was decided to also try an alternative specification with two years lag length. Results barely differ between the two. Autocorrelation LM tests indicate that autocorrelation is not a major problem and the null hypothesis of autocorrelation can always be rejected. The residuals are reasonably close to normally distributed and the null hypothesis of heteroscedasticity is rejected as well (see again Appendix A - Autocorrelation and normality tests). The model was estimated for the periods 1983 to 2019 for all the countries. However, for the United States we have employed (relative) EPL instead of the ITE due to data availability reasons, thus reducing the number of useful observations. All VARs satisfy the stability condition. The results of the structural estimation, i.e., the contemporaneous effects, are summarized in Tables 15 and 16.

Country	Italy			France			Germany		
	coefficient	std. Error	p-value	coefficient	std. Error	p-value	coefficient	std. Error	p-value
C[1;1]	0.010	0.001	0.000	0.008	0.001	0.000	0.017	0.002	0.000
C[2;1]	0.002	0.001	0.162	0.003	0.001	0.000	0.001	0.001	0.402
C[3;1]	0.018	0.003	0.000	0.014	0.002	0.000	0.021	0.003	0.000
C[4;1]	0.001	0.000	0.000	0.002	0.000	0.000	0.002	0.000	0.000
C[5;1]	-0.005	0.002	0.002	-0.006	0.001	0.000	-0.010	0.002	0.000
C[6;1]	-0.013	0.006	0.025	-0.010	0.006	0.086	0.010	0.007	0.115
C[1;2]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[2;2]	0.008	0.001	0.000	0.005	0.001	0.000	0.009	0.001	0.000
C[3;2]	0.012	0.002	0.000	0.008	0.001	0.000	0.008	0.002	0.000
C[4;2]	0.002	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.403
C[5;2]	0.001	0.002	0.561	-0.002	0.001	0.080	-0.003	0.001	0.045
C[6;2]	0.005	0.006	0.336	-0.002	0.006	0.775	0.017	0.006	0.006
C[1;3]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[2;3]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[3;3]	0.009	0.001	0.000	0.004	0.001	0.000	0.009	0.001	0.000
C[4;3]	0.001	0.000	0.000	0.000	0.000	0.170	0.001	0.000	0.015
C[5;3]	0.002	0.002	0.210	-0.004	0.001	0.001	0.002	0.001	0.072
C[6;3]	0.003	0.006	0.543	-0.003	0.006	0.630	0.007	0.006	0.234
C[1;4]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[2;4]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[3;4]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[4;4]	0.001	0.000	0.000	0.001	0.000	0.000	0.002	0.000	0.000
C[5;4]	0.000	0.002	0.969	-0.001	0.001	0.203	0.004	0.001	0.000
C[6;4]	0.003	0.006	0.628	-0.006	0.006	0.285	-0.009	0.006	0.098
C[1;5]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[2;5]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[3;5]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[4;5]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[5;5]	0.009	0.001	0.000	0.006	0.001	0.000	0.006	0.001	0.000
C[6;5]	-0.010	0.005	0.078	-0.004	0.006	0.489	0.012	0.005	0.022
C[1;6]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[2;6]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[3;6]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[4;6]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[5;6]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[6;6]	0.032	0.004	0.000	0.034	0.004	0.000	0.031	0.004	0.000
Sample		1983-2018			1983-2018			1984-2018	
Included		35			35			34	
Log likelihood		730.912			794.325			681.713	

Table 15 - Estimated contemporaneous effects (Italy, France, Germany).

Note: the period of estimation is 1983-2018.

Country	Spain			UK			USA		
	coefficient	std. Error	p-value	coefficient	std. Error	p-value	coefficient	std. Error	p-value
C[1;1]	0.005	0.001	0.000	0.008	0.001	0.000	0.007	0.001	0.000
C[2;1]	-0.013	0.003	0.000	0.001	0.001	0.477	0.003	0.002	0.109
C[3;1]	-0.013	0.004	0.001	0.011	0.002	0.000	0.012	0.003	0.000
C[4;1]	-0.002	0.000	0.000	0.001	0.000	0.060	0.002	0.000	0.000
C[5;1]	-0.003	0.002	0.061	0.000	0.003	0.936	0.000	0.001	0.858
C[6;1]	0.030	0.011	0.005	-0.004	0.002	0.087	0.007	0.002	0.001
C[1;2]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[2;2]	0.015	0.002	0.000	0.008	0.001	0.000	0.010	0.001	0.000
C[3;2]	0.018	0.003	0.000	0.009	0.001	0.000	0.013	0.002	0.000
C[4;2]	0.002	0.000	0.000	0.002	0.000	0.000	0.002	0.000	0.000
C[5;2]	-0.003	0.002	0.070	-0.007	0.003	0.012	0.002	0.001	0.124
C[6;2]	-0.012	0.010	0.209	-0.001	0.002	0.805	-0.002	0.002	0.236
C[1;3]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[2;3]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[3;3]	0.009	0.001	0.000	0.006	0.001	0.000	0.003	0.000	0.000
C[4;3]	0.001	0.000	0.000	0.001	0.000	0.044	0.000	0.000	0.002
C[5;3]	0.003	0.002	0.093	0.003	0.002	0.288	0.004	0.001	0.001
C[6;3]	-0.016	0.010	0.095	0.004	0.002	0.128	0.003	0.002	0.044
C[1;4]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[2;4]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[3;4]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[4;4]	0.001	0.000	0.000	0.002	0.000	0.000	0.001	0.000	0.000
C[5;4]	-0.005	0.002	0.003	-0.003	0.002	0.156	-0.001	0.001	0.408
C[6;4]	0.004	0.009	0.704	0.006	0.002	0.014	0.002	0.002	0.146
C[1;5]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[2;5]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[3;5]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[4;5]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[5;5]	0.009	0.001	0.000	0.014	0.002	0.000	0.007	0.001	0.000
C[6;5]	-0.017	0.009	0.061	-0.004	0.002	0.057	0.004	0.002	0.011
C[1;6]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[2;6]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[3;6]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[4;6]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[5;6]	0.000	0.000	NA	0.000	0.000	NA	0.000	0.000	NA
C[6;6]	0.053	0.006	0.000	0.012	0.001	0.000	0.009	0.001	0.000
Sample		1987-2018			1983-2018			1985-2013	
Included		31			35			28	
Log likelihood		623.719			740.755			665.946	

Table 16 - Estimated contemporaneous effects (Spain, UK and the US).

Note: the period of estimation is 1983-2018.

Overall, the results support the validity of the model. 95 out of the 126 estimated coefficients are statistically significant at the 10% level, 82 of them at the 5%. All their signs are as expected by theory (see Tables 17 and 18 below).

Shock in:	**France**						**Germany**						**Italy**					
	LP	E	AD	K	LS	*EPL*	LP	E	AD	K	LS	*EPL*	LP	E	AD	K	LS	*EPL*
LS																		
Short-run	+	-	+	+	NA	-	+		-	0	NA	+	+	+	+	+	NA	-
Long-run	+	-	+	+	NA	+	+	-	-	-	NA	+	0	+	+	+	NA	-
EPL																		
Short-run	+	-	+	-	+	NA	+	+	+	+	+	NA	-	+	+	+	-	NA
Long-run	+	+	+	-	+	NA	+	0	+	+	+	NA	+	+	0	+	+	NA

Table 17 - Estimated short and long-run effects (France, Germany, Italy).

Source: Author's own elaboration.

Shock in:	**Spain**						**United Kingdom**						**United States**					
	LP	E	AD	K	LS	*EPL*	LP	E	AD	K	LS	*EPL*	LP	E	AD	K	LS	*EPL*
LS																		
Short-run	+	-	-	-	NA	+	+	+	+	+	NA	-	+	-	-	-	NA	+
Long-run	+	0	+	-	NA	+	+	-	+	+	NA	+	+	0	+	-	NA	+
EPL																		
Short-run	-	+	+	+	-	NA	+	+	+	+	0	NA	+	+	+	+	-	NA
Long-run	-	+	+	+	+	NA	+	+	0	+	+	NA	+	0	+	+	-	NA

Table 18 - Estimated short and long-run effects (Spain, United Kingdom and the United States).

Source: Author's own elaboration.

The effect of a positive structural innovation to the labor share affects labor productivity positively and significantly (at 1%) all the countries, either in the short and the long run, made exception for Italy where the effect becomes zero in the long run. The labor share affects positively the level of employment in Italy while its long run effect is negative in France, Germany and the UK with a significance of 10% for France and 5% for Germany and the UK. Finally, the effect is virtually zero in Spain and the United States. The long run impact on aggregate demand is also positive in all the countries but Germany, with an effect which is significant everywhere except Italy and the UK. Capital accumulation increases following a labor share shock in France, Italy and the UK while reduces its pace in Germany, Spain and the USA. However, the effects turn out to be insignificant in the former group of countries while it has a significance of 1% in Germany and Spain. Finally, the same shock reduces the share of temporary employment (and hence raises the permanent one) in the long run in all the countries except Italy, with an effect which is always significant at 1%. In the latter case there is a short-term negative impact in France and the United Kingdom which is then reabsorbed as time goes by.

Turning to the employment protection legislation (EPL) which we have proxied by means of the share of temporary employment (ITE) we have that the effect of an increase in EPL (i.e., a decrease in the ITE) on labor productivity is statistically significant in all the countries except Germany (Spain and the USA at 1%) and - made exception for Spain and Italy in the short run - has a positive and strong impact in all the countries considered. EPL raise the level of employment in France, Italy, Spain and the UK, while it long-run impact is virtually zero in Germany and the USA with a short-run reduction in France. The effect of the shock is very significant in Germany. Aggregate demand is positively stimulated by a positive innovation in EPL in France, Germany, Spain and the USA either in the short and the long run, while its effect is roughly zero in Italy and the UK with however a positive short run influence. Nevertheless, the significance is at the 5% level only in the USA. When the EPL increases there is a beneficial impact also in terms of capital accumulation everywhere except in France and the effect is always significant (5% in Germany and the USA, and 10% in Italy, Spain and the UK). Finally, the effect of EPL on the labor share in the long run is always positive except in the USA and the effect is significant at 1% in every country. Notably there is a short-term negative effect in Italy and Spain.

France (LS->*)

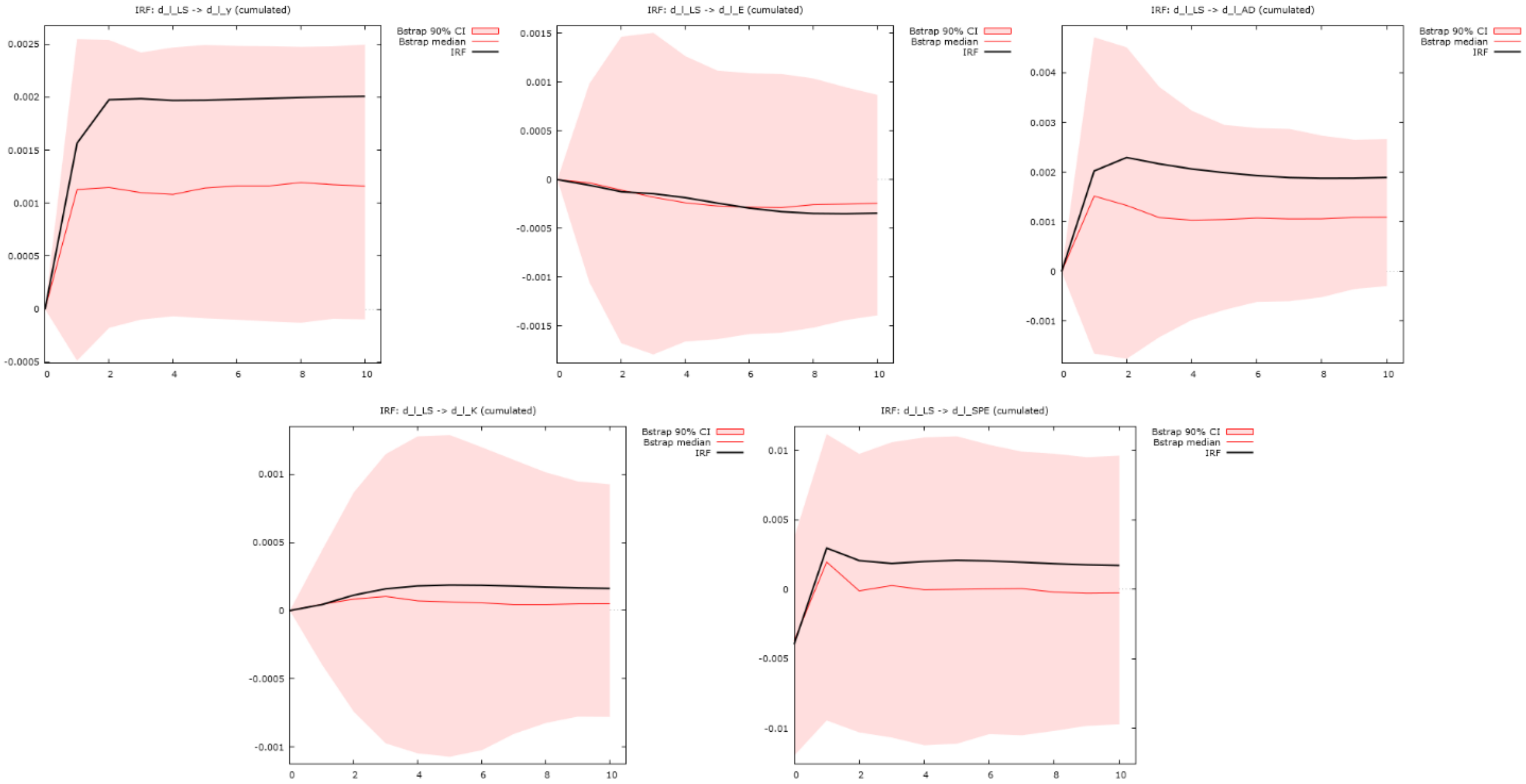


Figure 13 - Accumulated response to structural One S.D. shocks +- 2 S.E. to LS, France.

Source: Author's estimation.

Germany (LS->*)

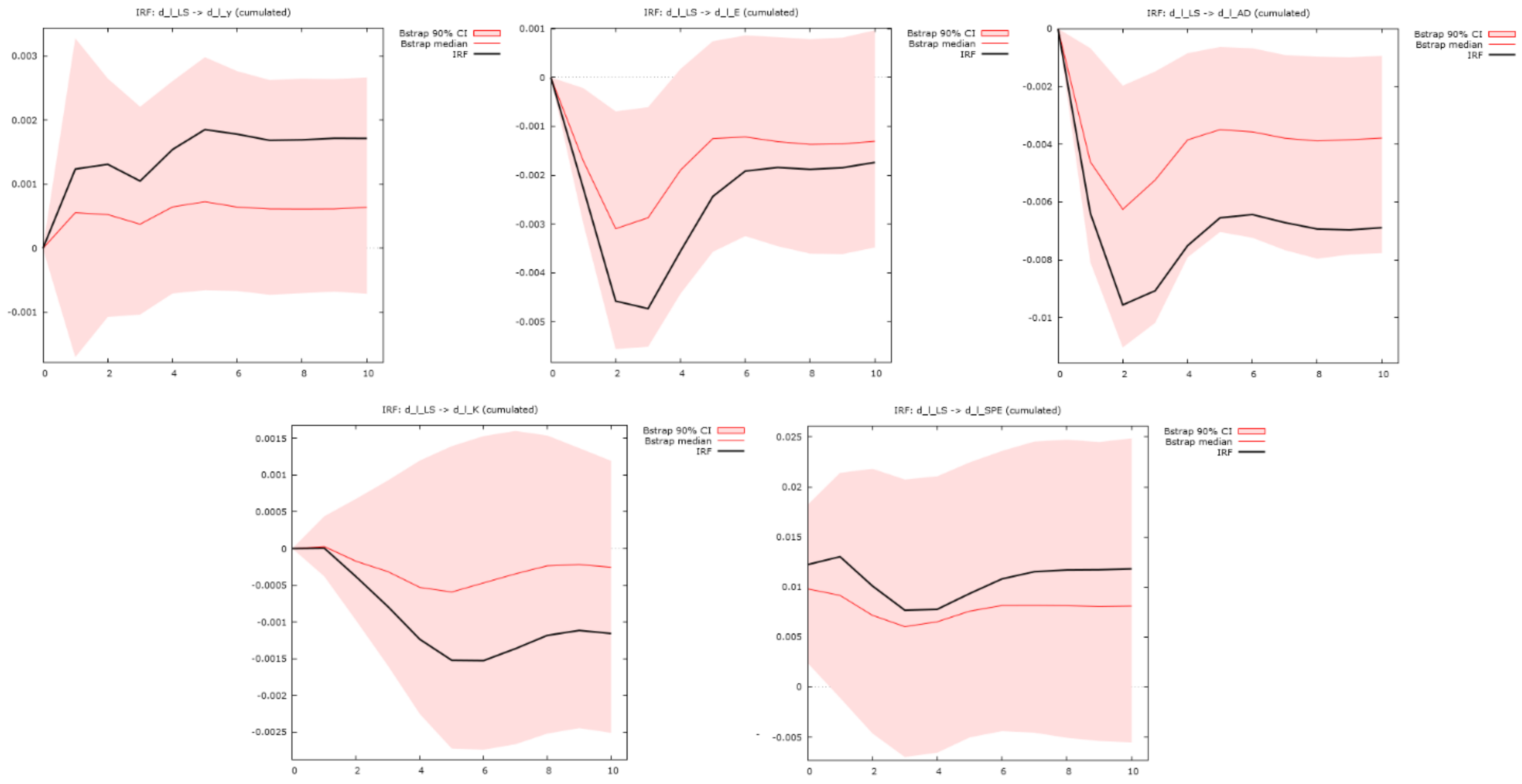


Figure 14 - Accumulated response to structural One S.D. shocks +- 2 S.E. to LS, Germany.

Source: Author’s estimation.

Italy (LS->*)

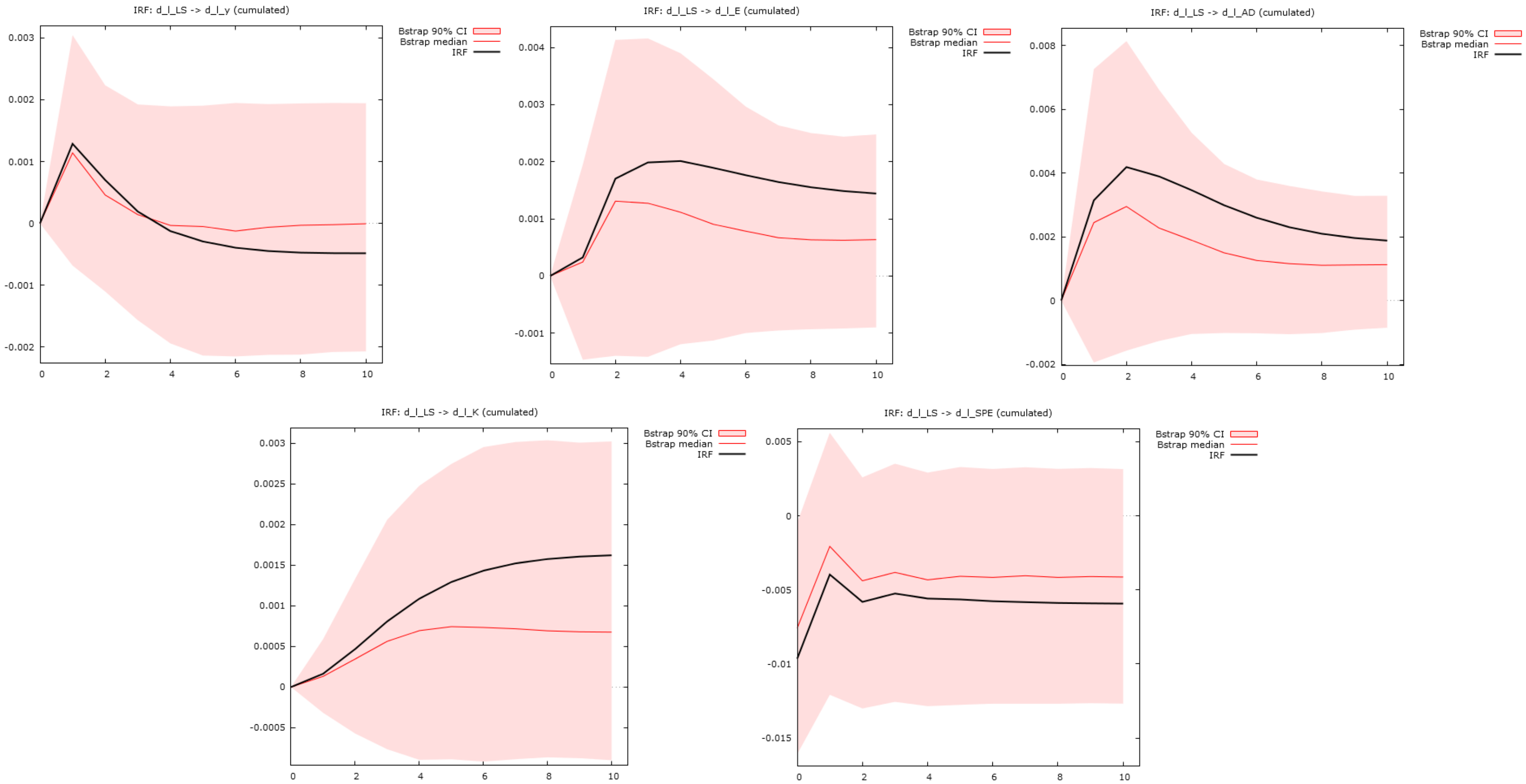


Figure 15 - Accumulated response to structural One S.D. shocks +- 2 S.E. to LS, Italy.

Source: Author's estimation.

Spain (LS->*)

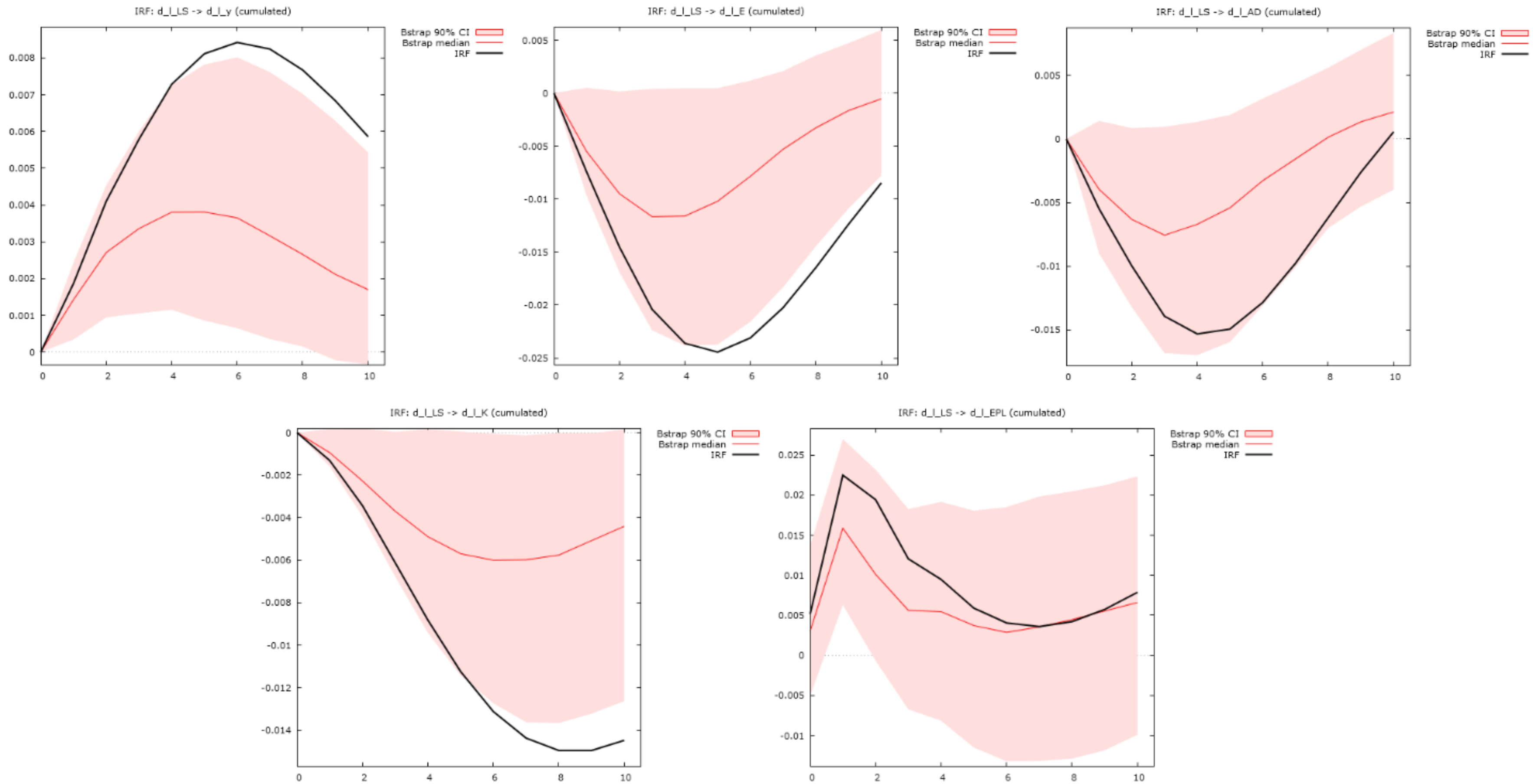


Figure 16 - Accumulated response to structural One S.D. shocks +- 2 S.E. to LS, Spain.

Source: Author's estimation.

UK (LS->*)

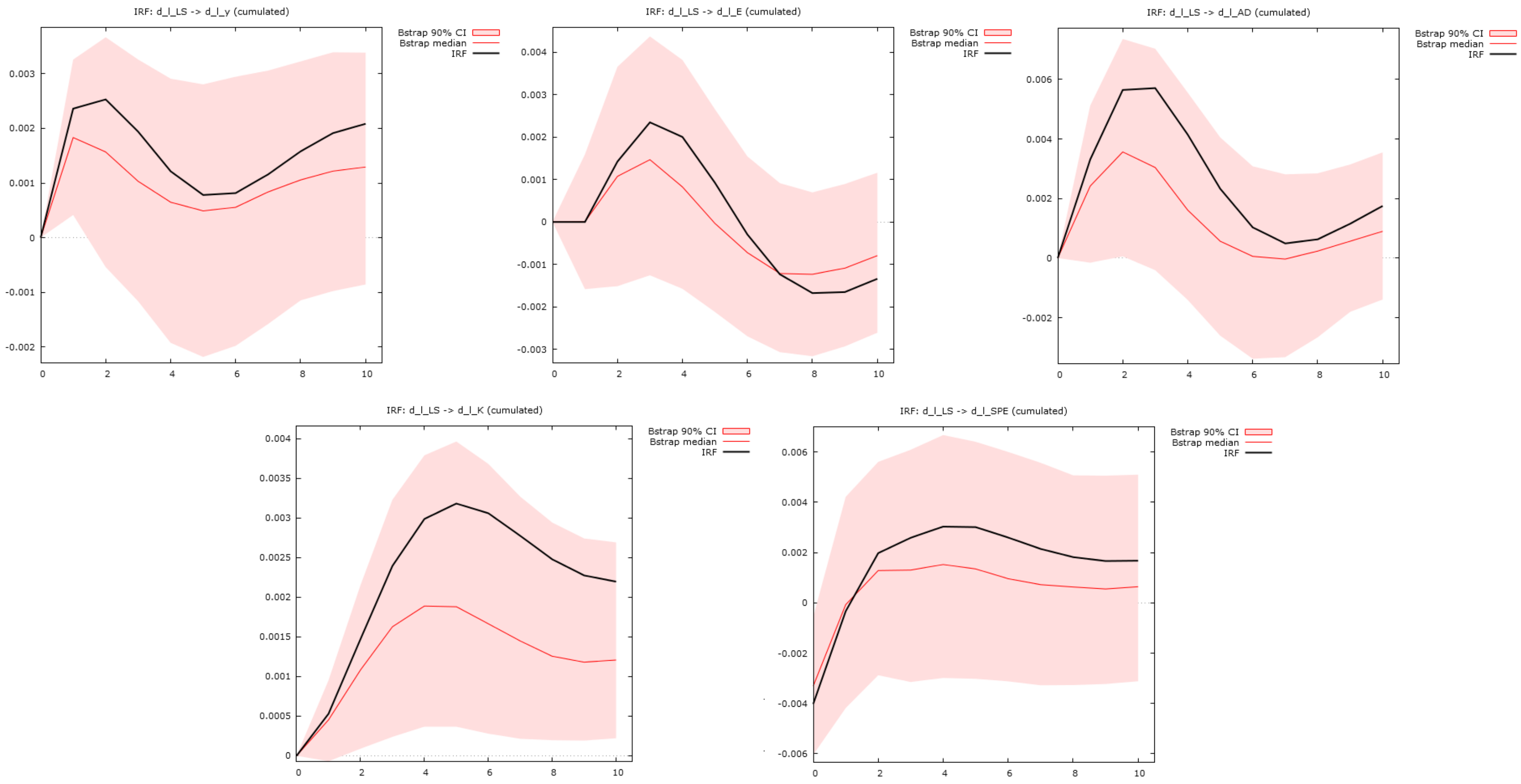


Figure 17 - Accumulated response to structural One S.D. shocks +- 2 S.E. to LS, United Kingdom.

Source: Author's estimation.

USA (LS->*)

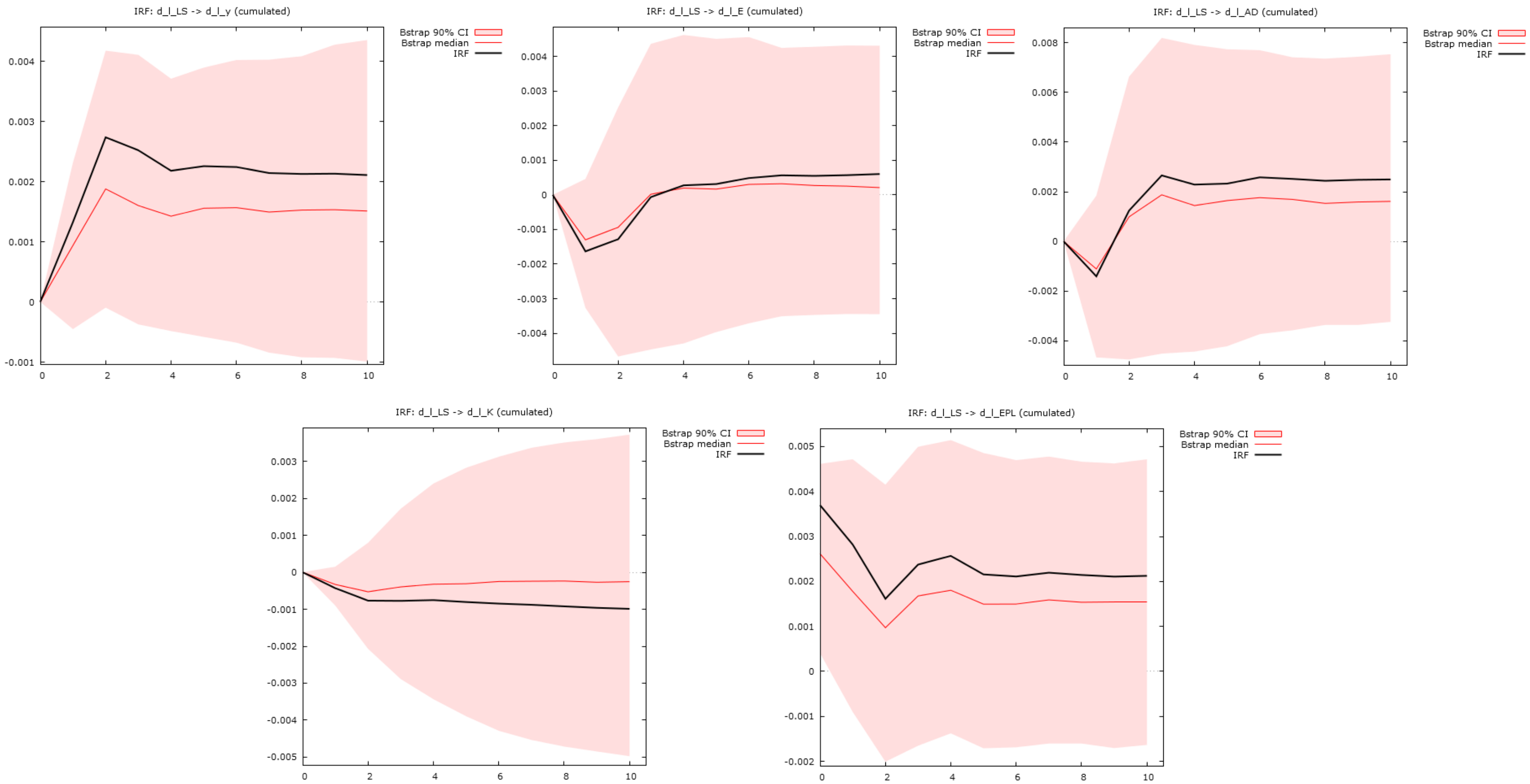


Figure 18 - Accumulated response to structural One S.D. shocks +- 2 S.E. to LS, United States.

Source: Author's estimation.

France (EPL->*)

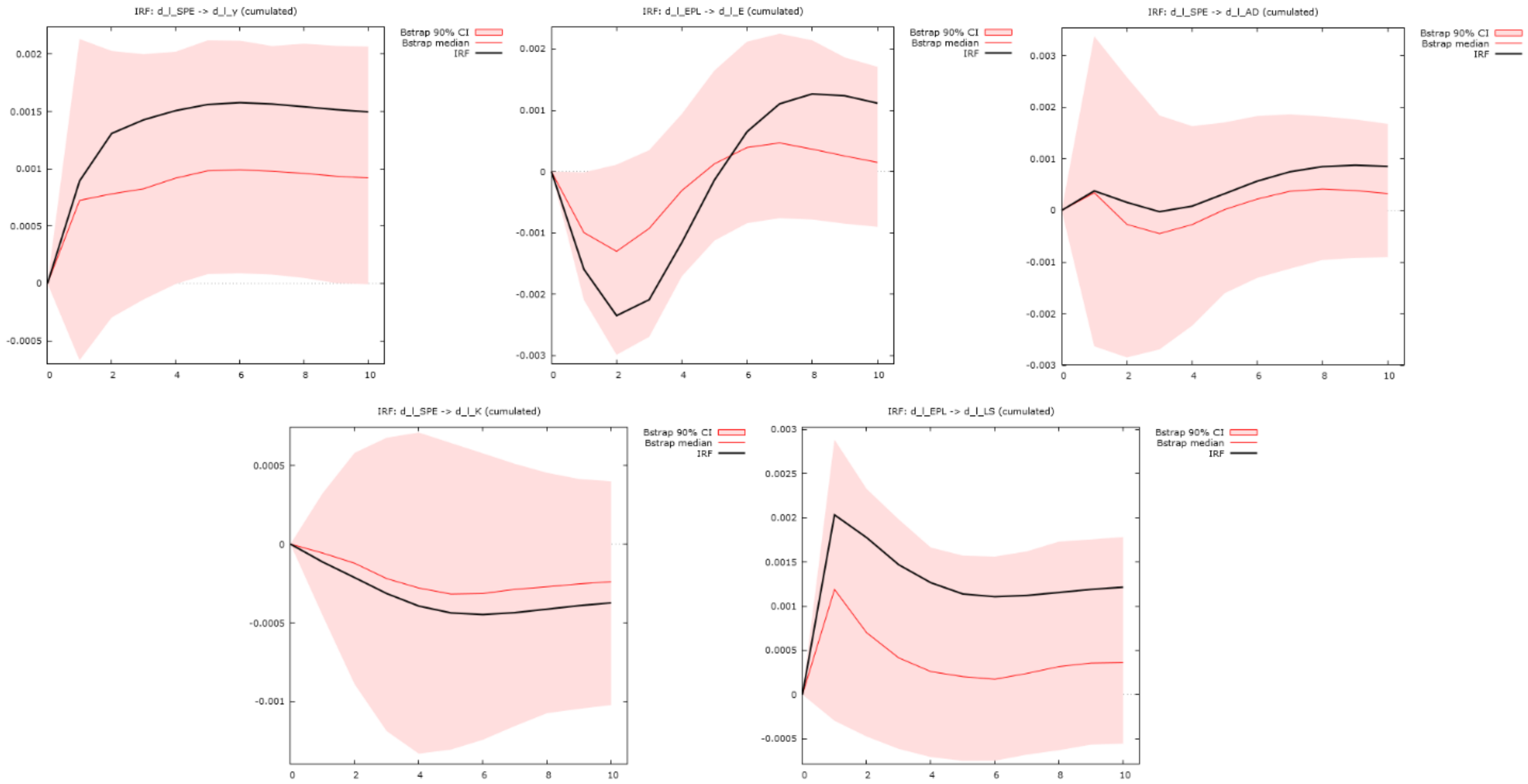


Figure 19 - Accumulated response to structural One S.D. shocks +- 2 S.E. to EPL, France.

Source: Author's estimation.

Germany (EPL->*)

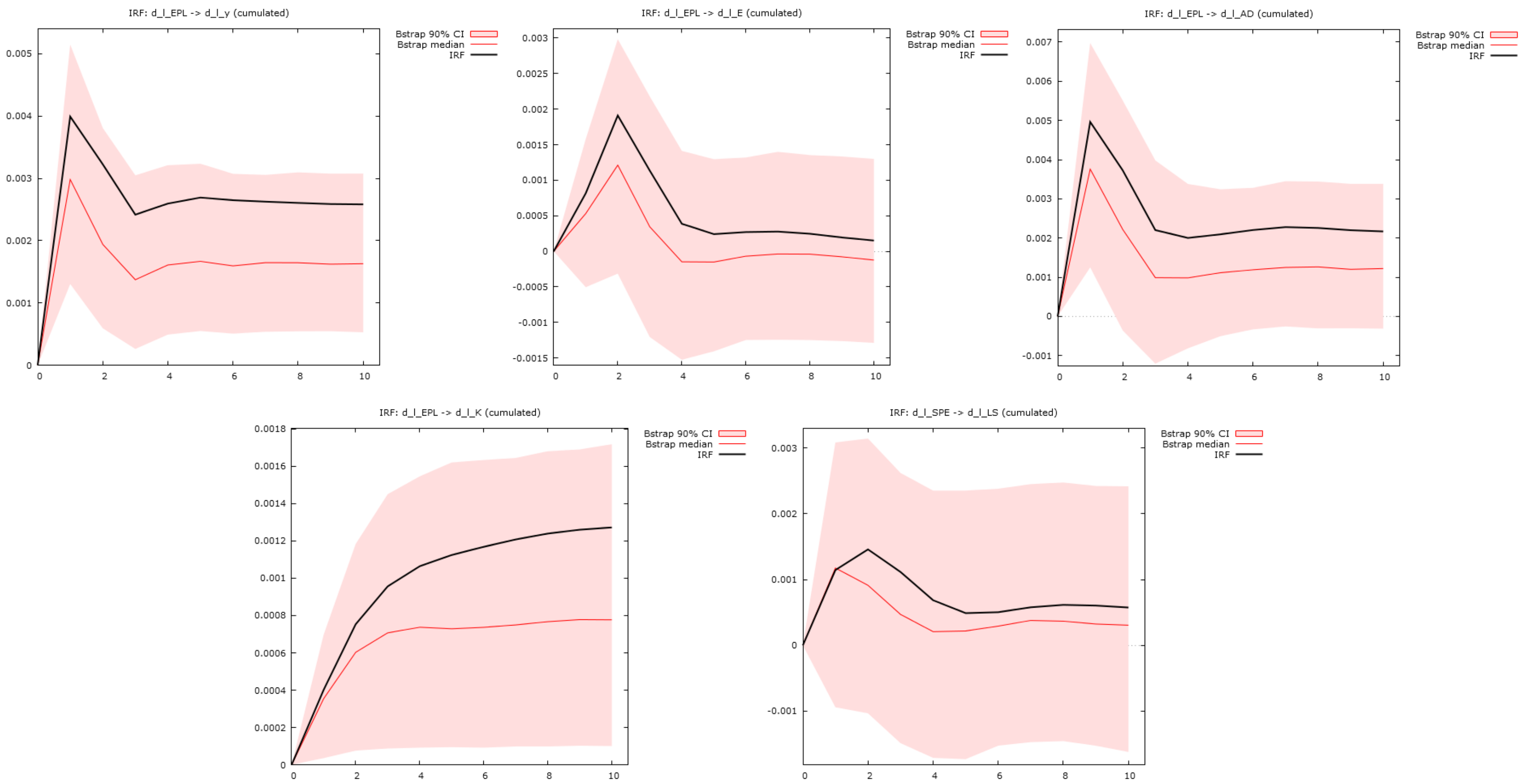


Figure 20 - Accumulated response to structural One S.D. shocks +- 2 S.E. to EPL, Germany.

Source: Author's estimation.

Italy (EPL->*)

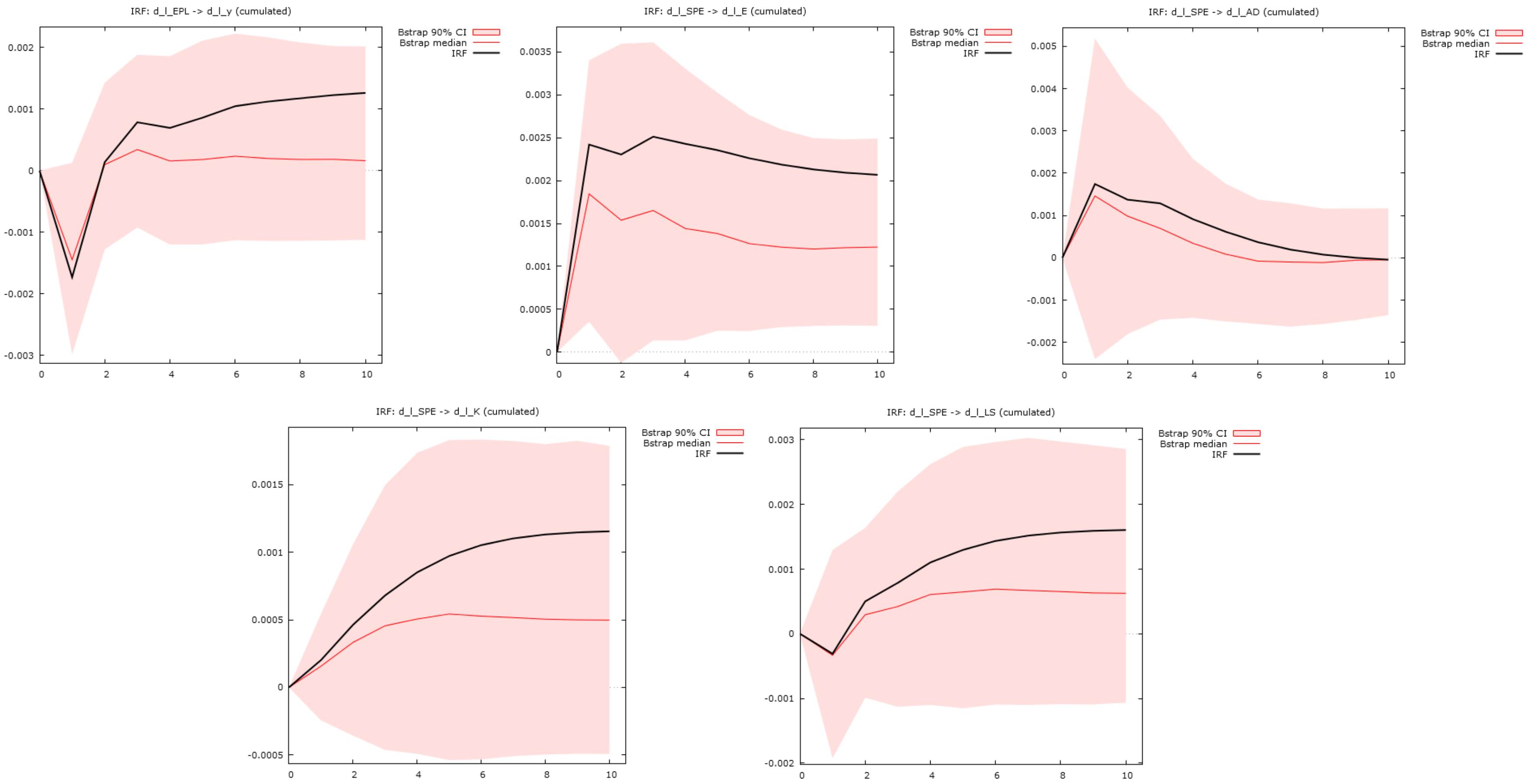


Figure 21 - Accumulated response to structural One S.D. shocks +- 2 S.E. to EPL, Italy.

Source: Author's estimation.

Spain (EPL->*)

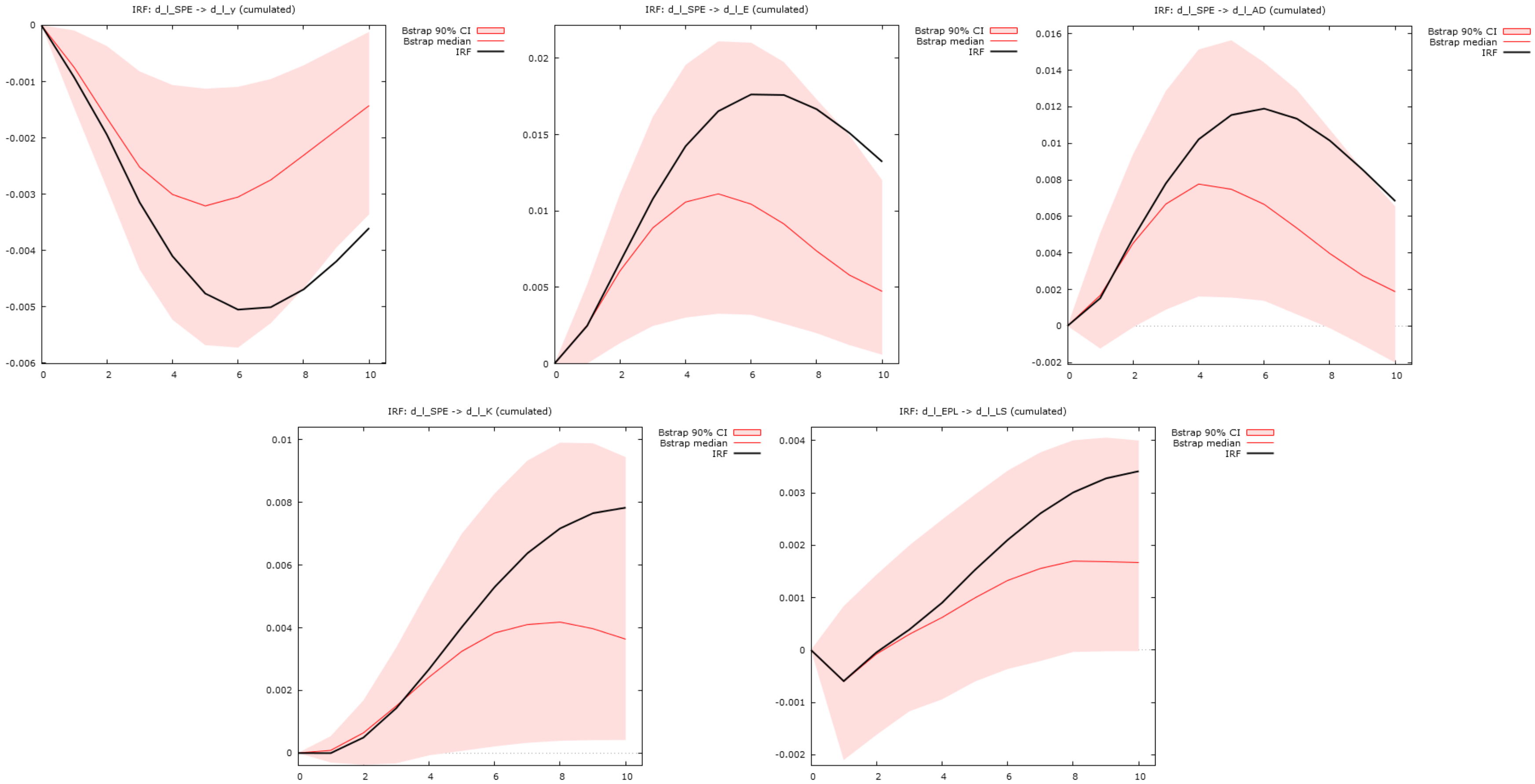


Figure 22 - Accumulated response to structural One S.D. shocks +- 2 S.E. to EPL, Spain.

Source: Author's estimation.

UK (EPL->*)

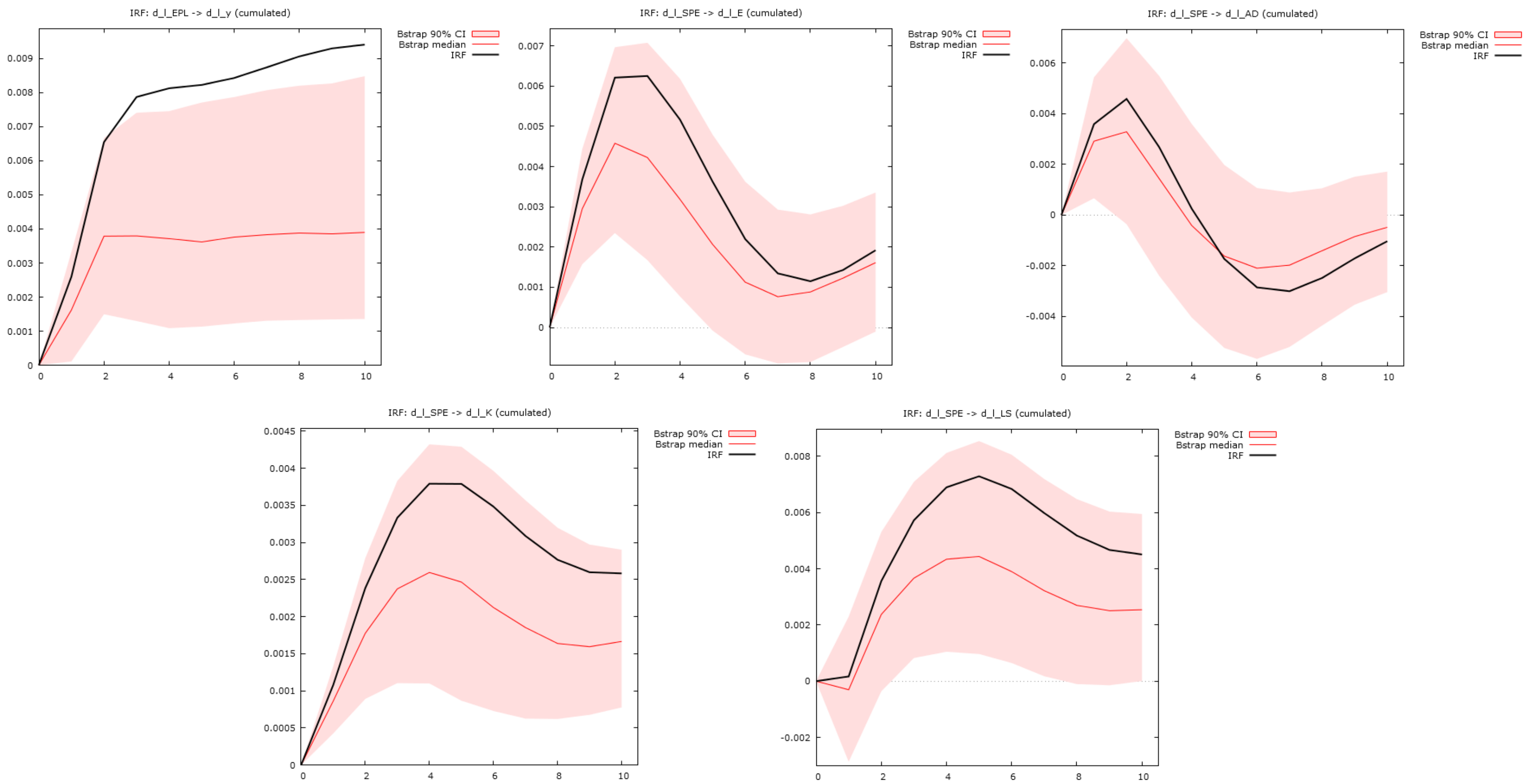


Figure 23 - Accumulated response to structural One S.D. shocks +- 2 S.E. to EPL, United Kingdom.

Source: Author’s estimation.

USA (EPL->*)

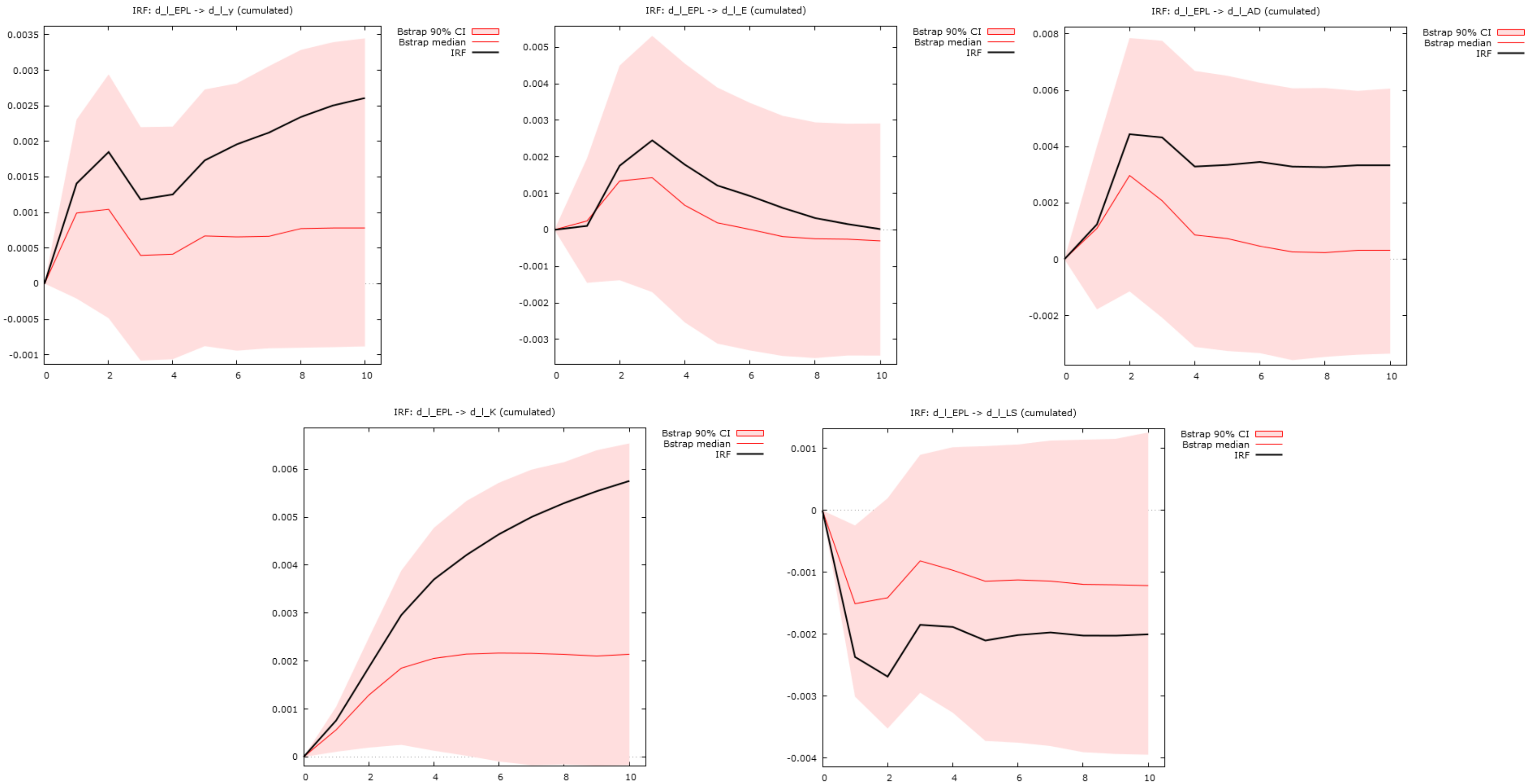


Figure 24 - Accumulated response to structural One S.D. shocks +- 2 S.E. to EPL, United States.

Source: Author's estimation.

The results of the impulse response analysis are reported in Figures 13-24 and summarized in Tables 17 and 18. The impulse responses with the effects of secondary shocks are shown in the tables A2-A7 in Appendix B. There is support for the demand-led labor market hypothesis. Goods market variables (i.e., aggregate demand) may play an important role in determining the level of employment also in the long run. This happens in all countries except France and the United Kingdom where the impact becomes negligible. Shocks to capital accumulation have a strong and statistically significant positive effects on employment too. The duration of these effects varies from one country to another. Distribution seems to play an important role in determining goods market outcomes also in the long run. The effects of the impulse responses were in most of the cases statistically significant (for what concerns AD, always at 1%). This is rather an important finding, since it means that there are apparently no offsetting effects on profitability, which is consistent with our theoretical framework. Further we found no evidence for the so-called “reserve army of labor” effect, as it is captured by the level of employment. An innovation to the employment level has little or no effect on the labor share. Only in France, Germany and Spain there is a negative effect, which however only in Spain turns out to be statistically significant. This is a surprising finding that is not in line with the literature and may be due to the fact that using the level of employment we do not consider of changes in the workforce. However, the results seem to be robust in terms of significance and even when we repeat the exercise by inserting the unemployment rate there are no significant changes observed. An innovation to productivity growth, on the other hand, does (statistically significantly) decrease the labor share in Germany, while raise the labor share in Spain, UK and the US. In this case the contemporaneous effects are also statistically significant. Therefore, productivity changes are not neutral in terms of distribution. An innovation to labor productivity growth does have a negative impact on employment in France and the USA. Finally, capital accumulation does not show a strong or statistically significant reaction to an innovation in labor productivity growth. Weak evidence was found for the neoclassical labor market hypothesis. No evidence has been found that an innovation in the labor share can affect the level of employment in the UK and France. In Italy and Spain, it seems to affect unemployment, but not at a standard level of statistical significance and only in the USA a labor share shock causes the effect expected at standard significance levels, however only after some periods. Finally, no evidence to support the substitution hypothesis of labor for capital was found. In no country has a labor share innovation had a clear negative effect on productivity. There is only a small temporary effect in Italy in the short run which, however, is reabsorbed after just 4 periods.

How reliable are these findings? A series of diagnostic tests were performed to ensure the robustness of the results. (i) Firstly, it was checked whether the results were sensitive to variable specification. Then the labor share of the business sector was used instead of the labor share of the total economy; the unemployment rate was used instead of the employment level; the relative EPL has also been used in place of the share of temporary employment as a measure of regulation in the labor market; finally, detrended GDP growth was used instead of aggregate demand. In none of the cases important changes in the results were observed. (ii) Secondly, we also tested further specifications to see if the missing variables are distorting the results. Again, there have been no major changes in impulse response functions, although it is not surprising that confidence intervals have increased. (iii) Thirdly, although unfortunately there is no standard test for structural breaks in a VAR, we estimated the model also for some sub-periods (1983-1995 and 1995-2018). None of these led to any dramatic changes in coefficient values or impulse response functions. However, diagnostic statistics for the sub-periods worsened considerably.

6. Conclusions and policy implications

The dramatic decline in the labor shares observed in both developed and developing countries during the last 40 years has been associated with generalized lower economic growth rates at the global level. The empirical analysis (either by means of a panel regression and a structural VAR model) allowed us to examine the effects of income re-distribution on growth in 20 developed economies and offered three important results to shed light on this adverse development. (i) Domestic private demand is likely to be wage-led in most of the countries because consumption is on average more sensitive to a decrease in the labor share than investments and the effect of a decrease in unit labor costs on net exports is not high enough to offset this adverse development on domestic demand. Foreign trade even after the remarkable increase in the degree of openness of economies as a result of globalization constitutes only a small part of aggregate demand in world's major economies. (ii) Similarly, when considering supranational economic areas that have strong trade relations and are characterized by a low volume of trade with external countries (e.g., the Eurozone), the resulting nature of demand is wage-led. (iii) Finally, we found that even if there are some countries which are profit-led, the global economy is overall wage-driven and hence a simultaneous cut in labor income in a highly integrated global system leaves most countries with only the negative effects on domestic demand, with the consequence that the global economy inevitably contracts. This means that even though there is room for individual countries to pursue mercantilism strategies and improve their relative position, most profit-led countries would also contract when they decrease their labor share if a similar strategy is implemented by their trading partners. In other words, “beggar the neighbor” policies cancel out the competitiveness advantages for each single country and are detrimental for everyone. This issue can be reconducted to a prisoner's dilemma where each country individually has an incentive to follow such a policy, thereby making everyone (including themselves) worse off.

In this perspective the traditional microeconomic framework that justifies a redistribution of income in favor of capital conflicts with the macroeconomic outcome at two levels: (i) at the national level in a wage-led economy, the consequence of a lower labor share is a lower aggregate demand, and even though a higher profit share may seems to be beneficial to individual firms, a generalized fall in the labor share generates a problem in the realization of profits due to a lack of aggregate demand. (ii) Even if increasing profit shares seem to support growth at the national level in profit-led countries, at the global level a generalized fall in the labor share leads to a global lack of aggregate demand. Therefore, what seems to make sense at the level of an individual firms or countries may result in a contradiction at the macro or global level.

Finally, the VAR model allowed us to confirm part of the basic Keynesian framework with good market variables that influence the labor market and hence employment. Little evidence was found for the hypothesis that changes in real wages or income distribution, effect unemployment. Similarly, we found no evidence that higher unemployment weakens labor’s bargaining position and therefore leads to lower labor shares. On the other hand, we found that the effect of a decrease in labor market regulation results in a rise of unemployment in the long run. Therefore, a stricter employment legislation may pay off in terms of higher productivity growth and higher employment. This happens because labor market regulation simultaneously raises wage claims as well as productivity growth.

These results have of course some important policy conclusions. (i) At the national level, if a country is wage-led, policies that lead to a pro-capital redistribution of income can be harmful to economic growth. Even in some profit-led cases - where the effect of distribution on growth is not very large - the results suggest the possibility of introducing policies to decrease income inequality without damaging the long-run growth potential of the economy. (ii) For large economic areas with high intra-regional trade, coordination of macroeconomic policy (for what concern the labor market regulation) can significantly improve equilibrium growth and employment. (iii) A global wage-driven recovery characterized by a significant increase in labor share and a reduction of inequalities to overcome the global recession, also considering the SARS-CoV-2 crisis is consistent with this.

There are several ways in which this work could be further extended within the Post-Keynesian framework. The lack of financial variables is the probably most obvious flaw. For instance, while there is significant theoretical work on “conflict inflation”, so far there has been little empirical research on the subject. Understanding the linkages between compensation and price dynamics especially considering the asymmetrical developments in the Euro area is therefore very relevant. In this sense, institutional factors could be better investigated. An important change to the European labor market institutional structure has been testified by a constant decline in unionization. In the private sector, the number of employed workers who are union members and the fraction of employed workers who are covered by a collective bargaining agreement have both dropped since the early 80s. Unions’ bargaining power is likely to increase workers’ share of the income generated in the production process (Hirsch, 2012). Further, more recently, the euro peripheral crisis has revived the old idea of internal devaluation as a way for countries within a currency union to improve competitiveness and export their way out of the crisis. Through successive reforms, wage adjustments relative to Germany fell substantially in all the countries in question, and the current account deficits have been greatly reduced. As such, a decline in union power along with these developments for real wages are likely to have played a major role in determining labor share dynamics in Europe.

Appendix A: mathematical appendix

(i) Derivation of the LPS

Consider the following increasing-returns-to-scale (IRS) variable elasticity of substitution (VES) production function:

$$Y = A[\delta K^{-\rho} + (1-\delta)\eta L^{-\rho} k^{-c(1+\rho)}]^{-\frac{v}{\rho}} \quad \text{A1}$$

With: $-1 < \rho < \infty$; $\rho \neq 0$; $0 < \delta < 1$; $h, A > 0$. Where:

- Y = GDP at constant prices;
- K = gross fixed capital stock (at constant prices);
- L = number of hours worked;
- $k = K/L$ is the capital-labor ratio;
- A = efficiency parameter;
- δ = distribution parameter;
- ρ = substitution parameter;
- v = returns-to-scale parameter (with $v > 1$ corresponding to IRS).

Denoting the price of capital by Π, the elasticity of capital-labor substitution σ is defined as:

$$\sigma = \frac{\partial(K/L)/(K/L)}{\partial(W/\Pi)/(W/\Pi)} = \frac{1}{1+\rho} \quad \text{A2}$$

From the first-order condition (i.e., $\partial Y/\partial L = W/P$), where W is the (nominal) wage rate and P is the GDP deflator, using the definition in $A2$, it follows that labor productivity y is equal to:

$$Y = A[\delta K^{-\rho} + (1-\delta)\eta L^{-\rho} K^{-c(1+\rho)} L^{c(1+\rho)}]^{-\frac{v}{\rho}}$$

$$Y = A[\delta K^{-\rho} + (1-\delta)\eta L^{-\rho+c(1+\rho)} K^{-c(1+\rho)}]^{-\frac{v}{\rho}}$$

$$\frac{\partial Y}{\partial L} = MP_L = \left(-\frac{v}{\rho}\right)\delta A(-\rho + c + c\rho)\eta K^{-c(1+\rho)} L^{-\rho+c(1+\rho)-1}\left[\delta K^{-\rho} + (1-\delta)\eta L^{-\rho} k^{-c(1+\rho)}\right]^{-\frac{v}{\rho}-1}$$

$$\frac{\partial Y}{\partial L} = \frac{v\left(1 - \frac{c}{\rho} - c\right)\eta\delta A\left(\frac{Y}{A}\right)^{1+\frac{\rho}{v}}}{K^{\,c(1+\rho)}L^{\rho-c-c\rho+1}}$$

$$\frac{\partial Y}{\partial L} = \frac{v\left(1 - \frac{c}{\rho} - c\right)\eta\delta A Y^{\frac{h+\rho}{h}} A^{-\frac{h+\rho}{h}}}{K^{\,c(1+\rho)}L^{\rho-c-c\rho+1}}$$

$$\frac{\partial Y}{\partial L} = \frac{v\left(1 - \frac{c}{\rho} - c\right)\eta\delta A^{\frac{\rho}{h}} Y^{\frac{\rho(1-h)}{h}} Y^{1+\rho}}{K^{\,c(1+\rho)}L^{1+\rho}L^{-c(1+\rho)}}$$

$$\frac{\partial Y}{\partial L} = \frac{v\left(1 - \frac{c}{\rho} - c\right)\eta\delta A^{\frac{\rho}{h}} Y^{\frac{\rho(1-h)}{h}}}{k^{\,c(1+\rho)}} y^{1+\rho}$$

$$\frac{\partial Y}{\partial L} = \frac{W}{P} = w$$

$$\frac{v\left(1 - \frac{c}{\rho} - c\right)\eta\delta A^{\frac{\rho}{h}} Y^{\frac{\rho(1-h)}{h}}}{k^{\,c(1+\rho)}} y^{1+\rho} = w$$

$$y^{1+\rho} = \frac{w}{\dfrac{v\left(1 - \frac{c}{\rho} - c\right)\eta\delta A^{\frac{\rho}{h}} Y^{\frac{\rho(1-h)}{h}}}{k^{\,c(1+\rho)}}}$$

$$y = \frac{w^{\frac{1}{1+\rho}}}{\dfrac{\left[v\left(1 - \frac{c}{\rho} - c\right)\eta\delta\right]^{\frac{1}{1+\rho}} A^{\frac{\rho}{h(1+\rho)}} Y^{\frac{\rho(1-h)}{h\,(1+\rho)}}}{k^{\,c}}}$$

$$y = \left[v\left(1 - \frac{c}{\rho} - c\right)\eta\delta\right]^{-\frac{1}{1+\rho}} w^{\frac{1}{1+\rho}} A^{\frac{\rho}{h(1+\rho)}} Y^{\frac{\rho(1-h)}{h\,(1+\rho)}} k^{\,c} \qquad \text{A3}$$

Log-differentiating $A3$ and dividing through by y gives us an expression for the proportional growth rate of labor productivity:

$$\dot{y} = \frac{\rho}{h(1+\rho)}\dot{A} + \frac{1}{1+\rho}\dot{w} + \frac{\rho(1-h)}{h\,(1+\rho)}\dot{Y} + c\dot{k} \qquad \text{A4}$$

If we assume that:

$$\dot{A} = \alpha_0 + \alpha_1 z \qquad \text{A5}$$

By substituting $A5$ into $A4$, we obtain:

$$\dot{y} = \frac{\rho}{h(1+\rho)}\alpha_0 + \frac{1}{1+\rho}\dot{w} + \frac{\rho(1-h)}{h\,(1+\rho)}\dot{Y} + c\dot{k} + \frac{\rho}{h(1+\rho)}\alpha_1 z \qquad \text{A6}$$

Or:

$$\dot{y} = \beta_0 + \beta_1\dot{Y} + \beta_2\dot{w} + \beta_3 z + \beta_4\dot{k} \qquad \text{A7}$$

Where $A6$ is the productivity equation (5). Note that:

- $\beta_1 = \left[\frac{(h-1)\rho}{h(\rho+1)}\right]$ is the Kaldor-Verdoorn elasticity, which is economically meaningful only if $v > 1$ (i.e., if there exist IRS);
- $\beta_2 = \sigma$ is the coefficient of wage-led technological change;
- $\beta_3 = \left(\sigma\frac{\rho}{h}\right)$ gives the impact of labor market regulation on productivity growth;
- $\beta_4 = c$ gives the impact of capital accumulation on productivity growth.

(ii) Total differentiation of eq. (13) in the main text

Let us denote with dX the total differential of a variable X. Let k be a constant. We need to know the following rules:

$$dk = 0$$

$$d(X+Y) = dX + dY \qquad \text{(constant rule)}$$

$$d(XY) = Y \cdot dX + X \cdot dY \qquad \text{(sum rule)}$$

$$d\left(\frac{X}{Y}\right) = \frac{Y \cdot dX + X \cdot dY}{Y^2} \qquad \text{(quotient rule)}$$

Now let us start with our equation (13). By applying the product rule, we get:

$$dY = d[\mu^{-1}(G^* + I + E)]$$

$$dY = d(\mu^{-1})(G^* + I + E) + \mu^{-1}d(G^* + I + E) \qquad \text{A8}$$

What is $d(\mu^{-1})$? Because $\mu^{-1} = \frac{1}{\mu}$, by applying the quotient rule we have:

$$d(\mu^{-1}) = d\left(\frac{1}{\mu}\right) = \frac{\mu d(1) - 1d(\mu)}{\mu^2} = \frac{-d(\mu)}{\mu^2} \qquad \text{A9}$$

By plugging $A9$ into the above intermediate result $A8$ and applying the sum rule we get:

$$dY = d(\mu^{-1})(G^* + I + E) + \mu^{-1}d(G^* + I + E)$$

$$dY = \frac{-d(\mu)}{\mu^2}(G^* + I + E) + \mu^{-1}(dG^* + dI + dE)$$

$$dY = \frac{-d(\mu)}{\mu}\mu^{-1}(G^* + I + E) + \mu^{-1}(dG^* + dI + dE)$$

$$dY = -\dot{\mu}x + \mu^{-1}(dG^* + dI + dE) \qquad \text{A10}$$

Where use was made of the definition of Y and the fact that $\frac{d(\mu)}{\mu} = \dot{\mu}$. Further note that since $\frac{dX}{X} = \dot{X}$ for any variable X, we also have $dX = X \cdot \dot{X}$; applying this rule to g, i and e and dividing the entire equation by x we get:

$$\dot{Y} = \frac{dY}{Y} = -\dot{\mu} + \mu^{-1}\frac{(dG^* + dI + dE)}{Y}$$

$$\dot{Y} = -\dot{\mu} + \mu^{-1}\frac{dG^*}{Y} + \mu^{-1}\frac{dI}{Y} + \mu^{-1}\frac{dE}{Y}$$

$$\dot{Y} = -\dot{\mu} + \frac{\mu^{-1}G^*}{Y}\dot{G}^* + \frac{\mu^{-1}I}{Y}\dot{I} + \frac{\mu^{-1}E}{Y}\dot{E} \qquad \text{A11}$$

Or:

$$\dot{Y} = -\dot{\mu} + \psi_g\dot{G}^* + \psi_i\dot{I} + \psi_x\dot{X} \qquad (14)$$

Where:

$\psi_g = \frac{\mu^{-1}G^*}{Y}$, $\psi_i = \frac{\mu^{-1}I}{Y}$, $\psi_X = \frac{\mu^{-1}X}{Y}$ are the multiplier-adjusted shares in GDP of net government expenditure, investment, and exports, respectively.

(iii) Derivation of steady state and long-run equilibriums

To derive the steady-state equilibrium of the system we start from the LPS, ADS and LMS reduced form equations:

$$\dot{y} = \beta_0 + \beta_1\dot{Y} + \beta_2\dot{w} + \beta_3 z + \beta_4\dot{k} \tag{5}$$

$$\dot{Y} = \dot{\Theta} + D[\dot{w} - \dot{y}] \tag{23}$$

$$\dot{L} = \left[\dot{Y}(1-\beta_1) - \beta_0 - \beta_2\dot{w} - \beta_3 z - \beta_4\dot{k}\right] \tag{25}$$

By substituting the LPS into the ADS, we get:

$$\dot{Y} = \dot{\Theta} + D\left[\dot{w} - \left(\beta_0 + \beta_1\dot{Y} + \beta_2\dot{w} + \beta_3 z + \beta_4\dot{k}\right)\right]$$

$$\dot{Y} = \dot{\Theta} + D\dot{w} - D\beta_0 - D\beta_1\dot{Y} - D\beta_2\dot{w} - D\beta_3 z - D\beta_4\dot{k}$$

$$\dot{Y}(1 + D\beta_1) = \dot{\Theta} - D\beta_0 + D\dot{w} - D\beta_2\dot{w} - D\beta_3 z - D\beta_4\dot{k}$$

$$\begin{aligned}\dot{Y} &= \frac{\dot{\Theta} - D\beta_0}{(1 + D\beta_1)} + \dot{w}\frac{D(1-\beta_2)}{(1 + D\beta_1)} - \frac{\beta_3 D}{(1 + D\beta_1)}z - \frac{\beta_4 D}{(1 + D\beta_1)}\dot{k} \\ &= \bar{\Theta} + \Xi\dot{\mathrm{w}} - \Phi\mathrm{z} - \varpi\dot{\mathrm{k}}\end{aligned} \tag{28}$$

Similarly, by substituting the ADS into the LPS we get:

$$\dot{y} = \beta_0 + \beta_1\left[\bar{\Theta} + \Xi\dot{w} - \Phi z - \varpi\dot{k}\right] + \beta_2\dot{w} + \beta_3 z + \beta_4\dot{k}$$

$$\dot{y} = \beta_0 + \beta_1\dot{\Theta} + \beta_1\Xi\dot{w} - \beta_1\Phi z - \beta_1\varpi\dot{k} + \beta_2\dot{w} + \beta_3 z + \beta_4\dot{k}$$

$$\dot{y} = \beta_0 + \beta_1\dot{\Theta} + (\beta_1\Xi + \beta_2)\dot{w} + (\beta_3 - \beta_1\Phi)z + (\beta_4 - \beta_1\varpi)\dot{k} \tag{29}$$

Finally, by substituting the ADS into the LMS we get:

$$\dot{L} = \left(\bar{\Theta} + \Xi\dot{w} - \Phi z - \varpi\dot{k}\right)(1-\beta_1) - \beta_0 - \beta_2\dot{w} - \beta_3 z - \beta_4\dot{k}$$

$$\dot{L} = \bar{\Theta}(1-\beta_1) + \Xi\dot{\mathrm{w}}(1-\beta_1) - \Phi\mathrm{z}(1-\beta_1) - \varpi\dot{\mathrm{k}}(1-\beta_1) - \beta_0 - \beta_2\dot{w} - \beta_3 z - \beta_4\dot{k}$$

$$\begin{aligned}\dot{L} = -\beta_0 + \bar{\Theta}(1-\beta_1) + [(1-\beta_1)\Xi - \beta_2]\dot{w} - [(1-\beta_1)\Phi + \beta_3]z \\ -[(1-\beta_1)\varpi + \beta_4]\dot{k}\end{aligned} \tag{30}$$

By imposing the long-run equilibrium condition to respectively the ADS and LPS (i.e., real wages must grow at the same rate of labor productivity $\dot{w} = \dot{y}$), we get:

$$\dot{Y} = \dot{\Theta} + D[\dot{y} - \dot{y}]$$

$$\dot{Y} = \dot{\Theta} = \frac{\psi_i f_0 \dot{b} + \psi_g \dot{G}^* + \psi_x x_0 - \psi_i f_3 r}{(1 - \psi_i f_2)} \qquad (38)$$

$$\dot{y} = \beta_0 + \beta_1 \dot{Y} + \beta_2 \dot{y} + \beta_3 z + \beta_4 \dot{k}$$

$$\dot{y} - \beta_2 \dot{y} = \beta_0 + \beta_1 \dot{Y} + \beta_3 z + \beta_4 \dot{k}$$

$$\dot{y}(1 - \beta_2) = \beta_0 + \beta_1 \dot{Y} + \beta_3 z + \beta_4 \dot{k}$$

$$\dot{y} = \frac{\beta_0}{(1 - \beta_2)} + \frac{\beta_1}{(1 - \beta_2)} \dot{Y} + \frac{\beta_3}{(1 - \beta_2)} z + \frac{\beta_4}{(1 - \beta_2)} \dot{k} \qquad (38)$$

From equation (27) we can derive the equilibrium unemployment rate u^*.

$$\dot{w} = \alpha_0 - \alpha_1 u + \alpha_2 \dot{y} + \alpha_3 z$$

$$u^* = \frac{\alpha_0 + \alpha_2 \dot{y} + \alpha_3 z - \dot{w}}{\alpha_1}$$

By inserting the long-run equilibrium condition:

$$\boldsymbol{u^* = \frac{\alpha_0 + \alpha_2 \dot{y} + \alpha_3 z - \dot{y}}{\alpha_1}}$$

$$\boldsymbol{u^* = \frac{\alpha_0 + \dot{y}(\alpha_2 - 1) + \alpha_3 z}{\alpha_1}}$$

Substituting the equilibrium ADS and LPS into it finally gives:

$$u^* = \frac{\alpha_0 + \left[\frac{\beta_0}{(1-\beta_2)} + \frac{\beta_1}{(1-\beta_2)} \dot{Y} + \frac{\beta_3}{(1-\beta_2)} z + \frac{\beta_4}{(1-\beta_2)} \dot{k}\right](\alpha_2 - 1) + \alpha_3 z}{\alpha_1}$$

$$u^* = \frac{\alpha_0 + \left[\frac{\beta_0(\alpha_2 - 1)}{(1 - \beta_2)} + \frac{\beta_1(\alpha_2 - 1)}{(1 - \beta_2)} \dot{Y} + \frac{\beta_3(\alpha_2 - 1)}{(1 - \beta_2)} z + \frac{\beta_4(\alpha_2 - 1)}{(1 - \beta_2)} \dot{k}\right] + \alpha_3 z}{\alpha_1}$$

$$u^* = \frac{\alpha_0}{\alpha_1} + \frac{\beta_0(\alpha_2 - 1)}{(1 - \beta_2)\alpha_1} + \frac{\beta_1(\alpha_2 - 1)}{(1 - \beta_2)\alpha_1} \dot{Y} + \frac{\beta_3(\alpha_2 - 1)}{(1 - \beta_2)\alpha_1} z + \frac{\beta_4(\alpha_2 - 1)}{(1 - \beta_2)\alpha_1} \dot{k} + \frac{\alpha_3}{\alpha_1} z$$

$$u^{*} = \frac{(1-\beta_2)\alpha_0 + (\alpha_2 - 1)\beta_0}{(1-\beta_2)\alpha_1} + \frac{(\alpha_2 - 1)\beta_1}{(1-\beta_2)\alpha_1}\dot{Y} + \frac{(\alpha_2 - 1)\beta_3}{(1-\beta_2)\alpha_1}z + \frac{(\alpha_2 - 1)\beta_4}{(1-\beta_2)\alpha_1}\dot{k} + \frac{\alpha_3}{\alpha_1}z$$

$$u^{*} = \frac{(1-\beta_2)\alpha_0 - (1-\alpha_2)\beta_0}{(1-\beta_2)\alpha_1} - \frac{(1-\alpha_2)\beta_1}{(1-\beta_2)\alpha_1}\Theta + \left[\frac{(1-\beta_2)\alpha_3 - (1-\alpha_2)\beta_3}{(1-\beta_2)\alpha_1}\right]z - \frac{(1-\alpha_2)\beta_4}{(1-\beta_2)\alpha_1}\dot{k} \qquad (40)$$

(iii) Profitability, real wages, productivity and capacity utilization

From a microeconomic point of view workers provide their labor service in exchange for money (since work gives them straight disutility). However, as we will show, there are still reasons to argue that higher wages raise profitability because they stimulate demand by providing more purchasing power to workers. Recall the standard definition of the profit rate ρ as the ratio of profits Π to invested capital $p_k K$:

$$\rho = \frac{\Pi}{p_k K} \qquad \text{A12}$$

Where:

- Π are the total profits;
- K is the capital stock;
- p_k is the price of the capital stock.

Let us define Y as the real gross domestic product and p as the general price level. If we multiply the right-hand side of equation $A12$ by the ratio (pY/pY), we get, after a little manipulation:

$$\rho = \frac{\Pi}{p_k K}\frac{pY}{PY} = \frac{\Pi}{pY}\frac{p}{p_k}\frac{Y}{K} = \Phi\frac{p}{p_k}\Theta \qquad \text{A13}$$

Where:

- Φ is the profit share (Π/pY);
- Θ is the output-capital ratio (Y/K), or the rate of capacity utilization.

The profit rate therefore depends positively on the profit share and capacity utilization. If we look more closely at the profit share Φ which equals total profits divided by GDP and further assume that total profits are equal to GDP minus wages, we get:

$$\Phi = \frac{\Pi}{pY} = \frac{pY - WL}{pY} = 1 - w\left(\frac{Y}{L}\right)^{-1} = 1 - wy^{-1} \qquad \text{A14}$$

Where:

- W is the money wage (per hour);
- L is the number of hours worked;
- y the hourly labor productivity.

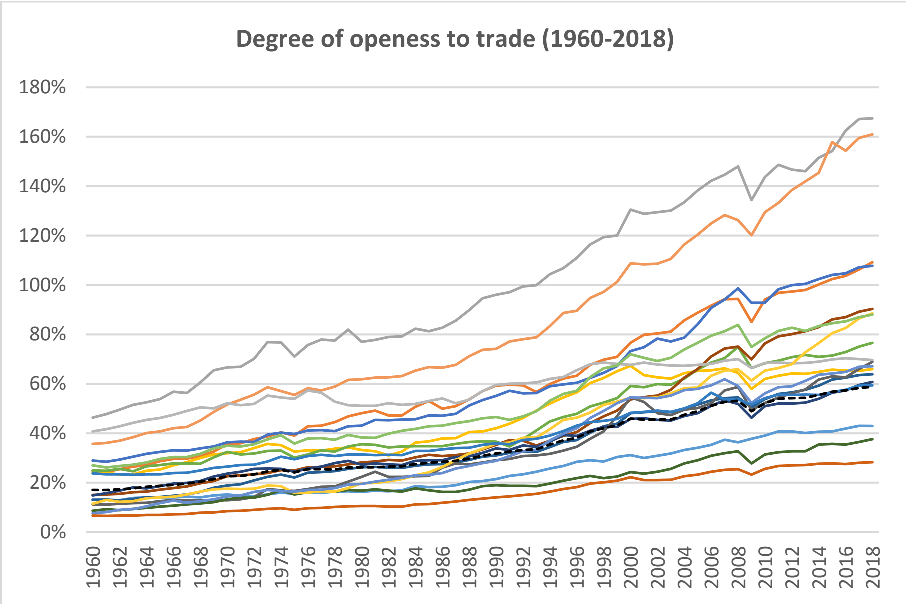
As we have already seen in the introduction, the profit share depends negatively on the real wage w and positively on labor productivity y. A higher real wage depresses the profit share, whereas higher productivity raises the profit share. Substituting A14 into A13, we obtain the following expression for ρ:

$$\rho = (1 - wy^{-1})\frac{p}{p_k}\Theta \qquad \text{A15}$$

Therefore, profitability has three main determinants: (i) the real wage, (ii) labor productivity, and (iii) capacity utilization. It is immediately clear from A15 that the profit rate declines in response to higher real wages because unit labor costs increase, and the profit share gets reduced. This, however, is just the direct impact. Higher wages also have a significant indirect effect on profitability, which operate through capacity utilization Θ and labor productivity y. Capacity utilization Θ would increase in response to higher real wages if the latter lead to higher aggregate demand. This increase in Θ immediately raises profitability, which will, in turn, induce higher investments by firms. Capital accumulation also increases in response to the growth in aggregate demand (though the Keynesian accelerator effect). The result is a sequence of rounds of demand growth and increases in utilization. The higher real wage reduces the profit rate, but higher capacity utilization raises the profit rate. Hence the net impact on profitability is no longer unambiguously negative in the short run. In addition, the new investments will result in a higher level of labor productivity y and the increase in aggregate demand, caused by higher wages, leads to an economywide deepening of the division of labor as well as more rapid learning by doing processes within firms that eventually get reflected in a higher growth of labor productivity (Kaldor-Verdoorn relation) (Kaldor 1957). The fact that profits have an important influence on investment is also supported by several time-series studies on investment trends.

Appendix B: additional figures and tables

(i) Additional figures



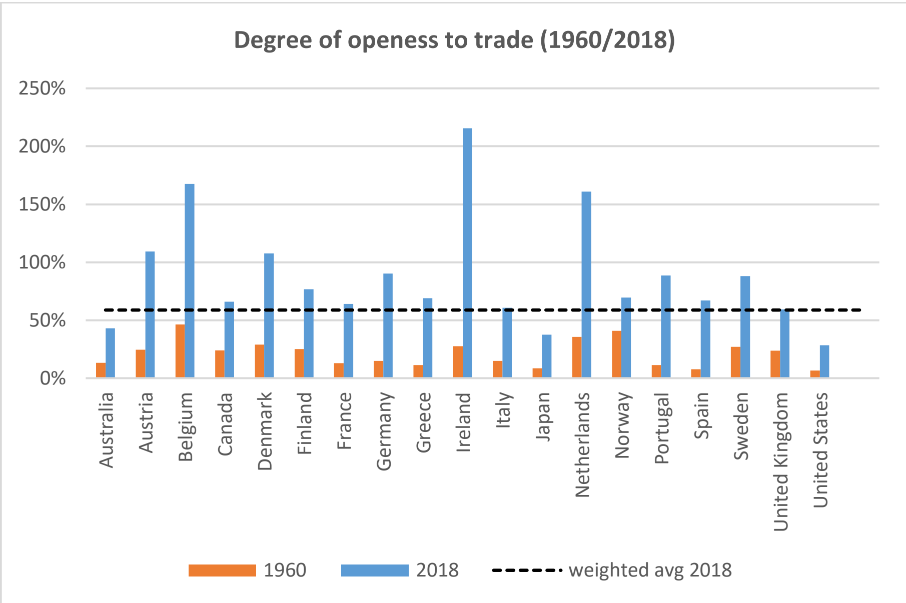


Figure A1 - Degree of openness to trade.

Note: 1960-2018. Panel a show the exceptional increase in the degree of openness to trade in all the 20 countries considered. From 1960 to 2018 the average economy increased its ratio of exports and imports to GDP from a weighted average - GDP at constant prices - of 17% to 59%. Panel b shows labor share levels in 1960 and 2018 for all panel countries along with the 2018 weighted average. The smallest increase was 1.71 times the 1960 level (Norway) and the largest 8.78 (Spain). *Source:* Author's calculation on AMECO data.

Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.

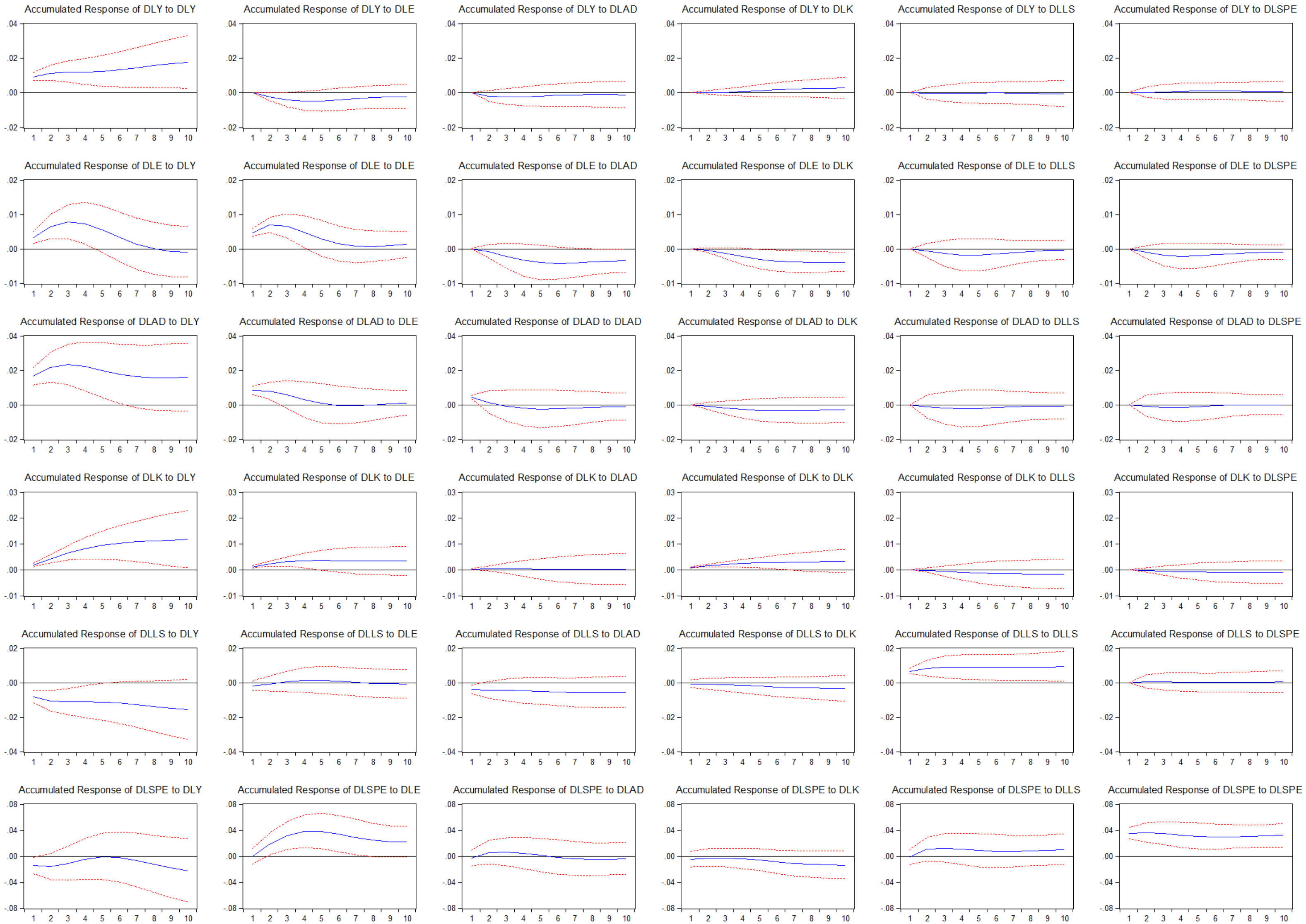


Figure A2 - Accumulated response (IRFs) to structural One S.D. shocks +- 2 S.E., France.

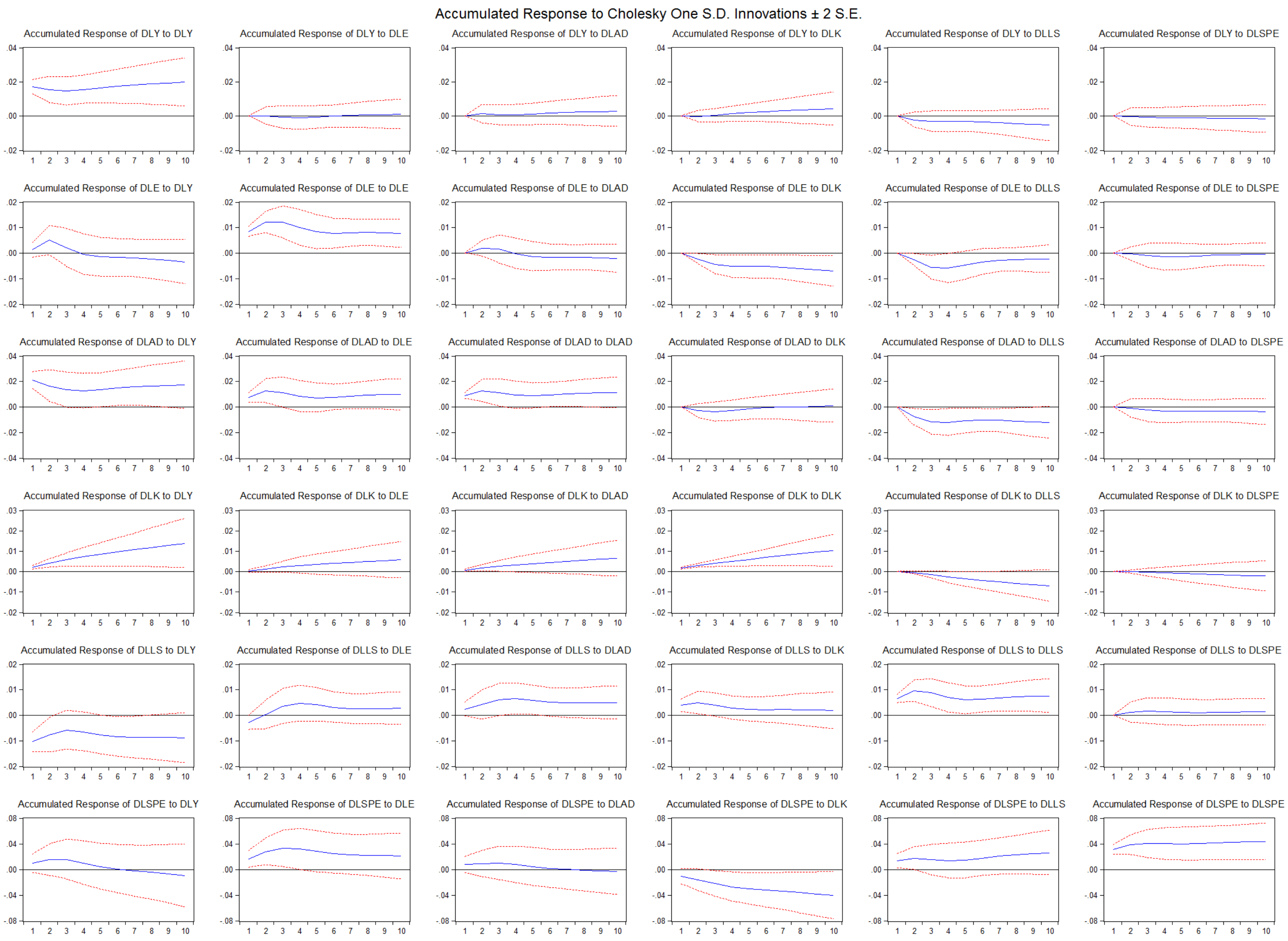


Figure A3 - Accumulated response (IRFs) to structural One S.D. shocks +- 2 S.E., Germany.

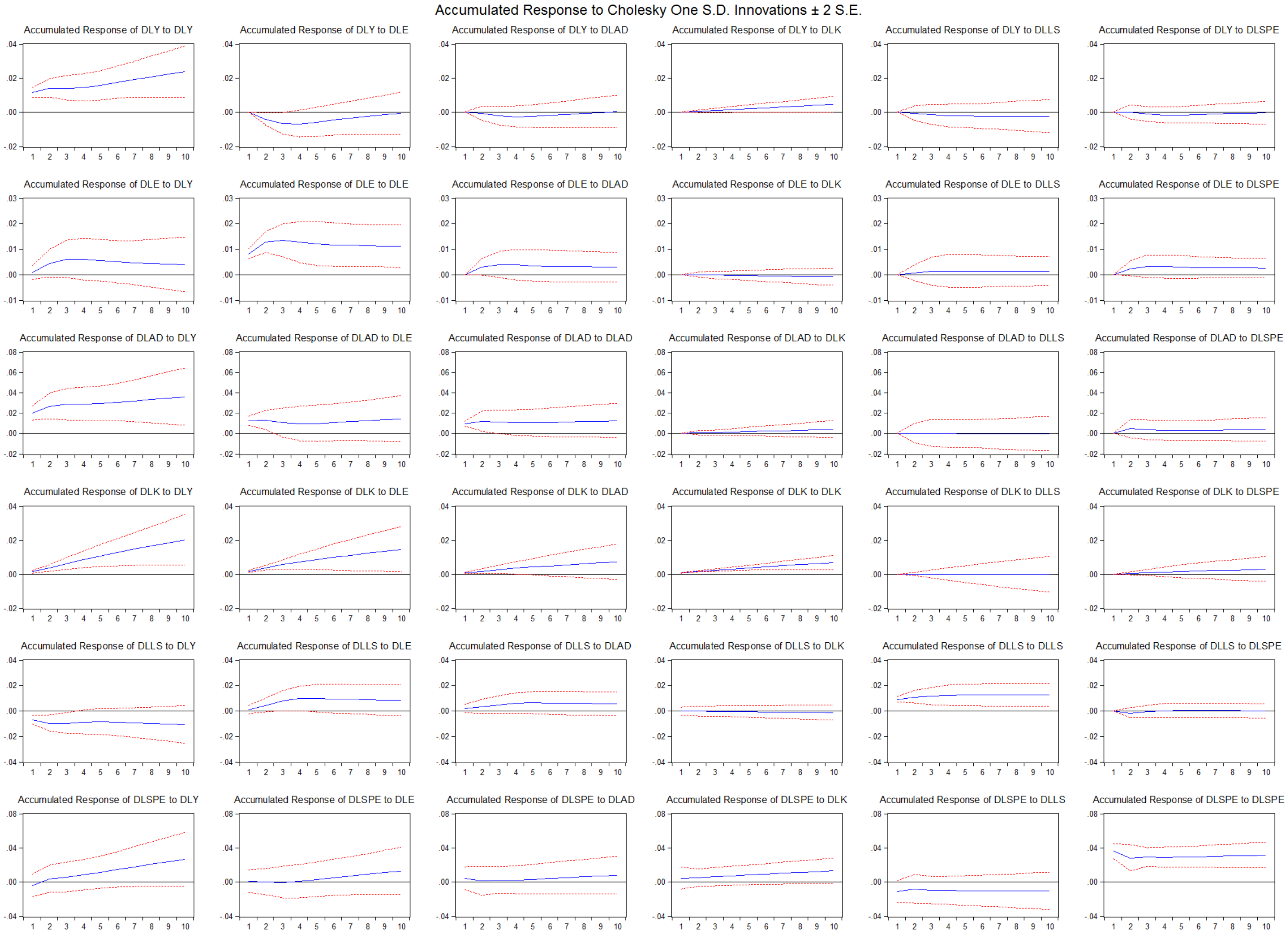


Figure A4 - Accumulated response (IRFs) to structural One S.D. shocks +- 2 S.E., Italy.

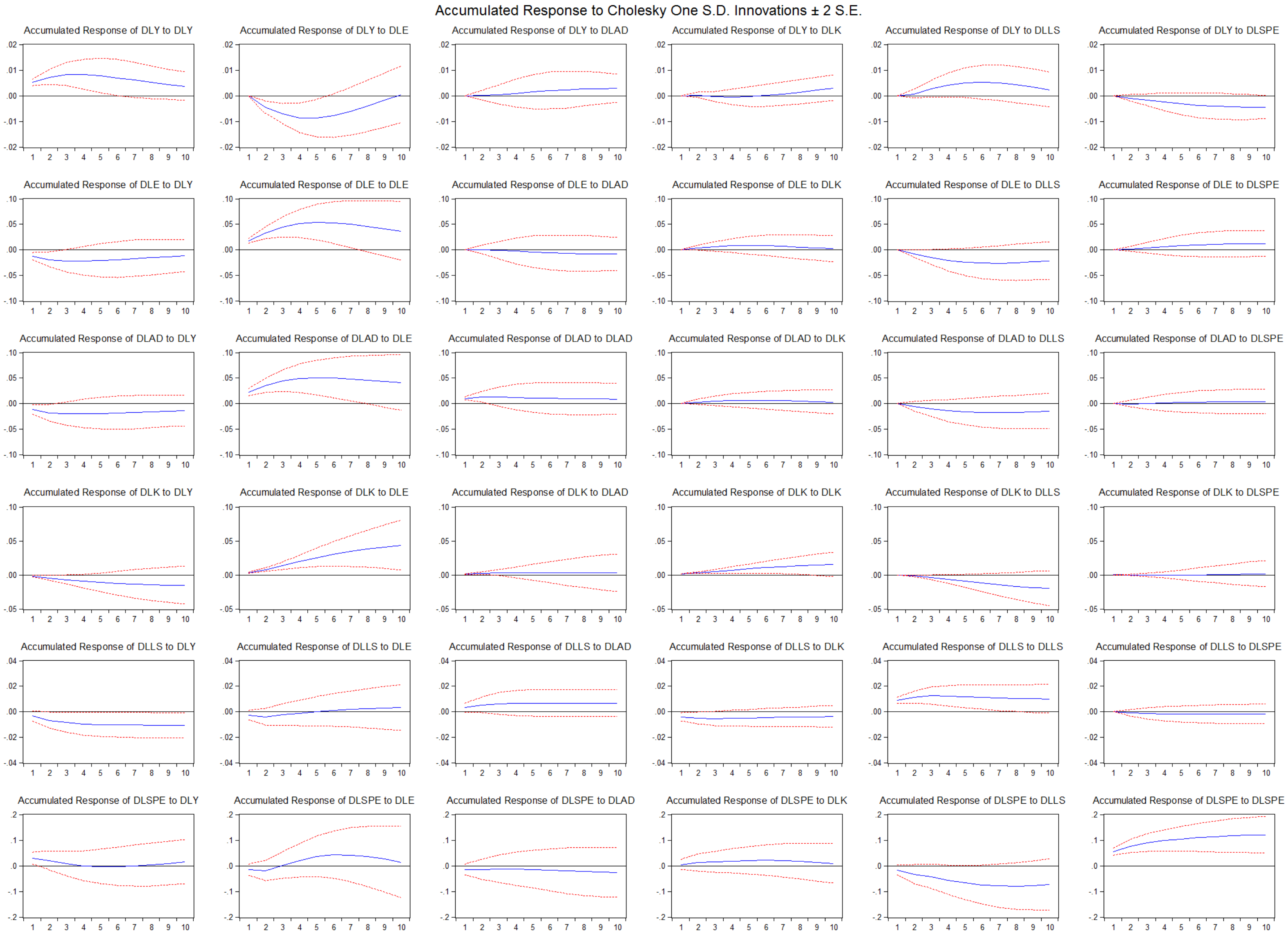


Figure A5 - Accumulated response (IRFs) to structural One S.D. shocks +- 2 S.E., Spain.

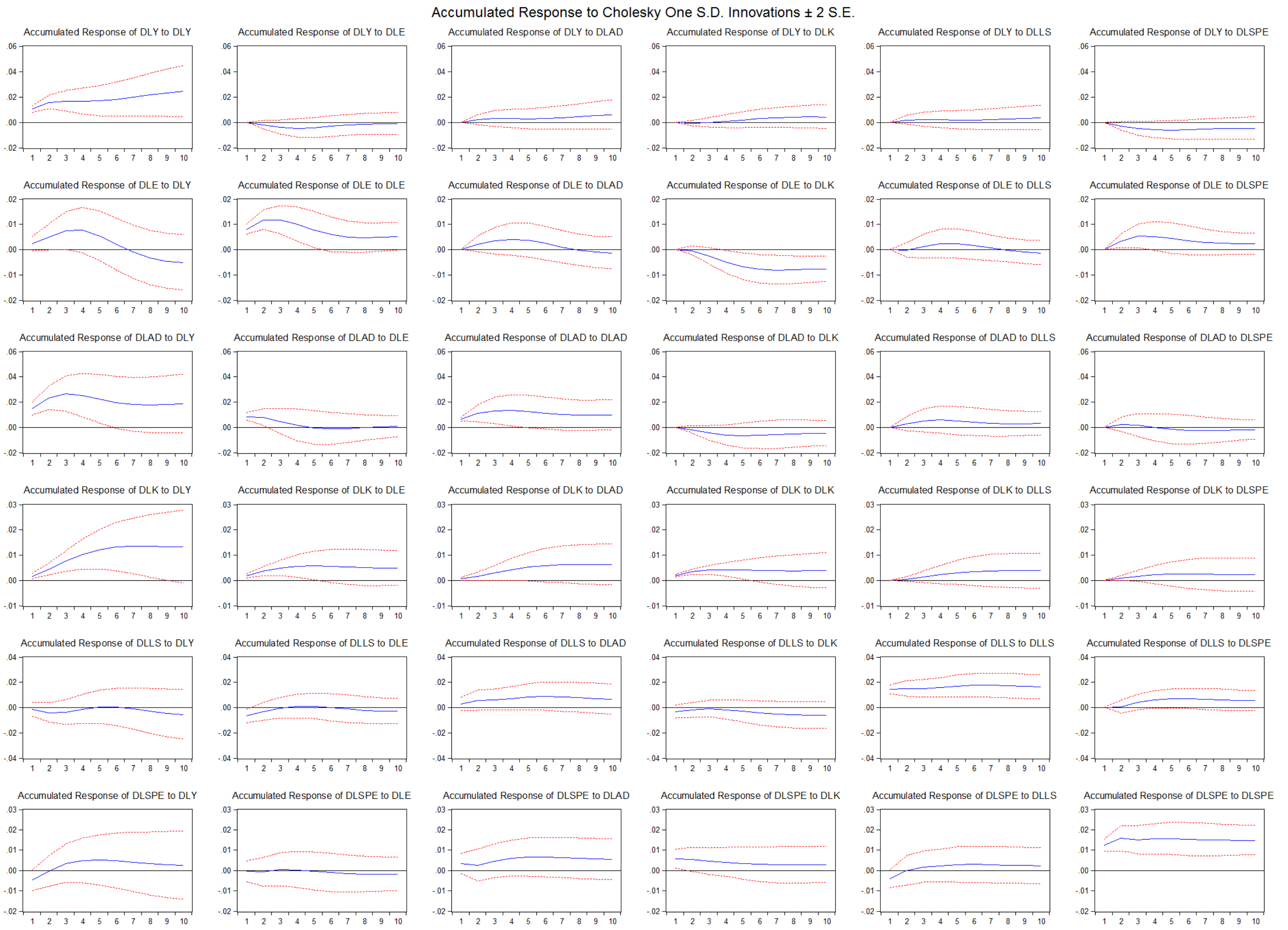


Figure A6 - Accumulated response (IRFs) to structural One S.D. shocks +- 2 S.E., UK.

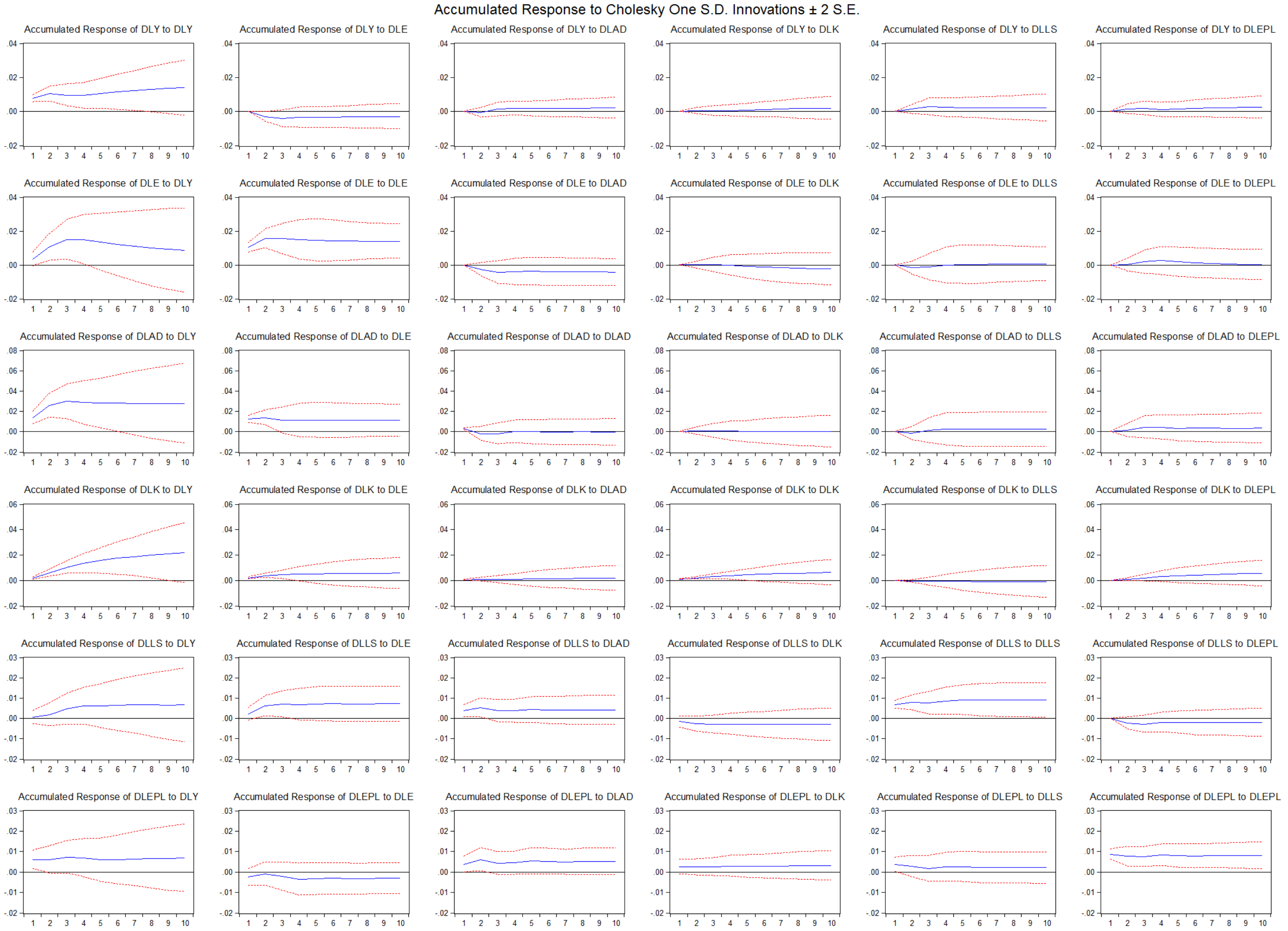


Figure A7 - Accumulated response (IRFs) to structural One S.D. shocks +- 2 S.E., US.

(ii) Lag-length tests

VAR Lag Order Selection Criteria

VAR system, maximum lag order 2

Endogenous variables: RVGDE NETD OUTT OIGT ALCD2 ITE
Exogenous variables: C @TREND
Sample: 1985 to 2018 Included observations: 33

lags	loglik	p(LR)	AIC	BIC	HQC
1	-520.229		33.072309	34.957813*	33.71532
2	-458.667	0	31.568634*	35.070284	32.762797*

Table A1 - Var lag selection tests for France.

Note: Symbol (*) indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level); AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

VAR system, maximum lag order 2

Endogenous variables: RVGDE NETD OUTT OIGT ALCD2 ITE
Exogenous variables: C @TREND
Sample: 1985 to 2018 Included observations: 33

lags	loglik	p(LR)	AIC	BIC	HQC
1	-616.574		39.913581	41.818227	40.554436
2	-543.406	0	37.660947*	41.198146*	38.851107*

Table A2 - Var lag selection tests for Germany.

Note: Symbol (*) indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level); AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

VAR system, maximum lag order 2

Endogenous variables: RVGDE NETD OUTT OIGT ALCD2 ITE
Exogenous variables: C @TREND
Sample: 1985 to 2018 Included observations: 33

lags	loglik	p(LR)	AIC	BIC	HQC
1	-577.551		36.44416	38.329664	37.087171
2	-509.378	0	34.551644*	38.053295*	35.745807*

Table A3 - Var lag selection tests for Italy.

Note: Symbol (*) indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level); AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

VAR system, maximum lag order 2

Endogenous variables: RVGDE NETD OUTT OIGT ALCD2 ITE
Exogenous variables: C @TREND
Sample: 1985 to 2018 Included observations: 33

lags	loglik	p(LR)	AIC	BIC	HQC
1	-470.073		34.1382	36.099877	34.765757
2	-379.341	0	30.489372*	34.132485*	31.654835

Table A4 - Var lag selection tests for Spain.

Note: Symbol (*) indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level); AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

VAR system, maximum lag order 2

Endogenous variables: RVGDE NETD OUTT OIGT ALCD2 ITE
Exogenous variables: C @TREND
Sample: 1985 to 2018 Included observations: 33

lags	loglik	p(LR)	AIC	BIC	HQC
1	567.9694		35.880556	37.76606	36.523567
2	498.22	0	33.895292*	37.396942*	35.089455*

Table A5 - Var lag selection tests for the United Kingdom.

Note: Symbol (*) indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level); AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

VAR system, maximum lag order 2

Endogenous variables: RVGDE NETD OUTT OIGT ALCD2 ITE
Exogenous variables: C @TREND
Sample: 1985 to 2018 Included observations: 33

lags	loglik	p(LR)	AIC	BIC	HQC
1	357.0926		29.562414	31.578160*	30.161801
2	-300.762	0	28.056469*	31.799998	29.169616*

Table A6 - Var lag selection tests for the United States.

Note: Symbol (*) indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level); AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

(iii) Autocorrelation test

Serial Correlation LM Tests
H0: no serial correlation at lag order h

Test for autocorrelation of order up to 3

	Rao F	Approx dist.	p-value
lag 1	2.228	F(36,77)	0.0017
lag 2	1.896	F(72,65)	0.0047
lag 3	1.556	F(108,35)	0.0679

Table A7 - Autocorrelation test for France.

Note: Sample: 1985 to 2018 Included observations: 33

Test for autocorrelation of order up to 3

	Rao F	Approx dist.	p-value
lag 1	3.714	F(36,73)	0
lag 2	3.29	F(72,60)	0
lag 3	2.851	F(108,30)	0.0008

Table A8 - Autocorrelation test for Germany.

Note: Sample: 1985 to 2018 Included observations: 33

Test for autocorrelation of order up to 3

	Rao F	Approx dist.	p-value
lag 1	2.182	F(36,77)	0.0022
lag 2	1.678	F(72,65)	0.00176
lag 3	1.4	F(108,35)	0.128

Table A9 - Autocorrelation test for Italy.

Note: Sample: 1985 to 2018 Included observations: 33

Test for autocorrelation of order up to 3

	Rao F	Approx dist.	p-value
lag 1	3.482	F(36,59)	0
lag 2	2.273	F(72,43)	0.0022
lag 3	2.81	F(108,12)	0.0244

Table A10 - Autocorrelation test for Spain.

Note: Sample: 1985 to 2018 Included observations: 33

Test for autocorrelation of order up to 3

	Rao F	Approx dist.	p-value
lag 1	2.783	F(36,77)	0.0001
lag 2	3.003	F(72,65)	0
lag 3	2.755	F(108,35)	0.0005

Table A11 - Autocorrelation test for the United Kingdom.

Note: Sample: 1985 to 2018 Included observations: 33

Test for autocorrelation of order up to 3

	Rao F	Approx dist.	p-value
lag 1	1.84	F(36,46)	0.0257
lag 2	1.296	F(72,27)	0.2284
lag 3	-8.2E+07	F(108,-5)	nan

Table A12 - Autocorrelation test for the United States.

Note: Sample: 1985 to 2018 Included observations: 33

(iv) Normality test

Residual correlation matrix, C (6 x 6)

1.000	0.887	0.622	0.723	-0.667	-0.310
0.887	1.000	0.860	0.854	-0.701	-0.404
0.622	0.860	1.000	0.815	-0.455	-0.458
0.723	0.854	0.815	1.000	-0.586	-0.311
-0.667	-0.701	-0.455	-0.586	1.000	0.328
-0.310	-0.404	-0.458	-0.311	0.328	1.000

Eigenvalues of C

0.028
0.159
0.288
0.599
0.822
4.104

Doornik-Hansen test
Chi-square(12) = 11.0525 [0.5244]

Table A13 - Autocorrelation test for France.

Residual correlation matrix, C (6 x 6)

1.000	0.870	0.476	0.686	-0.741	0.195
0.870	1.000	0.694	0.687	-0.646	0.212
0.476	0.694	1.000	0.532	-0.466	0.270
0.686	0.687	0.532	1.000	-0.173	0.127
-0.741	-0.646	-0.466	-0.173	1.000	-0.134
0.195	0.212	0.270	0.127	-0.134	1.000

Eigenvalues of C

0.032
0.136
0.532
0.839
0.958
3.502

Doornik-Hansen test
Chi-square(12) = 21.1229 [0.0486]

Table A14 - Autocorrelation test for Germany.

Residual correlation matrix, C (6 x 6)

1.000	0.748	0.055	0.422	-0.533	-0.216
0.748	1.000	0.613	0.743	-0.316	-0.235
0.055	0.613	1.000	0.553	-0.039	-0.215
0.422	0.743	0.553	1.000	-0.070	0.159
-0.533	-0.316	-0.039	-0.070	1.000	0.131
-0.216	-0.235	-0.215	0.159	0.131	1.000

Eigenvalues of C
0.045
0.183
0.577
1.061
1.336
2.799

Doornik-Hansen test
Chi-square(12) = 3.22199 [0.9938]

Table A15 - Autocorrelation test for Italy.

Residual correlation matrix, C (6 x 6)

1.000	-0.347	-0.445	-0.196	-0.278	0.332
-0.347	1.000	0.936	0.747	-0.004	-0.506
-0.445	0.936	1.000	0.764	-0.082	-0.530
-0.196	0.747	0.764	1.000	-0.062	-0.211
-0.278	-0.004	-0.082	-0.062	1.000	-0.111
0.332	-0.506	-0.530	-0.211	-0.111	1.000

Eigenvalues of C
0.046
0.204
0.617
0.743
1.267
3.123

Doornik-Hansen test
Chi-square(12) = 9.44315 [0.6647]

Table A16 - Autocorrelation test for Spain.

Residual correlation matrix, C (6 x 6)

1.000	0.771	0.142	0.597	-0.115	-0.320
0.771	1.000	0.653	0.767	-0.205	-0.211
0.142	0.653	1.000	0.635	-0.242	-0.021
0.597	0.767	0.635	1.000	-0.352	0.066
-0.115	-0.205	-0.242	-0.352	1.000	-0.325
-0.320	-0.211	-0.021	0.066	-0.325	1.000

Eigenvalues of C
0.051
0.200
0.560
0.790
1.456
2.944

Doornik-Hansen test
Chi-square(12) = 16.4284 [0.1724]

Table A17 - Autocorrelation test for the United Kingdom.

Residual correlation matrix, C (6 x 6)

1.000	0.640	0.132	0.579	0.107	0.607
0.640	1.000	0.775	0.948	0.118	0.140
0.132	0.775	1.000	0.734	-0.053	-0.175
0.579	0.948	0.734	1.000	-0.045	0.118
0.107	0.118	-0.053	-0.045	1.000	0.243
0.607	0.140	-0.175	0.118	0.243	1.000

Eigenvalues of C
0.015
0.117
0.337
0.914
1.594
3.023

Doornik-Hansen test
Chi-square(12) = 10.6386 [0.5601]

Table A18 - Autocorrelation test for the United States.

(iv) Autoregressive conditional heteroskedasticity (ARCH)

Test for ARCH of order up to 1				
Country	lag	LM	df	p-value
France	1	439.329	441	0.5135
Germany	1	463.781	441	0.2187
Italy	1	460.193	441	0.2548
Spain	1	461.871	441	0.2375
United Kingdom	1	490.355	441	0.052
United States	1	444.342	441	0.4464

Table A19 - Autoregressive conditional heteroskedasticity (ARCH) tests.

Appendix C: data appendix

(i) Data sources and definition of variables

The countries in the sample are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom and the United States. In the second part of the paper (VAR analysis), we restrict our sample to the 6 largest economies (4 of the Euro area), namely France, Germany, Italy and Spain, the United Kingdom and the United States.

- *Incidence of temporary employment (ITE)* for young workers on total employment (Dataset: LFS - Employment by Permanency TEMP_I). It refers to standardized age group 15-24 of the OECD statistics and captures changes in labor market regulation. Hence, ITE provides a measure of the impact of changes in labor market regulation on TFP. Following Calcagnini et al. (2018) and Bellocchi et al. (2020), we assume that the higher the labor flexibility, the higher is the share of temporary workers employed in production by firms.
- The *Employment Protection Legislation (EPL)* index for 1983-2013 is provided by the OECD and is part of the OECD Employment Database. It evaluates the regulation on the dismissal of workers on regular contracts and the hiring of workers on temporary contracts. It covers both individual and collective dismissals. We employ a weighted average of the strictness of

employment protection for individual and collective dismissals (regular contracts), i.e. the version 1 (EPRC_V1) of this indicator which incorporates 8 data items concerning regulations for individual dismissals and the strictness of employment protection on temporary employment, i.e. version 1 (EPT_V1) of the indicator for temporary employment measures the strictness of regulation on the use of fixed-term and temporary work agency contracts which incorporates 6 data items. We have created either an "absolute" version of this indicator by taking an average weighted by the weight of temporary contracts in the economy and a "relative" one, where the absolute indicator is compared to the average of the rest of the world.

- *Real GDP* is the Gross domestic product at constant market prices (OVGD);
- *Labor productivity* is the Gross domestic product at constant market prices per person employed (RVGDE);
- *Real wage* is the average annual growth of real compensation of employees; total economy (UWCD);
- Data on *Fixed capital stock* for most European countries and the United States is the Gross fixed capital formation at constant prices; total economy (OIGT);
- Data on the *Standardized unemployment rates* are the unemployment rates, total (percentage of civilian labor force); Member States: definition Eurostat (ZUTN);
- The *Employment level* is from the national account and more exactly the employed persons - all domestic industries (National accounts) (NETD).

All these variables and their relative codes refer to the AMECO database. EPL and the ITE are from the OECD Employment Database.

References

Abdih, Y., and Danninger, S. (2017). What Explains the Decline of the US Labor Share of Income? An Analysis of State and Industry Level Data. *International Monetary Fund*.

Afonso, A., Schuknecht, L., and Tanzi, V. (2010). Income distribution determinants and public spending efficiency. *The Journal of Economic Inequality 8.3*, 367-389.

Aghion, P., et al. (2009). The effects of entry on incumbent innovation and productivity. *The Review of Economics and Statistics 91.1*, 20-32.

Alesina, A., Ardagna, S., Perotti, R., and Schiantarelli, F. (2002). Fiscal policy, profits and investment. *American Economic Review 92(3)*, 571-589.

Alexiadis, S., and Dimitrios T. (2010). Is cumulative growth in manufacturing productivity slowing down in the EU12 regions?. *Cambridge Journal of Economics* 34.6 (2010): 1001-1017.

Allgoewer, E. (2002). Underconsumption theories and Keynesian economics: Interpretations of the Great Depression. *Forschungsgemeinschaft für Nationalökonomie an der Universität St. Gallen.*

Amable, B., Guillaud, E., and Palombarini, S. (2011). The political economy of neo-liberalism in Italy and France. *https://halshs.archives-ouvertes.fr/halshs-00639450*.

Angeriz, A., McCombie, J., and Roberts, M. (2008). Returns to Scale for EU Regional Manufacturing. *Centre for Globalization Research Working Paper 20*.

Anguo, L., Ge, G., and Kaizhong, Y. (2011). Returns to scale in the production of selected manufacturing sectors in China. *Energy Procedia 5*, 604-612.

Appel, H., and Orenstein, M. A. (2016). Why did Neoliberalism triumph and endure in the post-communist world? *Comparative Politics 48.3*, 313-331.

Arndt, H. W. (1983). The" trickle-down" myth. *Economic Development and Cultural Change 32.1*, 1-10.

Arrow, K. J. (1962). The Economic Implications of Learning by Doing. *The Review of Economic Studies Vol. 29, No. 3*, 155-173.

Atkeson, A., and Ohanian, L. E. (2001). Are Phillips curves useful for forecasting inflation? *Federal Reserve bank of Minneapolis quarterly review 25.1*, 2-11.

Atkinson, A. B. (2009). Factor shares: the principal problem of political economy? *Oxford Review of economic policy*, 3-16.

Auer, P. (2007). In search of optimal labour market institutions. *Economic and Labour Market Paper 2007/3.* .

Autor, D. H., Kerr, W. R., and Kugler, A. D. (2007). Does employment protection reduce productivity? Evidence from US states. *Economic Journal 117(521)*, 189-217.

Autor, D., and al., e. (2020). The fall of the labor share and the rise of superstar firms. *The Quarterly Journal of Economics 135.2*, 645-709.

Barbosa-Filho, N. H., and Taylor, L. (2006). Distributive and demand cycles in the US economy - a structuralist Goodwin model. *Metroeconomica 57.3*, 389-411.

Barradas, R. (2019). Financialization and neoliberalism and the fall in the labor share: a panel data econometric analysis for the European Union countries. *Review of Radical Political Economics* 51.3: 383-417.

Bartelsman, E. J. (2000). *Productivity and specificity in factor inputs. Productivity, Technology and Economic Growth*. Springer, Boston MA , 227-250.

Bassanini, A., and Duval, R. (2009). Unemployment, institutions, and reform complementarities: re-assessing the aggregate evidence for OECD countries. *Oxford Review of Economic Policy 25.1*, 40-59.

Bassanini, A., Nunziata, L., and Venn, D. (2009). Job protection legislation and productivity growth in OECD countries. *Economic policy 24.58*: 349-402.

Bassanini, A., and Manfredi, T. (2014). Capital's grabbing hand? A cross-industry analysis of The decline of the labor share in OECD countries. *Eurasian Business Review 4.1*, 3-30.

Battisti, M., Del Gatto, M., and Parmeter, C. F. (2018). Labor productivity growth: disentangling technology and capital accumulation. *Journal of Economic Growth 23.1*, 111-143.

Bebenroth, R., Dietrich, D., and Vollmer, U. (2009). Bank regulation and supervision in bank-dominated financial systems: A comparison between Japan and Germany. *European Journal of Law and Economics 27.2*, 177-209.

Bellocchi, A., et al. (2020). Market power, capital-output ratios, and technological change: the firm-level determinants of the labor share.

Bentolila, S., and Saint-Paul, G. (2003). Explaining movements in the labor share. *Contributions in Macroeconomics 3.1*.

Bertola, G., Foellmi, R., and Zweimüller, J. (2006). *Income Distribution in Macroeconomic Models.* Princeton: Princeton University Press.

Bhaduri, A. (2008). Endogenous economic growth: A new approach. *Cambridge Journal of Economics 30(1)*, 69-83.

Bhaduri, A., and Marglin, S. (1990). Unemployment and the real wage: the economic basis for contesting political ideologies. *Cambridge Journal of Economics 14*, 375-393.

Bhaskar, V., and Glyn, A. (1995). Investment and profitability: The evidence from the advanced capitalist countries. In G. Epstein, and H. E. Gintis, *Macroeconomic policy after the conservative era: Studies in investment, saving and finance* (p. 175-196). Cambridge University Press.

Blanchard, O., and Landier, A. (2002). The perverse effects of partial labour market reform: fixed-term contracts in France. *The Economic Journal 112.480*, F214-F244.

Blanchard, O., and Giavazzi, F. (2003). Macroeconomic effects of regulation and deregulation in goods and labor markets. *The Quarterly journal of economics 118.3*, 879-907.

Blecker, R. (1989). International Competition, Income Distribution and Economic Growth. *Cambridge Journal of Economics, vol. 13, issue 3*, 395-412.

Blecker, R. (2002). Distribution, Demand, and Growth in Neo-Kaleckian Macro Models, in Setterfield, M., ed., The Economics of Demand-Led Growth: Challenging the Supply-Side Vision of the Long Run, Edward Elgar.Blecker, R. A. (2016). Wage-led versus profit-led demand regimes: the long and the short of it. *Review of Keynesian Economics 4.4*: 373-390.

Boeri, T. (2005). Reforming Labor and Product Markets: Some lessons from two decades of experiments in Europe. *No. 5-97. International Monetary Fund.*

Boeri, T., and Garibaldi, P. (2007). Two tier reforms of employment protection: A honeymoon effect? *The economic journal 117.521*, 357-385.

Bond, S., Elston, J. A., Mairesse, J., and Mulkay, B. (2003). Financial factors and investment in Belgium, France, Germany, and the United Kingdom: A comparison using company panel data. *Review of Economics and Statistics 85(1)*, 153-165.

Boucekkine, R., Del Rio, F., and Licandro, O. (2003). Embodied Technological Change, Learning-by-doing and the Productivity Slowdown. *Scandinavian Journal of Economics 105.1*, 87-98.

Bowles, S., and Boyer, R. (1988). Labor discipline and aggregate demand: a macroeconomic model. *The American Economic Review 78.2*, 395-400.

Bowles, S., and Boyer, R. (1995). Wages, aggregate demand, and employment in an open economy: An empirical investigation. In G. Epstein, and H. E. Gintis, *Macroeconomic policy after the conservative era: Studies in investment, saving and finance* (p. 143-171). Cambridge: Cambridge University Press.

Braverman, H. (1974). Labor and monopoly capitalism: The degradation of work in the twentieth century. *New York: Monthly Review Press.*

Brida, J. G., Adrián Risso, W., and Sanchez Carrera, E. J. (2010). Real wages as determinant of labour productivity in the Mexican tourism sector. *European Journal of Tourism Research 3.1*, 67.

Buchele, R., and Christiansen, J. (1999). Labor relations and productivity growth in advanced capitalist economies. *Review of Radical Political Economics 31(1)*, 87-110.

Cahuc, P., and Postel-Vinay, F. (2002). Temporary jobs, employment protection and labor market performance. *Labour economics 9.1*, 63-91.

Calcagnini, G., Giombini, G., and Travaglini, G. (2018). A Schumpeterian model of investment and innovation with labor market regulation. *Economics of Innovation and New Technology 27.7*, 628-651.

Carlin, W., Glyn, A., and Van Reenen, J. (2001). Export market performance of OECD countries: An empirical examination of the role of cost competitiveness. *Economic Journal 111(468)*, 128-162.

Carroll, C., et al. (2017). The distribution of wealth and the marginal propensity to consume. *Quantitative Economics 8.3*: 977-1020.

Carruth, A., Dickerson, A., and Henley, A. (2000). Econometric modelling of UK aggregate investment: The role of profits and uncertainty. *The Manchester School 20*, 276-300.

Carter, S. (2007). Real wage productivity elasticity across advanced economies, 1963-1996. *Journal of Post Keynesian Economics 29.4*, 573-600.

Castiglione, C. (2011). Verdoorn-Kaldor's Law: An empirical analysis with time series data in the United States. *Advances in Management and Applied Economics 1.3*.

Chakraborty, S., and Ray, T. (2006). Bank-based versus market-based financial systems: A growth-theoretic analysis. *Journal of Monetary Economics 53.2*, 329-350.

Chen, X. (2011). Increasing returns to scale in US manufacturing industries: evidence from direct and reverse regression. *Bureau d'Economie Théorique et Appliquée, UDS, Strasbourg. No. 2011-11.*

Cheng, W., and Haiyang, X. (2004). The efficiency wage hypothesis: a mesoeconomic analysis. *Journal of Economic Behavior & Organization 55.2*: 257-269.

Cohen, J. N., and Angel Centeno, M. (2006). Neoliberalism and patterns of economic performance 1980-2000. *The Annals of the American Academy of Political and Social Science 606.1*, 32-67.

Cornwall, J., and Cornwall, W. (2001). *Capitalist development in the twentieth century: An evolutionary-Keynesian analysis.* Cambridge University Press.

Damiani, M., Pompei, F., and Ricci, A. (2016). Temporary employment protection and productivity growth in EU economies. *International Labour Review 155.4*, 587-622.

Das, D. K. (2018). *Productivity Dynamics in Emerging and Industrialized Countries.* Routledge.

Davanzati,G.F. (2019). High wages and economic growth in a Kaldorian theoretical framework. *Economic Crisis and Economic Thought: Alternative Theoretical Perspectives on the Economic Crisis*: 166.

De Angelis, M. (2000). *Keynesianism, social conflict and political economy.* Springer.

De Souza, J. P. (2017). Real wages and labor-saving technical change: evidence from a panel of manufacturing industries in mature and labor-surplus economies. *International Review of Applied Economics 31.2*, 151-172.

De Spiegelaere, S., Van Gyes, G., and Van Hootegem, G. (2014). Labour flexibility and innovation, complementary or concurrent strategies? A review of the literature. *Economic and Industrial Democracy 35.4*, 653-666.

Deleidi, M., Meloni, W. P., and Stirati, A. (2018). . Structural change, labour productivity and the Kaldor-Verdoorn law: evidence from European countries. *WP No. 0239. Department of Economics-University Roma Tre*.

Dew-Becker, I., and Gordon, R.J. (2012). The role of labor-market changes in the slowdown of European productivity growth. *Review of Economics and institutions 3.2*, 45.

Disoska, E.M., and Katerina T. (2016). Debt or wage-led growth: the European integration. *Journal of economic integration:* 326-352.

Diwan, I. (2001). *Debt as sweat: Labor, financial crises, and the globalization of capital*. Washington: Mimeo, The World Bank.

Dorn, D., and al., e. (2017). Concentrating on the Fall of the Labor Share. *American Economic Review 107.5*, 180-85.

Dosi, G., Sodini, M., and Virgillito, M. E. (2015). Profit-driven and demand-driven investment growth and fluctuations in different accumulation regimes. *Journal of Evolutionary Economics 25.4*, 707-728.

Dray, M., and Thirlwall, A. (2011). The endogeneity of the natural rate of growth for a selection of Asian countries. *Journal of Post Keynesian Economics, vol. 33, issue 3*, 451-468.

Driver, C., Temple, P., and Urga, G. (2005). Profitability, capacity, and uncertainty: A model of UK manufacturing investment. *Oxford Economic Papers 57(1)*, 120-141.

Duménil, G., and Lévy, D. (2010). The classical- Marxian evolutionary model of technical change: Application to historical tendencies. In M. Setterfield, *Handbook of alternative theories of economic growth* (p. 243-273). Cheltenham: Edward Elgar.

Dunhaupt, P. (2013). Determinants of functional income distribution: theory and empirical evidence. No. 18. *Global Labour University Working Paper*.

Dutt, A. (1984). Stagnation, Income Distribution and Monopoly Power. *Cambridge Journal of Economics, vol. 8, issue 1*, 25-40.

Dutt, A. (1987). Alternative Closures Again: A Comment on Growth, Distribution and Inflation. *Cambridge Journal of Economics, vol. 11, issue 1*, 75-82.

Dutt, K., Sébastien Charles, A., and Lang, D. (2015). Employment flexibility, dual labour markets, growth, and distribution. *Metroeconomica 66.4*, 771-807.

Elsby, M. W., Hobijn, B., and Şahin, A. (2013). The decline of the US labor share. *Brookings Papers on Economic Activity 2013.2*, 1-63.

Enders, W. (2015). *Applied econometric time series.* John Wiley and Sons.

European Commission. (2007). The Labour Income Share in the European Union. *Employment in Europe*.

European Commission. (2010). Understanding LabourIncome Share Dynamics in Europe. *Economic Papers 379*.

European Commission . (2015). Labour market and wage developments in Europe. *Directorate-General of Employment, Social Affairs and Inclusion*.

Fajgelbaumy, P., Grossman, G. M., and Helpman, E. (2011). *Income distribution, product quality, and international trade*. The World Bank.

Fazio, G., Maltese, E., and Piacentino, D. (2013). Estimating Verdoorn law for Italian firms and regions. *Letters in Spatial and Resource Sciences 6.1*, 45-54.

Fisher, J., et al. (2020). Estimating the marginal propensity to consume using the distributions of income, consumption, and wealth. *Journal of Macroeconomics*: 103-218.

Foley, D. K. (2019). *Growth and distribution.* Harvard University Press.

Francese, M. (2015). Functional income distribution and its role in explaining inequality. *IMF Working Paper No. 15/244*.

Funk, P. (2002). Induced innovation revisted. *Economica 69 (273)*, 155171.

Galbraith, J. K. (2012). *Inequality and Instability. A Study of the World Economy Just Before the Great Crisis.* Oxford University Press.

Gallardo, G., Piton, G., and Piton, S. (2019). Revisiting the global decline of the (non-housing) labor share. *Bank of Englan (BOE) working paper*.

Giacalone, R. A., and Jurkiewicz, C. L. (2003). *Handbook of workplace spirituality and organizational performance*. Me Sharpe.

Glyn, A. (1997). Does aggregate profitability really matter?. *Cambridge journal of economics* 21.5 (1997): 593-619.Glyn, A. (2006). *Capitalism unleashed: Finance, globalization and welfare.* Oxford University Press.

Goldstein, J. P. (2009). A Keynes-Marx theory of investment. *Heterodox macroeconomics: Keynes, Marx and globalization*, 112-126.

Gomme, P., and Greenwood, J. (1995). On the cyclical allocation of risk. *Journal of Economic dynamics and control 19.1-2*, 91-124.

Gordon, D. (1995). Putting the horse (back) before the cart: disentangling the macro relationship between investment and saving. *Marcoeconomic Policy After the Conservative Era*: 57-108.

Gordon, D. M. (1996). *Fat and mean: The corporate squeeze of working Americans.* New York: Free Press.

Growiec, J. (2012). Determinants of the labor share: evidence from a panel of firms. *Eastern European Economics 50.5*, 23-65.

Guarini, G. (2016). Macroeconomic and technological dynamics: A structuralist-Keynesian cumulative growth model. *PSL Quarterly Review 69.276*.

Guerriero, M. (2019). *The labor share of income around the world: Evidence from a panel dataset. Labor Income Share in Asia*. Springer, Singapore, 39-79.

Guerriero, M., and Sen, K. (2012). What determines the share of labour in national income? A cross-country analysis.

Harrison, A. (2005). Has Globalization Eroded Labor Share? Some Cross-Country Evidence. *Munich Personal RePEc Archive*.

Hartwig, J. (2013). Distribution and growth in demand and productivity in Switzerland (1950–2010). *Applied Economics Letters 20.10*, 938-944.

Hassel, A., and Ebbinghaus, B. (2000). From means to ends: Linking wage moderation and social policy reform. *Social Pacts in Europe: New Dynamics. Brussels: ETUI*, 61-84.

Haucap, J., and Wey, C. (2004). Unionisation structures and innovation incentives. *The Economic Journal 114.494*, C149-C165.

Hayashi, F. (2000). *Econometrics.* Princeton University Press.

Hein, E., and Mundt, M. (2013). *Financialization, the financial and economic crisis, and the requirements and potentials for wage-led recovery.* Palgrave Macmillan.

Hein, E., and Tarassow, A. (2010). Distribution, aggregate demand and productivity growth: theory and empirical results for six OECD countries based on a post-Kaleckian model. *Cambridge Journal of Economics 34.4*, 727-754.

Hein, E., and Vogel, L. (2008). Distribution and growth reconsidered: empirical results for six OECD countries. *Cambridge journal of Economics 32.3*, 479-511.

Hein, E. (2015). Finance-dominated capitalism and re-distribution of income: a Kaleckian perspective. *Cambridge journal of economics 39.3*: 907-934.

Henrekson, M. (2020). How labor market institutions affect job creation and productivity growth. *IZA World of Labor*.

Hermann, C. (2007). Neoliberalism in the European Union. *Studies in Political Economy 79.1*, 61-90.

Hicks, J. R. (1932). *The Theory of Wages.* Macmillan. and Co.

Hirsch, Barry T. (2012). Unions, Dynamism and Economic Performance. In *Research Handbook on the Economics of Labor and Employment Law*, edited by Michael Wachter and Cynthia Estlund. Northhampton, Mass.: Edward Elgar Series of Research Handbooks in Law and Economics.

Holt, R. P., and Greenwood, D. T. (2012). Negative trickle-down and the financial crisis of 2008. *Journal of Economic Issues 46.2*, 363-370.

ILO. (2014). How tight is the link between wages and productivity? A survey of the literature. *CONDITIONS OF WORK AND EMPLOYMENT SERIES No. 54*.

ILO. (2019). The Global Labor Income Share and Distribution. *Data Production and Analysis Unit, ILO Department of Statistics*.

IMF. (2017). Why is Labor Receiving a Smaller Share of Global Income? Theory and Empirical Evidence. *IMF Working Paper*.

IMF. (2019). Technological Changes, Offshoring, and the Labor Share. *Working Paper No. 19/142*.

IMF. (2019). The Structural Determinants of the Labor Share in Europe. *IMF Working Paper*.

Jacobson, M., and Occhino, F. (2012). Labor declining share of income and rising inequality. *Economic Commentary*.

Janssen, R. (2011). European economic governance: The next big holdup on wages. *Global Labour Column - Number 45*.

Jaumotte, M. F., and Tytell, I. (2007). How has the globalization of labor affected the labor income share in advanced countries? *International Monetary Fund, No. 7-298*.

Johnston, A., and Hancké, B. (2009). Wage inflation and labour unions in EMU. *Journal of European Public Policy 16.4*, 601-622.

Kaldor, N. (1957). A model of economic growth. *Economic Journal 67(268)*, 591-624.

Kaldor, N. (1961). *Capital accumulation and economic growth. The theory of capital.* Palgrave Macmillan, London, 177-222.

Kaldor, N. (1966). *Causes of the slow growth in the United Kingdom.* Cambridge University Press.

Kaldor, N., and Mirrlees, J. A. (1962). A new model of economic growth. *The Review of Economic Studies 29.3*, 174-192.

Karabarbounis, L., and Neiman, B. (2014). The global decline of the labor share. *The Quarterly journal of economics 129.1*: 61-103.

Karabarbounis, L., Neiman, B., and Adams, J. (2014). Labor shares and income inequality. *Meeting Papers. No. 539. Society for Economic Dynamics*.

Keller, B., and Seifert, H. (2004). Flexicurity–the German trajectory. *Transfer: European Review of Labour and Research 10.2*, 226-247.

Keynes, J. M. (1939). Relative movements of real wages and output. *The Economic Journal 49.193*, 34-51.

King, J. E. (2013). An Alternative Macroeconomic Theory: The Kaleckian Model and Post-Keynesian Economics. *Vol. 49. Springer Science & Business Media*.

Kleinknecht, A., Van Schaik, F. N., and Zhou, H. (2014). Is flexible labour good for innovation? Evidence from firm-level data. *Cambridge journal of economics 38.5*, 1207-1219.

Kohler, K., and Stockhammer, E. (2019). *Financialization and demand regimes in advanced economies*. Abingdon: Routledge.

Kristal, T. (2010). Good times, bad times: Postwar labor's share of national income in capitalist democracies. *American Sociological Review 75.5*: 729-763.

Krugman, P. (2009). *The conscience of a liberal.* WW Norton and Company.

Kurz, H. D. (1991). *Technical change, growth and distribution: A steady-state approach to "unsteady" growth on Kaldorian lines. Nicholas Kaldor and Mainstream Economics*. Palgrave Macmillan, London. 421-448.

Łaski, K., and Walther, H. (2015). *Kalecki's profits equation after 80 years. In Michał Kalecki in the 21st Century* (p. 131-156). London: Palgrave Macmillan.

Lavoie, M., and Stockhammer, E. *Wage-led growth: Concept, theories and policies.* Palgrave Macmillan, London. 13-39.

Lavoie, M., Rodriguez, G., and Seccareccia, M. (2004). Similitudes and discrepancies in post-Keynesian and Marxist theories of investment: a theoretical and empirical investigation. *International Review of Applied Economics 18.2*, 127-149.

Lawless, M., and Whelan, K. T. (2011). Understanding the dynamics of labor shares and inflation. *Journal of Macroeconomics 33.2*, 121-136.

Lawrence, M., Bivens, J., and Gould, E. (2012). *The state of working America.* Cornell University Press.

Leòn-Ledesma, M. A., and Thirlwall, A. (2002). The endogeneity of the natural rate of growth. *Cambridge Journal of Economics, vol. 26, issue 4*, 441-459.

Leschke, J., Schmid, G., and Griga, D. (2006). On the Marriage of Flexibility and Security: Lessons from the Hartz-reforms in Germany. *No. SP I 2006-108. WZB discussion paper*.

Lindbeck, A., and Snower, D. J. (2001). Insiders versus outsiders. *Journal of Economic Perspectives 15.1*. 165-188.

Lisi, D. (2013). The impact of temporary employment and employment protection on labour productivity: evidence from an industry-level panel of EU countries. *Journal for Labour Market Research 46.2*: 119-144.

Lorenz, E. H. (1992). Trust and the flexible firm: International comparisons. *Industrial Relations 31(3)*, 455-472.

Lundberg, E. (1985). The rise and fall of the Swedish model. *Journal of Economic Literature 23.1*, 1-36.

Lütkepohl, H. (2005). New introduction to multiple time series analysis. *Springer Science & Business Media*.

Magacho, G. R. (2016). Estimating Kaldor-Verdoorn's law across countries in different stages of development. *Proceedings of the 42ndd Brazilian Economics Meeting - Anais do XLII Encontro Nacional de Economia No. 140*.

Malcomson, J. M. (1997). Contracts, hold- up and labour markets. *Journal of Economic Literature 35*, 1917-1957.

Marelli, E., Signorelli, M., and Tyrowicz, J. (2012). Crises and Joint Employment–Productivity Dynamics: A Comparative Perspective for European Countries. *Comparative Economic Studies 54.2*, 361-394.

Marglin, S. A., and Schor, J. B. (1990). *The golden age of capitalism: Reinterpreting the postwar experience.* Oxford University Press.

Marquetti, A. (2004). Do rising real wages increase the rate of labor-saving technical change? Some econometric evidence. *Metroeconomica 55(4*, 432-441.

McCombie, J. S. (2002). Increasing returns and the Verdoorn law from a Kaldorian. In J. S. McCombie, M. Pugno, and B. Soro, *Productivity growth and economic per for mance: Essays on Verdoorn's law.* London: Macmillan.

McCombie, J. S., Pugno, M., and Soro, B. (2002). *Productivity growth and economic per for mance: Essays on Verdoorn's law.* London: Macmillan.

McCombie, J. S., and Spreafico, M. R. (2015). Kaldor's 'technical progress function'and Verdoorn's law revisited. *Cambridge Journal of Economics 40.4*, 1117-1136.

McKinsey Global Institute. (2019). A new look at the declining labor share of income in the United States. *Discussion paper May 2019*.

McLaughlin, C. (2009). The productivity-enhancing impacts of the minimum wage: Lessons from Denmark and New Zealand. *British Journal of Industrial Relations 47.2*, 327-348.

Mergulhão, A., and Pereira, J. A. (2019). Productivity-Wage Nexus: distributional approach on firms in Portugal. *Working paper 3/2019, GPEARI/Ministry of Finance*.

Milanovic, B. (2016). Increasing capital income share and its effect on personal income inequality. *No. 663. LIS Working Paper Series*.

Milberg, W., and Houston, E. (2005). The high road and the low road to international competitiveness: Extending the neo-Schumpeterian trade model beyond technology. *International Review of Applied Economics 19.2*, 137-162.

Millemaci, E., and Ofria, F. (2014). Kaldor-Verdoorn's law and increasing returns to scale. *Journal of Economic Studies*.

Naastepad, C. W. (2006). Technology, demand and distribution: A cumulative growth model with an application to the Dutch productivity growth slowdown. *Cambridge Journal of Economics 30(3)*, 403-434.

Naastepad, CW. M., and Storm, S. (2012). *Macroeconomics beyond the NAIRU*. Harvard University Press.

Navarro, V. (1998). Neoliberalism,"globalization," unemployment, inequalities, and the welfare state. *International journal of health services 28.4*, 607-682.

Nickell, S., and Layard, R. (1999). Labor market institutions and economic performance. *Handbook of labor economics* 3: 3029-3084.

Nicoletti, G., Scarpetta, S., and Boyland, O. (2000). Summary indicators of product market regulation with an extension to employment protection legislation. *Economics Department Working Paper No. 226*.

Nikiforos, M., and Foley, D. K. (2012). Distribution and capacity utilization: conceptual issues and empirical evidence. *Metroeconomica 63.1*, 200-229.

Nunziata, L. (2005). Institutions and wage determination: A multi-country approach. *Oxford Bulletin of Economics and Statistics 67.4*, 435-466.

O'Mahony, M., Vecchi, M., and Venturini, F. (2019). Technology, Market Regulations, and Labor Share Dynamics. In *Labor Income Share in Asia* (p. 81-101). Singapore: Springer.

OECD. (1999). Employment protection and labour market per for mance. *OECD employment outlook*, *Chapter 2*.

OECD. (2007). More jobs but less productive? The impact of labour market policies on productivity. *OECD employment outlook 2007*, *Chapter 2*.

OECD. (2012). The Labour Share in G20 Economies. *OECD Employment Outlook 2012*.

Onaran, O., and Obst T. (2016). Wage-led growth in the EU15 member-states: the effects of income distribution on growth, investment, trade balance and inflation. *Cambridge Journal of Economics 40.6*: 1517-1551.

Ostry, J. D., Berg, A., and Tsangarides, C. G. (2014). *Redistribution, inequality, and growth*. IMF Staff Discussion Note.

Palley, T. I. (2012). *From financial crisis to stagnation: The destruction of shared prosperity and the role of economics*. Cambridge University Press.

Park, J., and K. Ryu., H. (2006). Accumulation, technical progress, and increasing returns in the economic growth of East Asia. *Journal of Productivity Analysis 25.3*, 243-255.

Auer, P. (2007) Security in labour markets: Combining flexibility with security for decent work. *Internat Labour Office*.

Piketty, T. (2013). *Capital in the Twenty-first Century.* Harvard University Press.

Piketty, T., and Zucman, G. (2014). Capital is back: Wealth-income ratios in rich countries 1700-2010. *The Quarterly Journal of Economics 129.3*, 1255-1310.

Pug, G. (1998). The profit elasticity of investment in West Germany and the investment diversion effects of unification. *Applied Economics Letters 5(2)*, 97-99.

Rehn, G. (1952). The problem of stability: An analysis of some policy proposals. In R. Turvey, *Wages policy under full employment.* London: W. Hodge.

Reich, R. B. (2013). *Aftershock: The next economy and America's future.* Vintage.

Richardson, C., and Romilly, P. (2008). Investment functions and the profitability gap. *Journal of Post Keynesian Economics 31.1*, 35-56.

Ricoy, C. J. (2004). Kaldor on growth as a demand-induced process. *Conference Economic Growth and Distribution: On the Nature and Causes of the Wealth of Nations, Lucca, Italy*.

Roberts, M. (2017). The profit-investment nexus: Keynes or Marx? *Historical Materialism Conference, New York*.

Robinson, J. (1933). *The Economics of Imperfect Competition.* London: Macmillan.

Rodriguez, F., and Jayadev, A. (2010). The declining labor share of income. *Journal of Globalization and Development 3.2*, 1-18.

Rotemberg, J. J., and Woodford, M. (1999). The cyclical behavior of prices and costs. *Handbook of macroeconomics*, 1051-1135.

Rowthorn, B. (1981). *Demand, real wages and economic growth.* North East London Polytechnic.

Rowthorn, R. E. (1999). Unemployment, wage bargaining and capital-labour substitution. *Cambridge Journal of Economics 23(4)*, 413-425.

Ruttan, V. W. (1997). Induced innovation, evolutionary theory and path dependence: Sources of technical change. *Economic Journal 107(444)*, 1520-1529.

Sennett, R. (1998). *The corrosion of character: The personal consequences of work in the new capitalism*. WW Norton & Company.

Sethi, A. S., and Kaur, S. (2013). Does Labour Productivity Bear any Causal Linkage with Wage Rate? The Indian Experience. *Journal of International Economics 4.2*, 21.

Setterfield, M., and Cornwall, J. (2002). A Neo-Kaldorian Perspective on the Rise and Decline of the Golden Age. In *The Economics of Demand-Led Growth* (p. Chapter 5). Edward Elgar Publishing.

Siegenthaler, M., and Stucki, T. (2015). Dividing the pie: firm-level determinants of the labor share. *ILR Review 68.5*, 1157-1194.

Sims, C. A. (1980). Macroeconomics and reality. *Econometrica: journal of the Econometric Society*, 1-48.

Sims, C. A. (1986). Are forecasting models usable for policy analysis? *Quarterly Review Win*, 2-16.

Sims, C. A., Stock, J. H., and Watson, M. W. (1990). Inference in linear time series models with some unit roots. *Econometrica: Journal of the Econometric Society*, 113-144.

Smith, A. (1776). *An inquiry into the nature and causes of the wealth of nations.* Chicago: University of Chicago Press.

Solow, R. M. (1958). A skeptical note on the constancy of relative shares. *The American Economic Review*, 618-631.

Stiglitz, J. (2012). *The Price of Inequality.* New York: W.W. Norton and Company.

Stiglitz, J. E. (2015). The origins of inequality, and policies to contain it. 425-448.

Stiglitz, J. E. (2016). Inequality and economic growth. 134-155.

Stockhammer, E. (2009). Determinants of functional income distribution in OECD countries. *IMK Study, No. 5*.

Stockhammer, E. (2011). *Neoliberalism, income distribution and the causes of the crisis.* London: Palgrave Macmillan.

Stockhammer, E. (2013). *Why have wage shares fallen? An analysis of the determinants of functional income distribution*. London: Palgrave Macmillan.

Stockhammer, E., and Onaran, O. (2013). Wage-led growth: theory, evidence, policy. *Review of Keynesian Economics 1.1*, 61-78.

Stockhammer, E., Onaran, O., and Ederer, S. (2009). Functional income distribution and aggregate demand in the Euro area. *Cambridge Journal of Economics, vol. 33, issue 1* , 139-159.

Stockhammer, E., Constantine, C., and Reissl, S. (2015). Neoliberalism, trade imbalances, and economic policy in the Eurozone crisis. *Nova Economia 25.SPE*, 749-775.

Storm, S., and Naastepad, C. (2013). Wage-led or profit-led supply: wages. In M. Lavoie, and E. Stockhammer, *Wage-led Growth: An Equitable Strategy for Economic Recovery.* Basingstoke and Geneva: Palgrave Macmillan and ILO.

Tavani, D. (2009). Wage bargaining and induced technical change in a linear economy: Model and application to the US (1963– 2003). *MPRA Paper No. 14635. Munich: Münich Personal RePec Archive.*

Tavani, D., Flaschel, P., and Taylor, L. (2011). Estimated non-linearities and multiple equilibria in a model of distributive-demand cycles. *International Review of Applied Economics 25.5*, 519-538.

Taylor, L. (1991). *Income distribution, inflation, and growth: lectures on structuralist macroeconomic theory.* Mit Press.

Taylor, L. (2004). *Reconstructing macroeconomics: Structuralist proposals and critiques of the mainstream.* Cambridge. MA: Harvard University Press.

Taylor, L. (2010). *Maynard's revenge: Keynesianism and the collapse of free market.* Edward Elgar Publishing.

Uxó, J,, Paúl, J., and Febrero, E. (2014). Internal devaluation in the European periphery: the story of a failure. *Documentos de Trabajo DAEF* 2.

Uzawa, H. (1962). Production functions with constant elasticities of substitution. *The Review of Economic Studies 29.4*, 291-299.

Van Biesebroeck, J. (2014). How tight is the link between wages and productivity?: a survey of the literature. *ILO*.

Van Schaik, T., and Van de Klundert, T. (2013). Employment protection legislation and catching-up. *Applied Economics 45.8*, 973-981.

Vandille, G. (2002). Essays on the impact of income redistribution on trade. 0516-0516.

Verdoorn, P. J. (1949). Fattori che regolano lo sviluppo della produttività del lavaro. *L'Industria 1*: 45-53. Reprinted in En glish as: On the factors determining the growth of labor productivity, in Luigi L. Pasinetti, ed., *Italian Economic Papers*, vol. 2, 59-68. Oxford University Press, 1993.

Vergeer, R., and Kleinknecht, A. (2007). Jobs versus productivity? The causal link from wages to labour productivity growth. *TU Delft Innovation Systems Discussion Papers, IS 1*.

Vergeer, R., and Kleinknecht, A. (2010). The impact of labor market deregulation on productivity: a panel data analysis of 19 OECD countries (1960-2004). *Journal of Post Keynesian Economics 33.2*, 371-408.

Vergeer, R., and Kleinknecht, A. (2012). Do flexible labor markets indeed reduce unemployment? A robustness check. *Review of Social Economy 70.4*, 451-467.

Vitols, S. (2001). Varieties of corporate governance: Comparing Germany and the UK. In P. A. Hall, and D. Soskice, *Varieties of capitalism: The institutional foundations of comparative advantage* (p. 337-360). Oxford University Press.

Wallerstein, M. (1990). Centralized bargaining and wage restraint. *American Journal of Political Science*, 982-1004.

Watson, M. W. (1994). Vector Autoregressions and Cointegration. In R. F. Engle, and D. L. McFadden, *In editors, Palgrave Handbook of Econometrics, Volume 4, chapter 47* (p. 2843-2915). Amsterdam: Elsevier.

Yellen, J. (1995). Efficiency wage models of unemployment. *Essential readings in economics.* Palgrave, London, 280-289.