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A Geography of Multidimensional Inequalities in the European Union

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Introduction

This dissertation is a cumulative one. It is a collection of three papers, which represent at the same time three separate and independent research articles, as well as three consecutive sections of the same analysis. Aim of this dissertation has been the study of the relations in place between socio-economic inequalities and the spaces they concern. Main research questions have been about the effects of territorial characteristics specific to the EU regions on their levels of multidimensional inequality. First, they asked what have the *between* and *within* inequalities been in terms of human development across European regions. Then, investigated the spatial distribution of inequality at the regional level within the EU15 when accounting for dimensions other than income. Finally, tried to understand what can be relevant drivers of this multidimensional inequality within specific regional characteristics. Underlying hypotheses assumed social capital and local economic specialisation in industrial clusters to play a crucial role.

Concerning the theoretical framework, the dissertation combines several strands of literature.

The definition of inequality assumed here is multidimensional, and relates to the human development economics and *capability approach*[1]. Therefore, this is the main theoretical reference in the first paper, and the methodological choices made throughout the analysis it presents. The second paper looks specifically into localisation dynamics of firms and the spatial disparities they engender. Consequently, the economic geography is the theoretical framework it moves within, because in the economic literature, it is the discipline that has mainly dealt with agglomeration externalities and related research questions. The third paper focuses on the role of social capital in the determination of inequality, and thus it includes also sociological references besides the ones on economics of inequality.

Concerning the conceptual framework for the analysis, two layers have been investigated in parallel.

The first one is the *territorial inequality*, associated with the spatial distribution of resources. These could be both the economic (factor endowments, industrial clusters, labour markets, etc.) and social ones (both human and social capital), in terms of local characteristics that are considered to provide people with a better quality of life and opportunities. To say it in terms of capability approach, these endowments are assumed to allow people to include some capabilities in their own *capability set*. If I have a strong civic association network and voluntary organisations active in my territory, I can wisely assume that social climate in that place is higher than where that kind of sociality is missing. Talking at the level of capabilities, it is irrespective of the actual *functionings* realised by individuals, and look just at the availability of access to place-based social networks.

[1] This explicitly refers to Sen, and will be properly explained throughout the dissertation, especially in the first paper. For the scope of this introduction, it is worth clarifying just that this approach defines *capabilities* as the opportunities people have of either doing or being in their lives, and *functionings* as what people actually are or do.

These are instead accounted by the second layer. It is the *individual level of inequality*, which represents the inequality in the accessibility of territorial resources differently experienced by each individual. The opportunities of taking part in social activities and build a personal network of effective social relations, from which one benefits in the daily life and thanks to which one plays an active role in the society, can be significantly different for every each of us.

Now, underlying hypothesis is that these two levels of analysis are mutually connected, and reinforce each other. If you live in a region with good socio-economic endowments, your capability set will be wider than a person's living in a deprived region. One's ability to convert these capabilities in functionings, will be biased by the inequality he experiences in his region though, due to the lack of accessibility of (economic, social, and environmental) resources in the first place, and that translates also into an individual conversion factor that varies from person to person. What one can measures are both the available regional assets and the individual achievements, or to better say, some proxy of them. GDP, employment rate, value added in economic activities, pollution and geographic accessibility indicators, quality of local government and educational institution, are some common proxies for the local (economic, environmental, and social) assets. Wage, disposable income, educational attainments, life expectancy, (declared) participation in social activities, (declared) happiness and life satisfaction, are just a few examples for the individual level. The variable you use among them will depend on the measurement approach you are referring to, and the specific domain of the analysis of course.
In the case of this work, specific attention has been devoted to the regional characteristic of economic production structure and social capital (in its collective sense). This will mean trying to link the territorial inequality in the distribution of these socio-economic resources, to the individual level of inequality in the multidimensional achievements in basic capabilities' domains- especially health, education, and income.

Based on this, the dissertation has been structured according to the following scheme.

1. *A multidimensional analysis of the EU regional inequalities.* First section explains the procedure followed to construct the measure of inequality assumed as dependent variable in the study. It was obtained comparing the estimated Human Development Index (HDI) to its adjustment to within-region inequalities. Following the related literature and the most recently applied UNDP methodology (HDR, 2016), regional HDIs and Inequality-adjusted Human Development indices have been calculated over a span of time of twelve years, from 2000 to 2011. The territorial unit of analysis has been set at the Eurostat NUTS2 regions, within the EU15 only. Results say that despite a general increase in the potential human development across regions, the levels of its loss due to inequality have not significantly improved over the selected period. Especially, its spatial distribution reveals complex dynamics, showing an increasing concentration of better performances around some more advanced and educated core regions, and confirming the well-known North-South contrast.
Preliminary findings of this work were presented in several occasions at Humboldt University BGSS in Berlin during the 2nd year's research stay, and at the SESS PhD Annual Seminar at Southampton in

December 2016. The final version of this article has been already accepted for publication by the "Social Indicators Research" journal (Springer).

2. *Exploring the spatial context: economic specialisation and inequality*. Second section looks into the territorial inequalities in the spatial distribution of socioeconomic variables assumed meaningful in establishing those preconditions that allow individuals to achieve vital functionings. Specific attention was given here to regional production structure and local economic specialisation. The descriptive analyses it presents rely on ecological data about employment structure and economic production of regions, and follow a literature review on their importance with regards to inequality and spatial imbalances. Moreover, an explorative Principal Component Analysis was used to synthesise the available information on industrial clusters of firms across regions, for the same 205 territories in the same twelve-years' time of the first paper. Extracted indicators have been compared to the levels of the estimated multidimensional measure of inequality in the regions. Findings say that spatial distributions of considered domains share similar patterns, opposing better performances of the North to worst of the South of Europe.

Preliminary findings from this article were presented at the Postgraduate Research Conference within the International Research Week at Salford University in September 2017 (after a blind referee process started in April 2017), and at the 5th Master Class on EU Cohesion Policy within the European Week of Regions and Cities at the EU CoR in October 2017.

3. *Social capital and inequality in EU regions.* Third and last section serves to reconcile the two layers of the analysis, aiming at investigating the levels of individual inequality of the first paper by means of the levels of territorial inequality of the second paper. That is, to explain the individual experience of inequality focusing on the spatial disparities at the regional level in the selected economic domains. Social capital is assumed to be the link between the two levels, so specific theoretical attention has been given to it here. The paper presents the econometric analysis performed in order to test the relations assumed relevant. The interrelations within panel data on social capital and inequality in EU regions have been tested by OLS, and GLM with both fixed and random effects. In order to test the robustness of the model, it has been run on different dependent variables. Besides the constructed measure of multidimensional inequality object of the first section, other economic inequality indices have been used (i.e. Gini and Atkinson measures). Significance of results did not change. Also, synthetic indicators for cluster specialisation and social capital -constructed by means of the Factor Analysis exposed in the second section- were used as predictors, and degree of urbanisation and quality of local institutions as control variables. Findings provide statistically significant results, and seem to confirm the hypotheses.

The final version of this article has been already accepted for publication by the "Regional Studies, Regional Science" journal (Taylor & Francis).

A further section was initially foreseen. It would have been devoted to the more in depth analysis of the inferred relations, by mean of a mixed method approach in case study analyses. The initial idea was to replicate the study in different territorial levels and contexts, in order to test its significance with differing

databases too. Also, results would have been combined with qualitative data collected by semi-structured interviews. Due to my participation in a Marie Sklodowska-Curie funded research project, in an international and multidisciplinary research networks with US Universities partners, I got the chance to undertake this challenge in the San Diego area. Moreover, the interest in production cluster dynamics and their relation with regional development and well-being is very much related to my participation in this project. The research has been about innovative strategies for the implementation of smart specialisation strategies and cluster policies by a multidisciplinary and comparative case study approach between the US and the EU. It gave me the chance to spend six months in San Diego, researching on the local processes of urban and regional redevelopment- collecting both secondary (quantitative) and primary (qualitative, via semi structured interviews) data. Findings from the case study I realised there were presented in the MAPS-LED Mid-term meeting of June 7, 2017 at the San Diego State University, and have been selected to be shown at the Human Development and Capability Association 2018 HDCA Conference in Buenos Aires. Due to the extension and complexity of the outputs though, and to the willingness to be as consistent as possible with the cumulative structure of dissertation, this research has eventually fallen within a parallel paper and is not included here.
Furthermore, specific case study analyses within the EU area were planned too, to go more in depth within analysed territories and making use of a comparative approach between them. Due to unforeseen issues with data collection and time constraints, this section is not included either and is still open to further refinements beyond the scope of this dissertation.

To conclude, I acknowledge the precious support received by my supervisor throughout these long years, along with the knowledgeable advise provided by scholars I encountered during my Ph.D. journey- within and outside my Department, they have been too many to name them all. Hence the recognition of the vital role played by the research stays I spent abroad, at BGSS of Humboldt University in Berlin and at SDSU in San Diego. Both of these experiences provided me with new and enlightening insights- for my dissertation, my present and future research interests, and my personal development. All of this might not appear explicitly in these pages, but this final outcome -which would not have been the same without them- necessarily conceals it.

A MULTIDIMENSIONAL ANALYSIS OF THE EU REGIONAL INEQUALITIES

Abstract: This article illustrates the steps followed to construct a measure that accounts for multidimensional inequality across European regions in terms of human development. First, a multidimensional index to explore the *between* inequalities across regions has been produced. Referring to UNDP updated methodology (2015) and integrating it with the European Commission contributions (2011, 2014), a *Human Development Index* has been calculated for 205 regions in the European Union, within the span of time from 2000 to 2011. These estimates have then been adapted to inequality, based on intra-regional distribution of selected variables following the UNDP methodology to calculate an *Inequality-adjusted Human Development Index*. This allowed to explore how the human development pattern changes when accounting for *within* inequalities, and to estimate the *Loss in potential human development* due to inequality in the society. The latter can serve as a measure for multidimensional inequality. Results show a generally increased level of human development achievements despite a widespread persistent level of inequalities in its distribution, as well as a spatial connotation of both dynamics.

Keywords: Europe, human development economics, inequality, multidimensional, regional.

Introduction.

Geography as a determinant of human beings and their communities' development is undisputable: coming from a particular territory strongly influences the fate of our lives and this is dramatically evident nowadays (Scott, 1998). However, if this is undoubtedly comparing extra-EU to communitarian citizens, what about the situation within the European Union borders? Unfortunately, even here there is sound evidence that inequality of outcomes exists, persists and possibly is currently increasing (Vacas Soriano, Fernández-Macías, 2017; OECD, 2016; Ramos, Royuela, 2014; Vieira, 2012). The reason why these inequalities should matter in a socioeconomic context is that public policies can potentially either reduce or produce them, both at the local and the national level, still in the European framework. Recently, the OECD stated that "many multidimensional inequalities are spatially concentrated" explaining how many dimensions of well-being are to a great extent determined by where people live, and stressing how inequalities' level between regions can be almost doubled than that between countries (OECD, 2016). In its analysis of multidimensional living standards in the OECD countries (MDLS), the same study states that these differences have recently increased during the 2000s, and that multidimensional inequality has raised comparatively more than the income one. Furthermore, the authors explain that most worrying trends are those of disposable income, life expectancy, employment and environmental quality parameters.

Due to the recognised importance of taking into account several dimensions of analysis, and the nowadays shared belief that the sole economic performance indicators are not sufficient means to report about levels of either development or well-being, many multidimensional analyses and indices have been recently produced (OECD, 2014, 2011; Istat, 2013; Porter et al., 2013). Especially after the reflections of the Sen-Stiglitz-Fitoussi Commission on the Measurement of Economic Performance and Social Progress (2010) the analysis perspective has been broadened, but most of the available contributions to the study of inequality is still unidimensional though. On the one hand, economic inequality scholars focus on various measures of income and wealth, and the country level of analysis is often still preferred because of wider data availability (Atkinson et al., 2011; Piketty, 2014). On the other hand, spatial inequality dynamics at sub-national level are otherwise inferred mostly looking at productivity and GDP gaps, or income as well, analysing convergence/divergence processes (Quah, 1996; Martin, 2005; Rodrìguez-Pose, 2009; Alcidi et al., 2018).

Willing to go beyond traditional measures, it becomes clear that also a paradigm shift is needed. The frame can be set by the human development economics and the capability approach, elaborated since the second half of 1980s (Deneulin, Shahani, Alkire, 2009). This is the conceptualisation that mostly oriented the change of course towards a multidimensional view of well-being happened not only in the academic environment but also in the policy analysis context (Brandolini, 2008). It is worth underlining that this approach radically focuses on human lives, claiming that the real wealth of nations is not their GDP but their people. Development becomes that process enabling people's freedom to grow, expand their capabilities and make them able to live the life they want to live (Sen, 1982). Also, the capability approach is intrinsically multidimensional, aiming to take into account as many domains as possible among those potentially affecting people's lives. *Capabilities* represent its core concept, and the opportunities people have of either doing or being. The individual capability set is indeed the whole basket of them, among which anyone operates her or his life choices. Based on individual conversion factors, means of living will be transformed in *functionings*, so to say what people actually are or do (Sen, 1980). And this passage is pretty much related to the importance of the evaluative change proposed to standard approaches widely used in social sciences. To cite Sen, "there is evidence that the conversion of goods to capabilities varies from person to person substantially, and the equality of the former may still be far from the equality of the latter" (Sen, 1979). Income being only a mean in this framework, studying inequalities in its distribution alone may not be enough to know about inequality. In the end, territories are made of people, and a better understanding of actual people needs and capabilities seems vital then in order to get a complete knowledge about the space they live in, especially for regional policies to be effective on a local basis.

Despite some criticalities (Noorbakhsh, 1998), an accepted measure of human development is the Human Development Index. The UNDP calculates it yearly since its conception by Mahbub ul Haq in 1990, and many national and subnational reports are regularly produced based on this example[2]. It can be intended as a proxy of a complex concept, but it has had the undeniable pro of shifting the attention of policy making from GDP to new measures of well-being, thanks to one of the basic properties of synthetic measures: collapsing all the information in one number, it is more straightforward in communicating that complexity also to the general public in an effective way. Furthermore, being a multidimensional index, it allows for a complete ordering that associates a real number to any multivariate distribution (Brandolini, 2008). Other pro is to draw attention to the strict relation between dimensions of development, their non-substitutability given.

One of the evident cons of a synthetic index is the loss of information due to the aggregation strategy. A recurrent critic to Human Development Index is its being blind to underlying distribution of considered variables, relying on average values only. Even if it is clear that inequalities matter for the evaluation and analysis of human development achievements - in both the *between* country-average HDIs and the *within* country HD-, inequality in the distribution is still rarely measured for domains other than income or wealth. This would be the starting point towards accounting for inequality in the human development achievements. Scarce availability of appropriate data is surely a real difficulty to face when willing to address this issue, as well as the lack of a broad consensus about how to measure inequality in HDI's distribution (Kovacevic, 2010). But this is not a reason good enough to stop walking in this direction.

The aim of this article is an attempt to reconcile these themes looking at regions in the European Union. It illustrates the steps followed to construct a measure that accounts for multidimensional inequality, and which serves to produce a systematic investigation over space. Compared to other contributions on inequality in the EU (Fredriksen, 2012; Di Falco, 2012; Vacas‐Soriano, Fernández-Macías, 2017, just to name a few), this work is intended to go beyond the sole income dimension, and to do this at the regional level. Compared with similar studies in the frame of regional human development (DG Regio, 2011; JRC, 2014), this analysis aims to go further than the HDI calculation and explore the inequality in its distribution. Also, a more comprehensive picture is provided by the yearly replication of the calculated measures, instead than one-time exercises. The main research questions to be answered are the following:

- What have the *between* inequalities been in terms of human development across European regions?
- How does the human development pattern change when accounting for *within* inequality?
- How much does the *loss* in potential human development reveal of regional inequality differentials?

Preliminary hypotheses consider that *between* variations have probably reduced, in line with the convergence process almost closing some national gaps between territories in Europe, while *within* variations have raised. Looking at both the Members States and the regions' level, the intra-national and intra-regional ranges of variations are the worrying ones and those determining the overall increase in the level of inequality (OECD, 2017; Inchauste, Karver, 2018; Ridao-Cano, Bodewig, 2018). Human development levels have generally increased, but with different patterns internal to the regional distribution, so differently influenced by inequality dynamics both within people groups (e.g. gender differentials between male and female HDI) and the territories they live in.

Aiming to explore which these recent patterns of regional inequality have been in the EU in this multidimensional framework, the work starts with the estimation of a regional Human Development Index for a twelve years' time that spans from 2000 to 2011[3]. This index' spatial distribution can give an intuition

[2] UNDP website provides related sections for both territorial level of analysis. The Measures of America program from the US Social Science Research Council is an example of independent research in the same evaluative framework.

[3] The choice of this period of analysis has been driven by data availability issues. Due to the combination of several different statistical sources and databases, the time interval ensuring wider coverage has been selected. Further details are provided in the "Data and methodology" section as well as in the Annex.

of the unequal development of territories and of *between*-inequalities across them. More interestingly, its distribution can serve as first step to inquire on the multidimensional inequality trends in the same regions.

Additionally, the inequality in the distribution of the index has been estimated, referring to the methodology currently used by UNDP (2015) for the calculation of the Inequality-adjusted Human Development Index. Drawing on both indices, a synthetic measure of multidimensional inequality has been produced in accordance with the same background methodology (Alkire, Foster, 2010; Kovacevic, 2010). Regardless of the focus that different studies can have, all of the existing approaches to inequality have one thing in common: the pursuit of equality of something. And even when dealing with the measurement of inequality, one can distinguish between different aspects to give priority to. They can be summarised by three main strands: inequality of process, inequality of opportunities and inequality of outcomes. Here we take into account the last one, defining our outcomes of interest referring to Sen's capability approach and measuring inequality as Loss of human development due to the inequality present in the society.

The article is then structured as follows. The first section provides a brief overview of the rationale behind the Human Development Index and its adjustments to inequality. The second section explains data and methodology here followed to construct the Index for the 205 selected regions, and to adjust it to sub-regional distribution of the included dimensions. The third section discusses some results comparing estimations for the considered period. The Annex contains some additional notes on data and methodology.

1. Between and Within Inequalities in the HDI.

Since its first calculation in 1990, the UNDP Human Development Index has gone through many refinements. Last published version from 2016 Human Development Report consists of three dimensions, i.e. health, education and income. First one is expressed by life expectancy; the second, by aggregating expected and mean years of schooling; last one, by logs of Gross National Income (GNI) (UNDP, 2016).

Worldwide, regional analyses have been produced so far (e.g. Quadrado et al., 2001), and some important exercises remain as recognised references like the one on Mexico by Foster, Lopez-Calva and Szekely (2005). In Europe, researchers from DG Regio produced two relevant papers in this regards: Bubbico and Dijkstra in 2011, and Hardeman and Dijkstra in 2014. In the first case, UNDP report is a more direct reference in applying the same methodology to the same three dimensions. The sole exceptions adapting it to the specific case of the EU concerns two variables: educational attainments instead of years of schooling; disposable income instead of GNI[4]. All data here used were from 2007 (Bubbico, Dijkstra, 2011). In the second case, researchers from the JRC produced a more accurate work in the specification of dimensions and indicators, drawing on European regional specificities and providing a more in depth analysis of variables and correlation between them. Some interesting measures were added, like the NEETs percentage within the education dimension for example, and the final index accounted for three dimensions made up of six indicators[5]. Despite the valuable contribution of this work, it rests on 44% of missing data in selected variables, in the time range 2006-2012 (Hardeman, Dijkstra, 2014). The latter represents one of the main reasons why the 2011 EU exercise has been here used as primary reference in the translation of the UNDP methodology to the regional context within Europe. Furthermore, the will of keeping the composite measure as simple as possible played a role, in order to derive a comprehensible measure of multidimensional inequality from it, and to make this one more easily interpretable and finally used as a dependent variable in further applications.

[4] When available as in the European case, disposable household income is a more precise measure than the national aggregate. Tertiary education was instead preferred over years of schooling as a better representative of educational attainments in the case of advanced economies (Bubbico, Dijkstra, 2011).

[5] *Health*: life expectancy and healthy life expectancy, plus infant mortality; *Knowledge*: NEET and general tertiary education; *Income*: employment and net adjusted disposable income.

As already introduced, one of the recurrent critics to the Human Development Index is that of not taking into account the inequality existent in the underlying distribution of considered items. When we calculate the traditional HDI, we aggregate *average* values in different dimensions, so we are considering how the achievement would be for each person if there was a perfectly equal distribution of achievements. As a matter of fact, two regions with different distributions of achievements can score the same average HDI values.

In order to deal with this limitation, different strategies have been proposed, based on different needs to accomplish with. Indeed, inequality is something recognised as hampering development, in the human development framework especially, valuing equality as something important also per se (Sen, 1992). Attention to this point has been drawn since 1990, but a first measure of the level of human development that accounts for inequality in the society has been introduced in the 2010 Human Development Report only, straight following the preliminary studies carried by Alkire and Foster at OPHI (2010).

Since then, the IHDI is produced too, intended to account for the *within-dimension* inequality. This can be done by combining the estimate of the basic HDI to the Atkinson measure of inequality. The reasons why exactly this one has been preferred to other measures of inequality (HDR 2010, 2011, 2015) are at least three, as explained by the authors who developed the IHDI methodology now in use[6]. It satisfies four basic properties[7] that an inequality measure should have together with the peculiar one that others like Gini do not- the subgroup consistency[8]. Its interpretation is intuitive and meaningful: it is the share of per capita achievement wasted as a result of inequalities in the distribution of achievements. It has a neat connection with the general means, such as the geometric mean which is used to penalise inequality between dimensions (Alkire, Foster, 2010).

Atkinson theorised it (1970) on income inequality referring to the social welfare function. The core concept in his reasoning is the Equally Distributed Equivalent (EDE): given the distribution of considered achievement, the equally distributed equivalent achievement is the level of achievement that, if assigned to all individuals, would produce the same social welfare than the observed distribution. When there is perfect equality in the distribution, this means that the EDE achievement is equal to the distribution mean, and the Atkinson measure is 0. When the EDE achievement is less than the distribution mean, then the Atkinson measure assumes positive values. This can be summarised by the following equation:

$$A_x = 1 - \frac{x_{EDE}}{\mu_x} \qquad so\ that \qquad \begin{cases} x_{EDE} = \mu \ \rightarrow \ A_x = 0 \\ x_{EDE} < \mu \ \rightarrow \ A_x > 0 \end{cases} \qquad (a)$$

Since the Atkinson measure A_x presents a parametric family, there are several possible formulas to compute the x_{EDE}. One particular case, that is the one implemented by UNDP since 2010, is the geometric mean. It can be derived through subsequent steps to obtain the following[9]:

$$x_{EDE=} \begin{cases} \left[\frac{1}{N}\sum_{i=1}^{N} {y_i}^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} & \varepsilon \neq 1 \\ \prod_{i=0}^{N} {x_i}^{1/n} & \varepsilon = 1 \end{cases} \qquad (b)$$

[6] The Alkire and Foster (2010) adaptation of the Foster, Lopez-Calva, Szekely (2005) method. That is why this index is somewhere also referred to as "FLS IHDI".

[7] 1.Population invariance= the amount of inequality does not depend on the population size; 2.Symmetry (or anonymity)= the amount of inequality does not depend on who has each achievement; 3.Scale invariance= the amount of inequality does not depend on the total achievement; 4.Pigou-Dalton Principle= if there is a regressive transfer, inequality increases (Salvareda, Nolan, Smeeding, 2011).

[8] That is, if inequality in one population subgroup decreases (increases), and inequality in the other population subgroup remains unchanged, overall inequality should decrease (increase).

[9] This case assumes an additive social welfare function, defined itself by a utility function with a constant risk aversion parameter. For a detailed derivation of the formula, see also Alkire and Foster (2010).

This formulation can be differently declined so depending on the aversion to inequality ε one wants to use. The inequality aversion parameter concerns the degree to which lower achievements are stressed and higher achievements are de-stressed. It has important intrinsic implications on the theoretical ground, as it represents the assumed level of societal aversion to inequality. When ε is equal to 0, society is not interested in distributive issues; when it is equal to ∞, the aversion to inequality is instead at its peak.

Previously to this formulation of IHDI, there had been a very few attempts to reframe the HDI so that it accounts for both the average achievement in HD's relevant dimensions in a country, and for inequality in the distribution of HD achievements within that country (Hicks, 1997, Foster et al, 2005, Stanton, 2006). These adjustments have been particularly useful for international comparisons of disparities among countries. To examine HDI inequalities within territories otherwise, another useful approach is to calculate separate HDIs for different groupings, disaggregating by ethnic groups, by income quintiles, or across gender for example. Such disaggregation helps provide a better understanding of human development and of gaps between different groups, revealing part of concealed inequalities of the average index.

The pattern shown by the HDI changes a bit when looking at values separately for men and women indeed. The index has here been recalculated separately for men and women, using gender-specific values of life expectancy and educational attainments for the same 205 NUTS2-level regions between 2000 and 2011. Obtained results, enclosed in the Annex, confirm the importance of a joint analysis at different levels.

2. Data and Methodology.

Data have been collected using the Eurostat NUTS[10] regions as territorial unit of analysis, within the EU15[11] and excluding the extra-continental regions[12]. The level of detail has been set to NUTS2 for at least two reasons: wider and more homogeneous availability of human development variables in the selected span of time for countries of interest; comparability to other regional performance and innovation indicators not available yet at a lower territorial specification. As regards the HDI, ecological data aggregated at the regional level come from Eurostat and OECD databases. As for the IHDI, individual microdata were taken mainly from the EU Survey on Income and Living Conditions (EU-Silc). The selected period is a twelve years' time, from 2000 to 2011[13]. The following paragraphs explain in detail procedure and data used per each indicator, starting from the HDI, passing by the IHDI, estimating the inequality via the comparison between the two, and concluding with a look at other indicators.

2.1. Inequalities between regions.

Health indicator has been obtained by normalising the values of life expectancy at birth provided by Eurostat regional database, which are estimated on the basis of National Statistics Institutes[14]. Normalisation has been done using min and max values internal to distribution of life expectancy across the considered European regions, in the time range 1990- 2013[15], applying the following formula:

[10] From the original French definition: *Nomenclature des Unités Territoriales et Statistiques*. The higher territorial level in the NUTS hierarchy is 0, which stands for countries. Sub-national levels slightly vary across Member States, adapting to national administrative systems. Generally speaking, level 1 represents macro-regions, level 2 regions and level 3 sub-regional partitions. The classification here used is that from 2010 revision.

[11] The choice of restricting the study to 15 Member States only has been due to data availability and comparability across countries.

[12] Four French, three Spanish and two Portuguese oversea departments (FR91-FR94; ES63, ES64, ES70; PT20, PT30).

[13] Due to the wider coverage it ensures across the considered domains of the analysis.

[14] *Life expectancy at given exact age* is defined by Eurostat as "the mean number of years still to be lived by a person who has reached a certain exact age, if subjected throughout the rest of his or her life to the current mortality conditions (age-specific probabilities of dying)".

[15] Min appears to be Norte (PT11) in 1991 with 74 years, and Max is Comunidad de Madrid (ES30) in 2013 with 84,8 years.

$$Normalised\ value = \frac{actual\ value - \min value}{\max value - \min value} \qquad (c)$$

A few regions presented missing data for some years, and in those occurrences the values have been imputed from previous available year, assuming that life expectancy is something not suddenly changing from one year to the following one[16].

Education indicator has been estimated following the first proposed methodology for the application of HDI at the regional level in Europe (Bubbico, Dijkstra, 2011). As introduced, it combines low and high educational attainments, respectively coded by ISCED levels 0-2 and 4-5[17]. Low education has been considered in its complementary to one, in order to convert it in a positive measure and so to consistently contribute to the overall HD index. These two separate indicators have been aggregated into the Education one by means of a weighted geometric mean, attributing 1/3 weight to lower and 2/3 to higher levels.

Main source is the Eurostat regional database of Labour Force Survey. In addition, the Danish National Statistical Institute has been the reference to estimate some missing data for Denmark regions[18].

Income indicator has been obtained by normalising the values of regional disposable income per equivalised households provided by the OECD[19]. The selected variable has been here considered in purchasing power standards per capita[20], so to represent the income each individual has at disposal thanks to the "sum of primary income and social benefits and transfers other than in kind (monetary transfers) and less taxes on income and wealth, social contributions and effect transfers" (OECD Regional Economic dataset – Metadata, 2015). Refined figures have been normalised, using min and max values internal to distribution of disposable incomes across the considered European regions, in the Eurostat database for the time range 1995- 2013[21]. Following Bubbico and Dijkstra and their regional HDI paper (2011), normalisation without a natural logarithm[22] have been used, because the differences in net adjusted household income in the EU 15 can be reasonably considered smaller than worldwide so to not follow the log transformation that UNDP normally applies. Even though that choice would have stressed the diminishing returns of income, its results appeared to over-smooth the existent differences in income values' among selected regions: the range size between minimum and maximum values is notable indeed, but it is biased by the distribution extremes and the Inner-Outer London outlier behaviour also, concealing a less impressive variance in terms of purchasing power parities- which would have been partly lost in the logarithm transformation.

HDI composite index. Health, education and income have then been aggregated into the multidimensional index of human development by a simple geometric mean as the following:

$$HDI = (I_{Health} \cdot I_{Education} \cdot I_{Income})^{\frac{1}{3}} \qquad (d)$$

The choice of weightings follows the UNDP considering implicit equal weights. Assigning no particular weight to any dimension ensures that each of them has the same incidence in the final index. The selection of geometric mean as way of aggregation depends instead on the willing of penalising inequality

[16] Cheshire (UKD6) and Merseyside (UKD7) in 2000/2001; The Netherlands in 2001; Germany in 2000/2001 [Detmold (DEA4) and Arnsberg (DEA5) also until 2009].

[17] Used data represent the percentage of people aged 25-64 with these levels of education, as derived from the Labour Force Survey and provided by Eurostat and available from 2000 to 2016.

[18] The applied estimate is explained in the Annex.

[19] Its data sources are National Institutes for Statistics. Since OECD territorial units' classification slightly differs from the Eurostat one, some preliminary data processing was needed. Detailed data treatment is reported in the Annex.

[20] PPS are an artificial currency unit derived by dividing any economic aggregate of a country in national currency by its respective purchasing power parities. Here they have been calculated by means of PPPs at EU15=1 (provided by Eurostat). Original data have been selected in national currency per head at current prices from OECD database. Additional notes on methodology and implications of conversion to PPS are provided in the Annex.

[21] Min appears to be Extremadura (ES43) in 1995 with a 6.519 PPS value, and Max is Inner London (UKI1) in 2013 with a 39.577 PPS value.

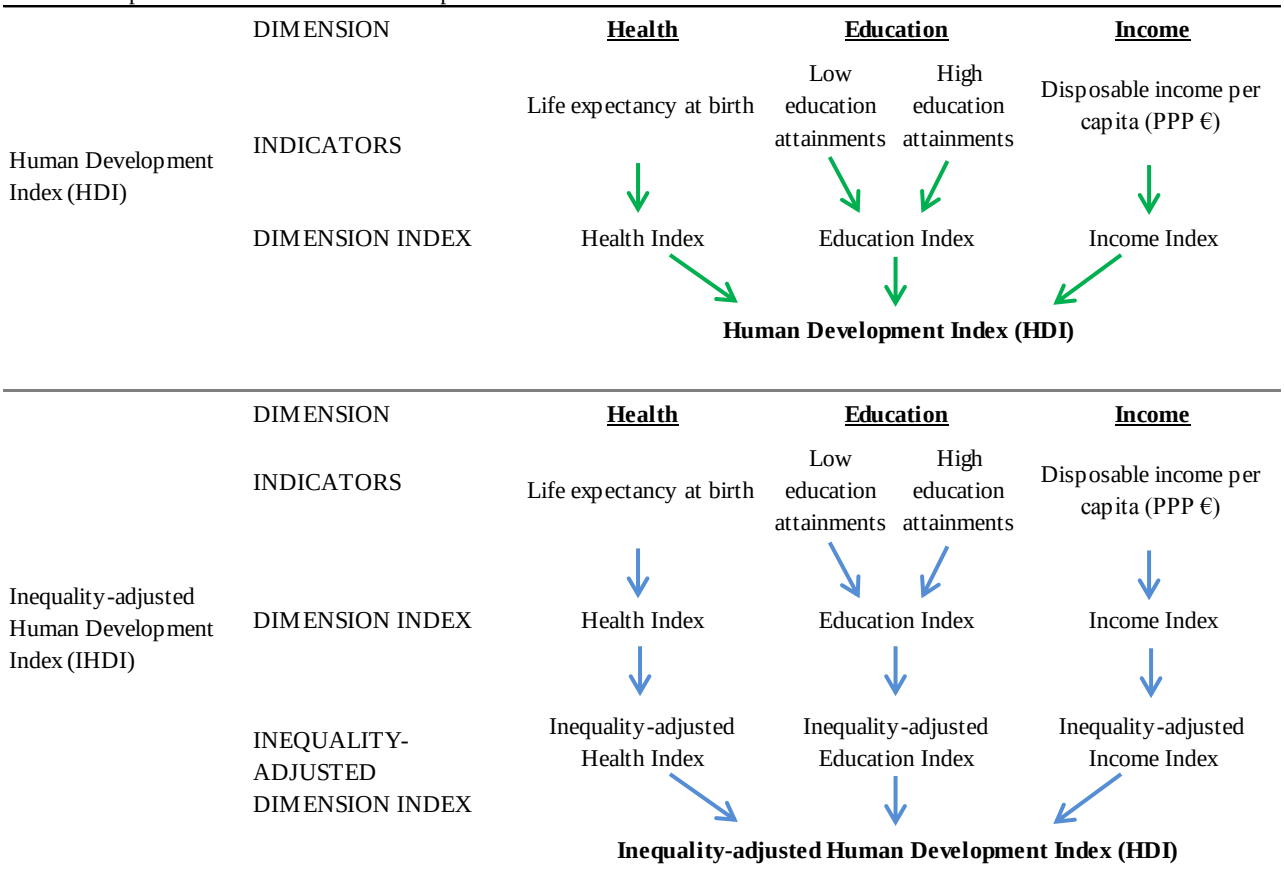
[22] Which would be foreseen by the latest UNDP methodology (2015).

between dimensions of development: higher level of the income indicator could not compensate lower levels of education, for example. Substitutability between dimensions is not allowed anymore, differently than how it was until arithmetic mean was used (HDR, 2010), and in this way each dimension is clearly considered intrinsically important and different. Furthermore, geometric mean confers higher importance to low values, so that they can hardly be balanced by higher values in the same dimension.

2.2. Inequalities in the Human Development.

Relying on available intra-regional distributions, Atkinson measures have been estimated for all of the three considered dimensions of human development, and then used to weight the three components of the composite index. Used methodological procedure follows Alkire & Foster, and Kovacevic (2010) and foresees three consecutive steps to compute the inequality-adjusted index.

Table 1. Steps to calculate the human development indices [1]



[1] *Author's adaptation of the 2015 HDR Technical Notes*

First of all, one needs to calculate inequality in the underlying distribution of each component. In this case, ε has been set to 1, following Kovacevic (2010) and UNDP (2015). This means that the *(a)* equation here becomes:

$$A_x = 1 - \frac{g_x}{\mu_x} = 1 - \frac{\sqrt[n]{X_1 \dots X_n}}{\bar{X}} \qquad (e)$$

In order to estimate A_x for each variable (life expectancy, educational attainments and disposal income), some previous data treatment has been necessary. Computations have been specific to each case, and include the following.

Health dimension index. As regards life expectancy at birth, the inequality in its intra-regional distribution has been directly calculated on the available life tables provided by Eurostat[23]. The distribution of the expected age at death has been defined drawing on the procedure explained by Kovacevic (2010). He refers to a model life table, which he describes being as normally following "a hypothetical cohort of 100,000 people born at the same time as they progress through successive ages, with the cohort shrinking from one age to the next according to a set of death rates by age until all people eventually die. Such a table is used for computation of life expectancy at birth broadly defined as the average number of years a group of people born in the same year can be expected to live under the constant-mortality assumption, i.e., mortality is maintained constant at the level estimated for the reference year or period".

Education dimension index. Considered variable from the EU-Silc is higher educational attainment, labelled PE040 in the EU-Silc survey[24]. It represents the ISCED level attained by the survey respondent, so ranges from 0 to 5[25]. The adjustment of education indicators for inequality in the distribution of educational attainments has been done applying the *(e)* formula to the available microdata. It is worth reminding that UNDP quantifies educational attainments by years of schooling (expected and mean), so the IHDI contains a dimension of education inequality-adjusted based on the distribution of these variables. Here in the HDI calculated in the previous paragraph, main reference for the education dimension was Bubbico Dijkstra (2011) so using percentage of people with higher and lower ISCED level[26]. That is why now the ISCED level reported in the EU-Silc is the sub-regional distribution on which the inequality-adjustment is computed, as explained. However, in order to better fit the distribution of this proxy to that of educational attainments among population, the reported ISCED levels have been converted in number of years presumably necessary to obtain them, on average within the EU15[27]. This underlines the non-linear scale it has differently from the 0-5 ISCED range, and so estimates the unequal distribution of achievements across levels of the scale more appropriately.

Income dimension index. Disposable household income, labelled HY020 in the survey, expresses the total household disposable income in national currency, and here it has been equivalised per capita dividing it by the equivalence scale parameter[28], labelled HX050. Also in this case, available surveyed distribution of selected variable has been used to estimate an Atkinson measure of inequality, applying the *(e)* equation. Since zero values are not allowed in the Atkinson measure formula though (due to the presence of a geometric mean) disposable incomes have been further treated. Zero and negative incomes have been set equal to the lower value of the bottom 0.5 percentile of positive incomes in each yearly distribution. Also, top 0.5 percentile incomes have been truncated to avoid distortion by these extreme higher values on the final measure[29]. Furthermore, data have been converted to purchasing power standards[30].

IHDI composite index. After all of these refinements, application of equation *(e)* produced three new variables, which are the estimated Atkinson measures in education, income, and health. By means of

[23] It has to be noted that UN life tables are abridged ones with five-years age interval, while Eurostat available ones are year-by-year. The used age interval here considered has then been $n = 1$.
[24] Considered available data range from year 2004 to 2011.
[25] EU-Silc data refer to 1997 classification of International Standard Classification of Education. ISCED were designed by UNESCO in 1970s to ease the comparability of educational attainments across different national educational systems.
[26] See previous paragraph 2.2.
[27] Correspondence has been set to: 0=two, 1=seven, 2=ten, 3=fourteen, 4= seventeen, 5=twenty-two.
[28] Equivalence scales are the parameter by which, in income analysis, members of a household receive different weightings based on their age as the ability to earn and spend the household income. Dividing the total household income by the sum of the assigned weights produces a representative income per person. In the EU-Silc, Eurostat uses the "Modified OECD equivalence scale", which counts: 1 for the first adult (≥14 years); 0.5 for other adults; 0.3 for children <14.
[29] For more details on the sensitivity analysis of income data, see Kovacevic (2010).
[30] Using the same Eurostat purchasing power parities at EU15=1 previously applied to the HDI income indicator.

them, a coefficient can also be calculated here to quantify the *human inequality*. It is obtained as an unweighted arithmetic average of the inequalities in the three dimensions, using the following formula:

$$Coefficient\ of\ HI = \frac{A_{Health} + A_{Education} + A_{Income}}{3} \qquad (f)$$

Once inequality within separate dimensions has been estimated, the second step is to apply this measure to development indicators previously calculated, by simply multiplying them to obtain the inequality-adjusted indicators per each x dimension:

$$I^* = (1 - A_x) \cdot I_x \qquad (g)$$

Now that each dimension accounts for within-inequality, the three can be aggregated into the composite inequality-adjusted index, using a geometric mean again, in the third step as follows:

$$IHDI^* = (I^*_{Health} \cdot I^*_{Education} \cdot I^*_{Income})^{1/3} =$$

$$= [(1 - A_{Health}) \cdot (1 - A_{Education}) \cdot (1 - A_{Income})]^{1/3} \times HDI \qquad (h)$$

The main disadvantage of the IHDI is that it is not association sensitive, so it does not capture overlapping inequalities, that is it does not account for if a person experiences one or multiple deprivations. Despite this, the FLS inequality adjustment of HDI has the relevant pro of being comparable with unadjusted HDI. When there is inequality in the distribution of a variable, the IHDI of an average individual in the considered territory will be less than the aggregate HDI: the greater the difference between the two indices, the higher the inequality in the concerned society. The loss in potential human development due to multidimensional inequality is often expressed as a percentage and can be then quantified as:

$$Loss = 1 - \frac{IHDI^*}{HDI} =$$

$$= 1 - [(1 - A_{Health}) \cdot (1 - A_{Education}) \cdot (1 - A_{Income})]^{\frac{1}{3}} \qquad (i)$$

When inequalities are of similar magnitude in all dimensions, the loss in HDI assumes values close to the coefficient of human inequality. When inequalities differ between dimensions, the loss in HDI tends to be higher than the coefficient. Under the perfect equality ideal circumstances, IHDI and HDI are equal and the loss is zero.

Through the example of Inner London, the following tables 2. and 3. provide a summary of all steps followed in the indices' calculation. Also, they highlight how good performances in development indices may however conceal high inequalities[31]. Displayed region is often ranked first both by HDI and IHDI, nevertheless joining four times the worst 20 regions in terms of estimated inequality, and showing one of the highest Loss in 2011 (i.e. 7%).

Table 2. Indices' calculation, example of steps for Inner London (UKI1) in 2011.

	Indicator	Dimension index	Inequality Measure	Inequality-adjusted index
Life expectancy	81.4	0.68	0.013	0.67
Higher educational attainment	17.8% = 0.82	0.66	0.04	0.62
Lower educational attainment	59% = 0.59			
Disposable household income	27898	0.60	0.13	0.56

[31] This will be better shown by related graphical representation in paragraph 3.1.

Table 3. Calculated indices, Inner London (UKI1) in 2011.

Human Development Index	Inequality-Adjusted Human Development Index	Percent Loss in Human Development	Coefficient of Human Inequality
$(\mathbf{0.68 \cdot 0.66 \cdot 0.60})^{\frac{1}{3}} = \mathbf{0.64}$	$(0.67 \cdot 0.62 \cdot 0.56)^{\frac{1}{3}} = 0.62$	$1 - (0.62/0.64) = 0.07$	$0.013 + 0.04 + 0.13/3 = 0.06$

2.3. Robustness' analysis of indices

Robustness is a propriety of estimators, by which the characteristics it has under certain hypotheses continue mostly to hold even when far from the starting hypothesis. In this case, the initial hypothesis is that regional human development in considered space and time is influenced -and can so be reasonably approximated- by dimensions and indicators selected. The robustness analysis is then carried out by testing if it confirms or not this hypothesis when slightly modifying the index. Two different strategies have been here used. In the first one, a weighted geometric mean is calculated instead of the simple one previously employed, and dimensions' importance changes three times, so that the formula is:

$$rhdi_x = \left(I_x{}^2 \cdot I_y{}^1 \cdot I_z{}^1\right)^{1/4} \qquad (j)$$

where *x* is first income, then health and finally education.

In a second check, the aggregation procedure is used as it is in the main index, but each dimension is left out of the calculation once, following a "leave one out" approach.

Six new indices have been obtained this way, and related new rankings of 205 considered regions have been calculated. Rank correlation has been calculated on these rankings, and the Pearsons's correlation coefficients have been estimated[32].Spearman's tests have been run by each year separately as well, and results are significant at the same percentage. The performed analysis can eventually say that the estimated index of regional human development is robust. In fact, only three coefficients are below 0.7 and all of them prove a level of significance at 1% or lower.

Robustness of IHDI has been checked as well. As suggested by Alkire and Foster (2010), tests for this index should focus especially on the sensitivity to certain aspects of variables' distribution. They might include sensitivity to: a change in the lower bound (e.g., of 15 vs 20 years for life expectancy); a change in the upper bound (e.g., of disposable income); transformations of income (e.g., using log values for income); alternative forms of generating the educational index (using arithmetic rather than geometric mean of educational achievements). Since similar considerations about the index composition have already been done regarding the estimate of the HDI, further attention has here been given to the distribution of variables used to account for inequality. Therefore, other four versions of the IHDI have been estimated.

The first and second ones change respectively the lower and the upper bound of the income distribution, using the 1st and 99th percentiles' thresholds respectively to trim the income distribution, instead of the 5% and 95% values. The third one considers equally specified years of schooling for each ISCED level, as if they were unvarying in their levels' distribution. And finally, the one with abridged age intervals in the life tables.

Once these four additional indices have been done, their results have been checked by the Spearman's rank correlation test, as already done with the HDI. All ranking correlation coefficients produced by the test are above 0.75 threshold in values[33] and show significance level at the 1% or lower, meaning the index can be considered robust. Spearman's tests have been run by each year separately as well, and results are still significant at the same percentage.

[32] Detailed description of applied methodologies are reported in the Annex, along with obtained results of tests.
[33] Six out of ten are above 0.9. Summary of results is provided in the Annex.

3. Results Across EU Regions.

Looking at HDI first, the comparison between 2000 and 2011 in terms of human development says that it has generally increased across European regions. As can be seen from the summary maps below, some of the regions with lower values in the index at the beginning reached those with medium level of development, as the reduction of the extension of lighter colours at the end of the considered range of time shows. It can also be noted how an overall increased level of development seems to go hand in hand with a raise in spatial concentration of higher values around some dynamic cities' areas, identified by darkly coloured spots. These regions, which confirm their better performances over time, increased their level of the index, but have been approached just by a few of those that were lagging behind. Despite increased values, southern regions confirm their poor scores at the bottom of the distribution. Besides London (UKI1) and Paris (FR10), among highest values in 2011 are those of Oxfordshire (UKJ1) and Sussex (UKJ2), Antwerp (BE21), Upper Bavaria (DE21), Luxembourg (LU00), Spanish and Scandinavian capitals (ES30 and SE11 respectively).

Fig. 1 HDI in 2000

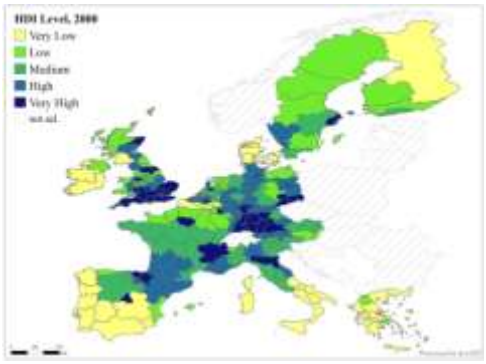
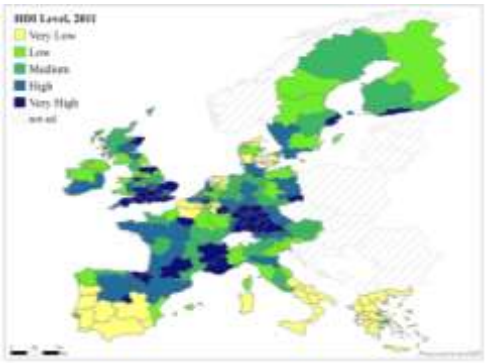


Fig. 2 HDI 2011

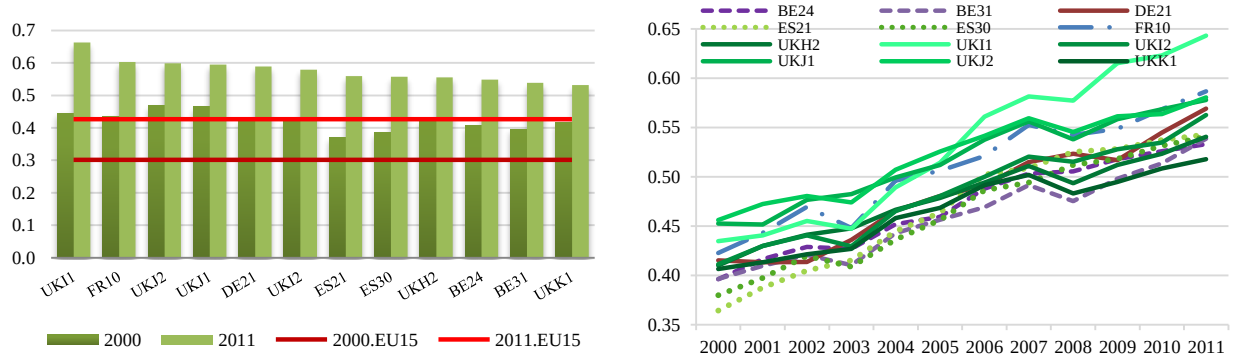


Classes of values reported in the above Fig. 1 and 2 represent the magnitude of deviations from the mean, and the cut-off points roughly correspond to the quintiles of the distribution.

Rankings show how the variation range of values is on average 0.4 points in the index scores, and that the performance of regions is different irrespective of their nationality. In pole positions we always find UK Sussex and Oxfordshire, followed by Paris, London, Flanders regions (BE24) in Belgium, País Vasco (ES21) and Madrid for Spain, Upper Bavaria and Stuttgart (DE11) in Germany, Stockholm in Sweden. Surprisingly, most Scandinavian regions are just in the middle of the rankings. True for all of them but especially for Copenhagen (DK01) and Helsinki (FI1B), this seems due to the proportionally lower scores performed in the Income dimension. Disposable household income is relatively lower in Scandinavian countries compared to the rest of western Europe, despite their higher performances in terms of welfare state. At the bottom of the rankings we always find Portugal, Macedonia and Crete Island in Greece, and southern Italy.

Moreover, changes in the values of best and worst ranked regions can be looked at in the following graphs, along with their trends over the considered twelve years.

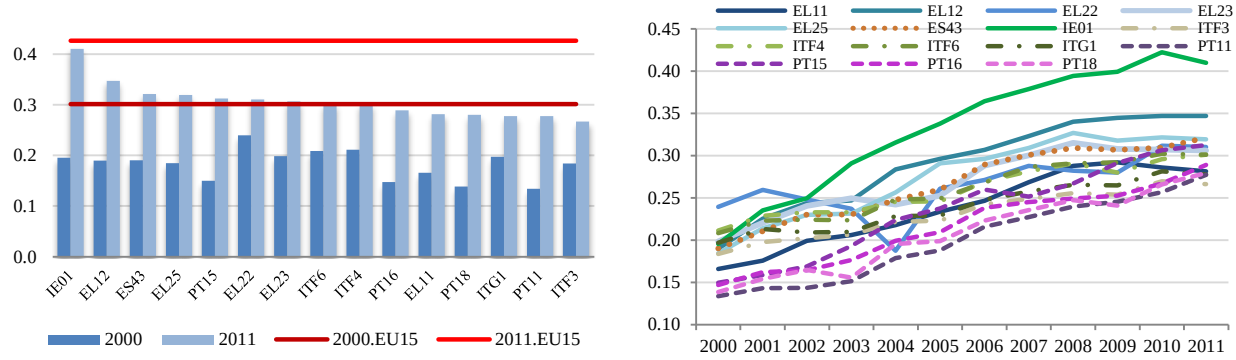
Fig. 3 Best performing regions in HDI and their trends over time



Here the already recognised increase in the level of HDI can be observed. If we look at the value scales though, a considerable gap can be noticed: higher values of the right end side of Fig.4 (blue lines) do not even reach the bottom ones of the right hand side of the Fig.3 (green lines), exception made for Border, Midland and Western Ireland (i.e. IE01). Same remark is evident looking at the EU15 lines[34] in both graphs: bottom ranking regions appear always around 15 percentage points below the European average value, while the top ranking ones are above of at least 10.

It can also be noted how the gain has been more homogeneous across the latter, along with a smoother path in their growth trends. At the same time, an interesting remark seems to be the trace of the economic crises in these trends. On the one hand, the external shocks in 2003 and 2008 evidently hit those high ranking regions who are more rewarded by their similarly better performances in the Income dimension of the composite index and whose economies are more tied with the financial sector (e.g. London and Paris in Fig.3). On the other hand, regions displayed in Fig.4 that come from a lower initial performance show a smoother growth over time, except for Greek regions that present more fluctuation, and especially Ionia Nisia (i.e. EL22) which is one of the main touristic destinations in Greece and has a remarkable shortfall in 2004.

Fig 4. Worst performing regions in HDI and their trends over time



Considering now the IHDI, the following maps in Fig. 5 and 6 summarise the comparison between first and last year of considered time period. Changes in pattern over time are in line with those previously observed with the HDI. Spatial persistence of difference in distribution rewards some more advanced core areas, and leaves behind the regions of southern Europe. Even if they register an increase in their values, the latter cannot reach the range of performance above the very low one.

[34] EU15 lines displayed in the graphs correspond to median values of the HDI values across regions per year. It counts 0.307 in 2000 and 0.441 in 2011. simple arithmetic mean were also calculated, and variation was minimal: -0.007 in 2000 (0.300) and -0.004 in 2011 (0.437).

Fig. 5 IHDI in 2000

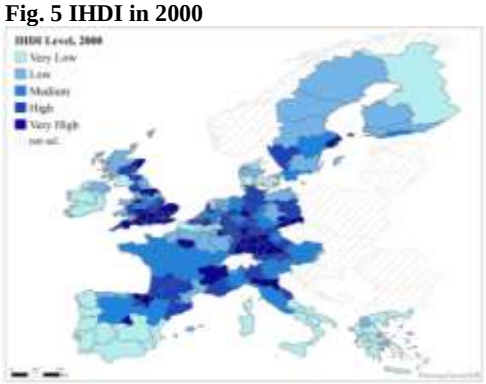
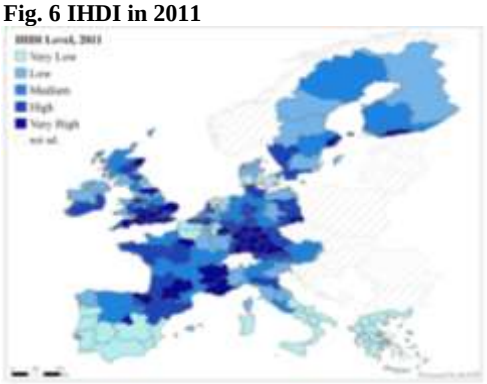


Fig. 6 IHDI in 2011



Classes of values reported in the above Fig. 5 and 6 represent the magnitude of deviations from the mean, and the cut-off points roughly correspond to the quintiles of the distribution.

Generally speaking, values of IHDI can be either equal to HDI ones, in the occurrence of perfect equality in the society, or lower than HDI levels, depending on the extent of the measured inequality. As can be seen also in the following graphs, performances of regions in IHDI generally follow those in HDI for the same year. First ranks are still occupied by UK and Germany best performing regions, along with the French Île de France (FR10).

Fig. 7 Best 10 regions, 2000

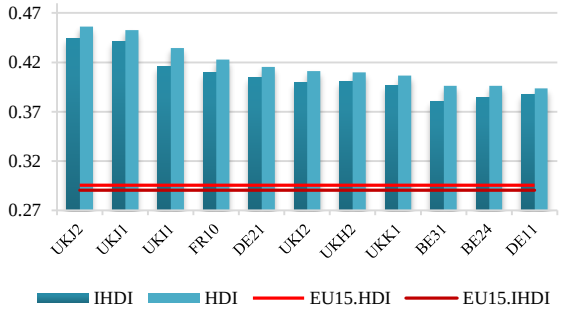
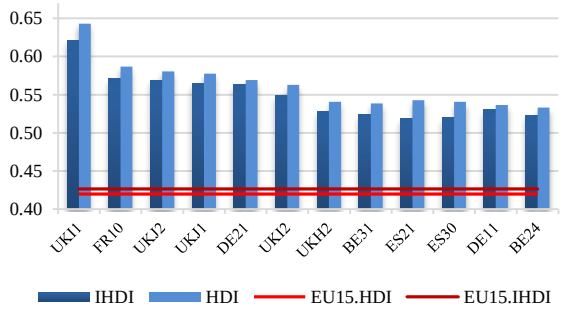


Fig. 8 Best 10 regions, 2011

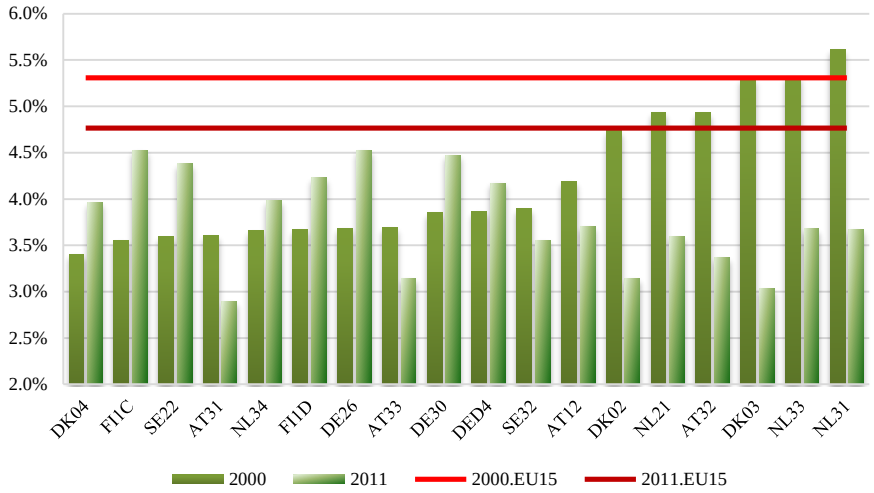


Their values of IHDI in 2000 shown in Fig. 7 appear only a bit lower than IHDI reported in 2011, Fig.8. Also bad performances are quite persistent, and the location of the worst ten regions has not substantially changed across years. It has to be remarked that this small differences increase in the central part of distribution, where more adjustments have occurred as can be noticed comparing HDI and IHDI results per each year[35]. Moreover, an intuition of the gap range between better and worst performing regions can be given by the median levels of IHDI outlined by the red lines, which are way lower than the top regions' scores in both years.

However, the situation appears slightly different if we turn to the results in the measure of multidimensional inequality previously introduced, the *loss* in potential human development. Here rankings clearly change, and top regions include those traditionally recognised for low levels of inequality in the society across Europe: Denmark, Sweden, Austria, along with a couple of best German performances as presented below.

[35] Maps have been realised per each year, and can be provided upon request.

Fig. 9. Percentage Loss in Human Development, best regions in 2000 and 2011.



The graph in Fig. 9 shows the first ten regions in 2000 and the first ten in 2011 together, according to their levels in percent loss in potential human development- so those who score the lower values signifying a less unequal society. The comparison of performances in both years tell us that, despite multidimensional inequality remained almost invariant on average between the examined points in time, some changes occurred among the top rankings too. Just two regions are twice in the top ten, which are the Austrian Oberösterreich and Tirol (i.e. AT31 and AT33). Interestingly, the only capital region in this chart is Berlin (DE30), which is fourth in 2000 but falls down to the 62nd position in 2011. As in previous charts, the median red lines[36] implicitly unveil the magnitude of the values range between the top and the bottom ranking regions, and the gap between the highest ranks and the majority of regions. What has to be considered are the changes in the distribution indeed. It seems to be quite persistent, with lagging regions left behind, a few changes in the values at the top, and some more variations in the middle section.

A cartographic representation of the same values may better help understand the spatial dimension of this distribution. The following Fig. 10 and 11 display reported levels of inequality, where classes of values represent the magnitude of deviations from the mean, and the cut-off points roughly correspond to the quintiles of the distribution.

Fig. 10 Loss in Human Development, 2000

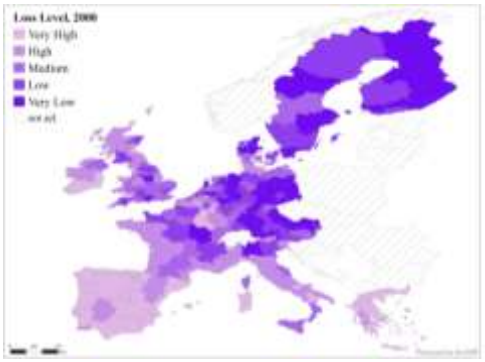
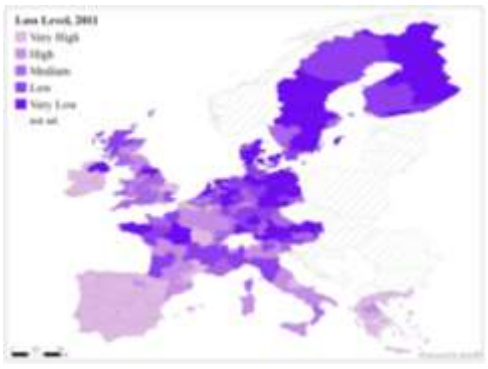


Fig. 41 Loss in Human Development, 2011



Despite some changes in the values of the index and a slight reduction in the average scores, the spatial connotation and persistence of the considered phenomenon is here evident. Lighter colours, corresponding to higher level of the estimated measure of inequality, are lingeringly associated with the southern regions. Lower levels of loss in human development, so to say lower levels of inequality, are

[36] Here median value is 0.052 in 2011 and 0.048 in 2000. Simple arithmetic mean is instead 0.055 in 2011 and 0.050 in 2000. Average values fluctuates around a percentage loss of 5%.

always more concentrated in the Scandinavian countries. Regions in the middle section of the distribution are those experiencing more fluctuations in their performances, and a general decrease can be seen for German and UK ones, with a wider subnational variation between the French territories instead. Nevertheless, these results might mean that further hidden dynamics are in place, besides the ones that spatial distribution patterns can suggest at a first glance.

3.1. How do these results compare with other indicators?

Finally, it can be interesting to compare the estimated measures to indicators traditionally used to evaluate regional performances in the economic dimension alone: production, income, unidimensional inequality.

Fig. 5 Comparing HDI to GDP, 2011

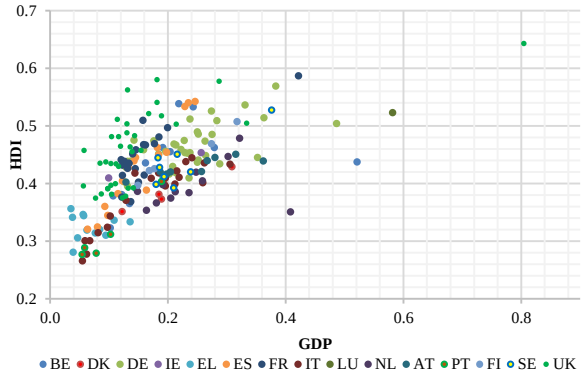


Fig. 7 Comparing IHDI to GDP, 2011

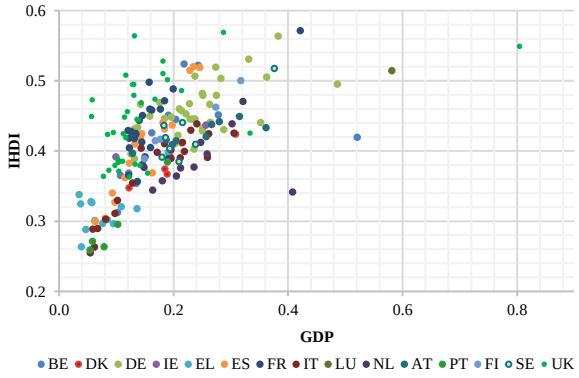


Fig. 6 Comparing Loss to GDP, 2011

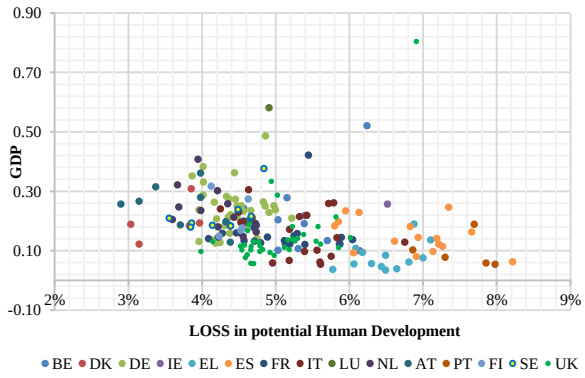
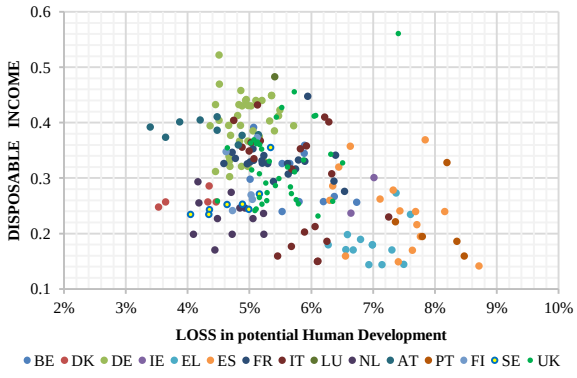


Fig. 8 Comparing Loss to Disposable Income, 2011



As shown in Fig. 12 to 15, the pattern results less clear than one could expect. The indicators partly capture the same variation, whilst the behaviour appears to be different among Member States, and not necessarily following a linear correlation. GDP data come from OECD regional database; originally expressed in national currency at current prices, they have been converted to PPS and then normalized in order to make them comparable to the values of estimated measures[37]. Disposable Household Income is the same variable used for calculating the HDI in the previous sections[38]. Better performing and richer regions do not imply a more equal distribution, as well known, and not even a higher inequality. Other variables and dimensions may play an important role, and these have to be further explored. As predictable, passing from HDI in Fig.12 to IHDI in Fig.13, the position of some outliers like London is resized making clearer that higher values may conceal higher inequalities in its outcomes' distribution. This is confirmed by Fig.14, where the same region shows one of the highest values of loss in potential human development. Additionally, Fig.15,

[37] Min and Max used have been selected among the internal distribution on extended time range, and happen to be respectively: UKI1 Inner London in 2013 with a PPS value of 100958, and ES43 Extremadura in 1999 with 11652.
[38] See paragraph 2.3 for further details.

where the x-axis is still representing the estimated inequality, produces a more scattered association witnessing a weaker correlation between GDP and disposable income of households.

Last comparison concerns a widely used measure of income inequality, the GINI Index. It has here been calculated on the EU-Silc disposable income data previously used to estimate the within inequality and to adjust the regional HDI to it. Despite some limitations due to data collection and availability characteristics[39], it is interesting to notice a correlation between the two measures as shown in Fig. 16 below. The two different measures of inequality may seem to share the same pattern across regions.

Fig. 9 Comparing Loss to GINI, 2011.

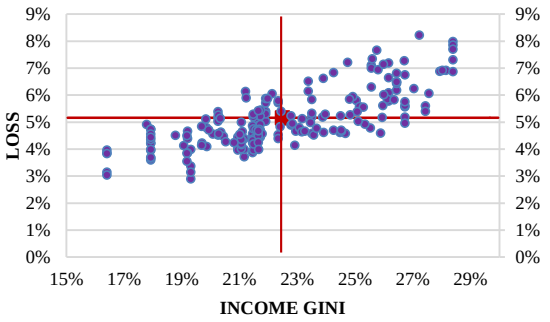
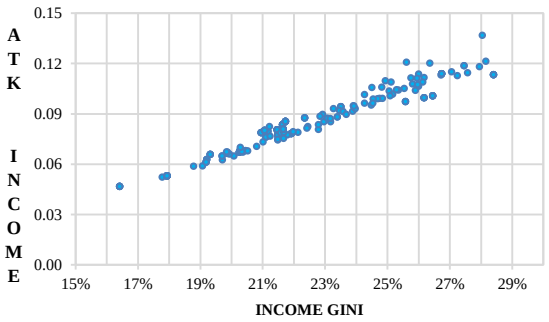


Fig. 107 Comparing Atkinson on Income to GINI, 2011.



Looking at the Loss components separately, though, the picture changes. The three single dimensions show different spatial distributions, and what emerges is the Atkinson measure calculated on disposable income data to be the one leading the results closer to the GINI index. Similarity is unsurprisingly more pronounced between the two income inequality measures indeed, while for the Atkinson measures calculated on either health or education distributions, the path appears more scattered and erratic- as depicted below, in Fig. 18 and 19 respectively.

Fig. 118 Comparing Atkinson on Health to GINI, 2011

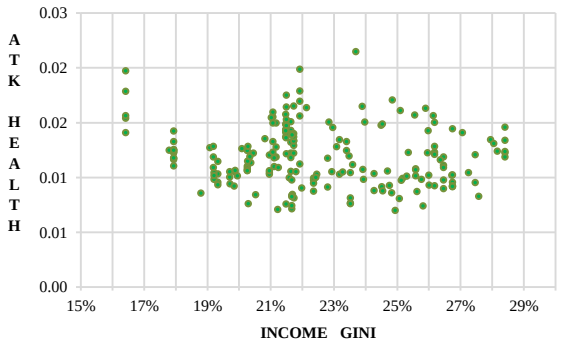
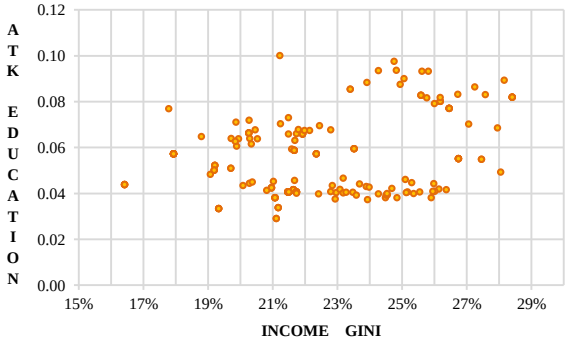


Fig. 129 Comparing Atkinson on Education to GINI, 2011



It is worth reminding that this analysis takes into account the *disposable* income distribution, and this choice unavoidably affects the obtained results and inferred conclusions. Redistribution, defined as the difference between market income[40] and disposable income inequality, has been estimated around 27% on average in OECD countries in 2016. This means that cash and in-kind transfers (e.g. unemployment benefits and health-care) along with income taxes, mitigated an average of one third of differences in income distribution. Disposable income implicitly excludes from consideration other components of income dynamics, like changes in market wages and tax base composition, and so may show also less remarkable fluctuations over time. Especially over a period of economic crisis, market incomes may experience shortfalls, and automatic stabilisers can change considerably due to response policy measures. However, all of this is somehow concealed in the disposable income distribution.

[39] See the "Additional notes on methodology and limits" in the Annex for further details.
[40] OECD (2016) defines market incomes as "labour and capital incomes plus private transfers".

Conclusions.

The aim of this article was to produce a measure of multidimensional inequality, possibly useful to investigate socioeconomic dynamics at the regional level in the EU15 in recent years. This goal has been tackled within the theoretical framework of Sen's *capability approach* (1987), following the human development paradigm in the choice of which methodology to apply, what relevant variables to include and how to statistically treat them. Therefore, a *Human Development Index* has been first realised, and then it has been adjusted to inequality based on sub-regional distribution of selected variables. The produced results allowed to infer the level of loss in potential human development due to registered inequalities, and so to obtain a proxy for multidimensional inequality. The purpose was to produce a measure as accurate as possible, and sensitivity analyses have been carried out. But it still has to be born in mind some basic and important assumptions, where many of the critical issues relate to data limitations and the imperfect alternatives within which one can choose. The inequality in the selected variable, for example, has to be agreed as an acceptable proxy of inequality in the related dimension, or at least that it moves in a similar direction (Alkire, Foster, 2010).

Besides the highlighted limits, this exercise confirms increased level of human development achievements despite a widespread persistent level of inequalities in its distribution between and within the EU, as well as spatial connotation of both dynamics. In the search for a synthetic measure of multidimensional inequality indeed, both the *between* inequalities in terms of human development across European regions and the *within* inequality in the underlying distributions of regional indicators have been accounted for. The better performing regions are those of southern UK and Germany, along with the French and Scandinavian capitals. The worst ranking ones are southern regions from Mediterranean countries. Placements are quite enduring over time, for either high or low values of the index, and the performances correlation appears pretty considerable also between HDI and IHDI.

When looking at the estimated loss in potential human development, its average levels tell us that multidimensional inequality has not significantly decreased over time: in most territories it did not change substantially in its values, in others slightly reduced. It is inversely correlated with human development indicators but in weak magnitude. Spatial distribution dynamics of considered inequality dimensions emerge already in this exploratory analysis, revealing part of the regional differentials.

To conclude, this is just a first step in exploring the pattern of inequalities across European regions, aiming to account for more than economic dimension alone. An important step further will be that of investigating on the potential correlation of the values of this multidimensional inequality to specific characteristics of considered places. This will serve to research on the substantial meaning of the calculated measure of inequality. For instance, it could be interesting reflecting on the connections between social, institutional, and geographic features, in the search for a really *multidimensional* explanation for the levels of inequality in a region. Further exploring the relations between these dimensions, and trying to assess their possible influence on inequality, will be the aim of the next section of this piece of research. A more in depth analysis of territorial dynamics will deal with regional production and social structures, making use of employment specialisation and social capital indicators contextualised by geographical proxies and governance quality measures. The final goal will be to test the spatial characteristics of inequality across EU regions.

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ANNEX

The example of gender subgroups in human development (§ 1):

In the male case, UK leads uncontested until 2005, when Northern Bavary scales up to the 8th position. It will remain in the top ten, reaching the second position in 2011. Also Stuttgart and Tubingen show good performance in the last year of the reference period, as well as Paris and Luxembourg in the last three years. País Vasco and Brabant Wallon appears just once per each.

About females, Germany is not there anymore (except for Northern Bayern ranked 8th in 2011), UK still leads almost alone, but besides Paris and Brabant Wallon, the Flounders and Stockholm with Helsinki appear in the last few years. Moreover looking at the values of the index performances, top measures are always around 0.55 for separate genders, and 0.66 for the aggregate; bottom values are about 0.20 for men and aggregate (even here there is a wider variation range), 0.25 for women.

Dividing the female HDI for the male HDI, we could also obtain the *gender-adjusted* HDI.

Estimates of Denmark regional education attainments (§ 2.1):

Missing data for this regional level in Denmark have been estimated on the basis of the available archives of the Danish National Statistical Institute, reconstructing the NUTS2 based on previous regional classification[41]. Educational attainments among Danish population aged 25-64 were available at the *ante-2007* counties and municipalities only. In order to include Denmark and not to leave its five regions totally empty in this substantive variable for a period of seven years, data have been so collected at the sub-regional level. The 271 Municipalities values in education have been divided by reference population in the same territories, and re-aggregated into current five NUTS2 regions on the basis of geographical pertinence[42].

Treatment of OECD regional data (§ 2.1):

Territorial Level 2 (TL2) covers the first administrative tier of subnational government[43], while Territorial Level 3 (TL3) stands for small regions under the OECD zone. The problem arises with the need of reporting TL2 and TL3 to NUTS classification, because NUTS2 corresponds to TL2 for some States, to TL3 for some others; a correspondence does not even exist for a few. Some estimates were necessary in order to make data comparable to our dataset in the cases of UK and Germany. In the first case, TL2s are NUTS1 and TL3s are NUTS3; in the second one, NUTS2 territories could be identified, but not by the 2010 classification, whose some units were missing. In both cases, data have been treated as follows: referring to Eurostat's Disposable household income[44] database, NUTS2 regions' incidence in the NUTS1 level has been estimated. Then this inferred percentage has been applied to TLs corresponding NUTS1s in order to estimate the missing NUTS2s. Where possible, the percentage incidence has been calculated per each year and so directly reported to the related year; otherwise on average of available years.

Luxembourg, whose NUTS2 level corresponds to NUTS1 and NUTS0 as well, is missing until 2006 though, and that is why it has been considered invariant at the 2006 level for the previous years

Health adjustment to inequality (§ 2.2):

Working directly on available life tables[45], a measure of inequality within the health dimension has been obtained using the distribution of the expected age at death that Kovacevic defines (2010) by $\{A_n(x), w_n(x)\}$, where:

[41] "On 1 January 2007, the Danish Local Government Reform came into force. The reform is the largest overall reform of the public sector in a generation. The reform has created a new map of Denmark. 98 municipalities replaced the previous 271. 13 counties were abolished and five regions were created" "The Local Government Reform – in brief", Ministry of Interior and Health, 2006. Further details online.

[42] Updated maps of 1983 Counties (Amter) along with Municipalities (Kommuner), as well as 2007 Regions (NUTS2 equivalent) can be found online.

[43] No regions have been defined for Luxembourg as well as it happens with NUTS classification.

[44] Taken at Euros per capita.

[45] It has to be noted that UN life tables are abridged ones with five-years age interval, while Eurostat available ones are year-by-year. The used age interval here considered has then been $n = 1$.

$w_n(x)$ is the proportion of the hypothetical starting cohort of 100,000 that dies in the age interval, calculated as follows:

$$w_n = \frac{l(x) - l(x+n)}{100{,}000} \qquad (k)$$

with $l(x)$ counting the number of survivors among the starting cohort at age x[46], and $\sum_{x=0}^{85} w_n(x) = 1$;

and $A_n(x)$ is the approximation of expected age of dying for those in the same age interval $(x, x+n)$ by

$$A_n(x) = x + \quad {}_n a_x \qquad (l)$$

whit ${}_n a_x$ representing the average number of years lived in the age interval $(x, x+n)$ by those dying during the same period.

Recalling the Atkinson's measure derivation *(e)* , it can now be applied to the estimated one in life expectancy:

$$A_x = 1 - \frac{M_0}{M_1} \qquad (m)$$

where: $\begin{cases} M_0 = \sum_{x=0}^{85} w_n(x) \cdot A_n(x) \\ M_{1=} \prod_{x=0}^{85} [A_n(x)]^{w_n(x)} \end{cases}$

HDI robustness analyses (§ 2.3):

Given the main aggregate HDI index made up of x_i dimensions[47], the second procedure follows the "leave one out" approach so to:

- remove the j[th] dimension
- recalculate the values of the index with x_{i-n}dimensions
- re-add the j[th] dimension
- remove the consecutive dimensions
- recalculate the values of the index without it
- repeat the procedure for all *n* dimensions[48]

Six new indices have been obtained this way. Based on these estimates, six new ranks of 205 considered regions have been calculated. Rank correlation has been calculated on these ranks, and the Pearsons's correlation coefficients have been estimated per each *xy* pair of ranks. These coefficients, labelled ρ_{xy}, are measures of their covariance[49] and always have value range of ± 1. Specifically, variables can be:

- directly correlated, with $\rho_{xy} > 0$
- uncorrelated, with $\rho_{xy} = 0$
- inversely correlated, with $\rho_{xy} < 0$

Based on the exact value they assume, correlation can be:

- weak, when $0 < \rho_{xy} < 0{,}3$
- moderate, when $0{,}3 < \rho_{xy} < 0{,}7$
- strong, when $\rho_{xy} > 0{,}7$

The following table reports rank correlation coefficients by the Spearman test: star coefficients mean significance level at the 1% or lower. Main index rank is labelled rhdi, followed by the weighted geometric means (rhdi**i** rhdi**h**

[46] Data are provided by Eurostat.
[47] Where $i = 1,2,3$ here.
[48] Here $n = 3$: health, education, income.
[49] Covariance is a statistical measure of the intensity of the functional link existing between two considered variables. It can assume either positive or negative values, but it anyway shows the way of the correlation. In this case, since it has been estimated on rank pairs of indexes, it means if the change in index calculation, removing and adding each dimensions, are positively or negatively correlated.

rhdi**e**, where the bold letters stands for the dimension with the higher weight) and by the "leave-one-out" ones (rhdi**ie** rhdi**ih** rhdi**eh**, where the bold letters stands for the dimensions included) Spearman's tests have been run by each year separately as well, and results are still significant at the same percentage.

Fig. 18 Results of robustness analysis on HDI

	rhdi	rhdii	rhdih	rhdie	rhdiie	rhdiih	rhdieh
rhdi	1.0000						
rhdii	0.9647*	1.0000					
rhdih	0.9509*	0.9055*	1.0000				
rhdie	0.9382*	0.8549*	0.8330*	1.0000			
rhdiie	0.8782*	0.8768*	0.7080*	0.9216*	1.0000		
rhdiih	0.8295*	0.8881*	0.8967*	0.6087*	0.5887*	1.0000	
rhdieh	0.8167*	0.6584*	0.8180*	0.8874*	0.6627*	0.5086*	1.0000

The performed analysis can eventually say that the estimated index of regional human development is robust. In fact, only three coefficients are below 0.7 and all of them prove a level of significance at 1%.

IHDI robustness analysis' (§ 2.3):

The four additional indices have been checked by the Spearman's rank correlation test, as already done with the HDI. The following Fig.18 reports the rank correlation coefficients produced by the test. Star coefficients mean significance level at the 1% or lower. Main index' rank is labelled rihdi, followed by the four variants replications. First, the one with changes in income trimmed values, which uses the 1st and 99th percentiles' thresholds instead the 5% and 95% ones: rihd**lb** and rihdi**hb**, where the bold letters stands for higher and lower bound. Then, the one considering plain ISCED levels' distribution as if their years of schooling were unvarying: rihdi**ed**. And finally, the one with abridged life tables: rihdi**he**.

Fig. 139 Results of robustness analysis on IHDI

	rihdi	rihdihb	rihdilb	rihdied	rihdihe
rihdi	1.0000				
rihdihb	0.9980*	1.0000			
rihdilb	0.9978*	0.9997*	1.0000		
rihdied	0.7776*	0.7820*	0.7816*	1.0000	
rihdihe	0.9361*	0.9350*	0.9356*	0.7455*	1.0000

Additional notes on methodology and limits:

About the choice of ε=1 and its direct implications on the EDE achievement, that is this is computed by a geometric mean. The meaning and the interpretation of parameter ε is relatively well studied in the literature on income inequality, especially as it relates to the idea of redistribution of income (by the Okun's "leaky bucket" approach, 1975). This is directly related to the consideration that, once accounted for inequality in the distribution, the poor could benefit from its reduction via a transfer from the rich and see their level of income increased. Atkinson itself reformulated the Okun questions in order to conceptualise the proportion of the transfer based on the chosen ε along with the average income of the group from which the transfer is made (Atkinson, 1983). Transposition of this reasoning to the case of human development achievements is weak though: reduction of multidimensional inequality is not possible through a transfer of years of schooling from more educated to less educated people; as it is for health, since longevity of some individuals cannot be reduced to gain in length of life for others. Although the aversion to inequality of outcomes different than income of course exists, it cannot be neither easily assessed nor normatively set. Some authors tried for example to measure the attitudes to inequality aversion of people by survey data (Kovacevic reports of Amiel et al, 1999), and found that their estimates are lower than the values typically used in inequality analysis.

About the use of EU SILC microdata. Despite being the best measures available for our variables of interest at the individual level, they are not available for all selected NUTS2 regions: the survey is originally intended for analysis at the national level, and most of the reliability rest at that one. When surveyed data are broken down by region, the primary concern is the increased sampling error. However, robust analyses have been produced explaining the correct ways one can use to infer at subnational level, and so do many studies (Verma, Betti, Gagliardi, 2010). Therefore in order to use these data source for the inequality-adjusted HDI and obtain estimates comparable to the previous HDI, there would have been two choices: either to (re)calculate the HDI at different NUTS levels in line with the regional availability in the EU-Silc regions (DB040); or to keep the chosen NUTS2 level and adapt the survey sub-level availability to it. Here the second one has been followed. Where the preferred level of detail was not available in the survey data, Atkinson measures have been calculated on NUTS at the immediately available upper level, as shown in the table below. These measure, which represent a macro-region averaged value actually, have so been weighted by virtue of the percentage distribution of population among regions in their macro-regions average values. Moreover, when NUTS2 levels where available for only some of the considered years, the results of calculations done on them have been extended to all other years. The reason for the latter is that the adjustment to inequality was intended more relevant for space comparisons than over time ones. Finally, for all years before 2004, values have been assumed to be constant at 2004 levels. These choices mean that in certain cases the trustworthiness of the estimated measures may have been compromised by virtue of spatial comparability.

Table 1. Available NUTS level, EU-Silc 2004-2011

Country	2004	2005	2006	2007	2008	2009	2010	2011
AT	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
BE	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
DK	0	0	0	0	0	0	0	0
DE	-	*1*	*1*	0	0	0	0	0
ES	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
FI	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
FR	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
GR	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
IE	0	0	0	0	0	0	0	0
IT	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
LU	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
NL	-	0	0	0	0	0	0	0
PT	0	0	0	0	0	0	0	0
SE	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
UK	-	0	0	0	0	0	**2**	**2**

Table 2. Descriptive statistics of relevant variables

Variable	Obs	Mean	Std. Dev.	Min	Max
HDI	2460	0.3721	0.0775	0.1300	0.6600
IHDI	2460	0.3522	0.0744	0.1185	0.6212
Loss	2460	0.0542	0.0142	0.0134	0.1116
coeffHI	2460	0.0538	0.0102	0.0349	0.0829
Health	2460	0.5497	0.1335	0.1000	0.9400
I.health	2460	0.5418	0.1334	0.0964	0.9337
Atk.he	2460	0.0153	0.0041	0.0067	0.0355
Education	2460	0.3368	0.0924	0.0800	0.6600
I.education	2460	0.3181	0.0888	0.0736	0.6274
Atk.ed	2460	0.0569	0.0169	0.0292	0.1024
Income	2460	0.2958	0.0918	0.0700	0.7400
I.income	2460	0.2697	0.0837	0.0607	0.6396
Atk	2460	0.0892	0.0203	0.0465	0.1609

Rankings according to different estimates of Human Development Index between 2000 and 2011

Table 5. Best 20 regions, according to the HDI estimated values

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
UKJ2	UKJ2	UKJ2	UKJ1	UKJ2	UKJ2	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1
UKJ1	UKJ1	UKJ1	UKJ2	UKJ1	UKI1	UKJ2	UKJ2	UKJ2	UKJ2	UKJ1	FR10
UKI1	FR10	FR10	FR10	FR10	UKJ1	UKJ1	UKJ1	FR10	UKJ1	FR10	UKJ2
FR10	UKI1	UKI1	UKI1	UKI1	FR10	FR10	FR10	UKJ1	FR10	UKJ2	UKJ1
DE21	UKI2	UKH2	UKH2	UKH2	UKI2	UKI2	UKI2	ES21	UKI2	DE21	DE21
UKI2	UKH2	UKI2	DE21	DE21	UKH2	ES21	DE21	DE21	ES21	ES21	UKI2
UKH2	BE24	UKJ3	UKI2	UKI2	DE21	UKH2	UKH2	UKI2	DE21	UKI2	ES21
UKK1	UKK1	BE24	UKE2	UKK1	UKK1	DE21	ES21	ES30	ES30	ES22	ES30
BE24	DE21	BE31	BE24	BE24	ES22	UKK1	ES22	BE24	BE24	ES30	UKH2
DE11	UKJ3	ES22	UKJ3	UKJ3	ES21	UKK2	BE24	ES22	UKH2	BE24	DE11
BE31	BE31	UKK1	UKK1	UKE2	UKJ3	ES22	UKK1	UKE2	UKE2	UKH2	BE31
UKE2	UKK2	UKK2	ES22	UKK2	UKK2	BE24	ES30	UKH2	ES22	BE31	ES22
UKJ3	ES22	ES30	UKK2	ES22	BE24	ES30	UKK2	DE11	UKJ3	DE11	BE24
SE11	UKE2	DE21	ES21	ES21	UKD6	UKJ3	BE31	UKJ3	LU00	UKK1	DE14
UKK2	DE11	UKE2	DE11	BE31	BE31	UKE2	UKJ3	SE11	BE31	LU00	LU00
ES30	ES30	UKG1	BE31	DE11	ES30	DE11	UKE2	UKK1	UKK1	UKJ3	SE11
DE14	DE14	ES21	DE14	UKD6	DE11	UKG1	UKD6	DE14	SE11	SE11	UKJ3
ES22	UKG1	DE11	ES30	ES30	UKE2	BE31	DE11	UKK2	DE11	UKK2	UKK1
DE71	ES21	SE11	SE11	DE14	DE14	UKD6	UKG1	UKD6	UKD6	DE14	DE13
DED5	SE11	FI20	UKD6	UKG1	UKG1	DE14	DE13	BE31	UKK2	UKE2	DE71

Table 6. Worst 20 regions, according to the HDI estimated values

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
UKM3	UKM3	EL23	FR30	DK02	EL13	EL42	ES62	EL13	DK03	DK02	EL42
ITF4	ITF4	UKM3	EL23	EL24	EL24	EL13	DK05	EL24	EL42	EL43	ITG2
ITF5	FI1D	EL12	EL12	ITG2	DK02	EL25	EL24	DK05	ES61	EL25	BE32
PT17	EL12	DK02	UKM3	EL25	EL42	ES43	ITF5	EL23	EL25	BE32	ES61
FR30	PT17	PT17	ITF5	EL14	ES61	ES61	EL23	ITF5	DK02	ES61	EL24
ITF6	BE32	ES61	ITG2	ES61	ITF5	EL23	ES43	ES61	EL23	EL24	ES43
EL14	ITF6	ITG2	EL22	ITF5	EL22	ITF5	ES61	ES43	ITF5	ITG2	ITF5
ES61	EL23	ITF4	ES61	BE32	ES43	DK02	DK02	DK02	ES43	ITF5	EL25
EL23	DK02	BE32	BE32	ES43	ITG2	ITG2	ITG2	ITG2	BE32	EL22	PT15
IE01	ES61	ES43	ITF4	ITF4	BE32	BE32	BE32	BE32	ITG2	PT15	EL43
ITG1	ITF5	ITF5	ES43	ITF6	EL23	EL22	EL22	ITF4	EL11	ES43	EL22
ES43	ITG1	EL25	EL25	EL23	ITF6	ITF6	ITF6	ITF6	PT15	EL23	EL23
EL12	EL25	ITF6	ITF6	ITG1	ITF4	ITF4	ITF4	EL11	ITF6	ITF6	ITF4
ITF3	ES43	ITG1	ITG1	PT15	PT15	PT15	EL11	EL22	EL22	ITF4	ITF6
EL25	ITF3	ITF3	EL11	ITF3	EL11	ITG1	ITG1	PT15	ITF4	EL11	PT16
EL11	EL11	EL11	ITF3	EL11	ITG1	EL11	PT15	ITG1	ITG1	ITG1	PT18
PT15	PT16	PT15	PT15	PT16	ITF3	ITF3	ITF3	ITF3	ITF3	PT16	EL11
PT16	PT15	PT16	PT16	PT18	PT16	PT16	PT16	PT16	PT16	ITF3	ITG1
PT18	PT18	PT18	PT18	EL22	PT18	PT18	PT18	PT18	PT18	PT18	PT11
PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT11	ITF3

Table 7. Best 20 regions, according to estimated "male-adjusted" HDI

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1
UKJ1	UKJ2	UKJ1	UKJ1	UKJ1	UKJ2	UKJ1	UKJ2	UKJ1	UKJ1	UKJ1	DE21
UKJ2	UKJ1	UKJ2	UKJ2	UKJ2	UKJ1	UKJ2	UKJ1	UKJ2	UKJ2	DE21	UKJ1
UKI2	UKH2	UKI2	UKH2	UKH2	UKI2	UKI2	UKI2	DE21	UKI2	UKJ2	UKJ2
UKH2	UKI2	UKH2	UKI2	UKI2	UKH2	UKD6	UKH2	UKI2	DE21	UKI2	BE31
UKK1	UKK1	UKJ3	UKJ3	UKD6	UKD6	UKH2	UKD6	UKM5	UKH2	DE11	DE11
UKE2	UKM5	UKM5	UKM5	UKK1	UKK1	UKK1	UKK1	DE11	LU00	LU00	UKI2
UKD6	UKJ3	UKK1	UKK1	UKE2	DE21	UKG1	DE21	ES21	UKM5	FR10	LU00
UKG1	UKD6	UKD6	UKE2	UKM5	UKM5	DE21	UKM5	UKH2	UKE2	UKM5	FR10
UKJ3	UKG1	UKM2	UKD6	UKJ3	UKG1	UKM2	FR10	UKD6	UKD6	UKH2	DE14
DE21	UKM2	UKG1	DE21	UKM2	UKJ3	UKE2	UKE2	UKE2	BE31	BE31	UKM5
UKM5	UKE2	UKK2	UKM2	DE21	UKM2	UKK2	ES21	BE31	FR10	DE14	DE71
UKM2	UKK2	FR10	FR10	UKG1	UKK2	UKM5	UKG1	FR10	ES21	BE24	DE12
UKK2	DE21	BE31	BE31	UKK2	FR10	UKJ3	UKJ3	BE24	DE11	ES21	ES21
BE31	BE31	UKE2	UKG1	FR10	UKE2	FR10	UKM2	UKM2	BE24	UKD6	UKH2
UKL2	FR10	UKJ4	UKL2	BE31	DE11	ES21	BE31	UKK1	UKK1	DE71	BE24
UKJ4	BE24	DE21	UKK2	UKH1	BE31	BE31	DE11	DE14	UKJ3	UKK1	DE13
DE11	UKH1	UKH1	DE14	DE11	BE24	DE11	BE24	NL31	DE14	DE25	DE25
DE71	DE11	UKL2	UKH1	BE24	DE14	BE24	UKK2	DE12	UKM2	DE12	DE60
FR10	DE14	UKK4	DE11	DE14	DE71	DE14	DE14	UKJ3	UKG1	DE13	DE27

Table 8. Best 20 regions, according to estimated "female-adjusted" HDI

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1
UKJ1	UKJ2	UKJ2	UKJ1	UKJ2	UKJ2	UKJ2	UKJ2	UKJ2	UKJ1	UKJ1	BE31
UKJ2	UKI2	UKJ1	UKJ2	UKJ1	UKJ1	UKJ1	UKJ1	UKJ1	UKJ2	UKJ2	UKJ1
UKI2	UKJ1	UKI2	UKH2	UKH2	UKI2	UKI2	UKI2	UKM5	BE24	BE31	UKJ2
UKK1	UKH2	UKH2	UKI2	UKI2	UKH2	UKM5	UKM5	UKI2	FR10	BE24	FI1B
UKM5	UKM5	UKJ3	UKE2	UKD6	UKM5	UKH2	UKH2	FR10	BE31	FR10	FR10
UKH2	UKK1	UKM5	BE31	UKM2	UKM2	UKM2	FR10	BE31	UKI2	FI1B	UKI2
BE31	BE31	UKK1	UKK1	UKK1	UKK1	UKK1	BE31	BE24	UKE2	UKI2	DE21
UKE2	UKM2	BE31	UKD6	UKM5	FR10	UKD6	UKD6	UKE2	UKM5	ES21	BE24
BE24	UKE2	FR10	UKM5	UKE2	UKD6	FR10	UKM2	UKH2	FI1B	SE11	SE11
UKM2	UKJ3	UKM2	UKM2	FR10	BE31	BE31	UKK1	ES21	ES21	UKH2	UKM5
FR10	FR10	UKE2	FR10	BE31	BE24	BE24	BE24	FI1B	UKH2	UKM5	ES21
UKD6	BE24	UKK2	BE24	BE24	UKE2	UKK2	UKE2	UKM2	SE11	DE21	LU00
UKG1	UKK2	UKD6	UKJ3	UKJ3	UKK2	UKG1	UKK2	UKD6	UKM6	ES22	UKH2
SE11	UKG1	BE24	UKK2	UKG1	UKG1	UKJ3	UKG1	UKK1	UKM2	UKK1	ES30
UKJ3	UKD6	UKG1	UKL2	UKL2	UKJ3	ES21	ES21	SE11	UKK1	UKM6	DE60
UKL2	UKL2	UKJ4	UKK4	UKK2	ES21	UKE2	FI1B	DE21	LU00	LU00	UKK1
UKK2	UKH1	UKK3	UKG1	UKJ4	UKL2	FI1B	UKJ3	UKJ3	ES22	ES30	ES22
BE10	SE11	UKH3	SE11	UKF2	UKJ4	ES22	UKM6	ES30	UKJ3	UKE2	UKE2
UKK4	UKJ4	UKM3	UKH1	UKH1	ES22	UKL2	ES22	ES22	ES30	UKD6	UKM2

Table 9. Worst 20 regions, according to estimated "male-adjusted" HDI

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
IE01	EL24	ITC2	ES42	EL24	ITC2	ES42	EL13	EL13	EL13	EL13	EL41
EL14	ES42	EL22	EL41	ES42	ES42	EL13	ES42	ES42	EL25	EL23	EL24
FR83	PT17	EL24	EL23	EL25	EL24	EL24	EL25	ITF1	FR83	EL25	EL43
ITF1	EL41	ITF1	ITF1	ITF1	EL42	EL25	EL11	EL11	EL23	EL42	EL23
ES42	ITF1	EL23	EL11	EL23	ITF1	EL42	EL42	EL24	ITC2	ITF1	EL13
EL23	EL23	PT17	ES43	EL11	EL23	ES43	EL24	ES43	ITF1	EL24	EL25
EL11	EL25	ES43	ITF2	FR83	ES43	ITF1	ITF2	FR83	ES43	EL11	EL11
ITF2	EL11	EL11	EL22	ITF2	EL11	EL11	ES43	EL42	EL42	EL22	ES43
EL25	ITF2	ITF2	EL25	ES43	ITF2	ITF2	ITF1	ITF2	ITF2	ES43	EL22
ITF6	ES43	EL25	FR83	ITF5	EL22	EL22	ITF5	ITF5	EL22	ITF2	ITF2
ES43	ITF4	ITF4	ITF5	ITF6	PT15	ITF5	EL22	EL22	ITF5	PT15	PT15
ITG1	ITF6	ITF3	ITF4	PT15	ITF5	ITF6	ITF6	ITF6	ITF6	ITF5	ITF6
ITF4	ITG1	ITF6	ITF3	ITF4	ITF6	PT15	ITF4	ITF4	PT15	ITF6	ITG2
ITF3	ITF3	ITG1	ITF6	ITF3	ITF3	ITF4	ITG1	ITG1	ITG1	ITG2	ITF5
ITF5	ITG2	ITF5	ITG1	ITG2	ITG1	ITG1	ITG2	ITF3	ITF3	ITF4	ITF4
ITG2	ITF5	ITG2	ITG2	ITG1	ITF4	ITF3	ITF3	ITG2	ITF4	ITG1	ITG1
PT15	PT16	PT18	PT15	EL22	ITG2	ITG2	PT15	PT15	ITG2	ITF3	ITF3
PT18	PT15	PT15	PT16	PT16	PT18	PT16	PT16	PT18	PT11	PT18	PT18
PT16	PT18	PT16	PT18	PT18	PT16	PT18	PT18	PT11	PT18	PT11	PT11
PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT16	PT16	PT16	PT16

Table 10. Worst 20 regions, according to estimated "female-adjusted" HDI

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
ES42	ITF1	ITF1	EL41	ITF2	PT15	EL23	ITF1	EL13	FR83	ES62	ES61
ITF1	EL24	ES43	ITF1	EL14	EL13	EL41	EL13	EL23	ITF1	EL43	ITF2
EL42	EL22	EL41	ES43	EL41	EL21	ITF2	ES43	EL41	EL23	PT15	ES43
EL14	EL41	ITF2	EL23	ES43	EL25	ES43	EL41	EL25	PT15	ITF2	PT15
EL24	ITF2	EL42	EL42	PT15	EL41	EL13	EL23	ES43	EL11	ES43	EL23
ES43	ES43	EL23	ITF2	EL42	ES43	EL25	EL25	EL24	ITF2	EL23	EL43
EL41	ITG2	EL25	EL24	EL24	EL23	PT15	EL24	FR83	ES43	EL25	EL25
EL23	EL42	EL24	ITG2	EL23	EL24	EL24	EL11	EL11	EL24	EL42	ITG2
ITG2	EL23	EL11	EL11	EL25	EL11	EL11	ITF5	PT15	EL25	EL11	EL22
ITF6	EL25	EL22	EL25	EL11	ITF5	ITF5	ITG2	EL42	ITG2	ITG2	EL24
EL25	ITF6	ITG2	EL22	ITG2	ITF6	ITG2	ITF6	ITF5	ITF5	EL24	EL42
EL11	EL11	ITF6	PT15	ITF6	ITG2	EL42	EL22	ITG2	EL42	ITF5	ITF5
ITG1	ITF4	ITF5	ITF5	ITF5	EL22	ITF6	EL42	ITF6	ITF6	PT18	PT18
ITF4	ITG1	ITF4	ITF6	ITF3	EL42	EL22	PT15	PT18	PT18	ITF6	PT16
ITF5	ITF3	PT15	ITF4	PT16	PT16	PT16	PT18	EL22	ITG1	EL22	EL11
ITF3	ITF5	ITF3	ITF3	ITF4	PT18	ITF4	PT16	ITF4	EL22	PT16	ITF6
PT18	PT18	ITG1	ITG1	ITG1	ITF3	ITF3	ITF4	ITG1	PT16	ITG1	PT11
PT15	PT16	PT18	PT16	PT18	ITF4	PT18	ITF3	PT16	ITF3	ITF3	ITF4
PT16	PT15	PT16	PT18	EL22	ITG1	ITG1	ITG1	ITF3	ITF4	ITF4	ITG1
PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT11	ITF3

Inequality-adjusted Human Development Index between 2000 and 2011, rankings:

Table 31. Best 20 regions, according to IHDI estimated values

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
UKJ2	UKJ2	UKJ2	UKJ1	UKJ2	UKJ2	UKI1	UKI1	UKI1	UKI1	UKI1	UKI1
UKJ1	UKJ1	UKJ1	UKJ2	UKJ1	UKJ1	UKJ2	UKJ2	UKJ2	UKJ2	UKJ1	FR10
UKI1	FR10	FR10	UKH2	FR10	UKI1	UKJ1	UKJ1	FR10	UKJ1	FR10	UKJ2
DE21	UKI1	UKI1	FR10	UKI1	FR10	FR10	FR10	UKJ1	FR10	UKJ2	UKJ1
FR10	UKH2	UKH2	UKI1	DE21	DE21	UKI2	UKI2	DE21	UKI2	DE21	DE21
UKH2	UKI2	UKI2	DE21	UKH2	UKI2	UKK1	DE21	ES21	DE21	UKI2	UKI2
UKI2	DE21	UKJ3	UKK1	UKI2	UKH2	DE21	UKH2	UKI2	BE24	ES21	UKH2
UKK1	UKJ3	BE24	UKE2	UKK1	UKK1	UKH2	UKK1	BE24	ES21	ES22	DE11
DE11	UKK1	UKK1	UKI2	UKJ3	UKJ3	UKK2	BE24	ES30	UKE2	BE24	BE31
BE24	BE24	UKK2	UKJ3	UKE2	UKK2	ES21	ES22	UKE2	UKH2	UKH2	SE11
BE31	UKK2	BE31	BE24	BE24	BE24	BE24	ES21	DE11	ES30	ES30	BE24
SE11	BE31	DE21	UKK2	UKK2	ES22	UKJ3	UKK2	ES22	ES22	UKK1	DE14
UKE2	UKE2	ES22	DE11	DE11	UKD6	ES22	UKJ3	UKH2	SE11	DE11	ES21
UKJ3	DE11	UKE2	ES22	BE31	DE11	UKE2	UKE2	UKJ3	UKJ3	BE31	LU00
DE14	ES22	ES30	DE14	UKD6	BE31	DE11	BE31	UKK1	LU00	LU00	ES30
UKK2	SE11	UKG1	BE31	ES22	ES21	ES30	DE11	SE11	UKK1	SE11	ES22
DE71	DE14	DE11	SE11	DE14	UKE2	UKG1	ES30	DE14	BE31	UKJ3	UKJ3
DED5	UKG1	SE11	DED5	ES21	DE14	BE31	UKD6	UKK2	DE11	UKK2	UKK1
DE13	DE71	FI20	FI20	UKG1	ES30	DE14	DE13	NL31	UKK2	DE14	DE71
UKD6	ES30	UKH3	DE71	ES30	UKG1	UKD6	DE14	DE12	DE14	DE71	DE13

Table 42. Worst 20 regions, according to IHDI estimated values

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
UKM3	UKM3	EL14	FR30	EL41	DK02	EL42	ES62	EL13	EL13	ES62	EL13
ITF5	EL14	UKM3	UKM3	EL24	EL24	EL25	EL25	EL42	DK02	EL43	BE32
ITF4	ITF4	EL23	EL23	ITG2	EL13	EL13	EL24	EL24	EL25	BE32	ITG2
FR30	DK02	EL12	ITF5	EL25	EL42	DK02	ITF5	ITF5	EL42	EL25	ES43
ITF6	ITF6	ITF4	EL12	BE32	ITF5	EL23	DK02	EL23	ES61	EL24	EL24
EL14	BE32	ITG2	ITG2	ITF5	EL22	ES61	EL23	DK02	EL23	ITG2	EL25
PT17	PT17	PT17	EL22	ES61	ES61	ITF5	ES43	ES61	ES43	ES61	ITF5
ES61	ES61	ES61	BE32	ITF6	BE32	ES43	ES61	ES43	ITF5	ITF5	ES61
IE01	EL23	BE32	ES61	EL14	ITG2	ITG2	BE32	ITG2	BE32	EL22	EL43
EL23	EL12	EL25	ITF4	ITF4	ES43	BE32	ITG2	BE32	ITG2	EL23	EL22
ITG1	ITG1	ES43	EL25	EL23	EL23	ITF4	EL22	ITF6	EL11	ES43	PT15
ES43	ITF5	ITF5	ES43	ES43	ITF4	EL22	ITF6	ITF4	ITF6	PT15	EL23
EL12	ES43	ITF6	ITF6	ITG1	ITF6	ITF6	ITF4	EL11	PT15	ITF6	ITF4
ITF3	EL25	ITG1	ITF3	ITF3	PT15	PT15	EL11	EL22	EL22	ITF4	ITF6
EL25	ITF3	ITF3	ITG1	PT15	EL11	ITG1	ITG1	PT15	ITF4	ITG1	PT16
EL11	EL11	EL11	EL11	EL11	ITG1	EL11	PT15	ITG1	ITG1	EL11	PT18
PT15	PT16	PT15	PT15	PT16	ITF3	ITF3	ITF3	ITF3	PT16	ITF3	EL11
PT16	PT15	PT18	PT16	PT18	PT16	PT16	PT16	PT16	ITF3	PT16	PT11
PT18	PT18	PT16	PT18	EL22	PT18	PT18	PT18	PT18	PT11	PT18	ITG1
PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT11	PT18	PT11	ITF3

Loss between 2000 and 2011, rankings:

Table 53. Best 20 regions, according to Loss in human development estimated values

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
DK02	DK03	DK02	DK02	SE11	DE26	DK05	DK05	NL31	NL13	NL22	FI19
SE33	SE12	SE31	SE23	DEA1	AT33	AT32	AT34	DK04	NL34	NL12	AT22
DEB3	SE22	SE33	DE30	FI1B	DE22	DK02	DK03	NL42	AT32	SE22	NL23
DEB2	AT21	ITC1	FI1C	DE73	DE21	DK04	AT22	SE32	DE93	FI1D	AT11
FR21	FI1C	AT12	SE12	DE12	NL33	SE23	DE22	DE94	DEB1	ITH2	UKK4
SE31	DE23	FI1C	DEF0	SE33	DK04	SE22	SE11	NL12	FR51	DE40	FI20
NL11	DE60	DK05	ITF3	NL33	AT32	DK01	SE33	FI1B	DE12	DK03	NL12
DK01	ITF1	DE30	NL34	DEB1	FI20	DEA3	UKK1	NL33	DK02	NL34	AT33
AT32	SE23	UKM6	DE72	DE26	AT22	DK03	SE22	DK05	AT21	AT22	NL41
NL22	DEE0	DEB3	NL31	FR25	DK01	NL34	SE21	FI1D	NL23	SE21	FR53
DEA4	NL31	AT33	NL21	DE93	AT21	DEA5	ITH3	NL23	DE27	FI1B	NL42
DK04	DED5	NL12	FI1D	SE23	UKL1	NL13	DE72	SE21	UKM6	FR21	FI1C
DE21	DE91	UKF3	DE24	AT13	DED2	AT21	SE12	SE31	NL12	UKK1	FR41
DE92	NL22	SE21	AT34	ITC2	DED5	DEB2	DEA5	FR72	FI20	FR24	DE27
DE71	DE94	FI20	NL12	AT12	SE32	DE14	DEB1	DE12	DE14	DE24	DK01
UKD1	DEA5	DEB2	DK04	DEG0	NL41	AT34	DED2	SE12	FI1B	DEB1	NL34
DED5	DEB1	DE24	DE11	DEC0	SE23	DEA2	DE11	AT12	DEF0	SE12	DE22
DK03	NL32	ITH5	DE22	NL32	DE80	ITH1	DE13	DED4	DE72	DE94	SE11
SE12	DEA1	FR51	SE32	SE32	DEC0	DE13	DE93	FR25	DK05	AT33	BE23
AT21	DE22	ITH3	DEA4	DK04	UKC1	AT12	FR25	NL11	UKK3	FR41	DK04

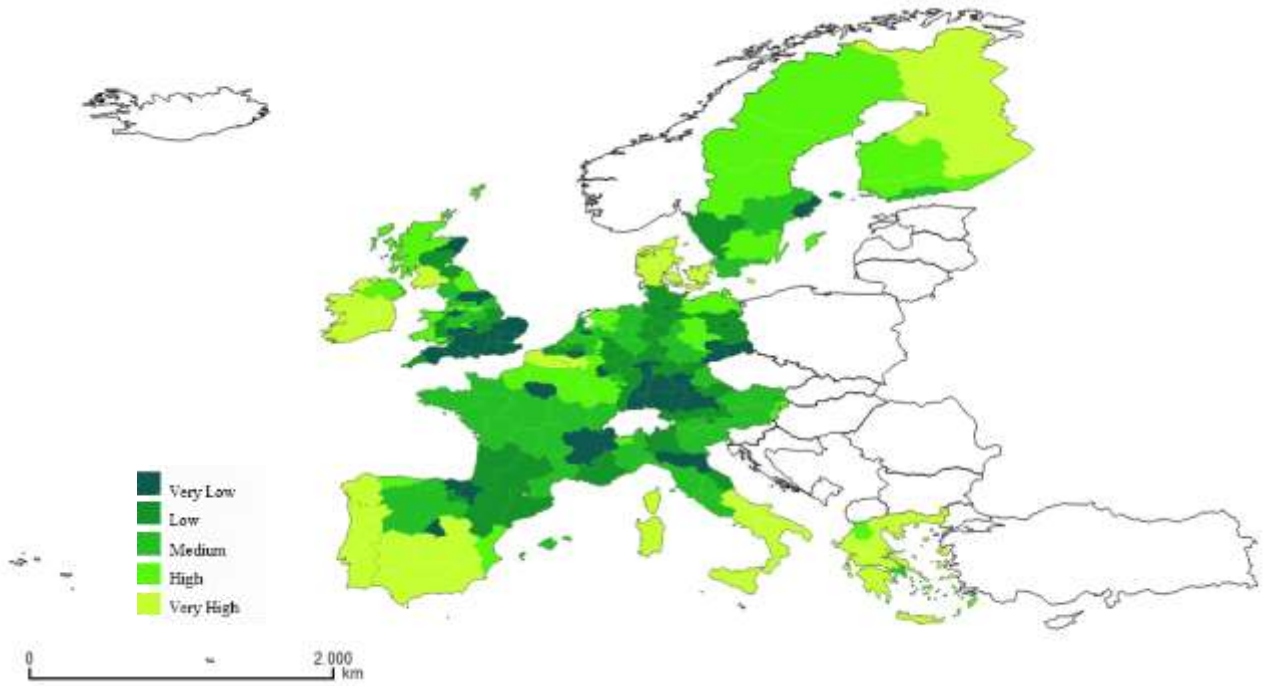
Table 64. Worst 20 regions, according to Loss in human development estimated values

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
ES13	PT11	EL24	ES52	ES11	ITF6	ITC1	PT16	PT18	ES22	ITF1	ES12
ES61	ES11	ES43	EL30	PT17	ES24	ES23	ES23	ES22	ITG2	ITG1	EL12
ES24	EL13	EL14	ES24	FR21	EL41	ES43	ES11	EL13	EL14	EL11	IE01
ES51	ES22	ITI4	ES61	ITI4	ES23	ES53	ES52	ITF2	ES23	ES52	IE02
EL30	FR81	ES30	EL24	ES42	EL14	ES30	EL43	EL30	EL41	ES51	ES52
EL42	EL42	PT11	BE10	ES52	ES43	EL24	ITF1	UKI1	FR81	EL13	EL23
BE35	ITF2	EL43	ES43	EL25	IE01	EL42	ES42	EL42	UKI1	EL24	ES23
ES52	FR30	ES51	ES12	ES22	ES53	PT16	ES53	EL14	PT11	ES30	BE10
PT15	ES43	ES12	EL42	PT11	EL43	EL25	EL23	ES24	ES43	PT18	EL30
PT11	ES23	ES13	ES42	ES30	IE02	EL13	ITG2	FR21	ES41	PT11	ITF4
PT18	ES52	ES11	PT16	ES62	ES62	BE10	ES21	ES12	ITF5	ITF6	ES21
ES53	EL25	ITC2	EL12	ITF4	PT16	FR23	EL42	ES62	EL11	ES41	EL22
ES11	EL21	PT15	PT15	EL12	ITG1	EL41	PT15	ITG2	ITG1	PT17	ES41
ES30	ITF3	PT17	EL14	ES23	EL25	FR83	ES30	ITF4	PT15	ES62	PT15
IE01	ES41	ES21	ES21	EL11	ES30	PT17	ES43	BE10	PT17	EL21	EL14
EL23	ES30	ITF5	ES51	PT15	ES21	ES21	ES41	EL41	BE10	ES21	ITF6
PT16	ES21	EL11	PT17	ES61	EL30	ES41	EL25	EL12	ES21	BE10	ES30
ITG1	ES53	BE10	EL11	ES43	ES61	PT18	PT11	ES30	ES52	ES61	ES51
PT17	ES62	IE01	ITF6	EL14	PT11	EL43	EL13	ES11	PT18	ES42	ES61
ES43	EL11	ES62	PT18	PT18	ES42	EL14	EL41	ES61	ITF3	PT15	ES42

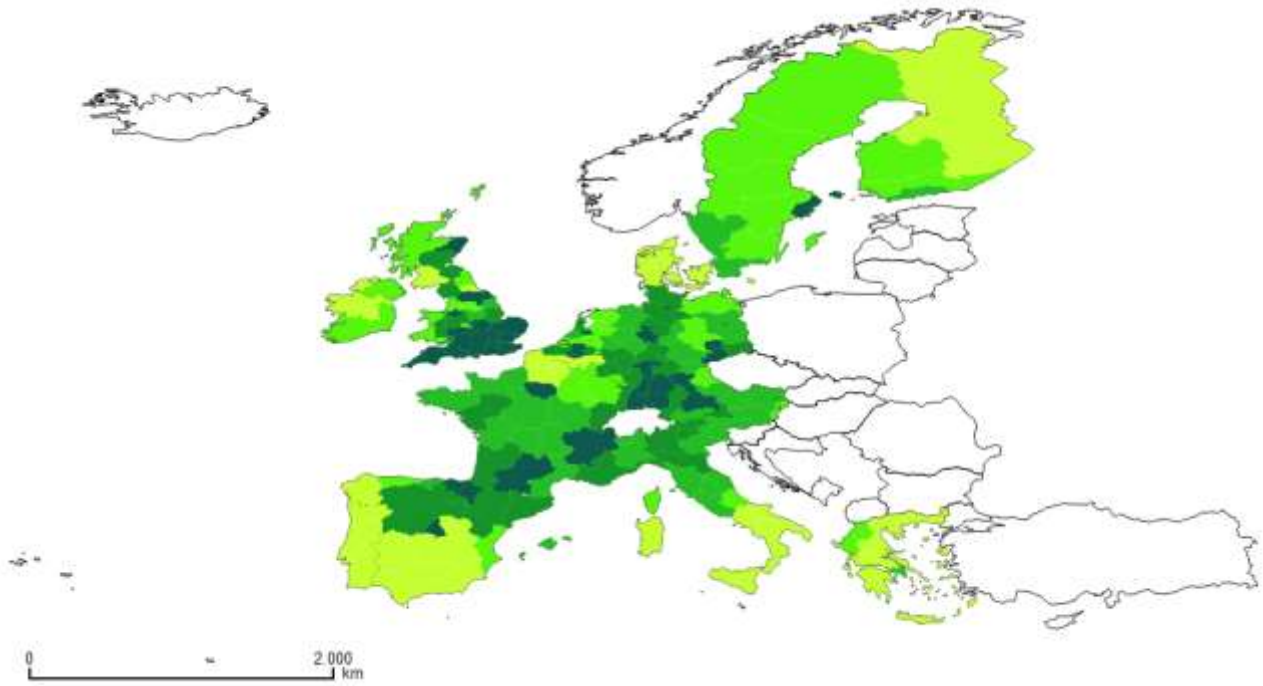
List of included regions:

BE10	Région de Bruxelles-Capitale
BE21	Prov. Antwerpen
BE22	Prov. Limburg (BE)
BE23	Prov. Oost-Vlaanderen
BE24	Prov. Vlaams-Brabant
BE25	Prov. West-Vlaanderen
BE31	Prov. Brabant Wallon
BE32	Prov. Hainaut
BE33	Prov. Liège
BE34	Prov. Luxembourg (BE)
BE35	Prov. Namur
DK01	Hovedstaden
DK02	Sjælland
DK03	Syddanmark
DK04	Midtjylland
DK05	Nordjylland
DE11	Stuttgart
DE12	Karlsruhe
DE13	Freiburg
DE14	Tübingen
DE21	Oberbayern
DE22	Niederbayern
DE23	Oberpfalz
DE24	Oberfranken
DE25	Mittelfranken
DE26	Unterfranken
DE27	Schwaben
DE30	Berlin
DE40	Brandenburg
DE50	Bremen
DE60	Hamburg
DE71	Darmstadt
DE72	Gießen
DE73	Kassel
DE80	Mecklenburg-Vorpommern
DE91	Braunschweig
DE92	Hannover
DE93	Lüneburg
DE94	Weser-Ems
DEA1	Düsseldorf
DEA2	Köln
DEA3	Münster
DEA4	Detmold
DEA5	Arnsberg
DEB1	Koblenz
DEB2	Trier
DEB3	Rheinhessen-Pfalz
DEC0	Saarland
DED2	Dresden
DED4	Chemnitz
DED5	Leipzig
DEE0	Sachsen-Anhalt
DEF0	Schleswig-Holstein
DEG0	Thüringen
IE01	Border, Midland and Western
IE02	Southern and Eastern
EL11	Ανατολική Μακεδονία, Θράκη
EL12	Κεντρική Μακεδονία
EL13	Δυτική Μακεδονία
EL14	Ήπειρος
EL21	Θεσσαλία
EL22	Ιόνια Νησιά
EL23	Δυτική Ελλάδα
EL24	Στερεά Ελλάδα
EL25	Πελοπόννησος
EL30	Αττική
EL41	Βόρειο Αιγαίο
EL42	Νότιο Αιγαίο
EL43	Κρήτη
ES11	Galicia
ES12	Principado de Asturias
ES13	Cantabria
ES21	País Vasco
ES22	Comunidad Foral de Navarra
ES23	La Rioja
ES24	Aragón
ES30	Comunidad de Madrid
ES41	Castilla y León
ES42	Castilla-La Mancha
ES43	Extremadura
ES51	Cataluña
ES52	Comunidad Valenciana
ES53	Illes Balears
ES61	Andalucía
ES62	Región de Murcia
FR10	Île de France
FR21	Champagne-Ardenne
FR22	Picardie
FR23	Haute-Normandie
FR24	Centre
FR25	Basse-Normandie
FR26	Bourgogne
FR30	Nord - Pas-de-Calais
FR41	Lorraine
FR42	Alsace
FR43	Franche-Comté
FR51	Pays de la Loire
FR52	Bretagne
FR53	Poitou-Charentes
FR61	Aquitaine
FR62	Midi-Pyrénées
FR63	Limousin
FR71	Rhône-Alpes
FR72	Auvergne
FR81	Languedoc-Roussillon
FR82	Provence-Alpes-Côte d'Azur
FR83	Corse
ITC1	Piemonte
ITC2	Valle d'Aosta/Vallée d'Aoste
ITC3	Liguria
ITC4	Lombardia
ITH1	Provincia Autonoma di Bolzano
ITH2	Provincia Autonoma di Trento
ITH3	Veneto
ITH4	Friuli-Venezia Giulia
ITH5	Emilia-Romagna
ITI1	Toscana
ITI2	Umbria
ITI3	Marche
ITI4	Lazio
ITF1	Abruzzo
ITF2	Molise
ITF3	Campania
ITF4	Puglia
ITF5	Basilicata
ITF6	Calabria
ITG1	Sicilia
ITG2	Sardegna
LU00	Luxembourg
NL11	Groningen
NL12	Friesland (NL)
NL13	Drenthe
NL21	Overijssel
NL22	Gelderland
NL23	Flevoland
NL31	Utrecht
NL32	Noord-Holland
NL33	Zuid-Holland
NL34	Zeeland
NL41	Noord-Brabant
NL42	Limburg (NL)
AT11	Burgenland (AT)
AT12	Niederösterreich
AT13	Wien
AT21	Kärnten
AT22	Steiermark
AT31	Oberösterreich
AT32	Salzburg
AT33	Tirol
AT34	Vorarlberg
PT11	Norte
PT15	Algarve
PT16	Centro (PT)
PT17	Área Metropolitana de Lisboa
PT18	Alentejo
FI19	Länsi-Suomi
FI1B	Helsinki-Uusimaa
FI1C	Etelä-Suomi
FI1D	Pohjois- ja Itä-Suomi
FI20	Åland
SE11	Stockholm
SE12	Östra Mellansverige
SE21	Småland med öarna
SE22	Sydsverige
SE23	Västsverige
SE31	Norra Mellansverige
SE32	Mellersta Norrland
SE33	Övre Norrland
UKC1	Tees Valley and Durham
UKC2	Northumberland and Tyne and Wear
UKD1	Cumbria
UKD3	Greater Manchester
UKD4	Lancashire
UKD6	Cheshire
UKD7	Merseyside
UKE1	E Yorkshire and N Lincolnshire
UKE2	North Yorkshire
UKE3	South Yorkshire
UKE4	West Yorkshire
UKF1	Derbyshire and Nottinghamshire
UKF2	Leicestersh., Rutland, N-hamptonsh.
UKF3	Lincolnshire
UKG1	Herefordsh.,Worcestersh,Warwicksh
UKG2	Shropshire and Staffordshire
UKG3	West Midlands
UKH1	East Anglia
UKH2	Bedfordshire and Hertfordshire
UKH3	Essex
UKI1	Inner London
UKI2	Outer London
UKJ1	Berkshire, Buckinghams.,Oxfordsh.
UKJ2	Surrey, East and West Sussex
UKJ3	Hampshire and Isle of Wight
UKJ4	Kent
UKK1	Gloucestersh.,Wiltsh.,Bristol/Bath
UKK2	Dorset and Somerset
UKK3	Cornwall and Isles of Scilly
UKK4	Devon
UKL1	West Wales and The Valleys
UKL2	East Wales
UKM2	Eastern Scotland
UKM3	South Western Scotland
UKM5	North Eastern Scotland
UKM6	Highlands and Islands
UKN0	Northern Ireland

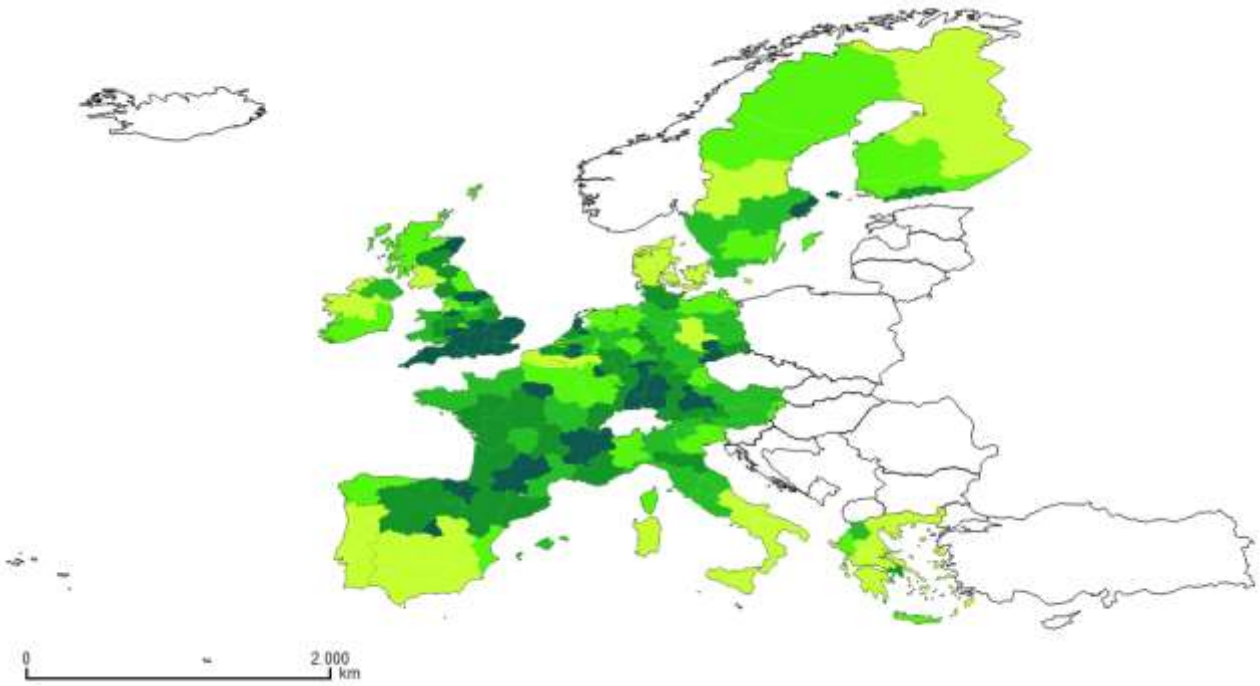
Map 1. HDI in 2000



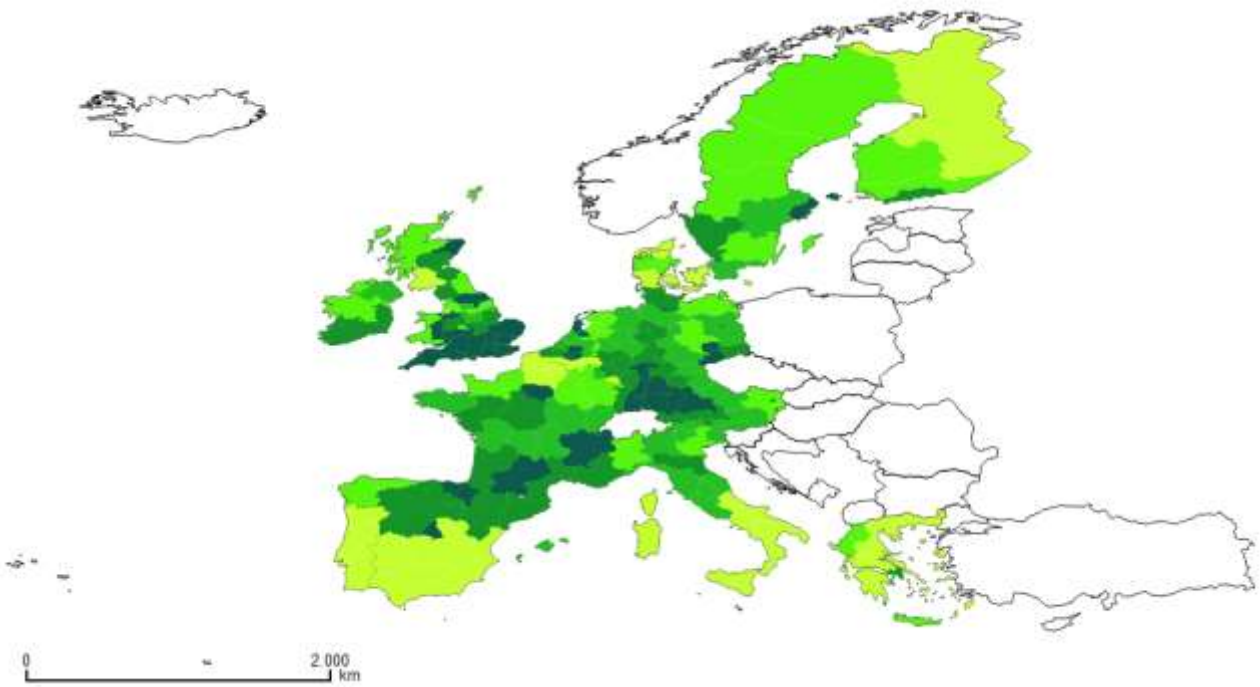
Map 2. HDI in 2001



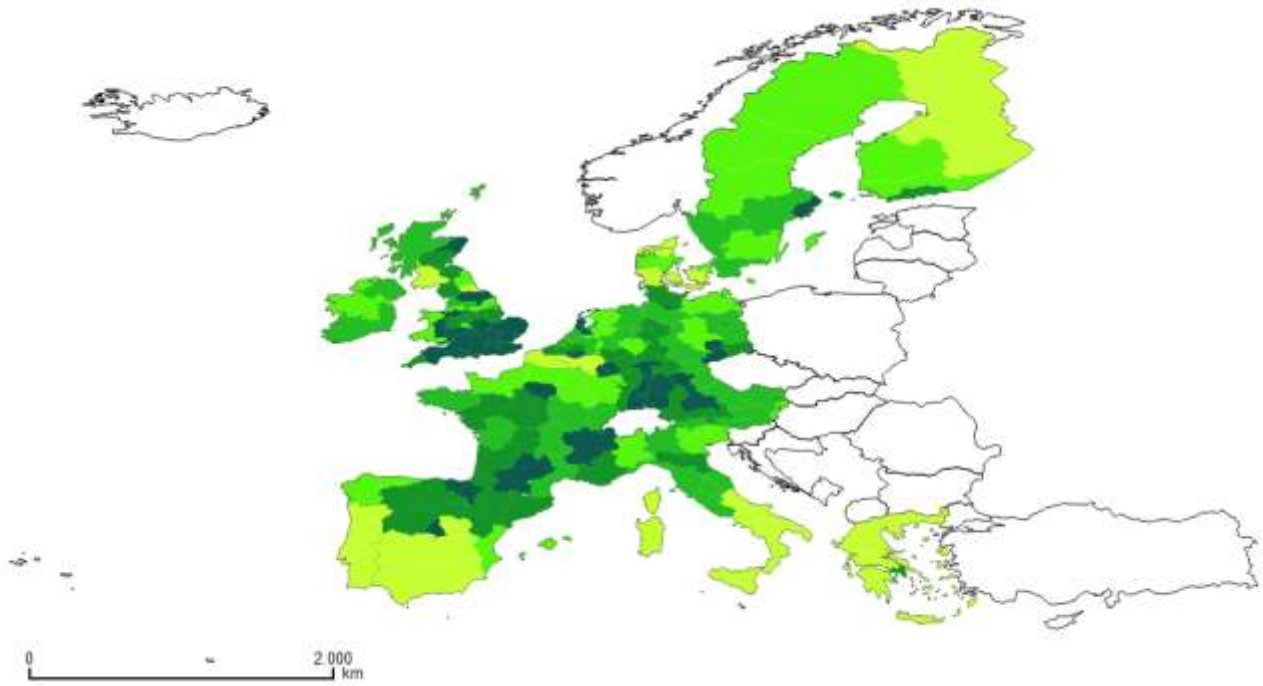
Map 3. HDI in 2002



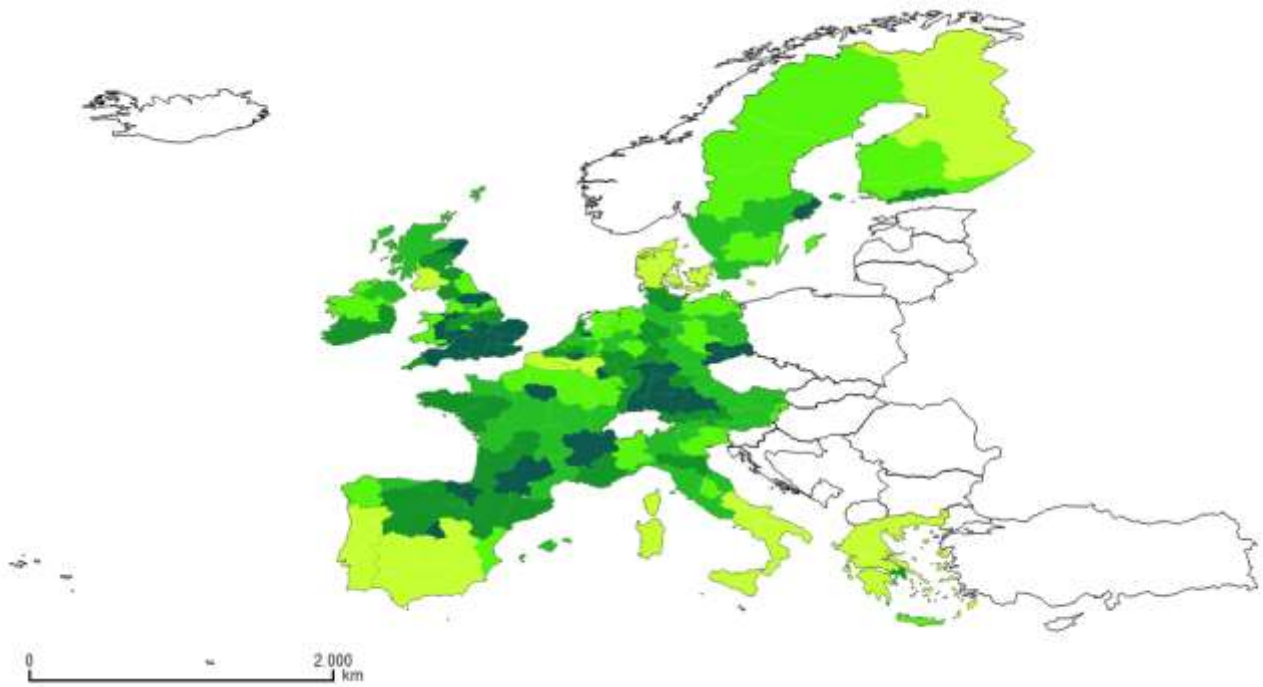
Map 4. HDI in 2003



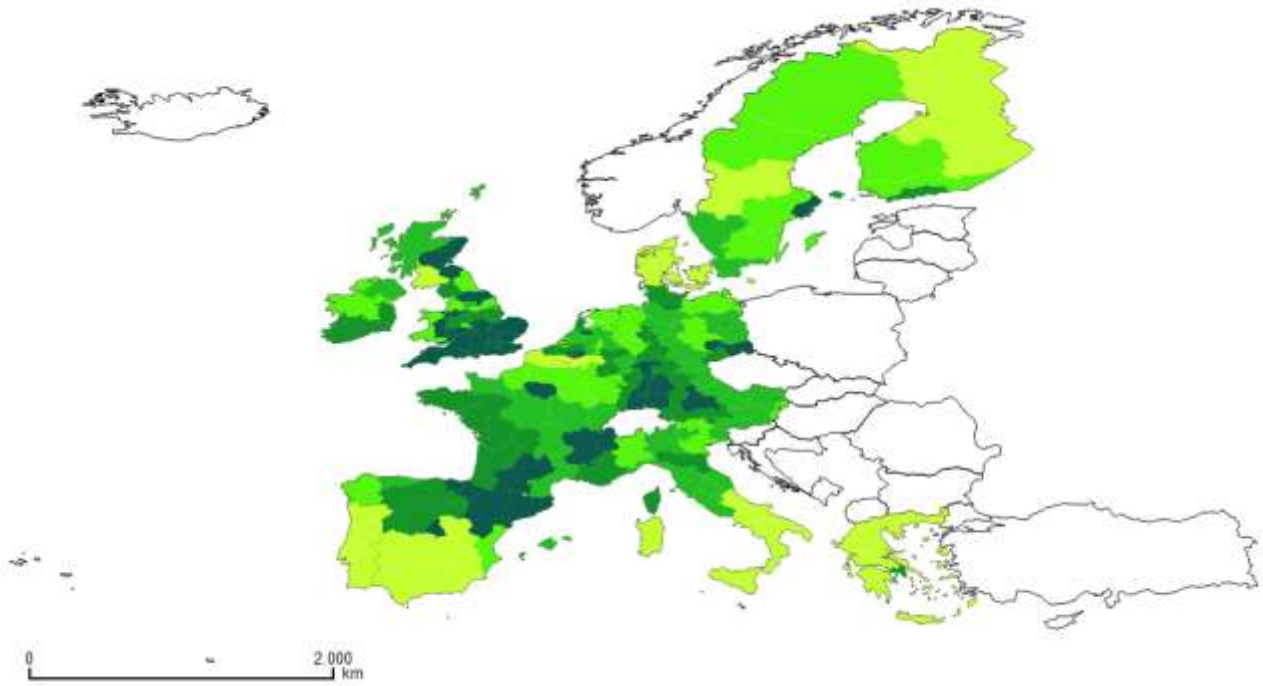
Map 5. HDI in 2004



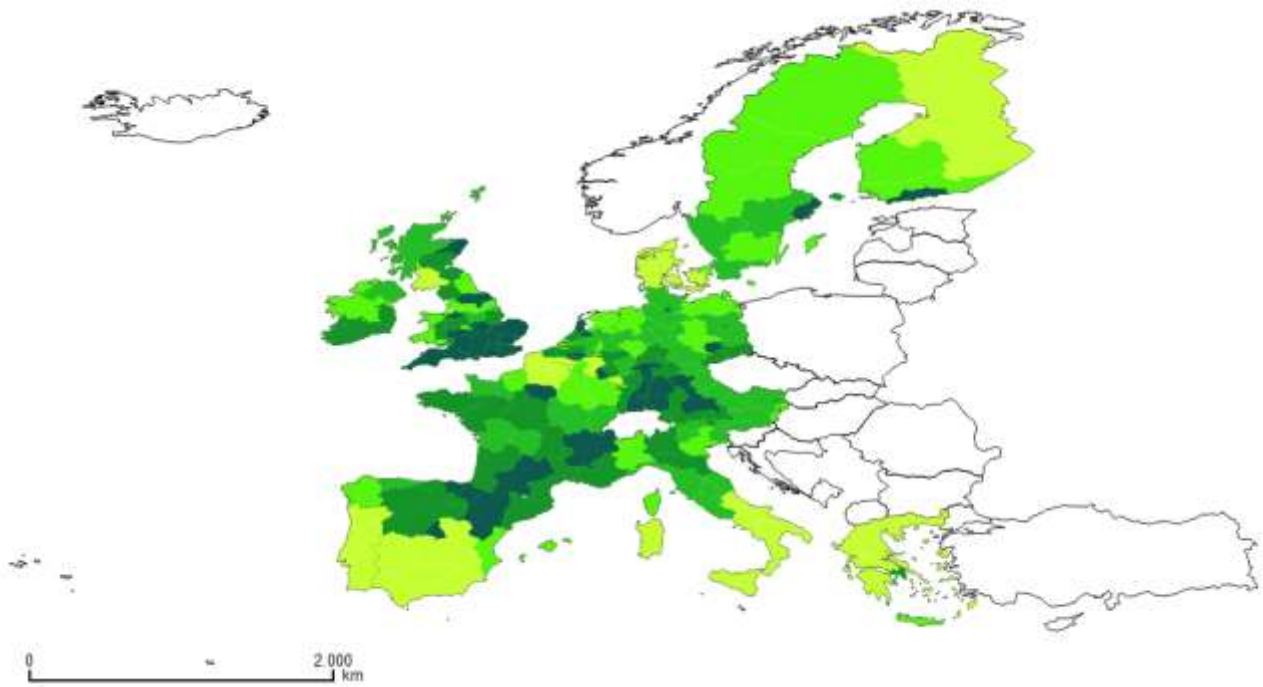
Map 6. HDI in 2005



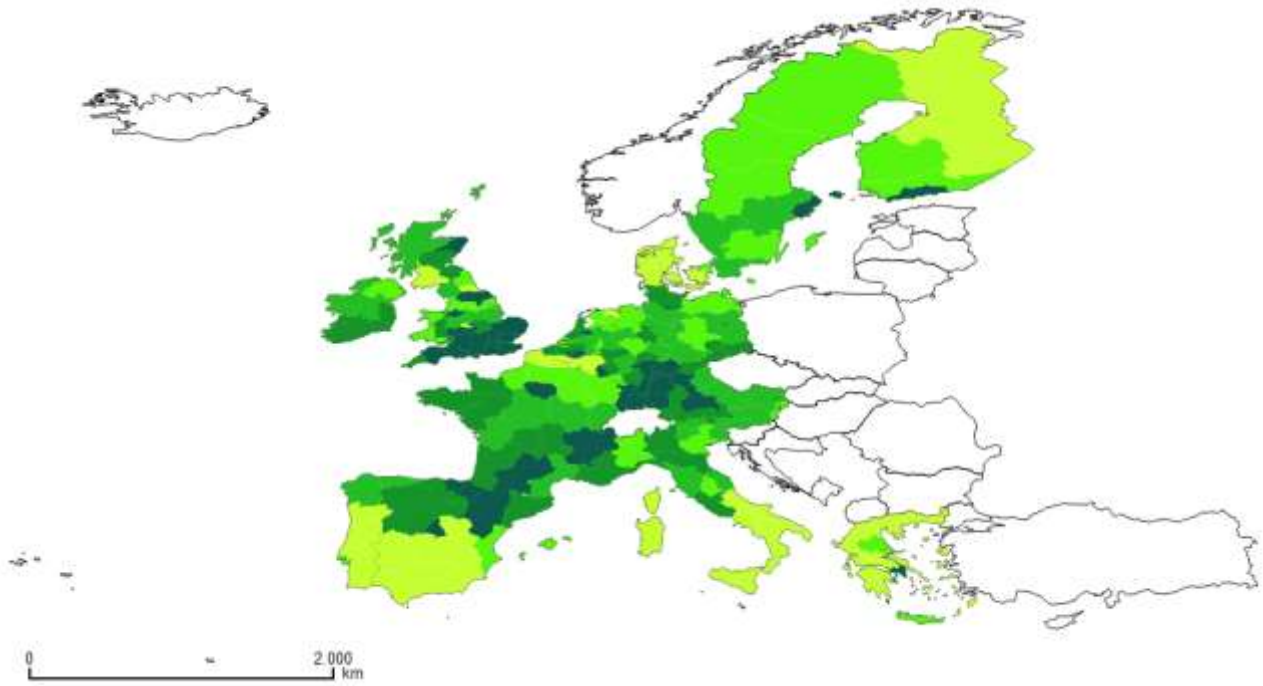
Map 7. HDI in 2006



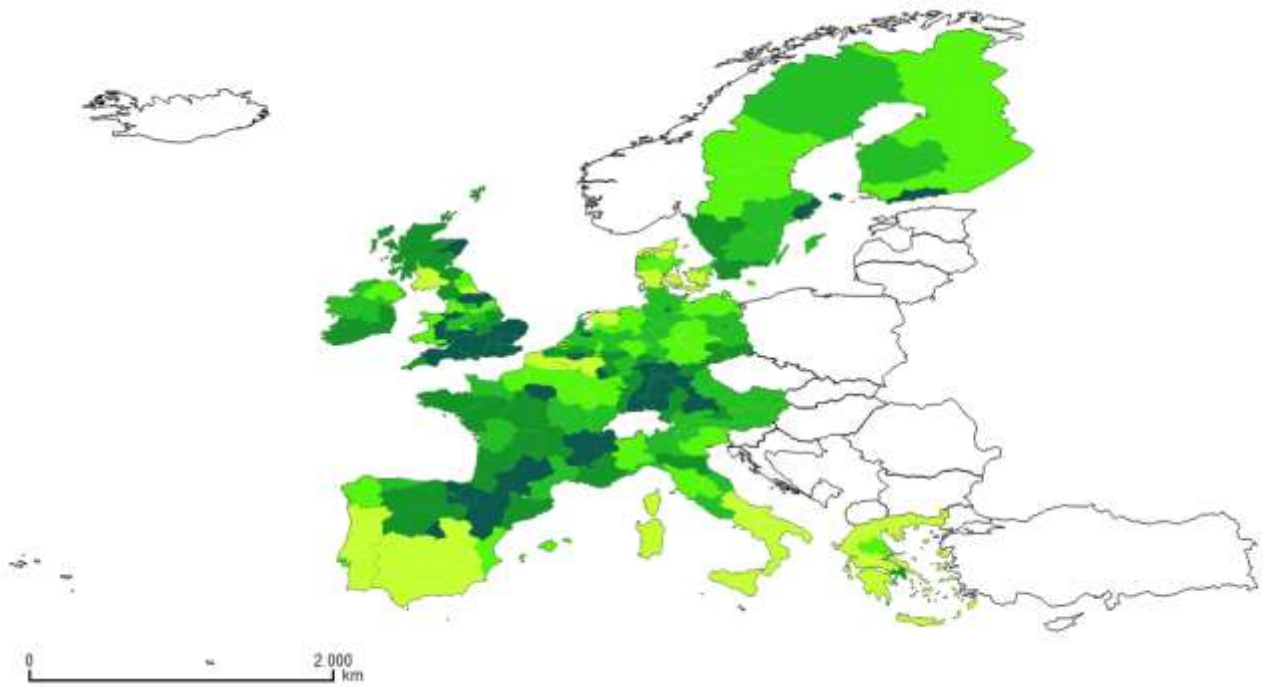
Map 8. HDI in 2007



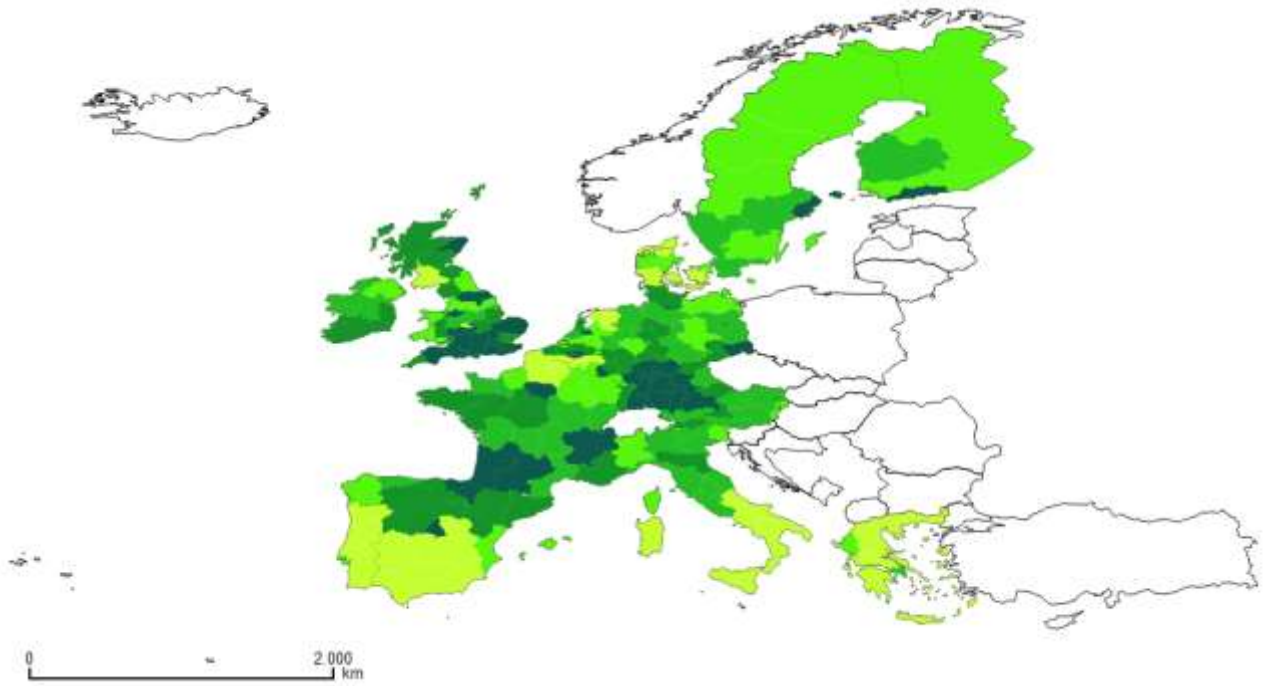
Map 9. HDI in 2008



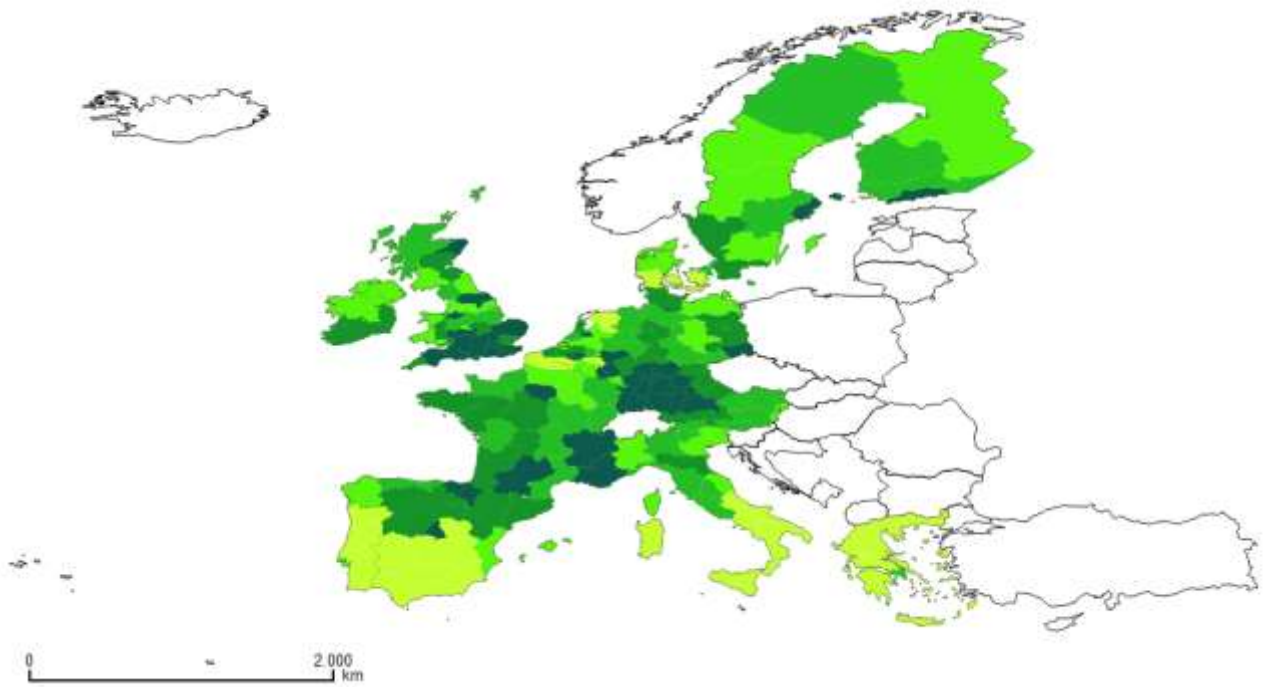
Map 10. HDI in 2009



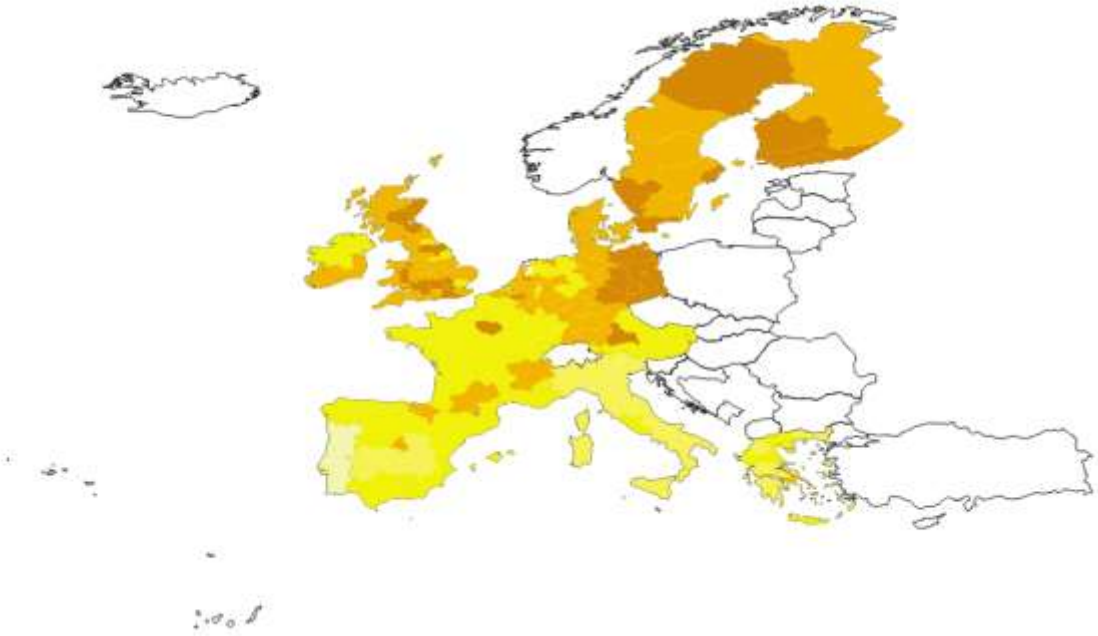
Map 11. HDI in 2010



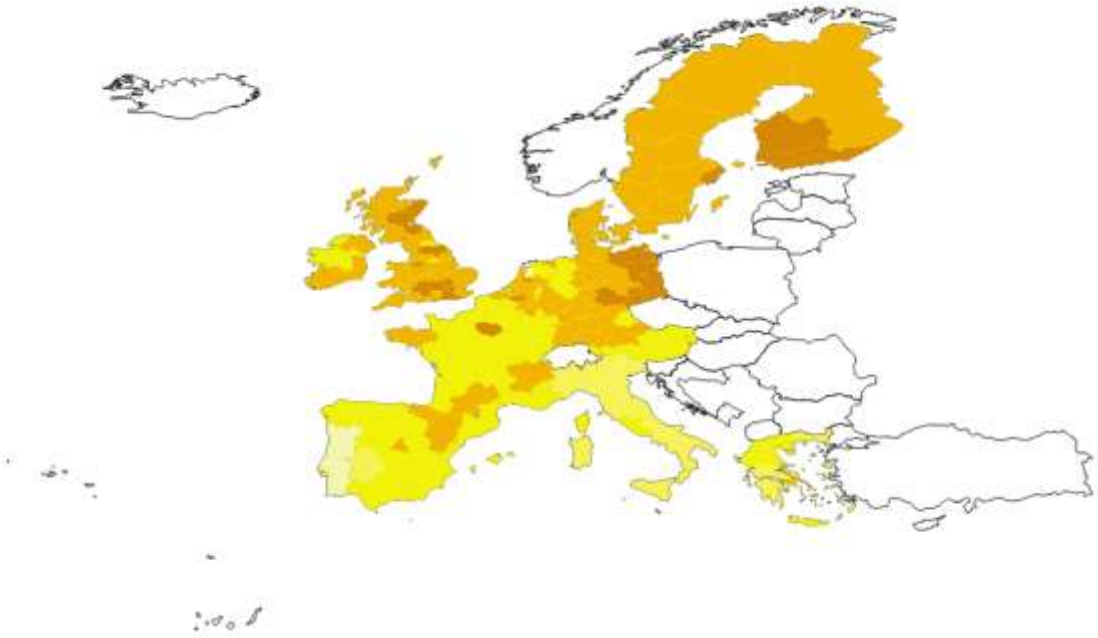
Map 12. HDI in 2011



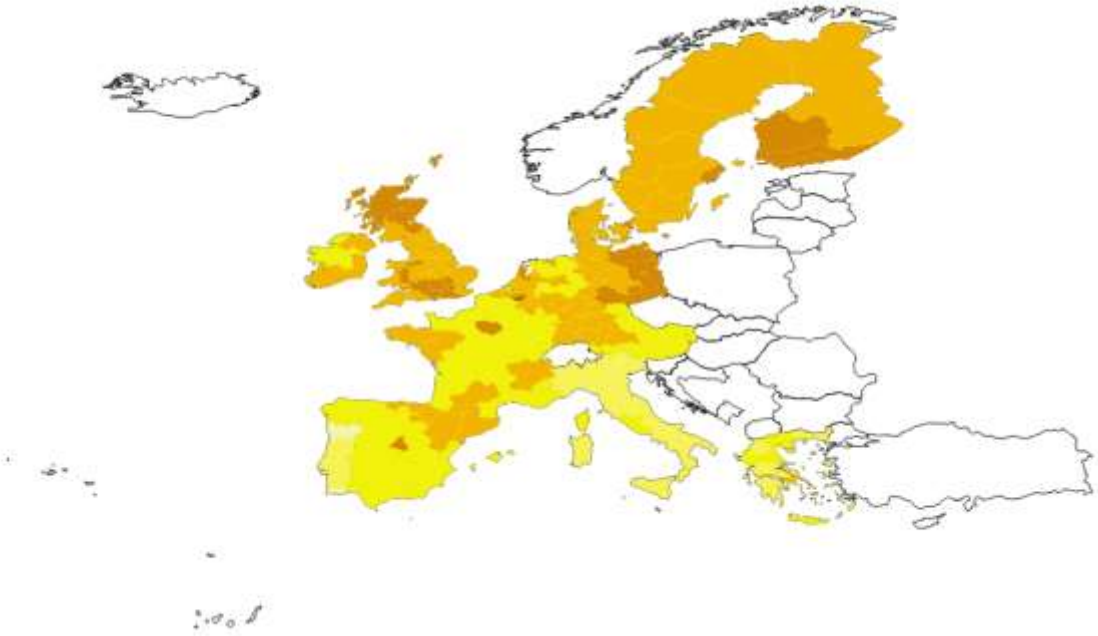
Map 13. Education in 2000



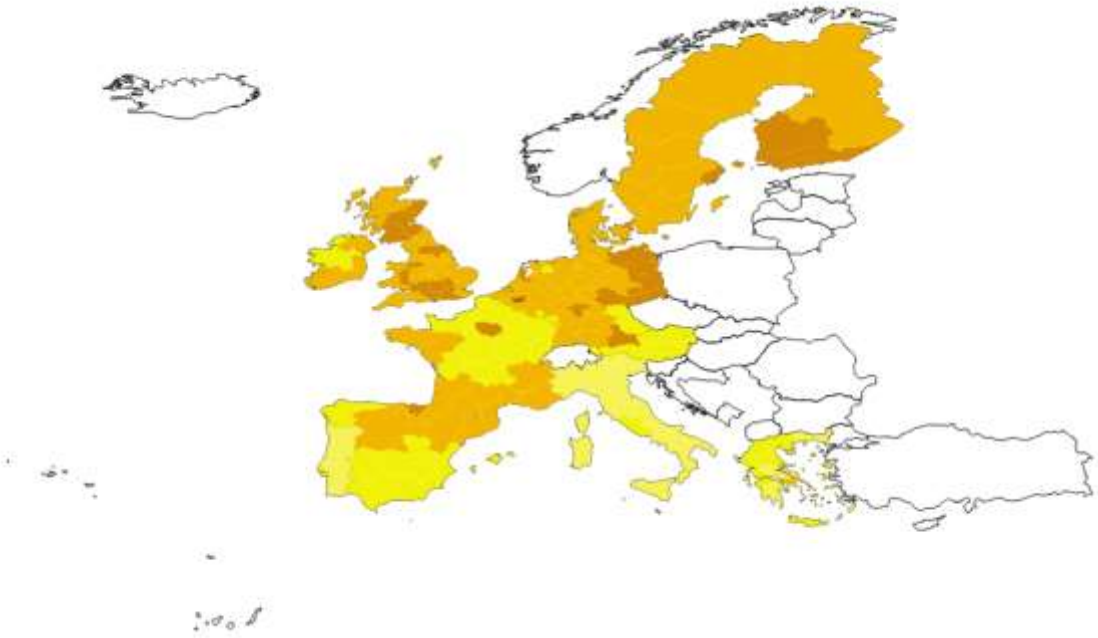
Map 14. Education in 2001



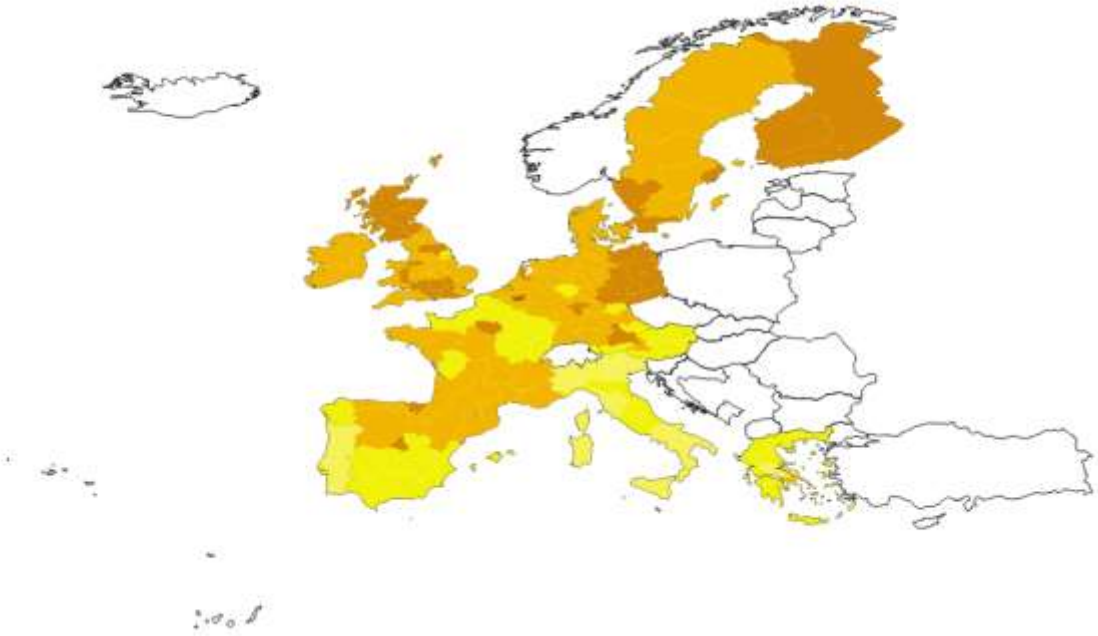
Map 15. Education in 2002



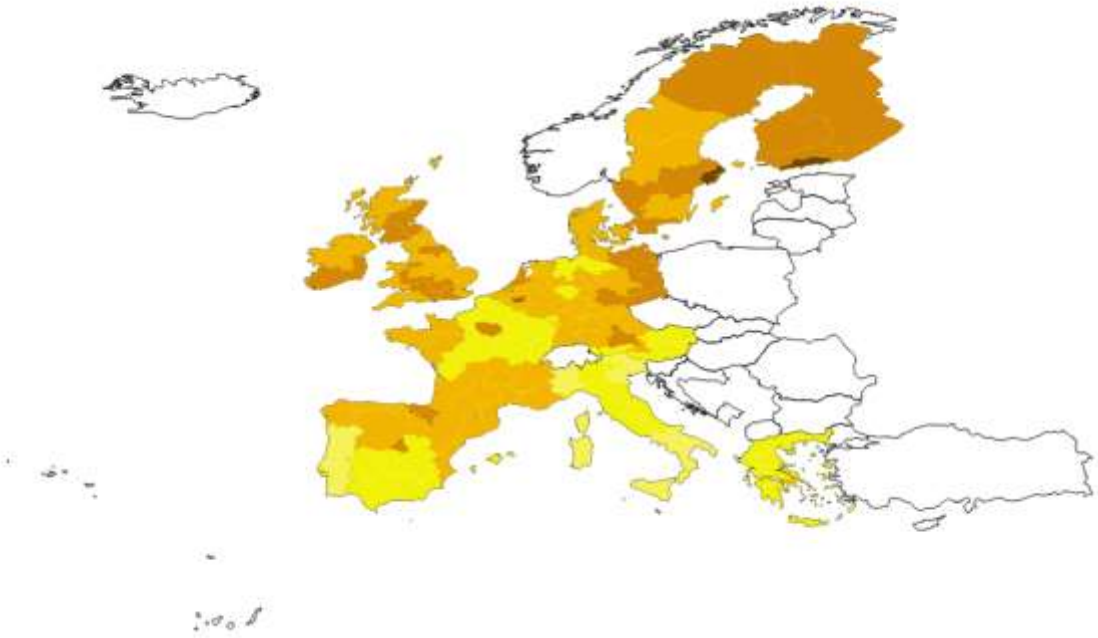
Map 16. Education in 2003



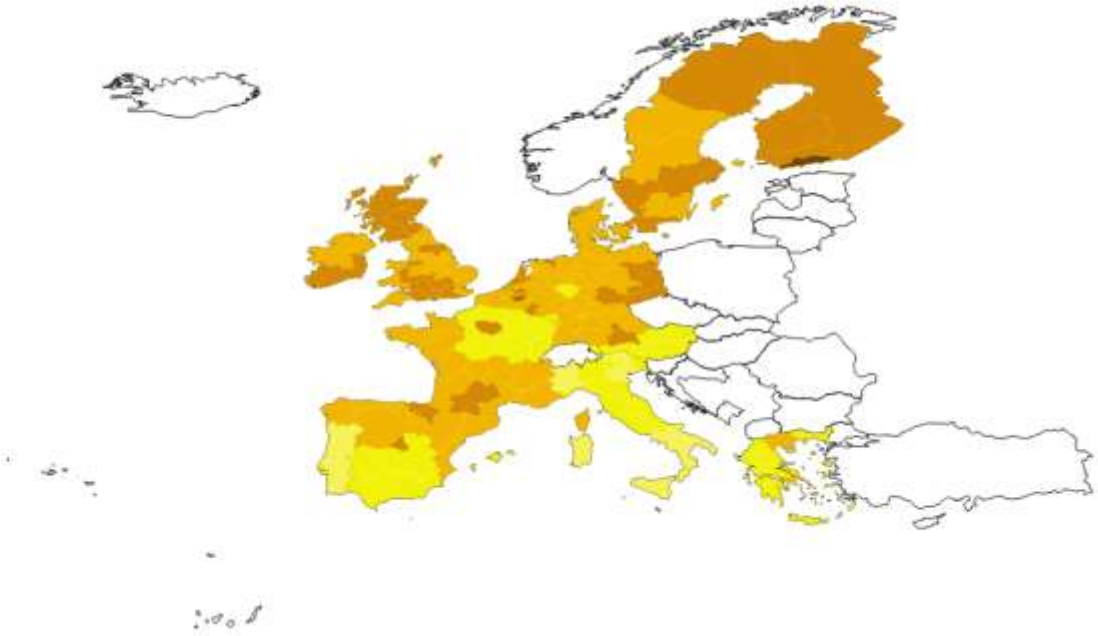
Map 17. Education in 2004



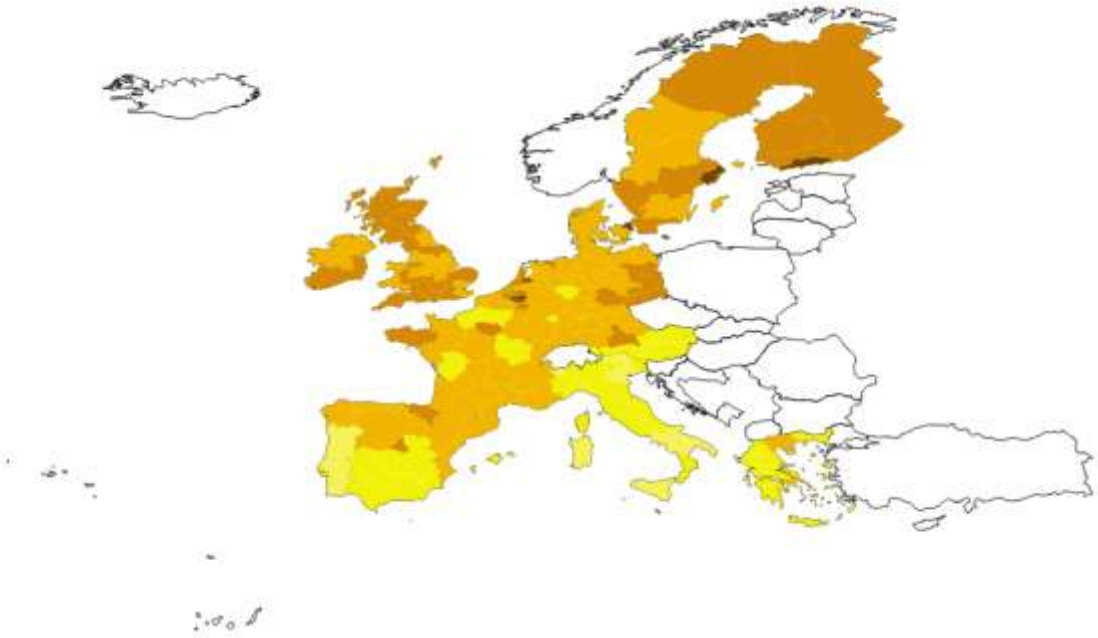
Map 18. Education in 2005



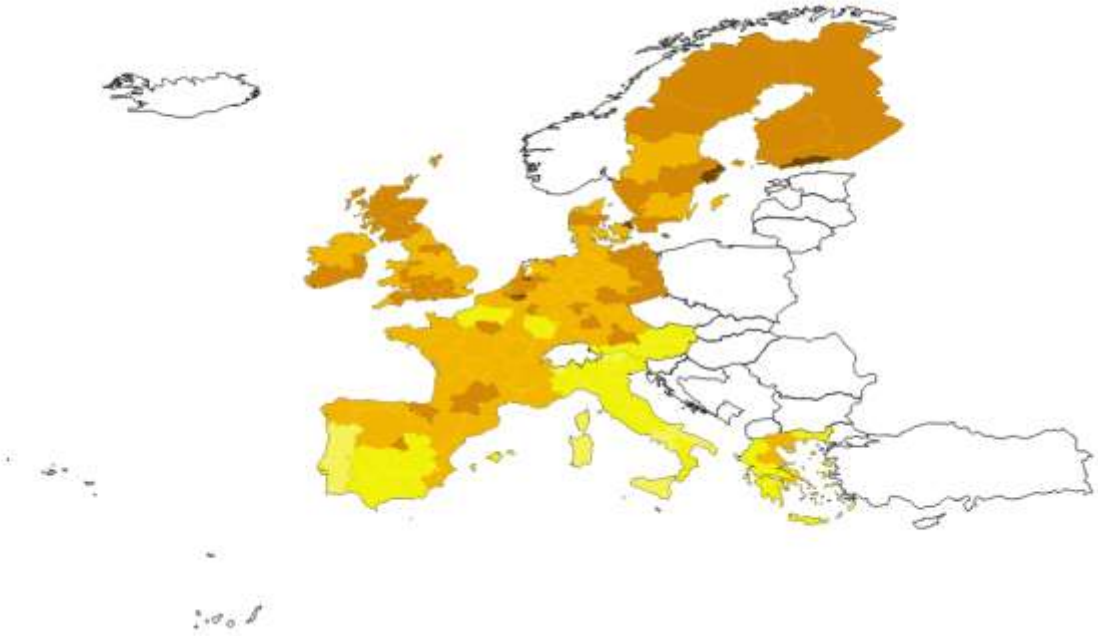
Map 19. Education in 2006



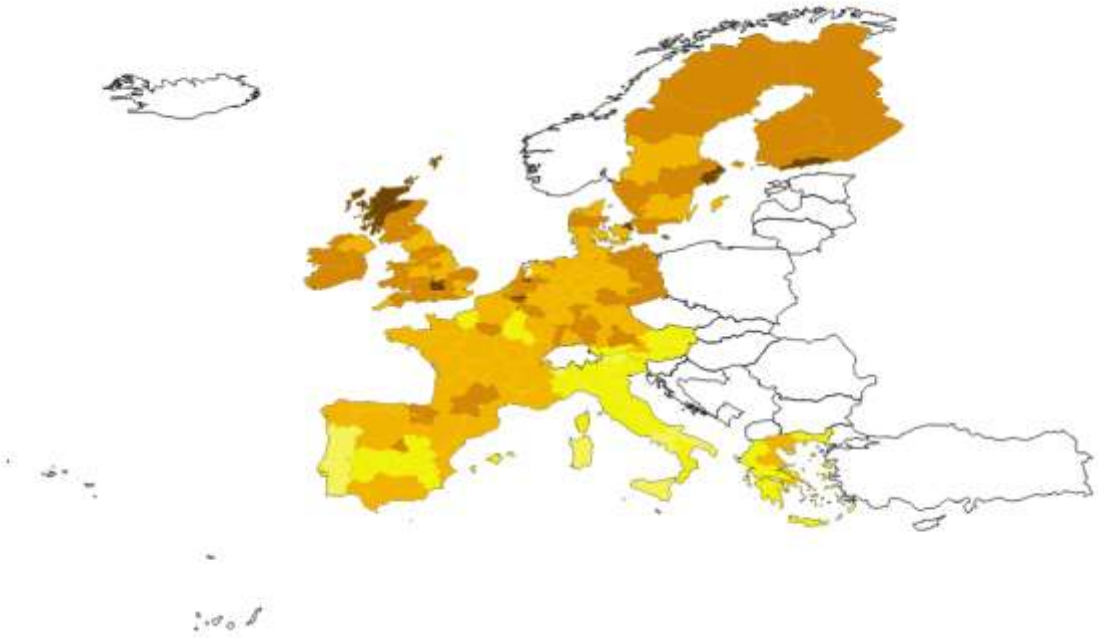
Map 20. Education in 2007



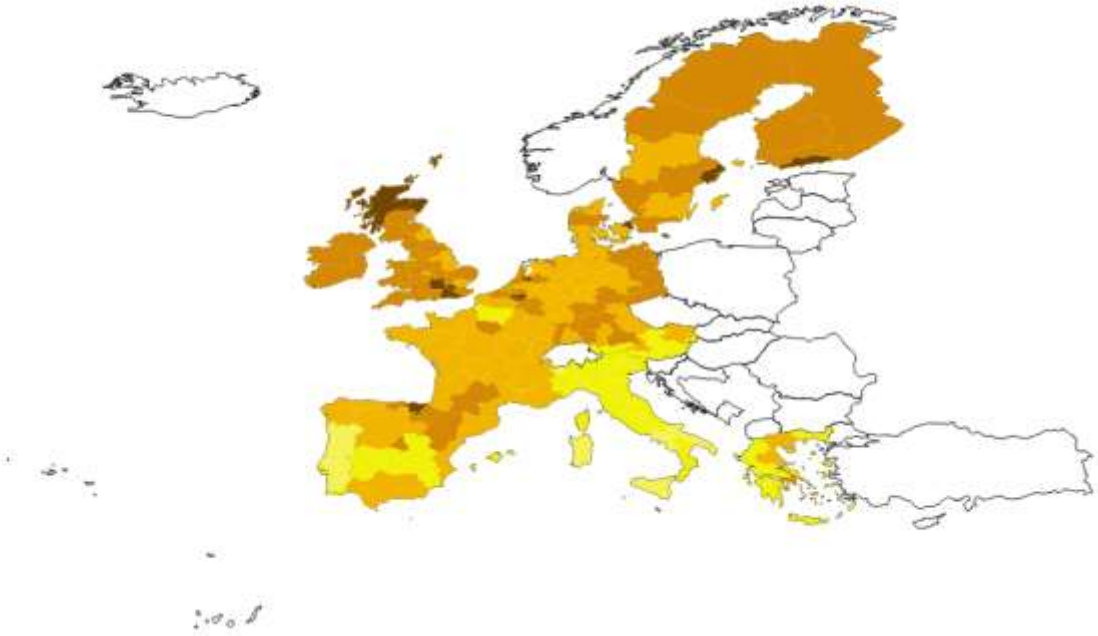
Map 21. Education in 2008



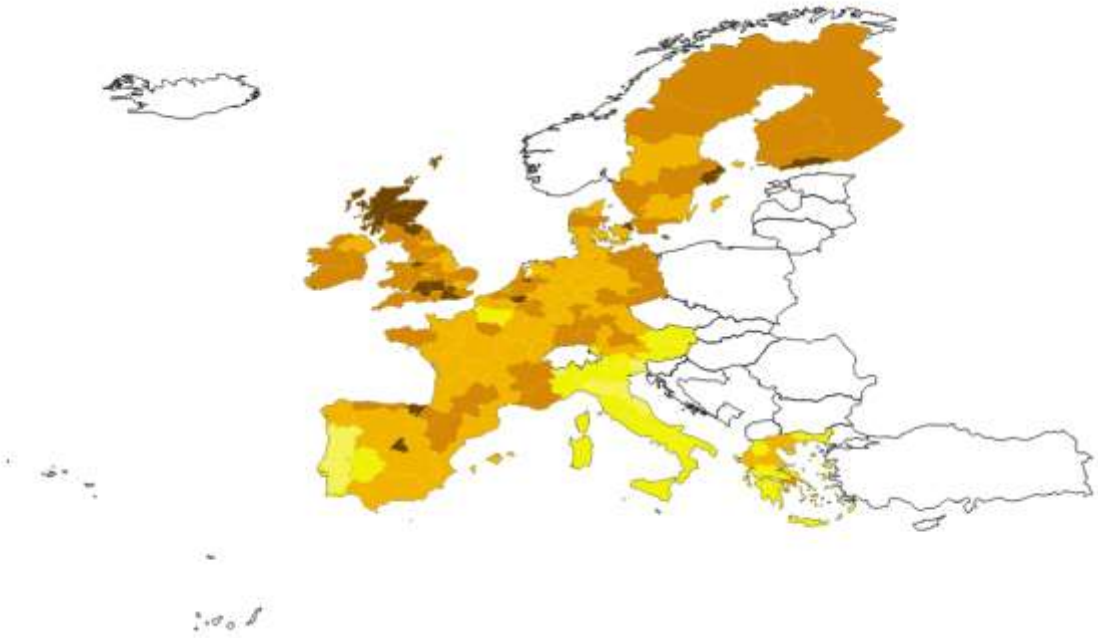
Map 22. Education in 2009



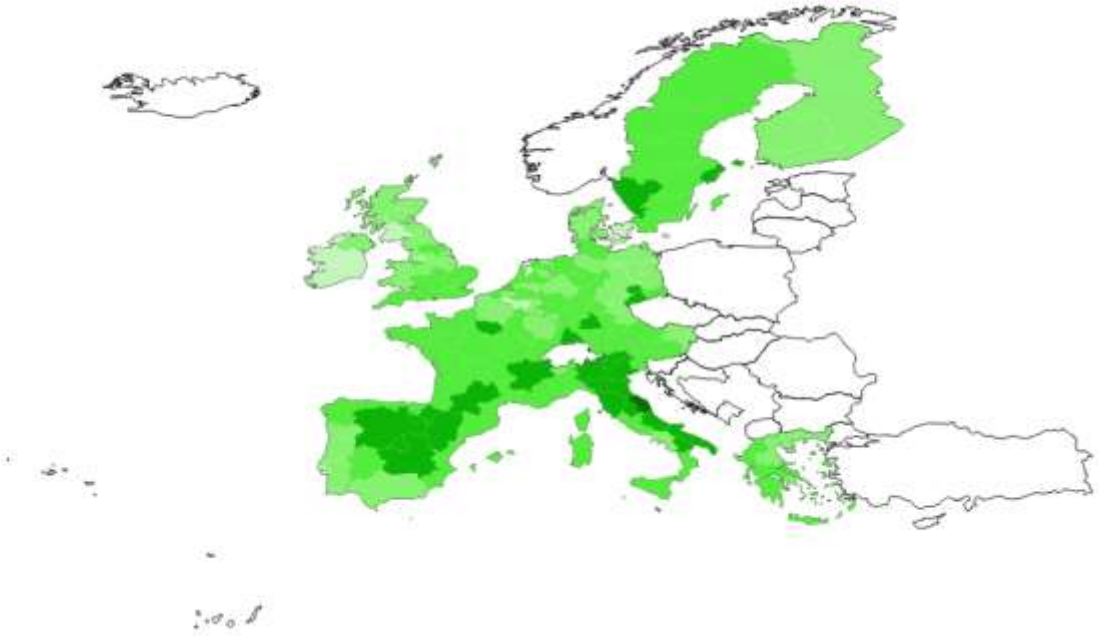
Map 23. Education in 2010



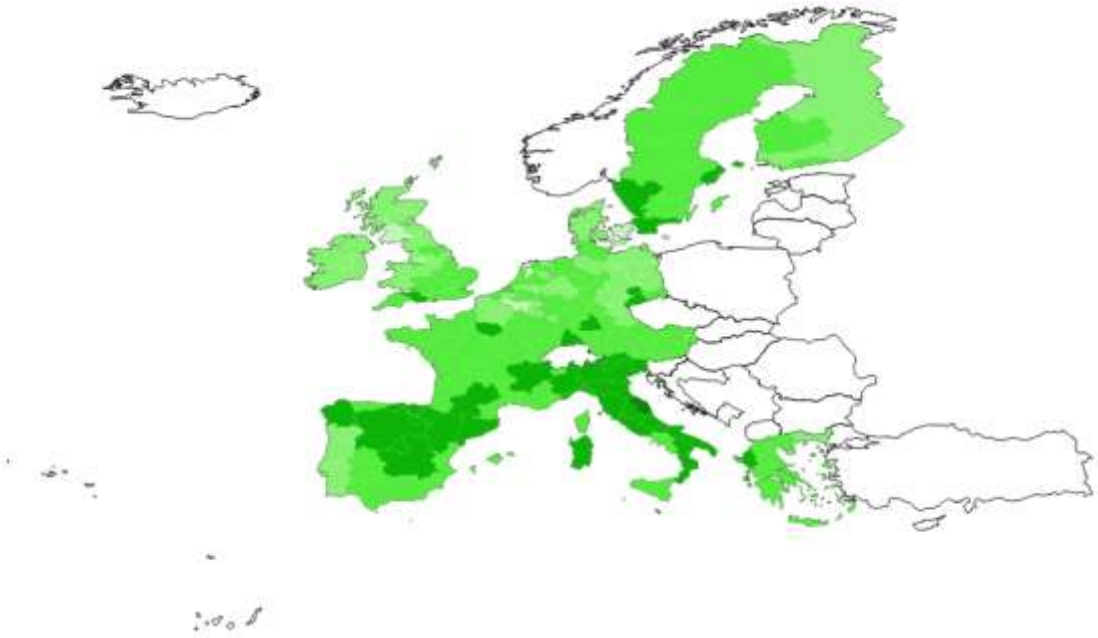
Map 24. Education in 2011



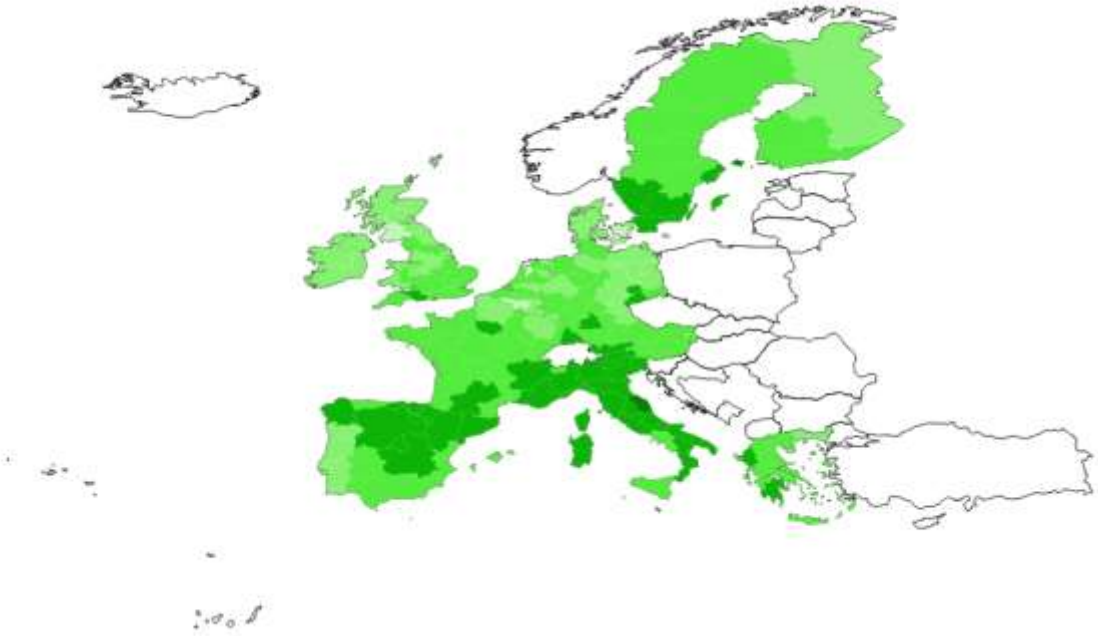
Map 25. Health in 2000



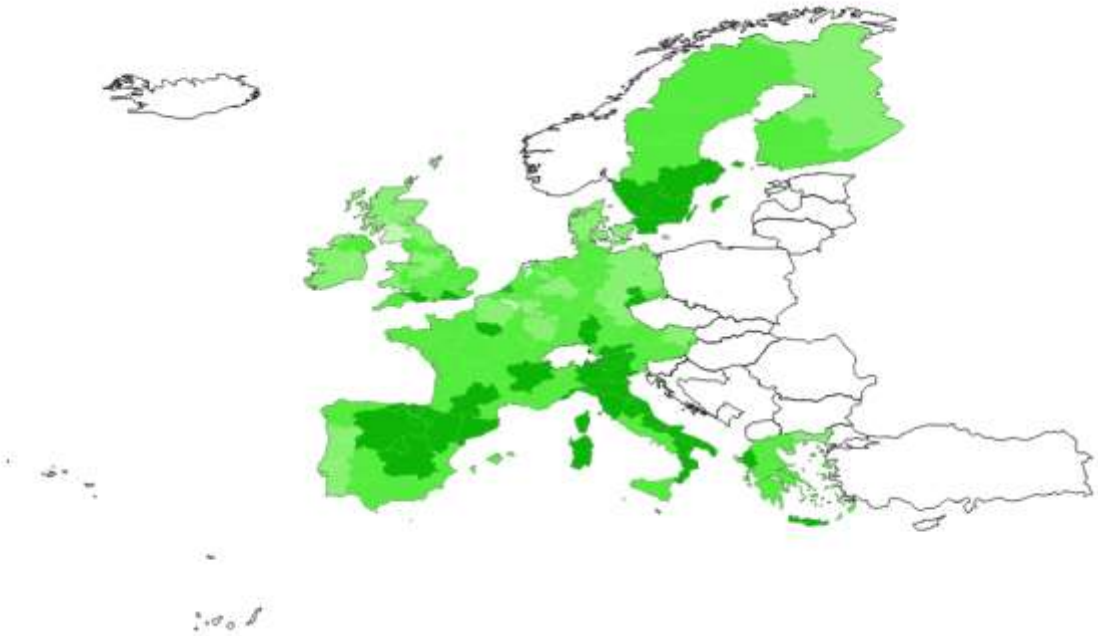
Map 26. Health in 2001



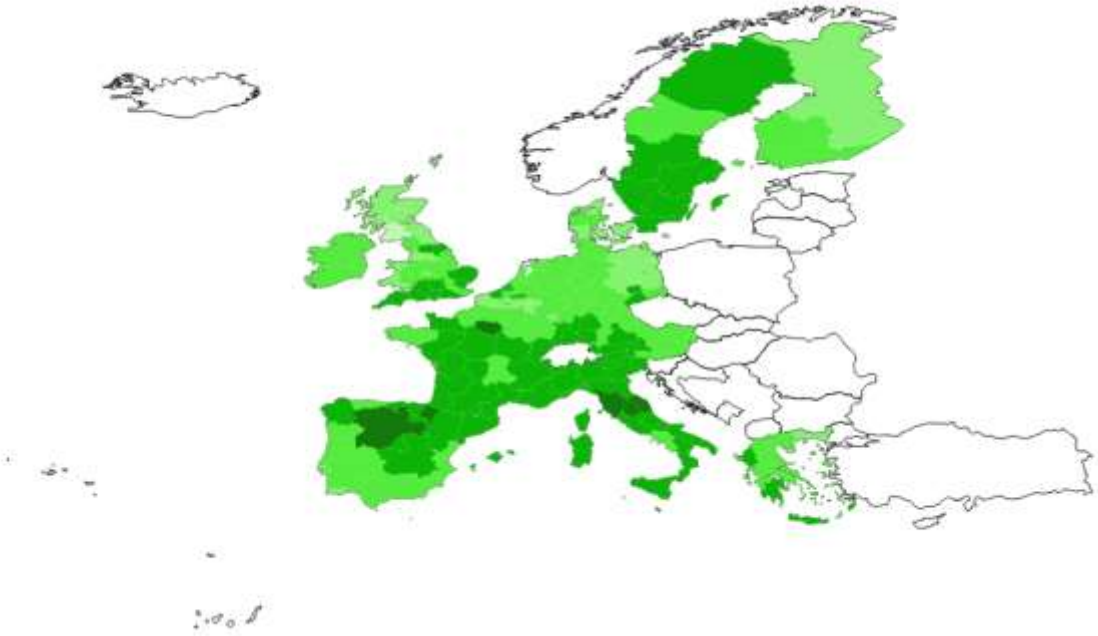
Map 27. Health in 2002



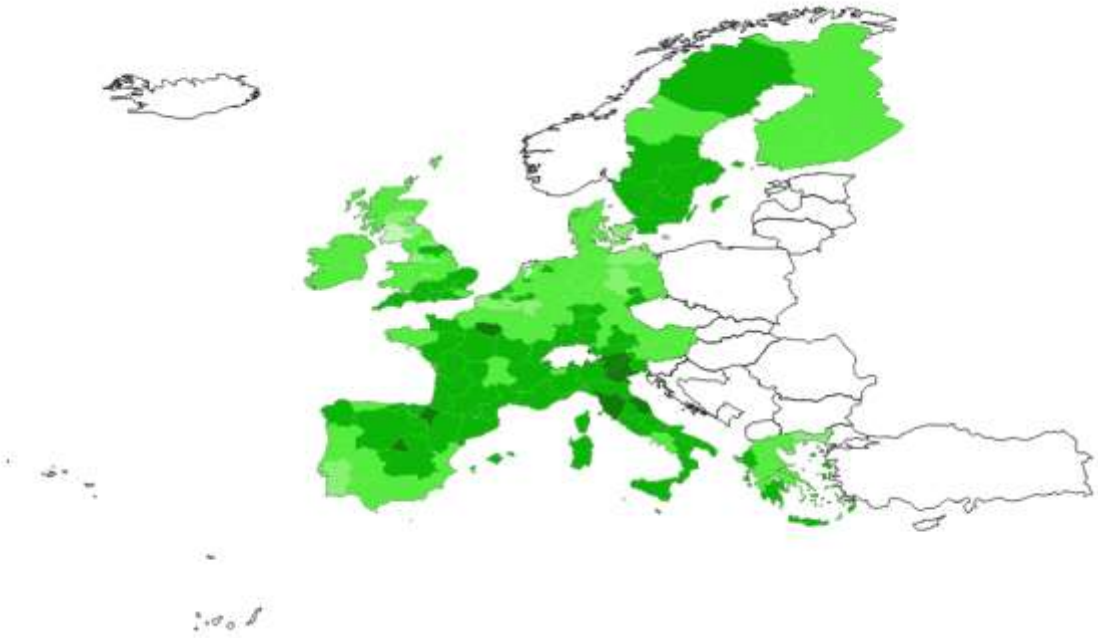
Map 28. Health in 2003



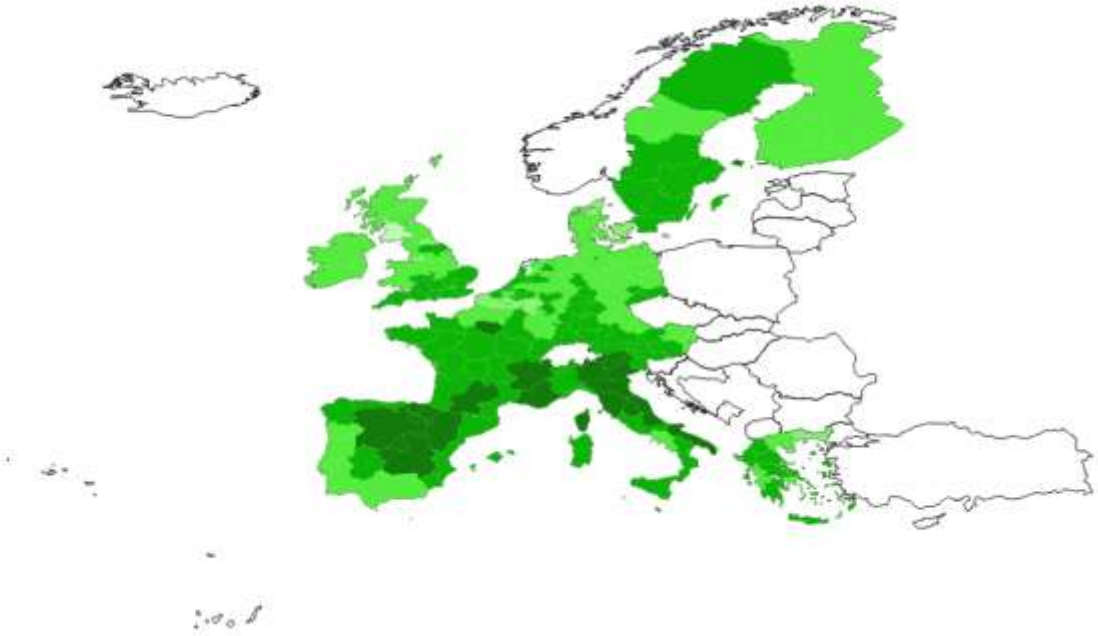
Map 29. Health in 2004



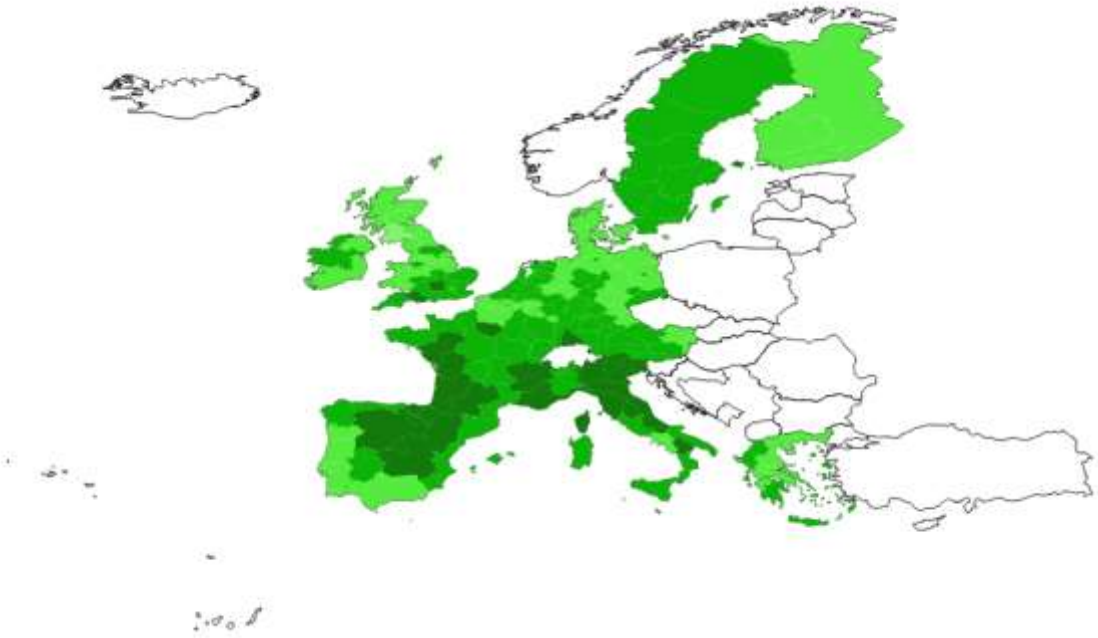
Map 30. Health in 2005



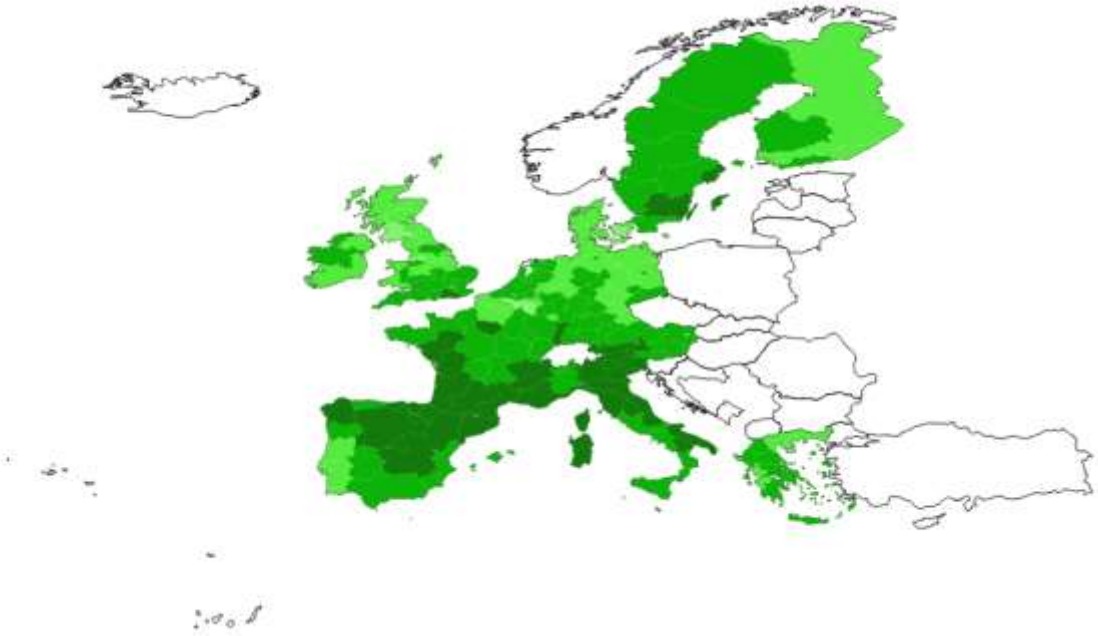
Map 31. Health in 2006



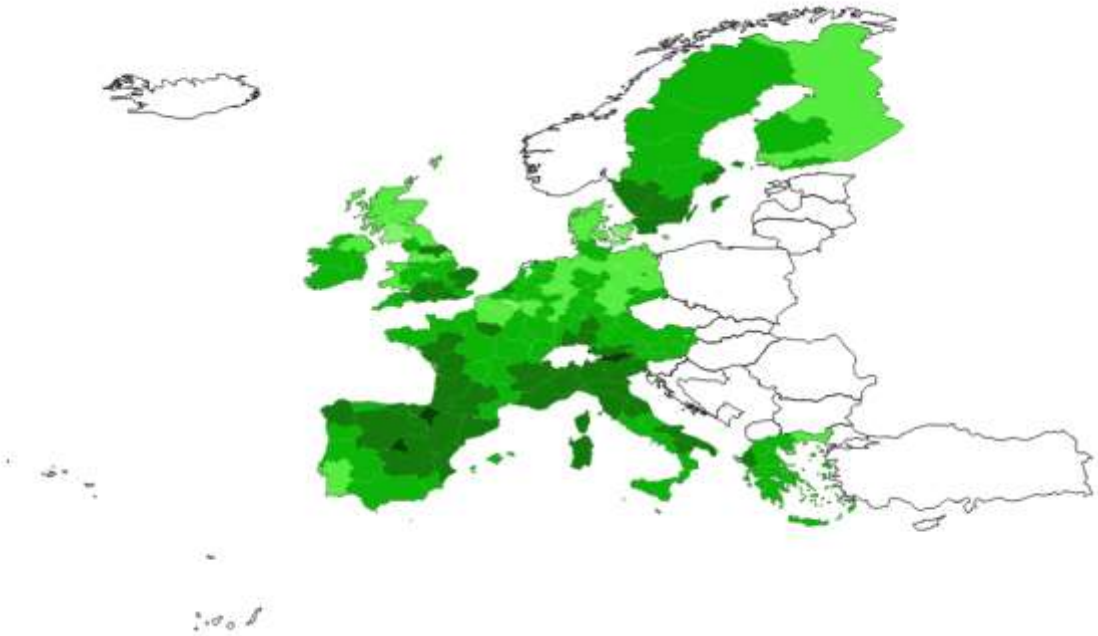
Map 32. Health in 2007



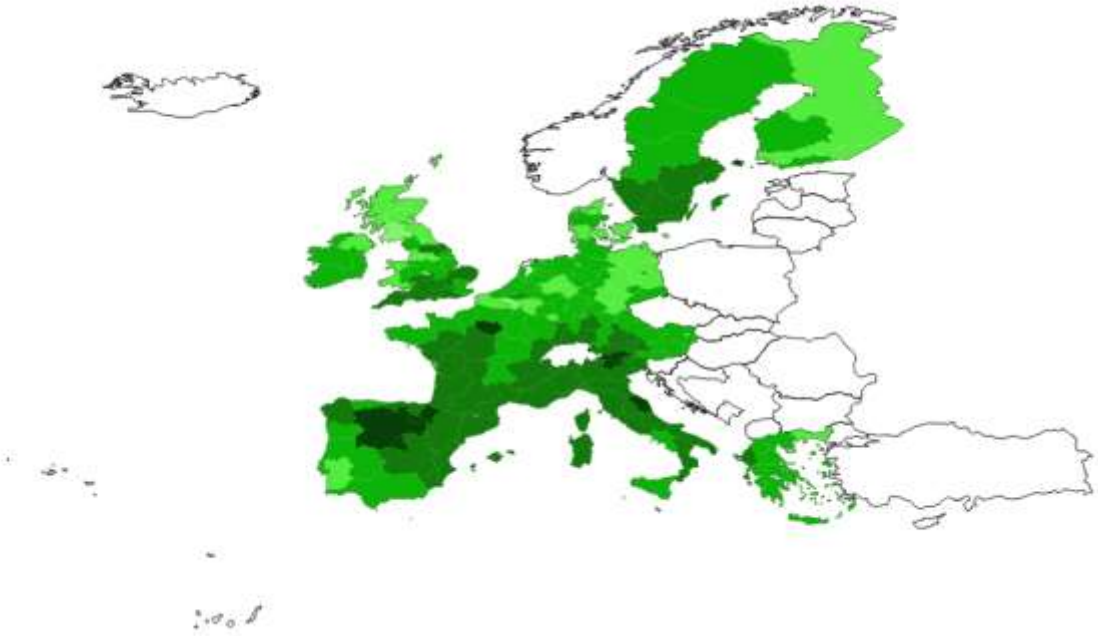
Map 33. Health in 2008



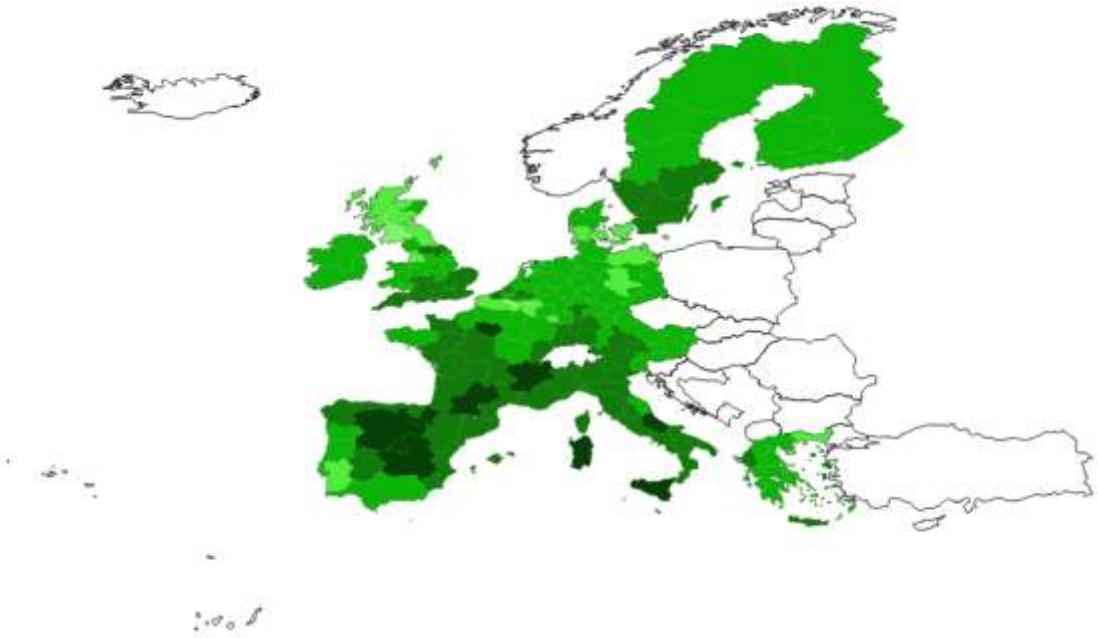
Map 34. Health in 2009



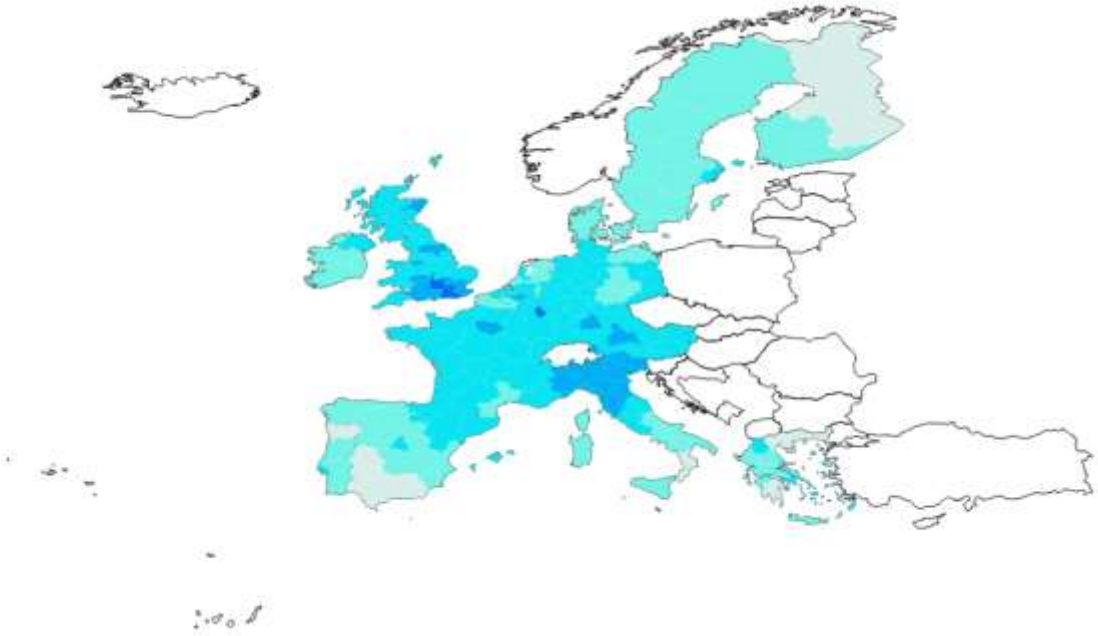
Map 35. Health in 2010



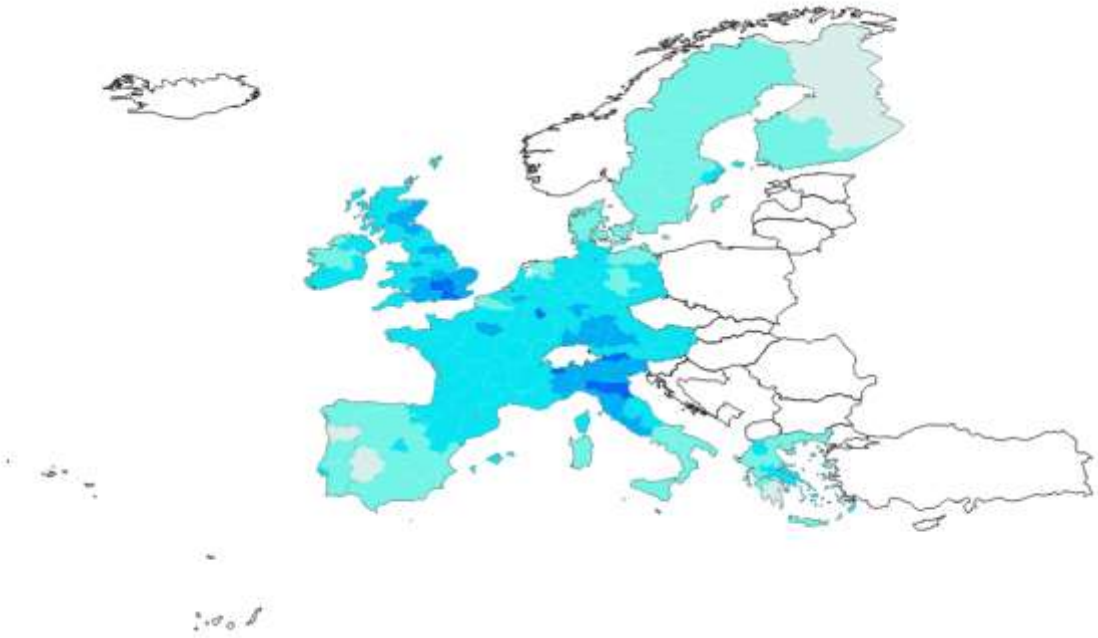
Map 36. Health in 2011



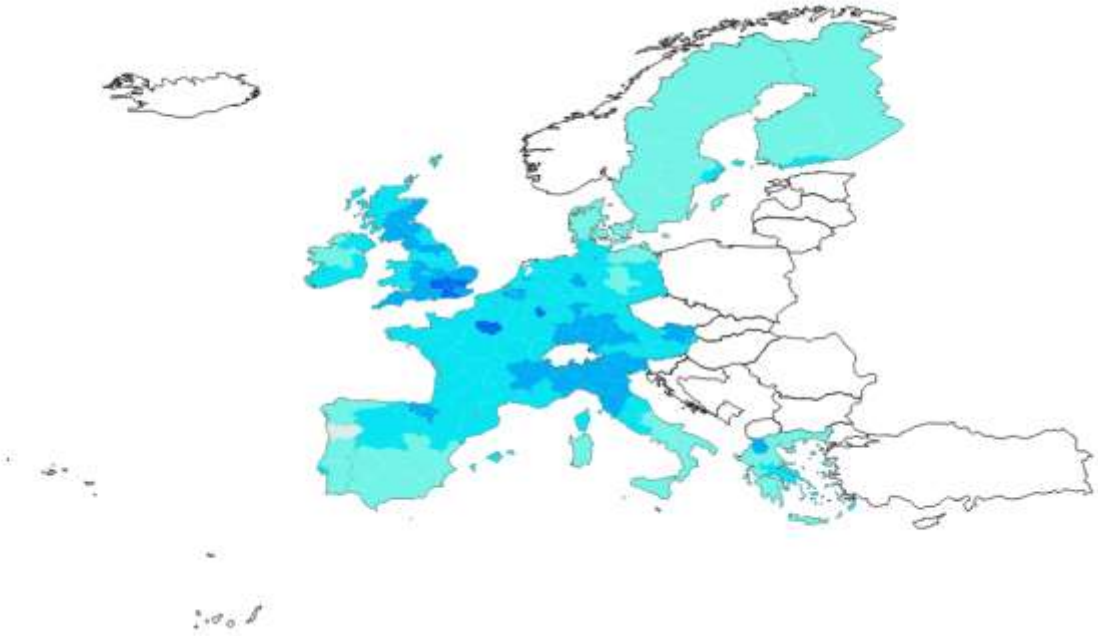
Map 37. Income in 2000



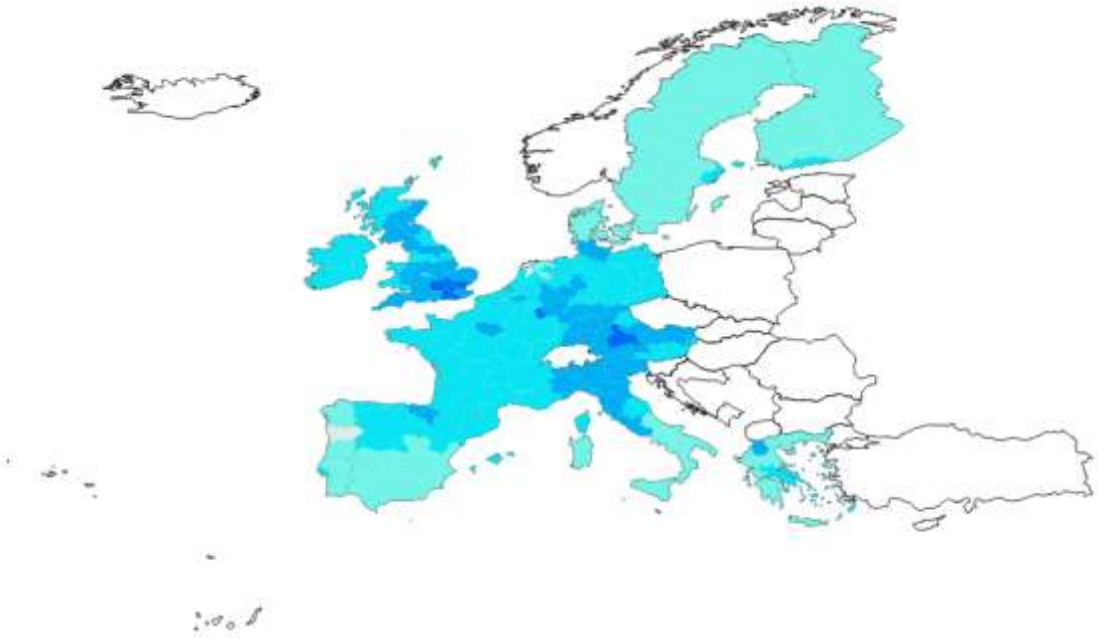
Map 38. Income in 2001



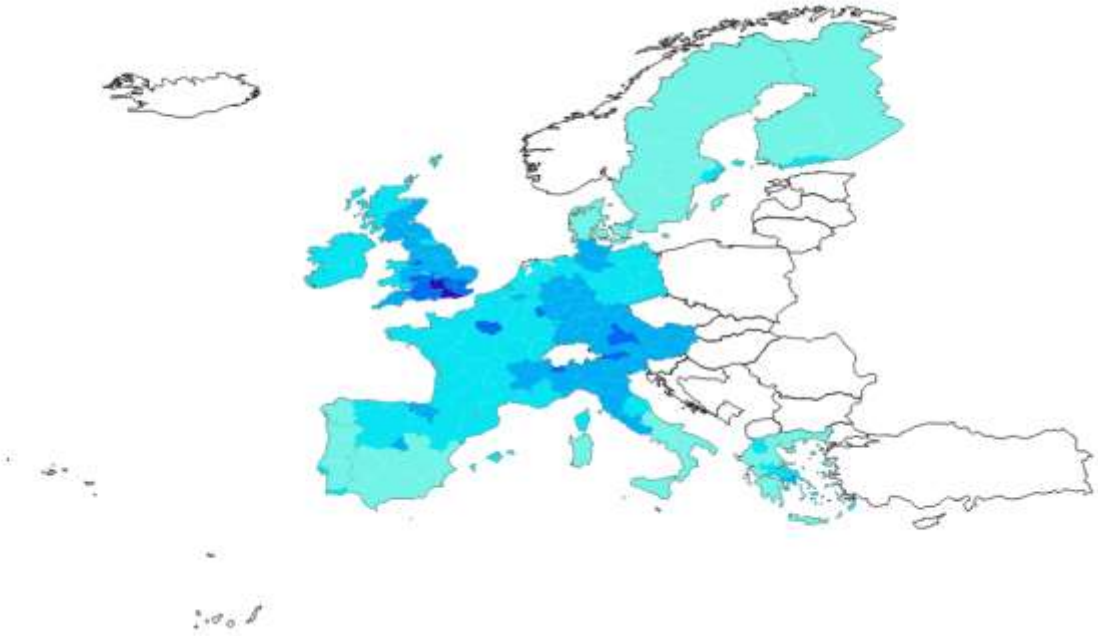
Map 39. Income in 2002



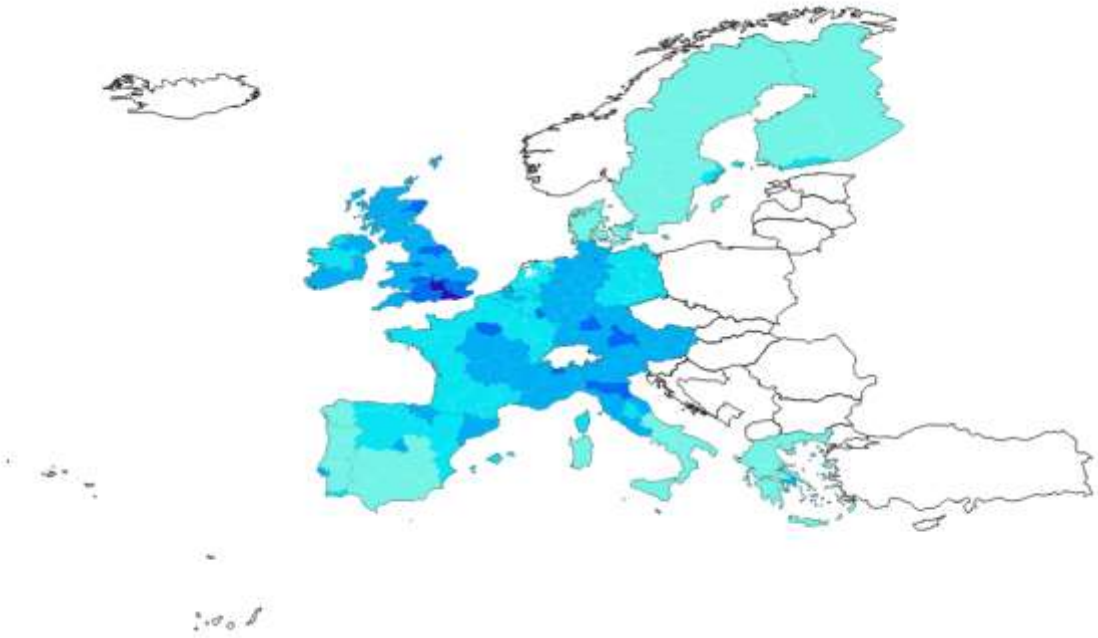
Map 40. Income in 2003



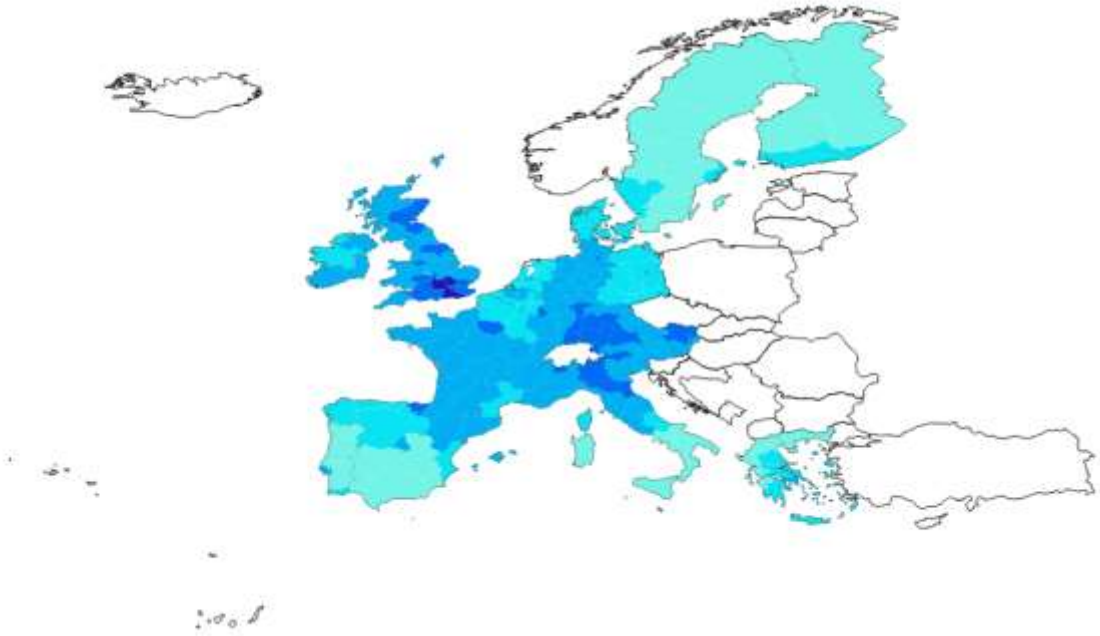
Map 41. Income in 2004



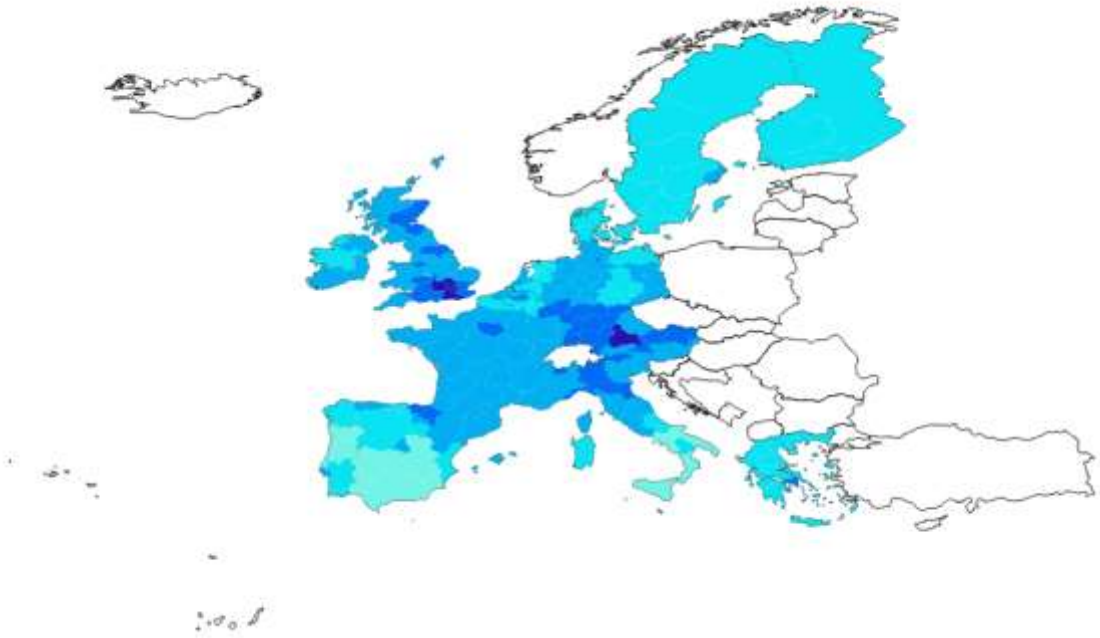
Map 42. Income in 2005



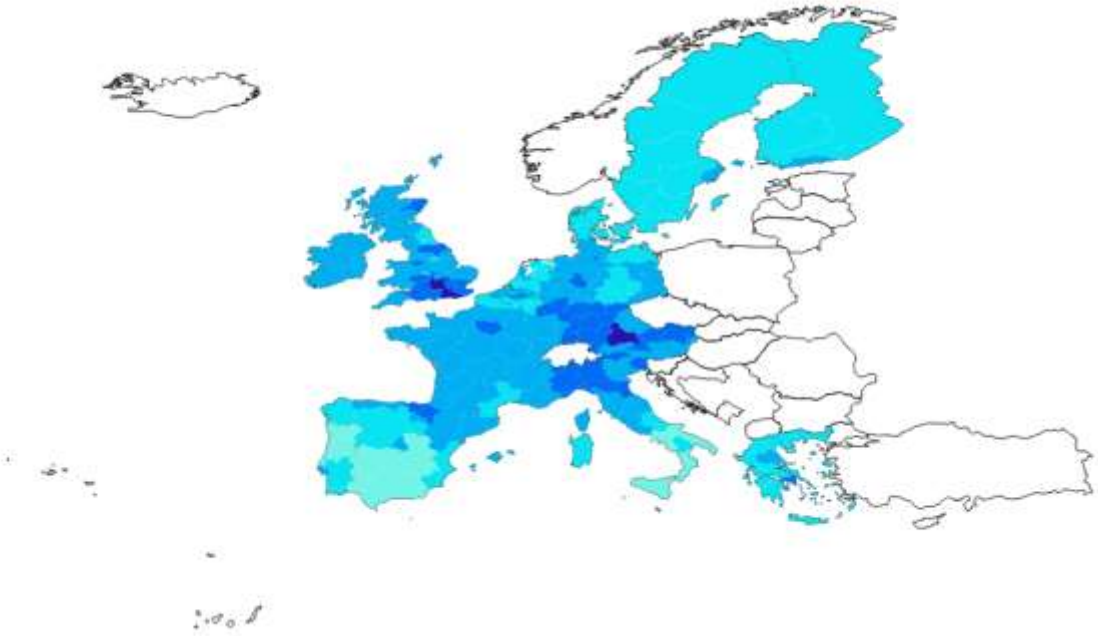
Map 43. Income in 2006



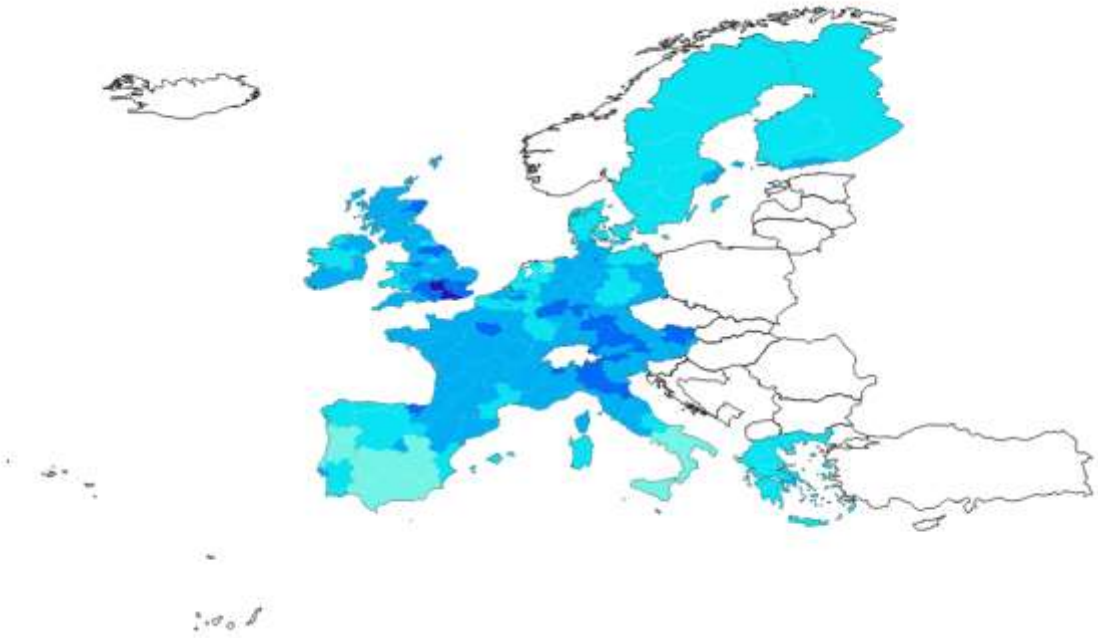
Map 44. Income in 2007



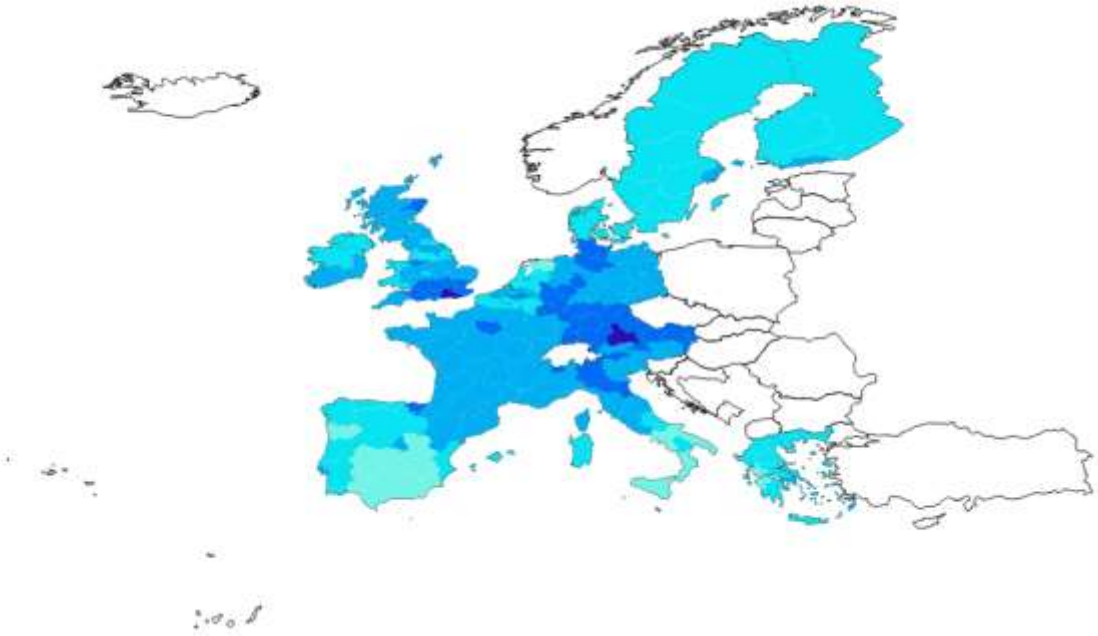
Map 45. Income in 2008



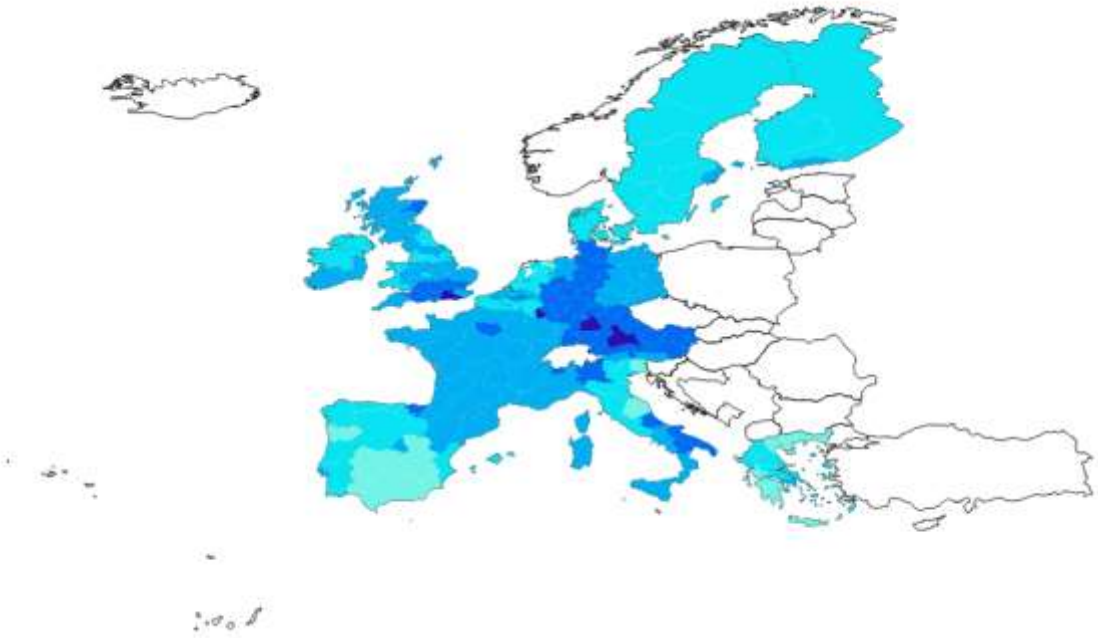
Map 46. Income in 2009



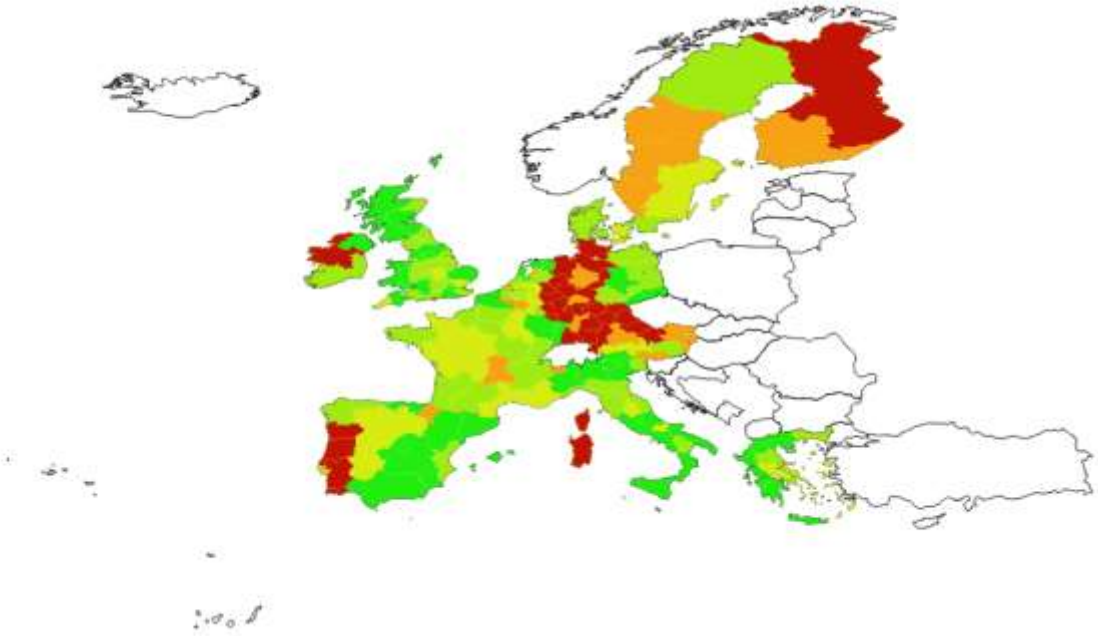
Map 47. Income in 2010



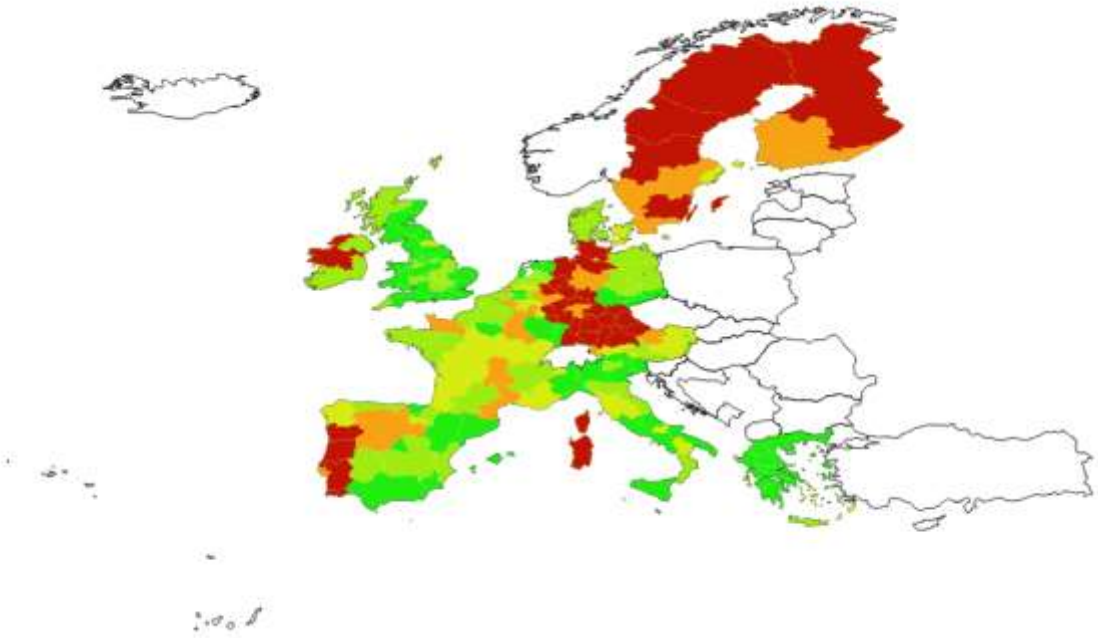
Map 48. Income in 2011



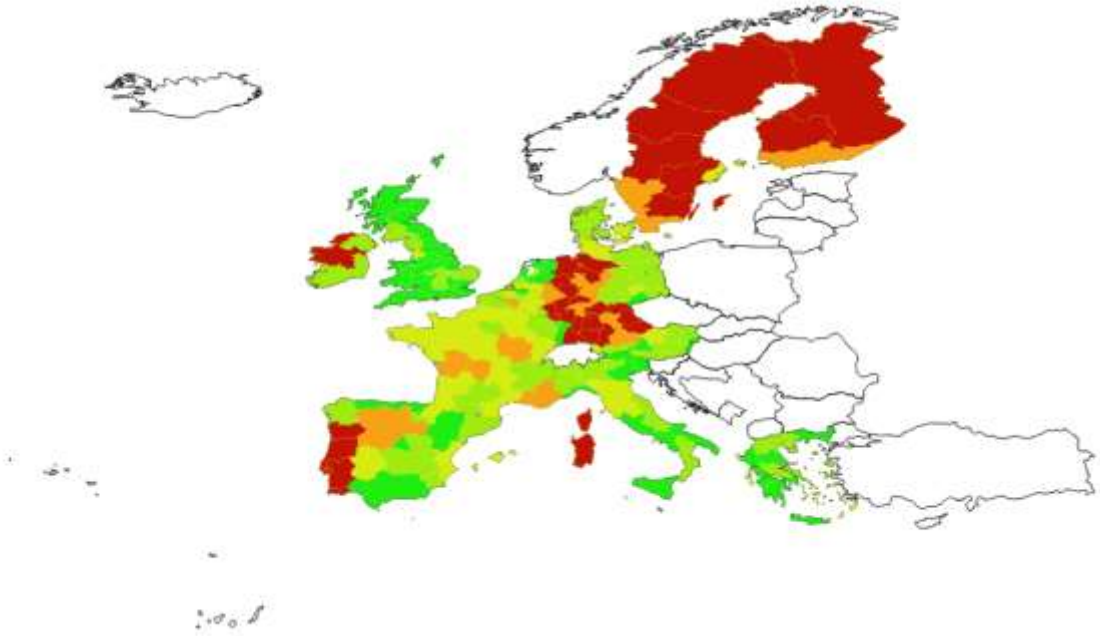
Map 49. GDI in 2000



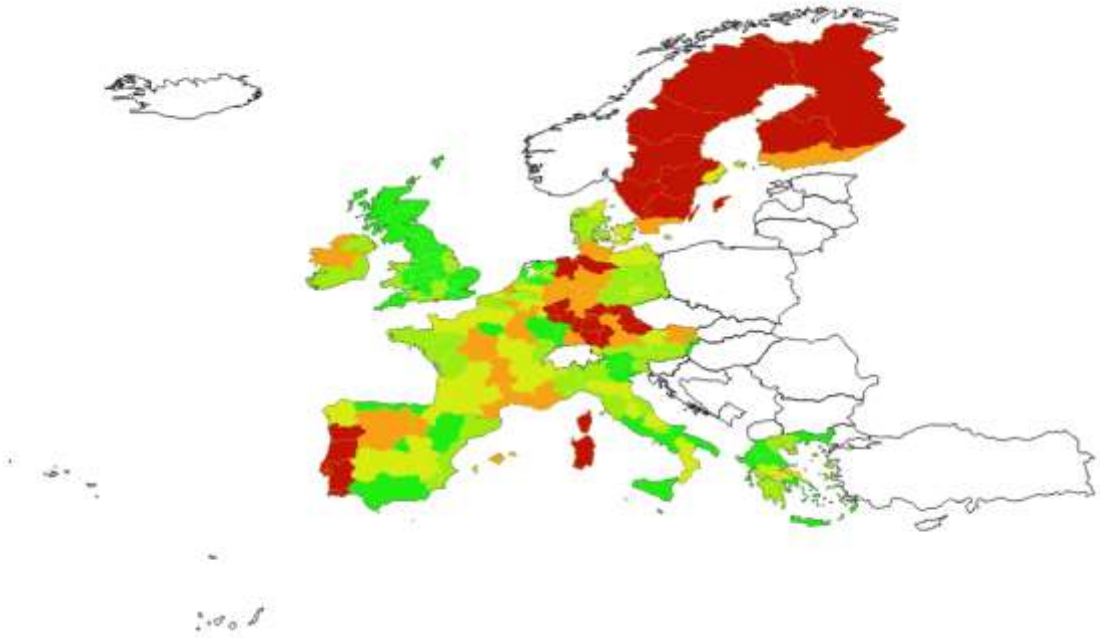
Map 50. GDI in 2001



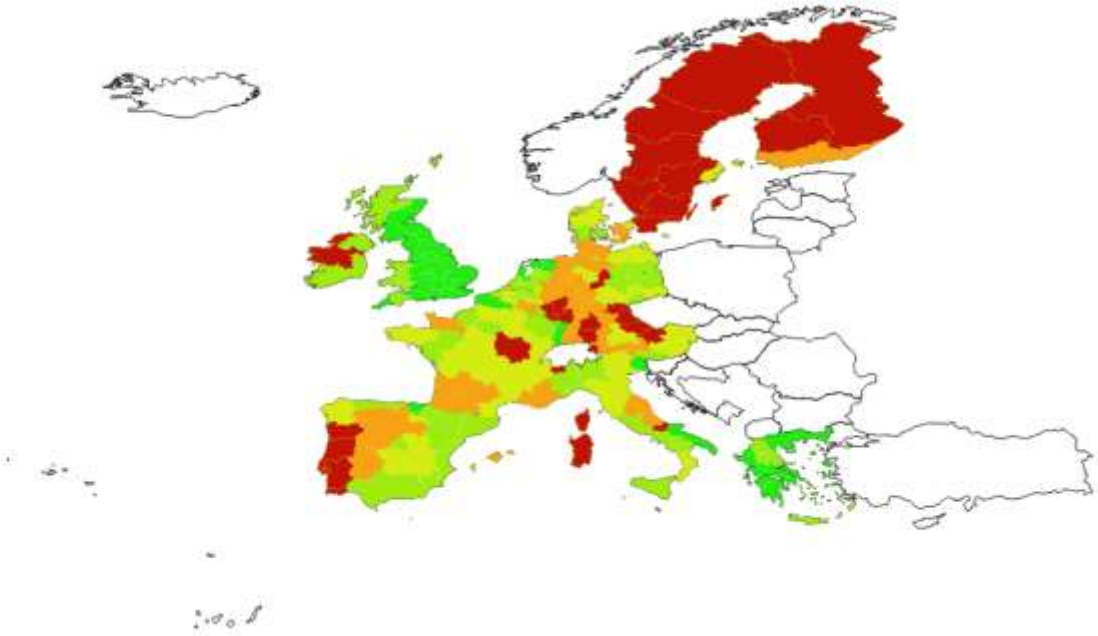
Map 51. GDI in 2002



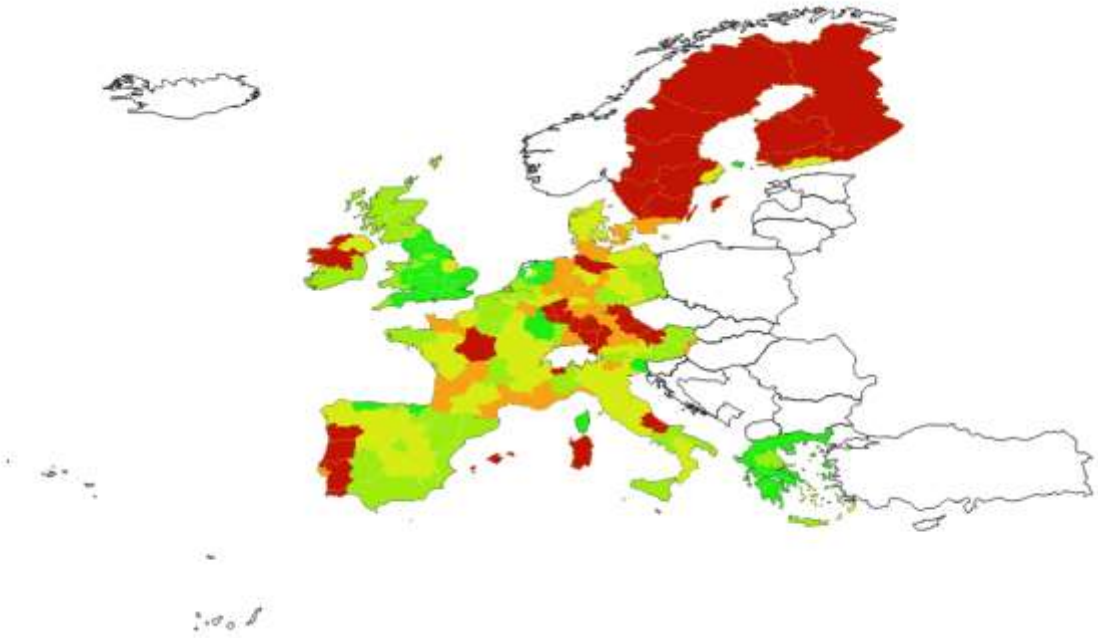
Map 52. GDI in 2003



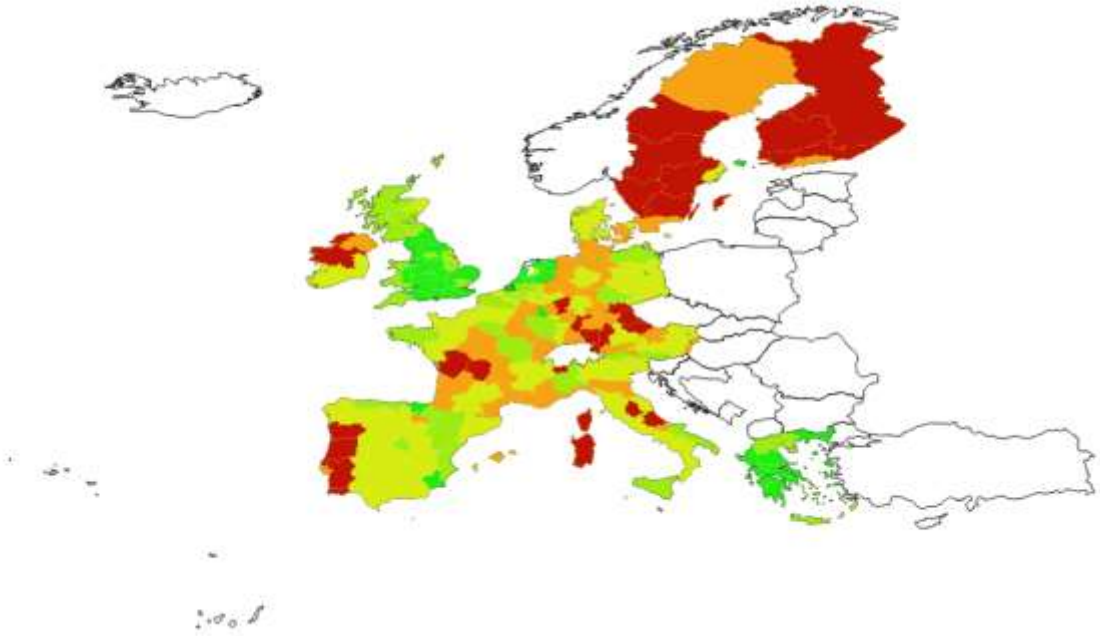
Map 53. GDI in 2004



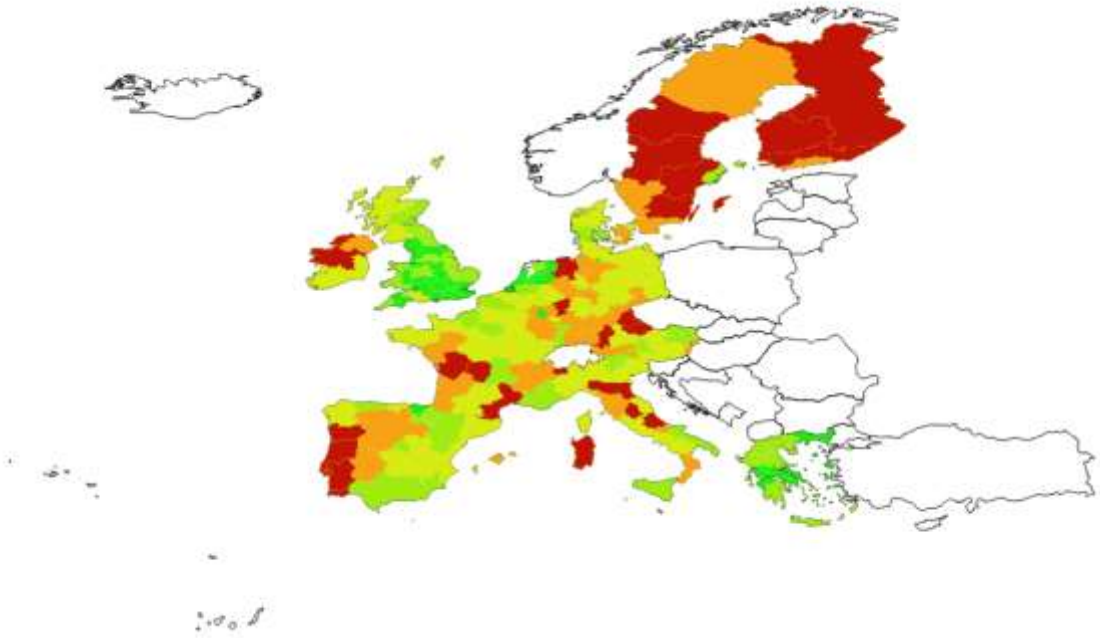
Map 54. GDI in 2005



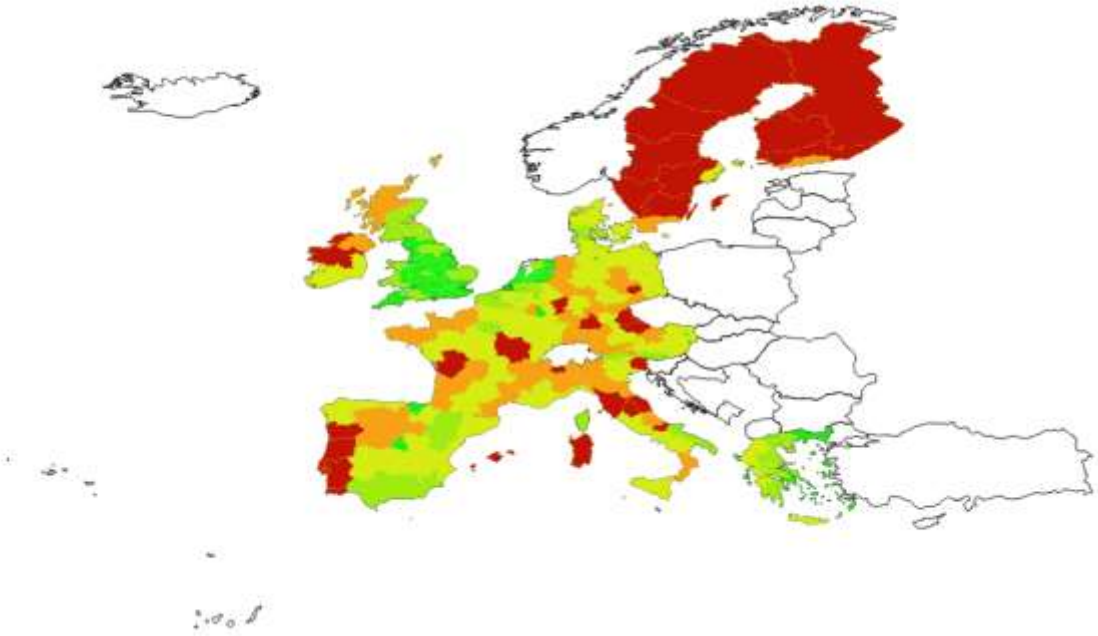
Map 55. GDI in 2006



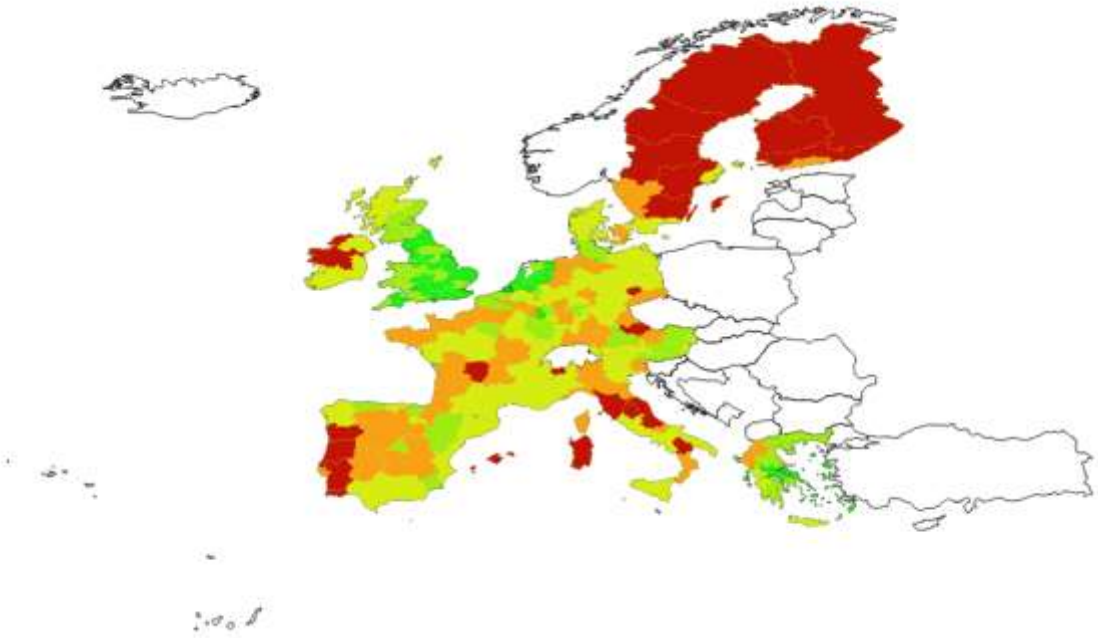
Map 56. GDI in 2007



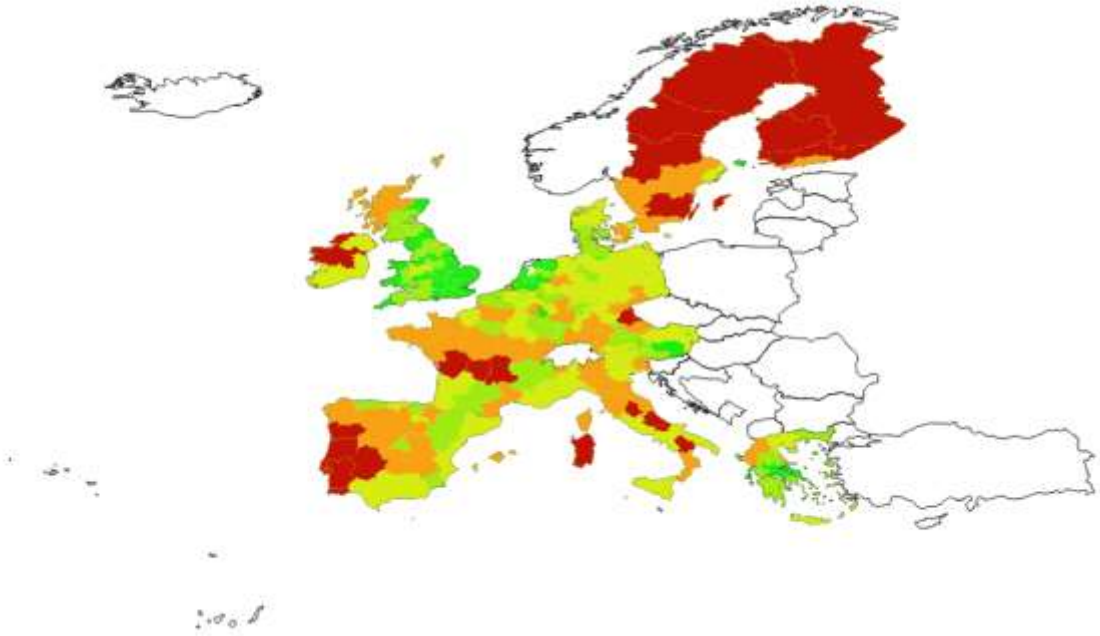
Map 57. GDI in 2008



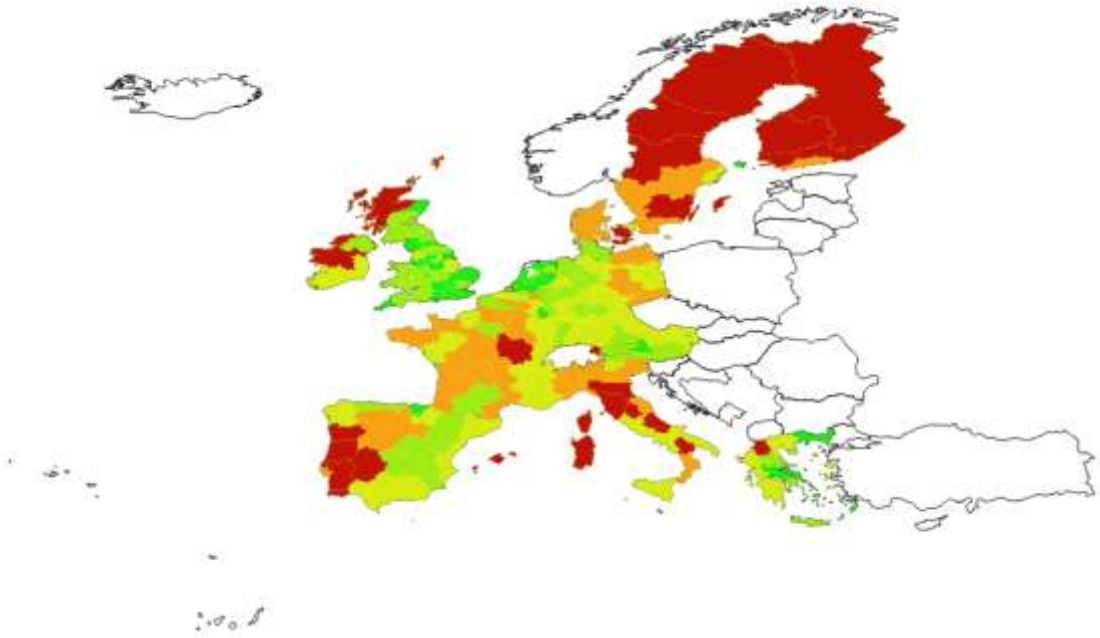
Map 58. GDI in 2009



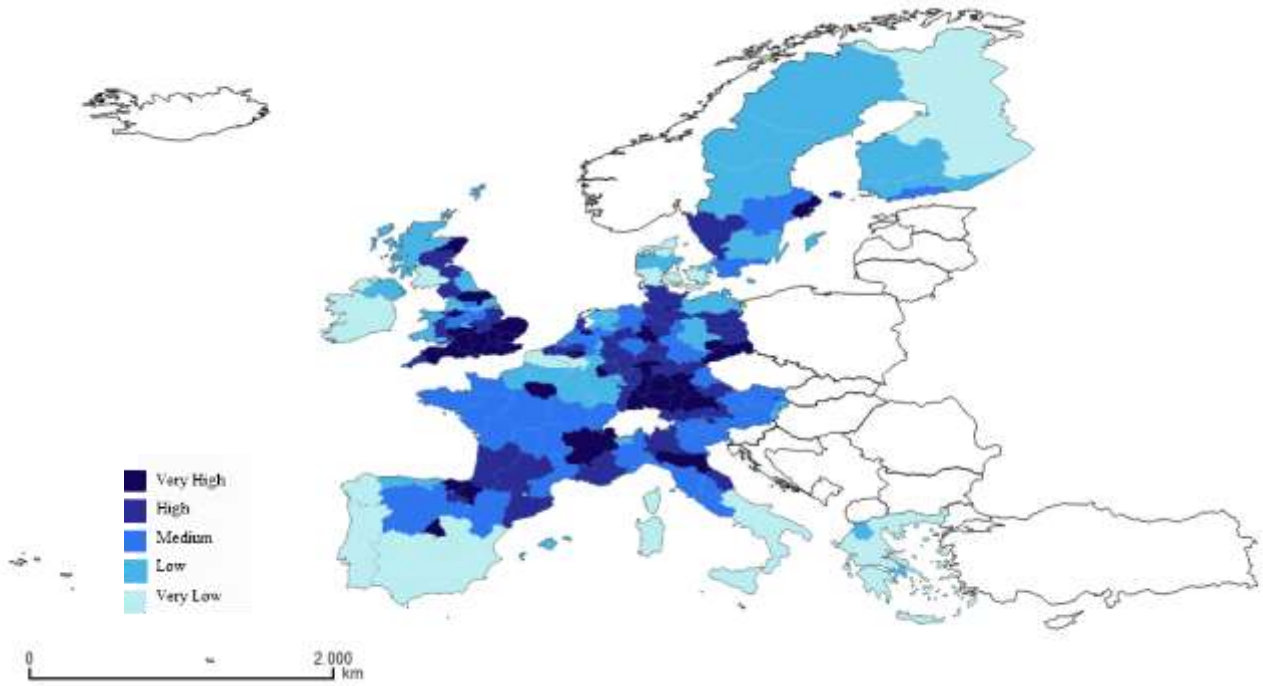
Map 59. GDI in 2010



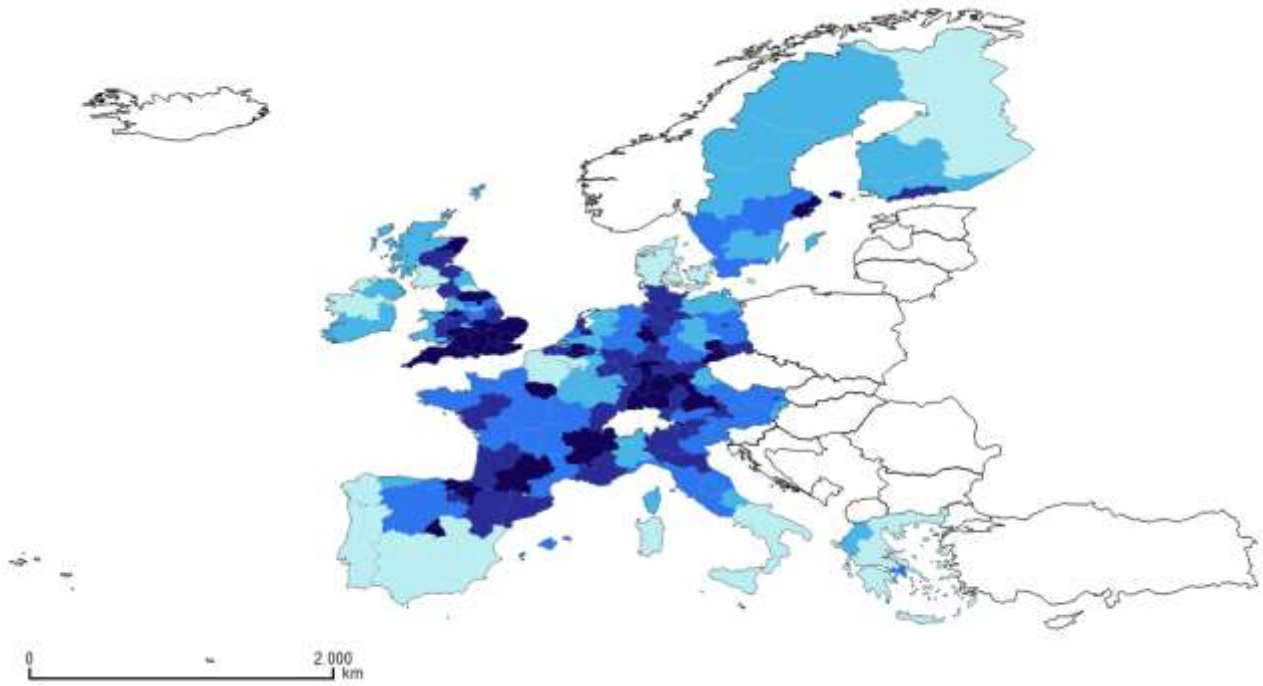
Map 60. GDI in 2011



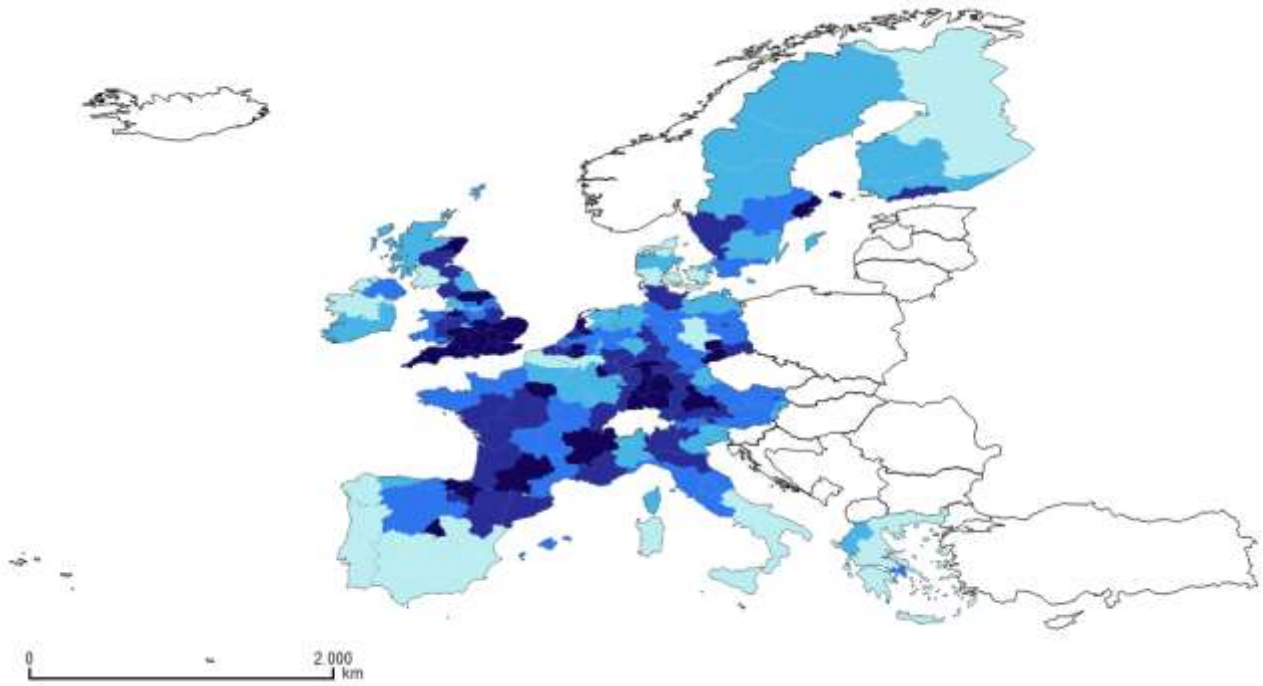
Map 61. IHDI in 2000



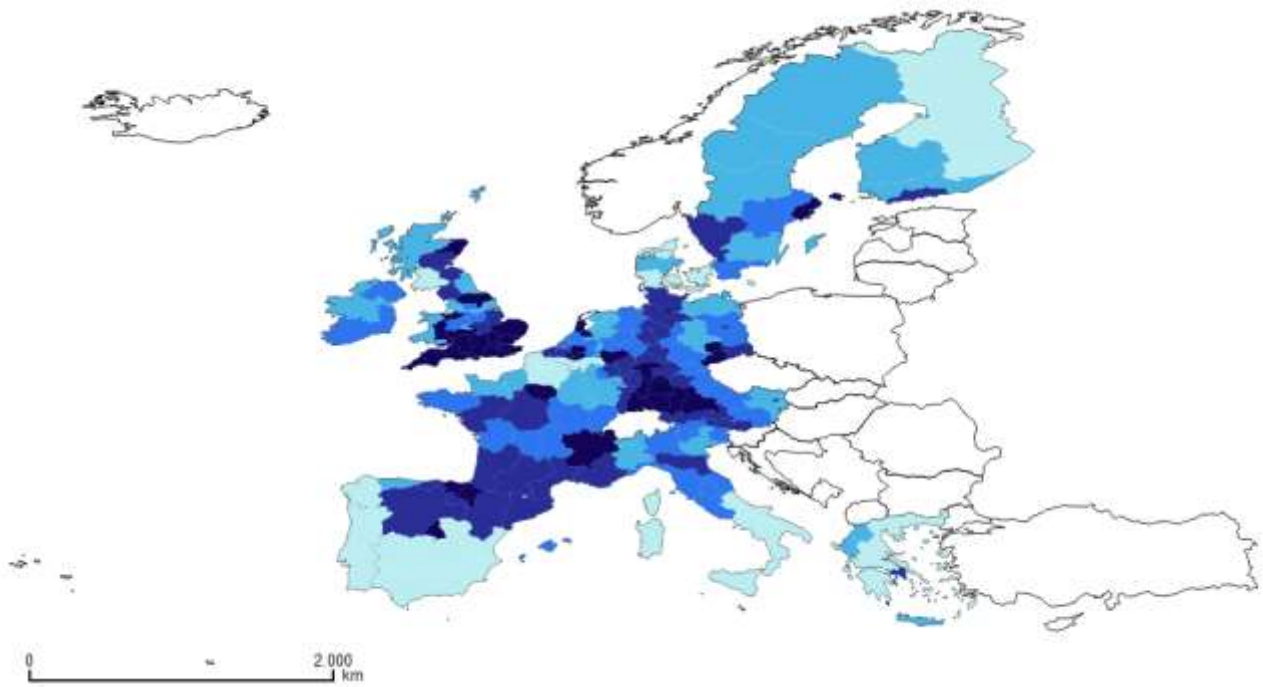
Map 62. IHDI in 2001



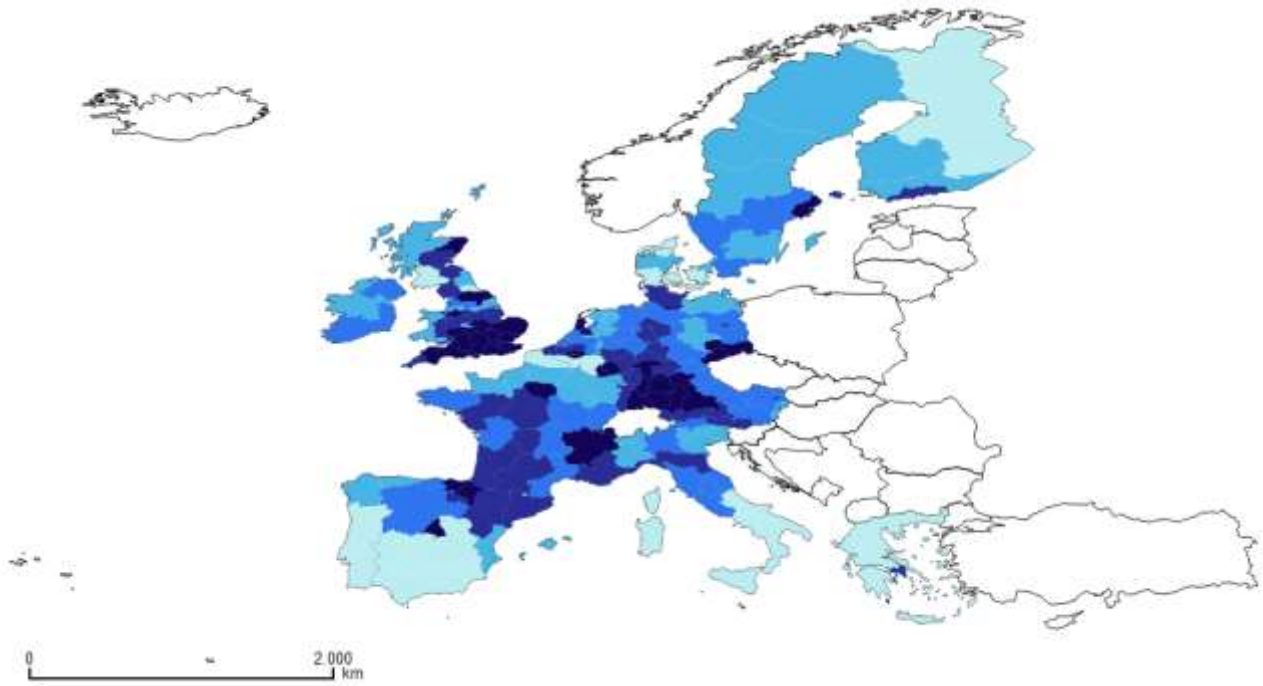
Map 63. IHDI in 2002



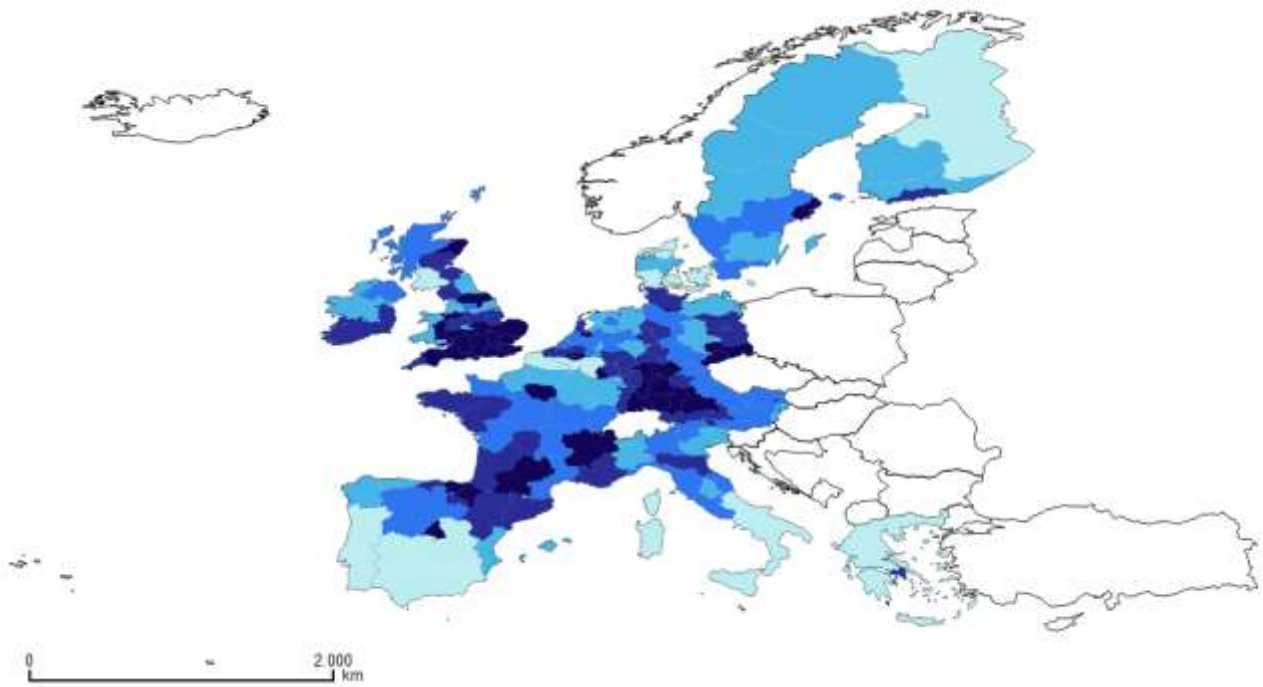
Map 64. IHDI in 2003



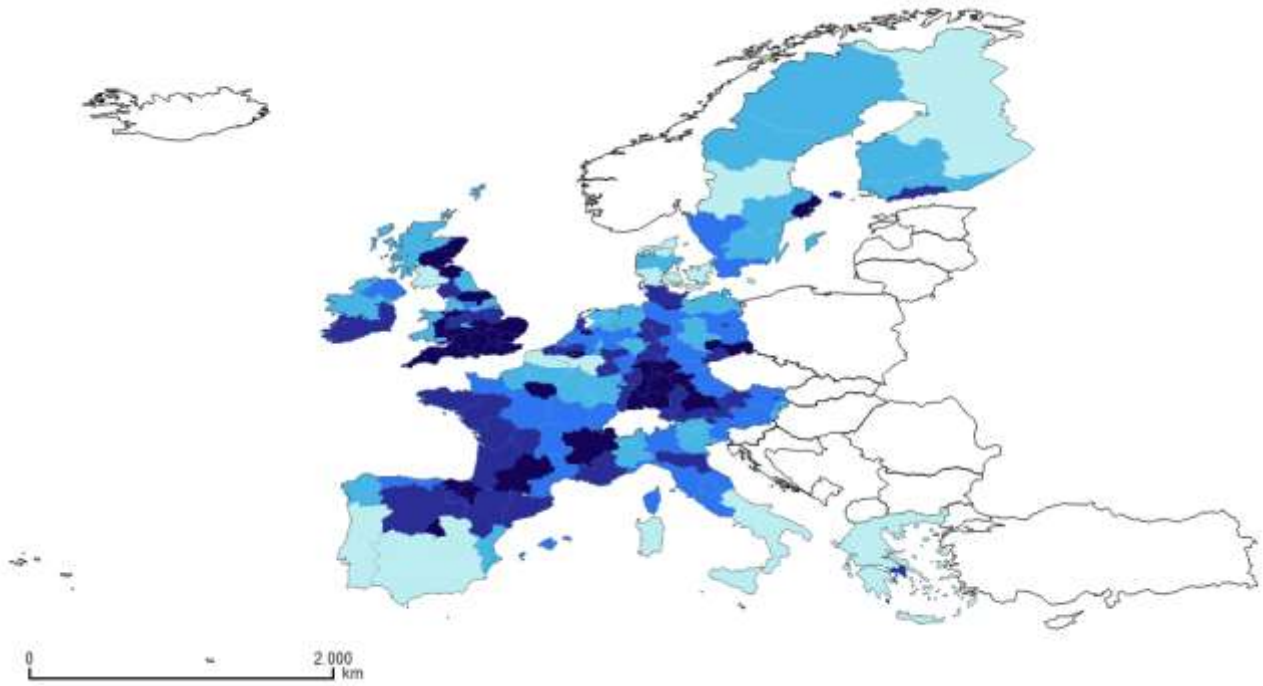
Map 65. IHDI in 2004



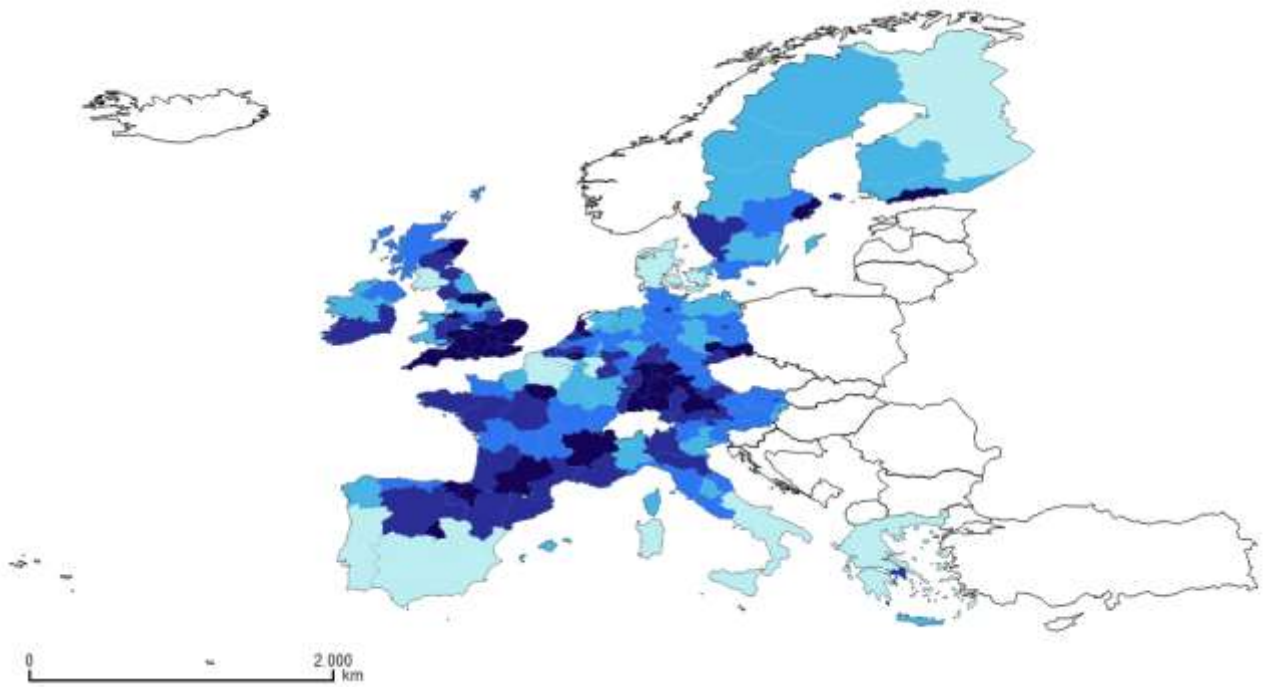
Map 66. IHDI in 2005



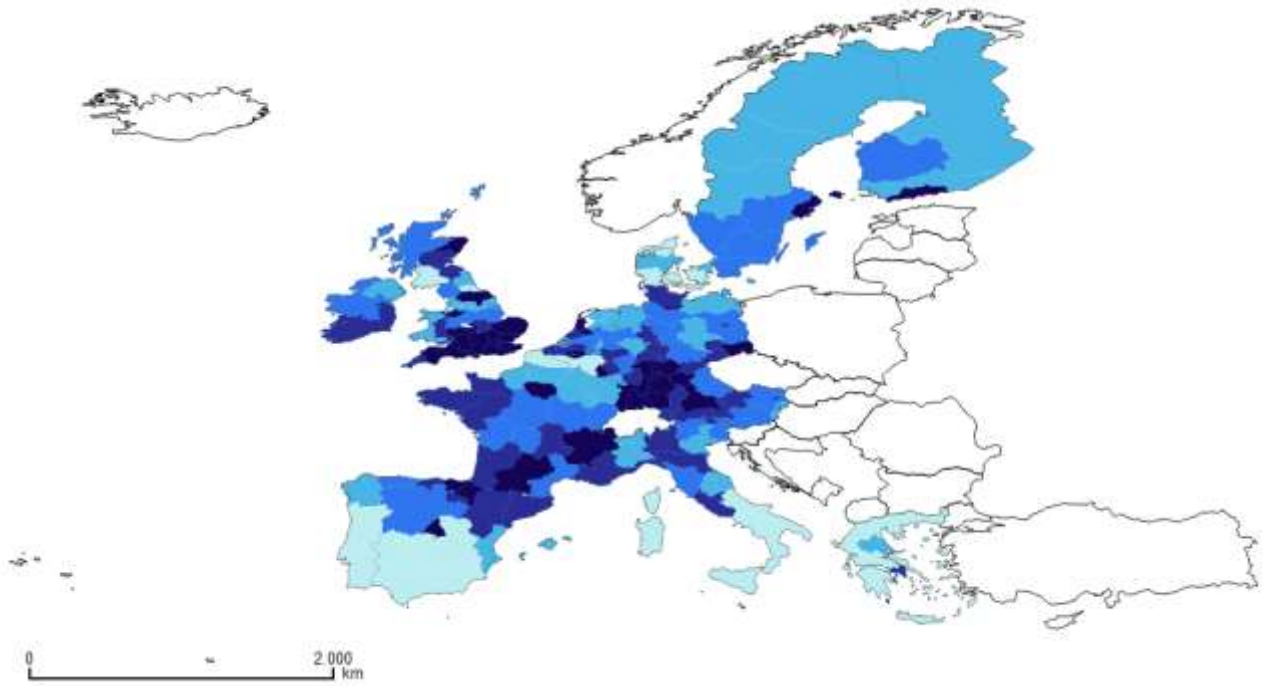
Map 67. IHDI in 2006



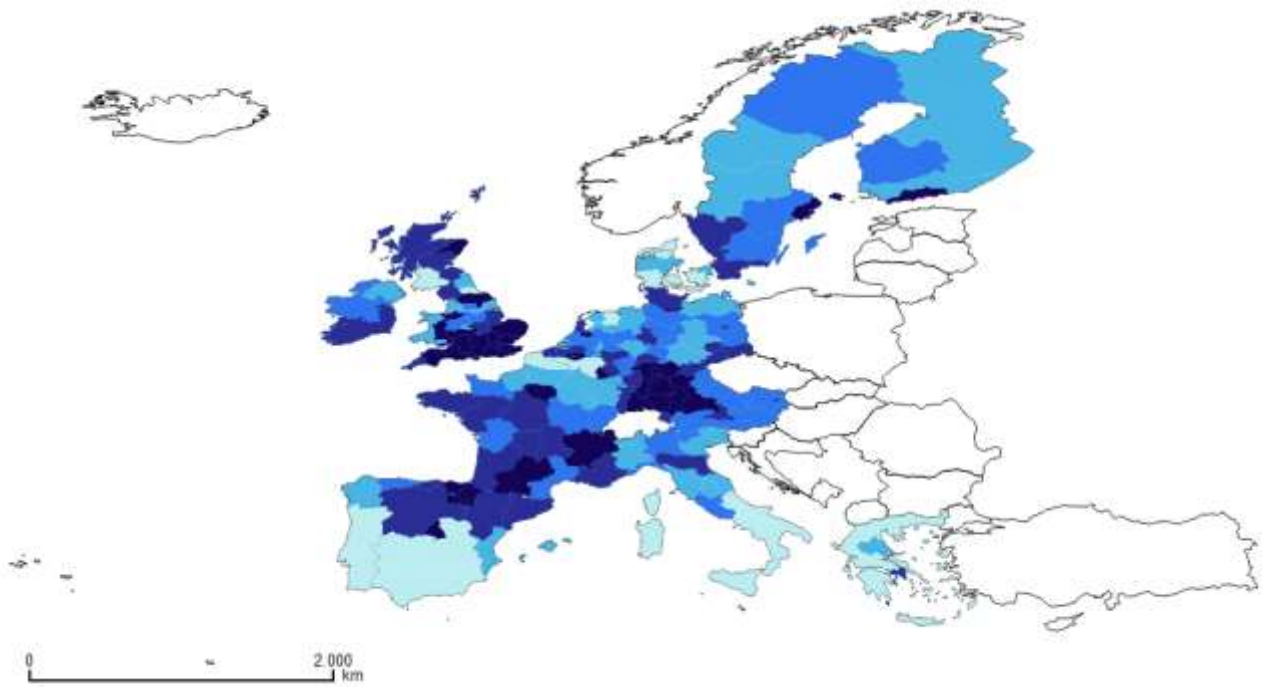
Map 68. IHDI in 2007



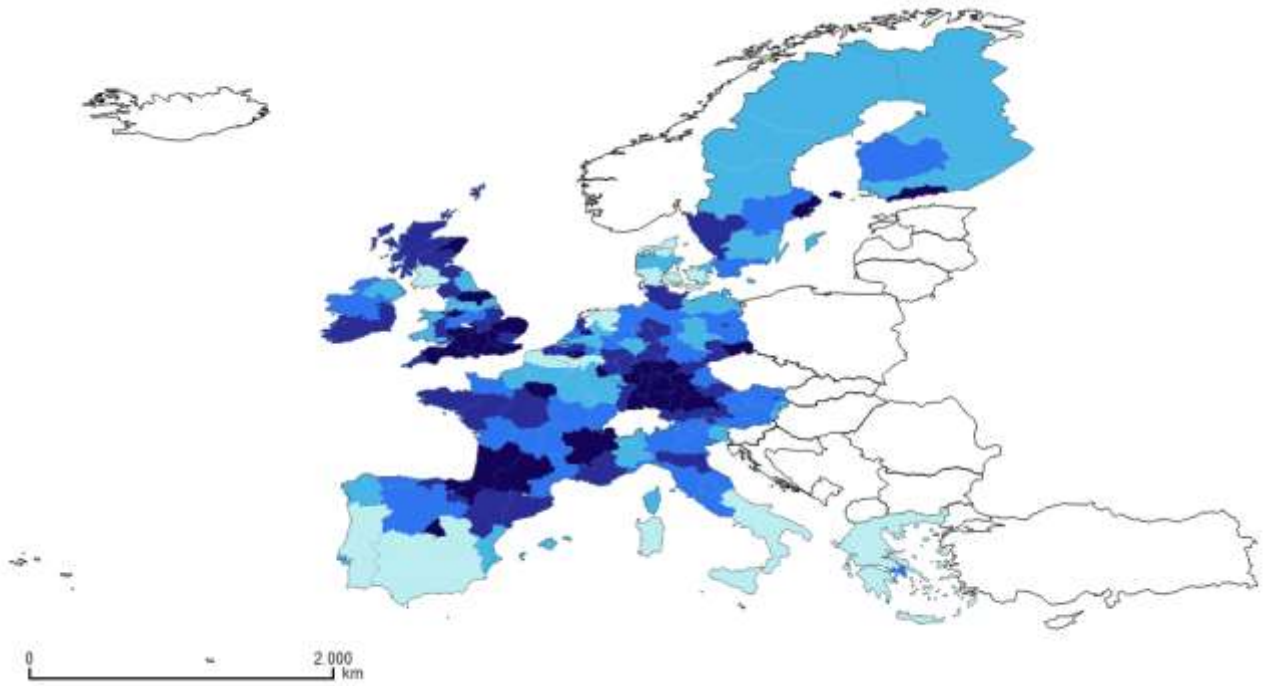
Map 69. IHDI in 2008



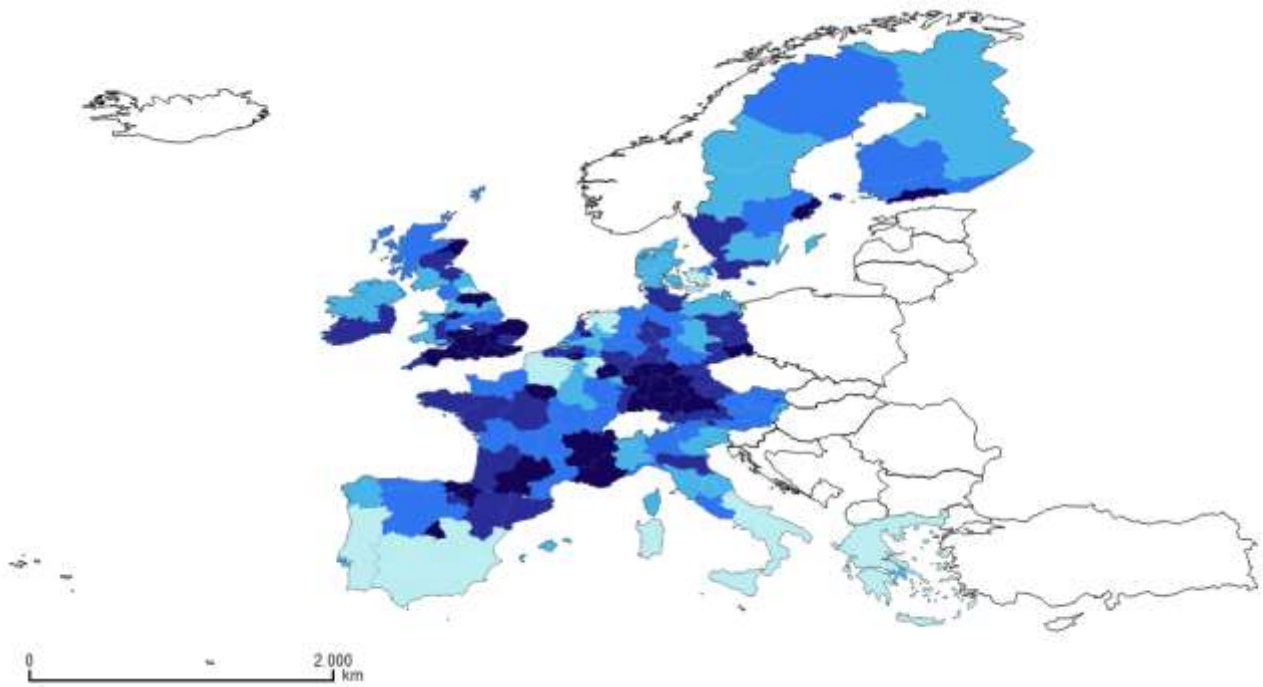
Map 70. IHDI in 2009



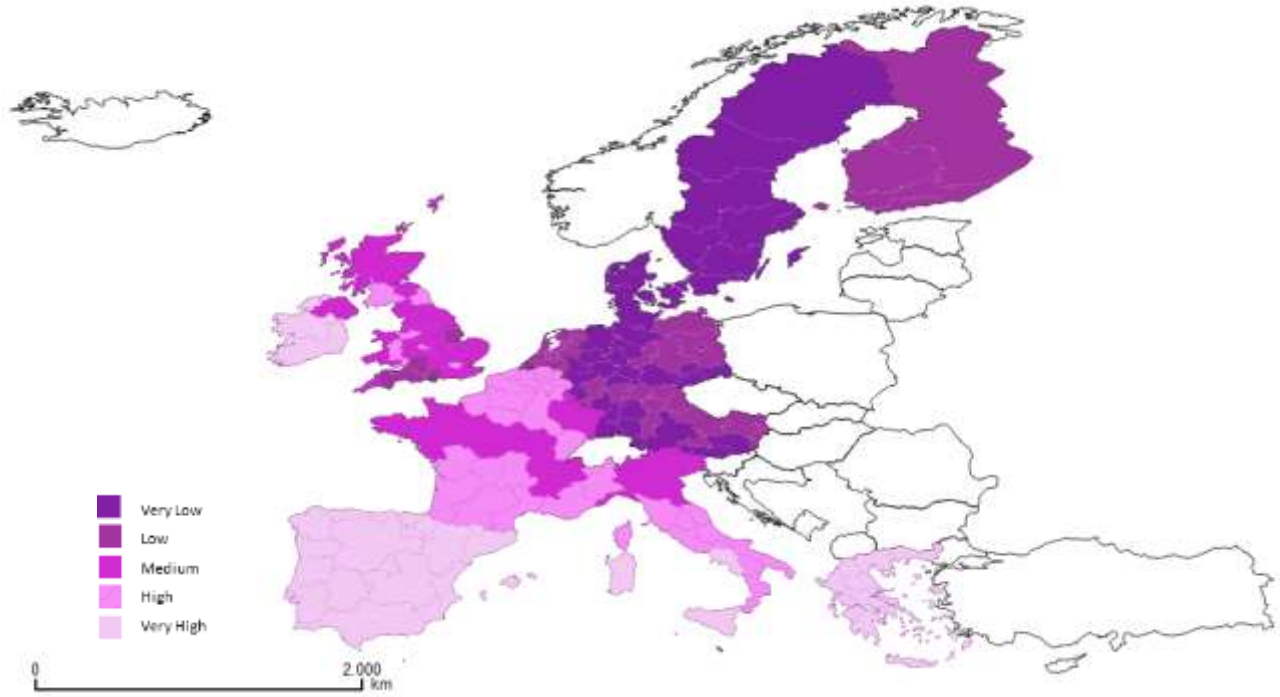
Map 71. IHDI in 2010



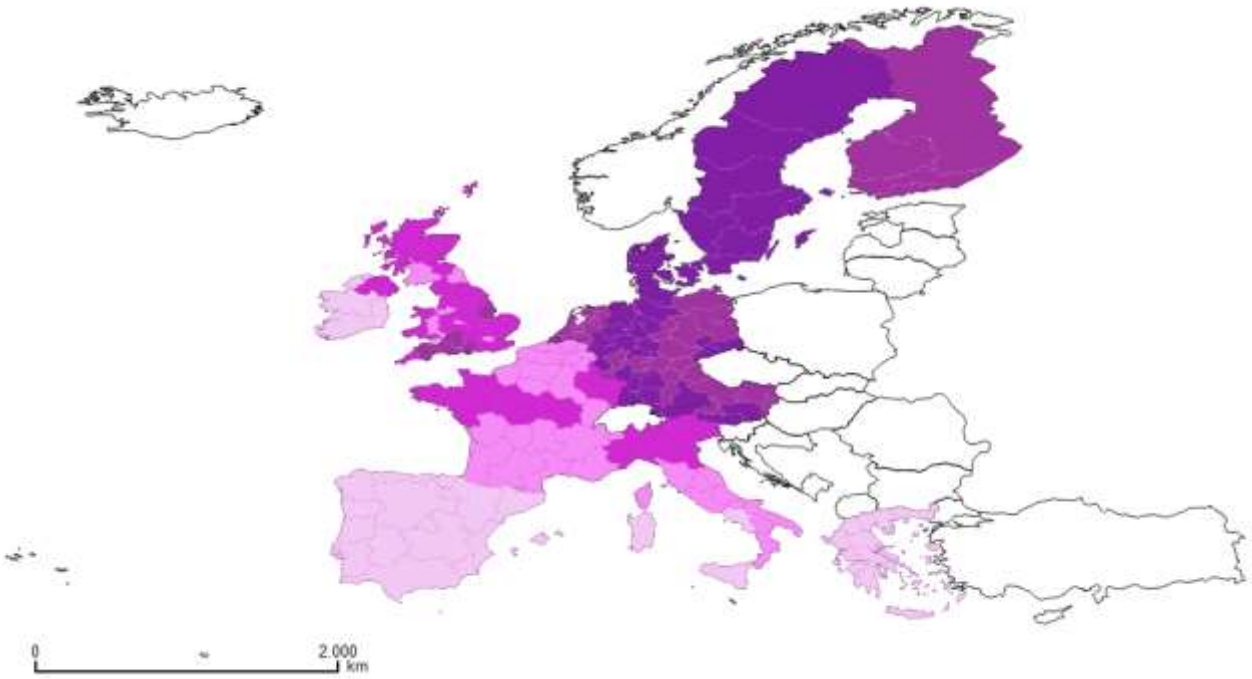
Map 72. IHDI in 2011



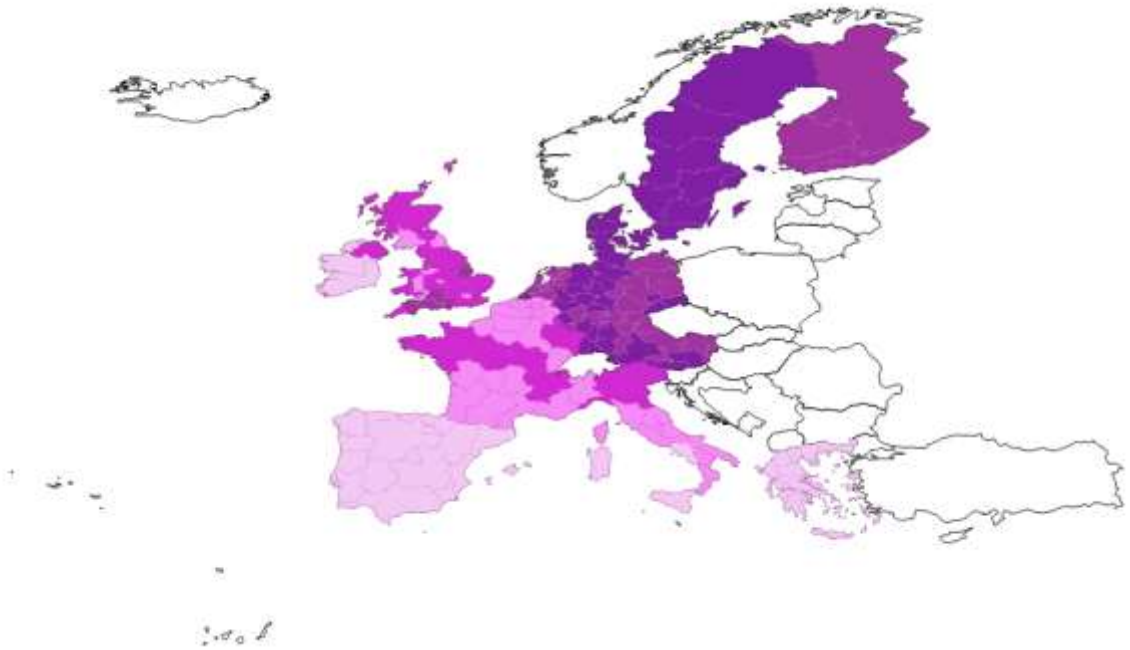
Map 73. Loss in 2000



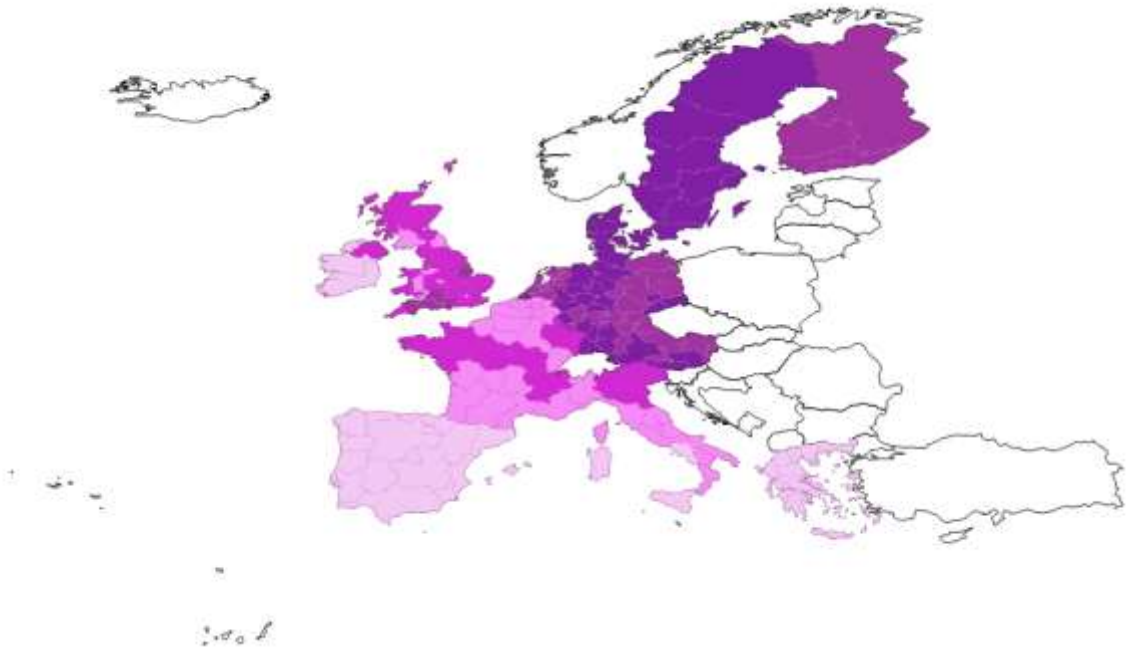
Map 74. Loss in 2001



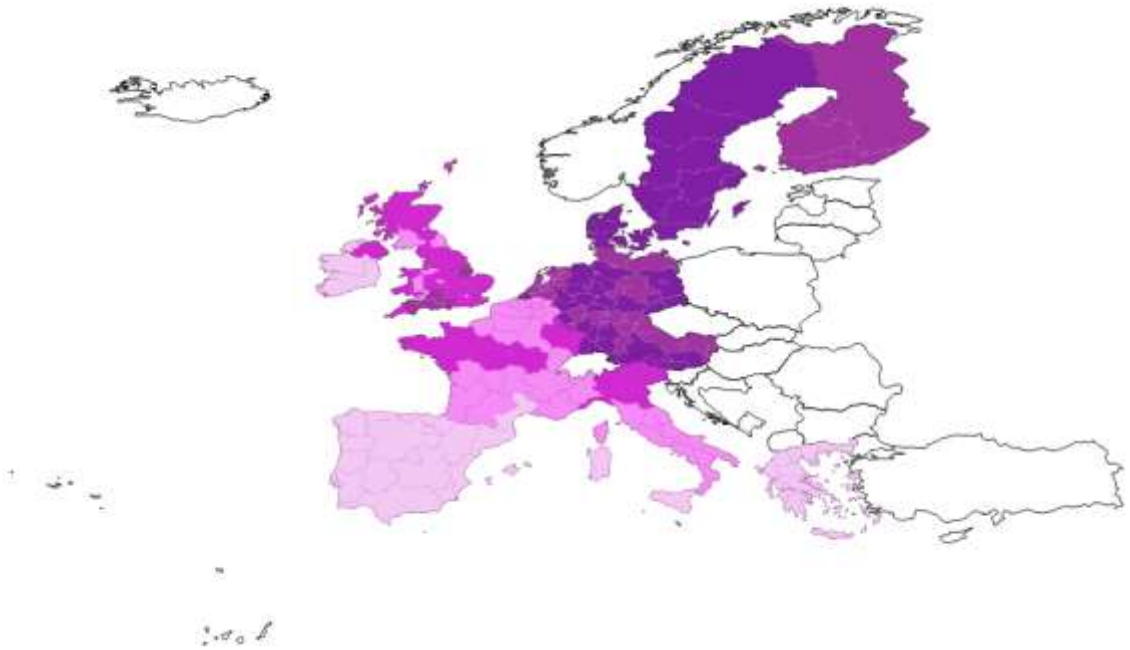
Map 75. Loss in 2002



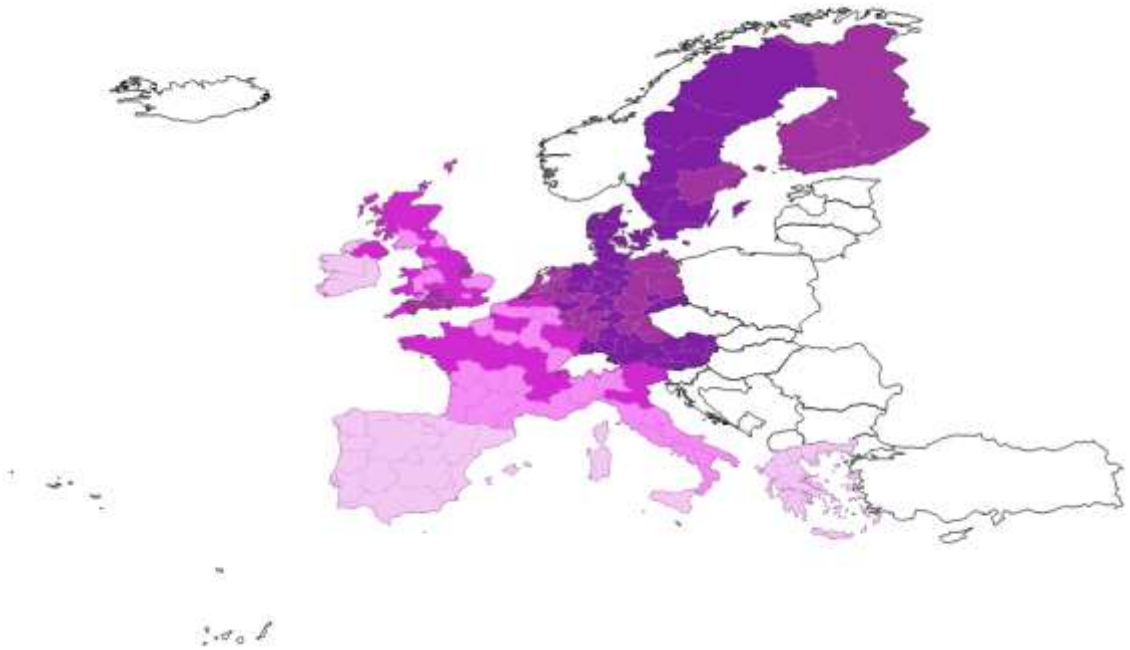
Map 76. Loss in 2003



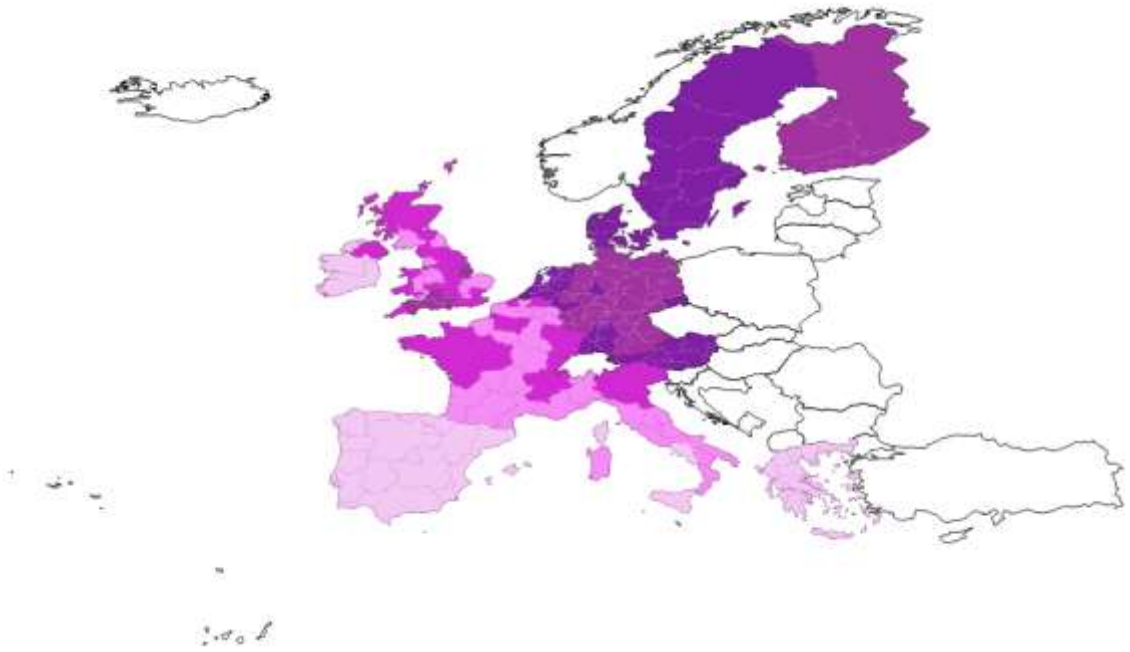
Map 77. Loss in 2004



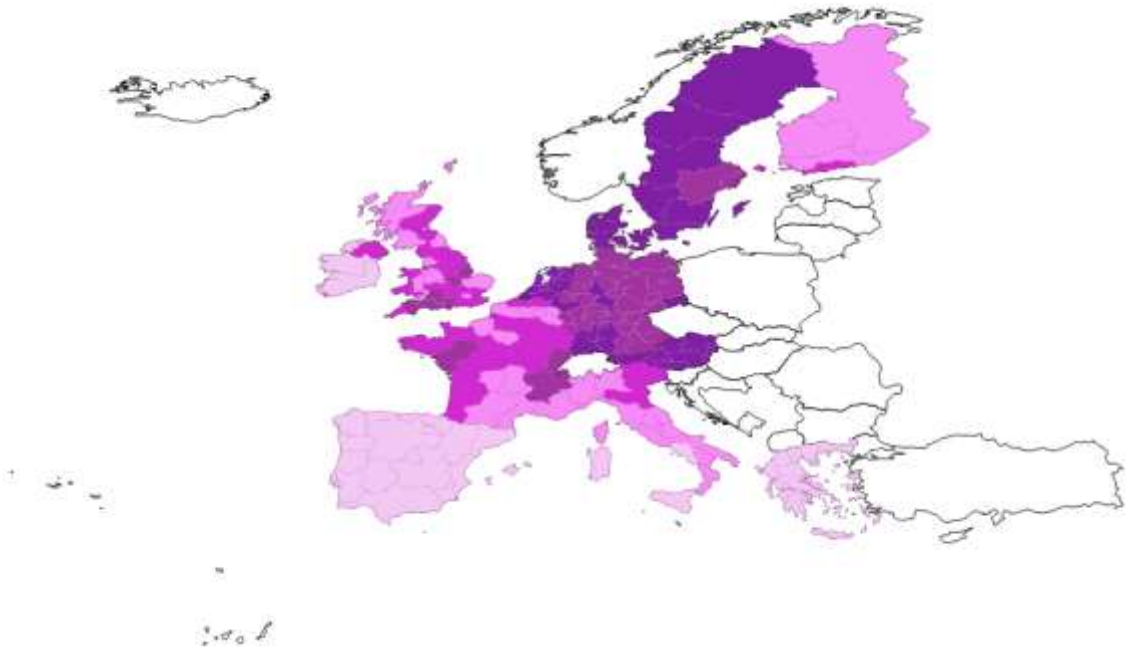
Map 78. Loss in 2005



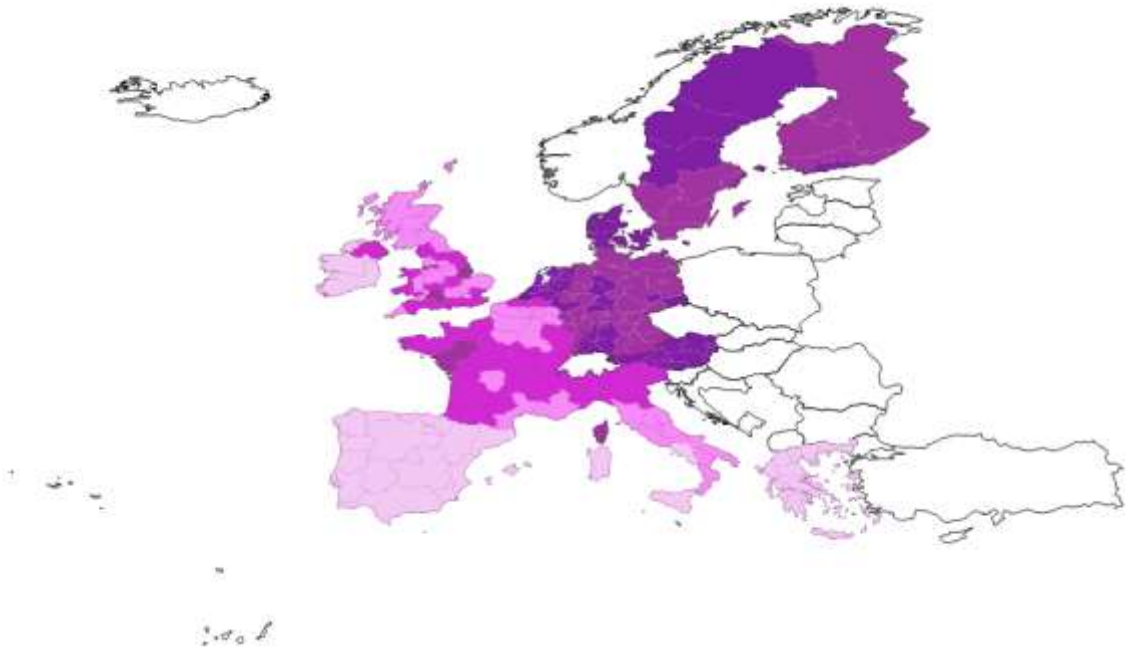
Map 79. Loss in 2006



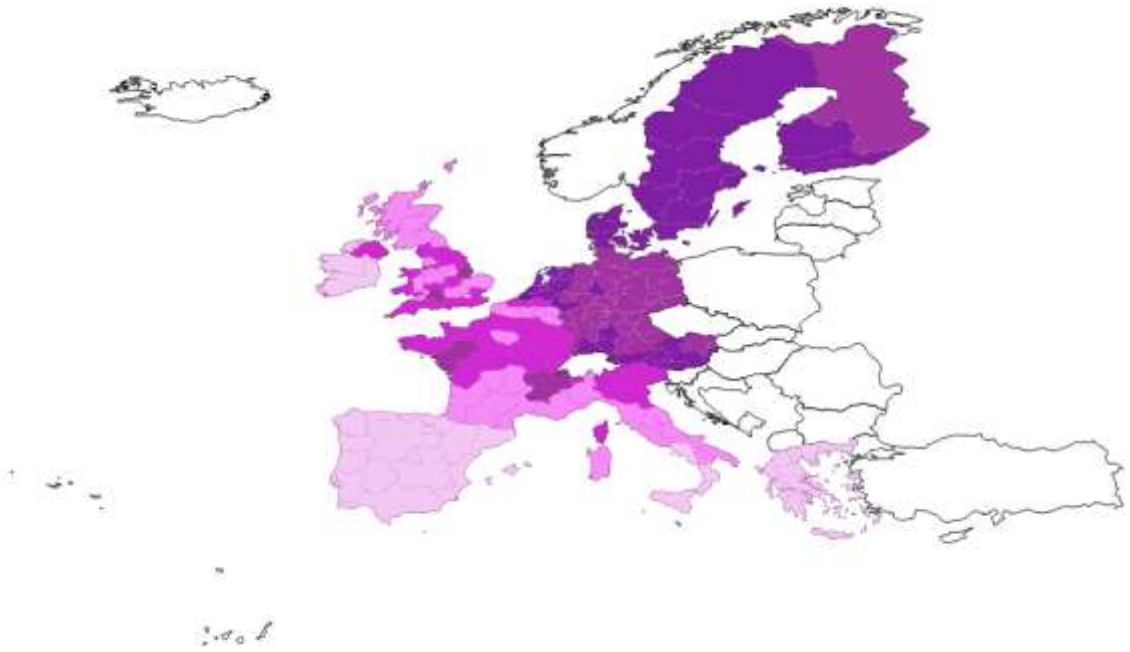
Map 80. Loss in 2007



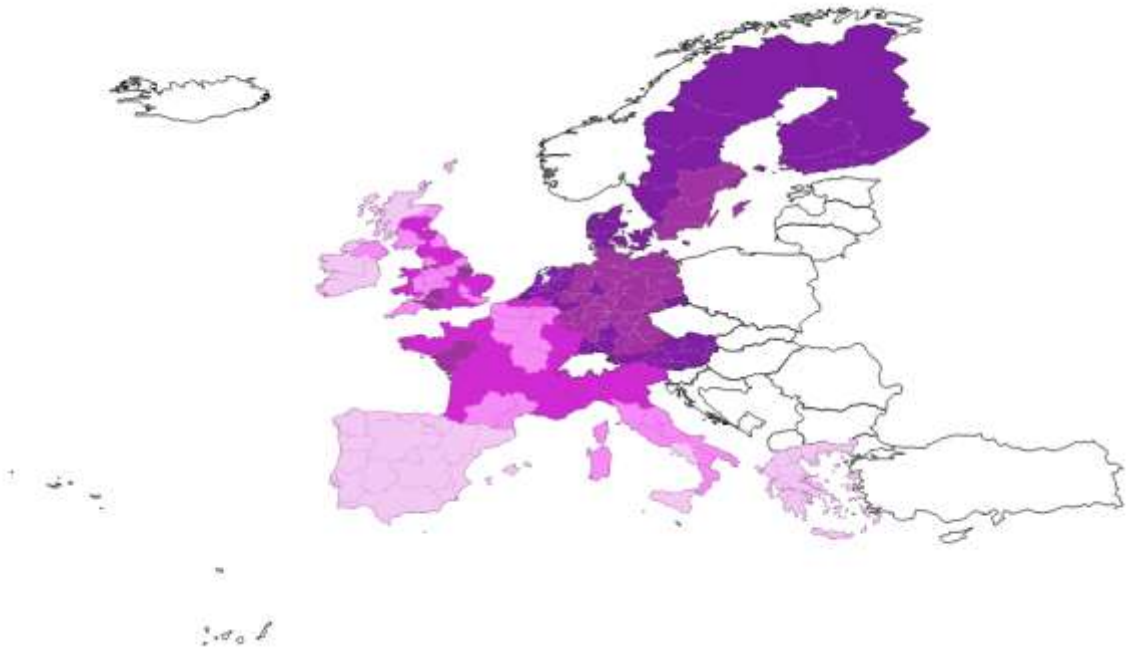
Map 81. Loss in 2008



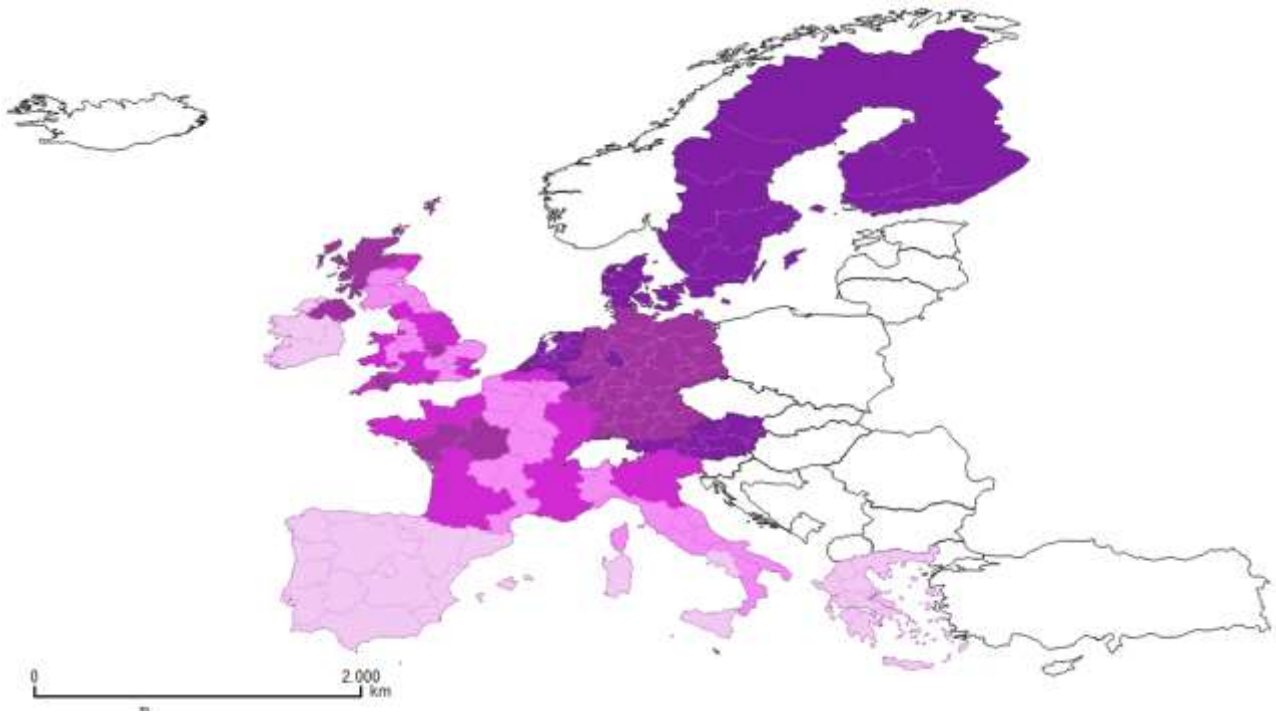
Map 82. Loss in 2009



Map 83. Loss in 2010



Map 84. Loss in 2011



EXPLORING THE SPATIAL CONTEXT: ECONOMIC SPECIALISATION AND INEQUALITY

Abstract: This paper provides an explorative analysis of regional characteristics relevant in the study of spatial disparities. Considering the economic production specialisations of regions and characteristics of their employment dynamics, it aims at describing the regional production structure and its spatial distribution within the EU15. Regional databases for 205 EU regions have been reviewed. Synthetic indicators of local production structures have been obtained through Principal Component Analyses. Spatial distribution of obtained measures has been compared to a previous estimation of multidimensional inequalities across the same regions. Findings show how lower levels of inequality are present in regions with stronger labour markets. At the same time, they appear to be the more economically productive and industrially diversified. Results suggest that different social and institutional settings may be the key for both economic and social development of European regions.

Keywords: European Union, industrial clusters, inequality, production structure, region.

Introduction.

Drawing upon multidisciplinary approaches to the study of territorial inequality, this analysis aims at exploring the spatial disparities in the EU, mainly looking at socio-economic characteristics of regional production specialisations.

Generally speaking, inequality is a matter of uneven distribution of resources among members of a certain community, and that is why it has always been a topic of interest for scholars of distribution theory indeed, within either economics or sociology. In addition, inequality means spatial disparity, and this is so because each territory has a set of geographic, social, cultural, institutional and human resources that constitutes the space of its own assets' endowment and development potential at the same time. The Oxford Dictionary of Human Geography defines *spatial inequality* as "the geographical expression of social inequality, recognising that space is both the medium and outcome of social relations" (2013). Disparities exist also because socioeconomic and policy dynamics of regions and cities are different from each other, and often they are particular to a specific geographic area: that is why the spatial dimension has to be considered when studying inequality (OECD, 2016).

In the wide range of spatial approaches to territorial analysis, valuable contributions to this research field have been produced by, among others, many economists, sociologists and geographers.

Specifically looking at the European case, regional studies in all of the above mentioned disciplines have contributed to the analysis of disparities between regions of the Union. Economists are usually more concerned with income inequalities or GDP growth rate differentials. They often look at convergence processes followed or not over time (Alcidi et al., 2018; Pieńkowski, Berkowitz, 2015; Quah, 1995), and variously decompose these trends into national and sub-national components (Martin, 2009). Sociologists are instead more prone to look at the local processes triggered by –or coming up with- social ties and collaborative activities (Berger-Schmitt, 2000, 2002; Acket et al., 2011), inferring about the systemic configuration of analysed mechanisms (Whelan, Maitre, 2008). Geographers have generally dealt with the spatial dynamics and localisation choices. Stress has been alternatively placed on institutions (Rodrik et al., 2002; Boschma, 2016), innovation (Rodrìguez Pose

et al., 2008, 2013), geography (Bosker, Garretsen, 2006), labour market dynamics (Glaeser, 2007, 2009; Moretti, 2013), business clusters (Porter, 1990, 2003; Ketels 2008, 2013), and so on.

Although such a variety of approaches contributes to improve our understanding of the persistence of inequalities in several domains, along with some of its possible drivers, there has been limited mutual enrichment between these different, but nevertheless complementary strands of literature. The relations in place between the considered dynamics of regional development, based on economic production and specialisation, have not been totally clarified yet. Finally, a comprehensive picture of the specific relationships between cluster policies and disparities of regional progress in non-economic terms across European regions is still missing.

Main research questions this paper intends to contribute to are then the following: are characteristics of economic production structure informative enough about the state of territorial disparities? Can the spatial distribution of production specialisations tell us something more about inequality within the EU regions?

Based on the available databases, the main aim of this piece of research is to explore the regional production structure of the EU regions, in order to understand if their characteristics conceal some latent factors able to synthesise different types of economic specialisation, as well as to describe a spatial distribution common to territorial inequalities. These characteristics include the share of knowledge intensive employment and the innovation outputs, along with labour market indicators[50] and the presence of production clusters. The definition of the latter here assumed refers to the concept of agglomeration of firms, and especially to the extensive research carried out by the Center for Strategy and Competitiveness (CSC) at the Stockholm School of Economics and the European Cluster Observatory (ECO) (Ketels et al., 2008; Ketels, Protsiv, 2013). Due to the several approaches available for the measurement of inequality itself, it is worth clarifying also that when used here this concept is intended as inequality of outcomes, specifically with regards to the multidimensional framework of human development economics and capability approach (Sen, 1987; Alkire, 2010).

Drawing on the mentioned strands of literature and available databases for the EU15[51] Member States, 205 regions have been considered over the period from 2000 to 2011. Statistics about regional production structure have been reduced to synthetic indicators by applying a Principal Component Analysis. Finally, spatial distribution of results has been mapped together with the level of multidimensional inequality, in order to explore their territorial patterns. Findings show how production diversification and innovative specialisation seem to go hand in hand with better performances in terms of inequality. Regions with economic productivity higher than average, generally show also lower inequality. Distribution of the indicators selected to synthesise the quality of labour market reveals similar patterns as well.

Given the acknowledged role of regions in the currently globalised economic and political system (Scott, 1998), spatially contextualising this study at a subnational scale is here meaningful for at least a couple of reasons. A regional system is probably the best territorial unit of analysis to gather and practice new policies. Soft elements of the competitive environment, such as social capital, are more likely to emerge as driving forces of development, and appear easier to capture in a local rather than national setting (Aranguren et al., 2010). Moreover, inequalities between territories may mean inequality of opportunities for their inhabitants, which may lead to low social mobility: too often socioeconomic issues are faced without taking into account their territorial aspects, while the consideration of the spatial context may be crucial for a correct analysis. Therefore in order to get a complete picture and a better understanding of the relationship between man, community and space,

[50] e.g. the long term unemployment rate and female employment rate. The complete list of considered variables is provided in paragraph 3. "Data and methodology".

[51].The choice to restrict the analysis to the EU15 only was driven by data availability issues at the NUTS2 regional level.

and how to study their joint development (eventually unequal), considering the local context seems vital (Prager, Thisse, 2012). Despite the fact that the phenomena studied here occur also at a very smaller scale (i.e. up to cities and their neighbourhoods), the territorial tier here chosen to identify regions is that of NUTS2[52]. This pertaining to a statistical partition, and often overlapping administrative borders, it implicitly introduces the problem of the arbitrariness of the areal unit. In terms of the spatial scale, this is an unsolved issue, and it has been known in geography for decades as MAUP (Modifiable Areal Unit Problem[53]). As any sort of partitioning of the space does -be it in either states, regions, cities, or neighbourhoods- it implies that everything inside the partition is presumed to be connected and homogeneous, while everything just outside the partition border is not connected anymore. Nevertheless, this local level has been here preferred, and specifically the NUTS2 partition has been chosen mainly due to data availability issues. As a matter of fact, it ensures wider and more homogeneous statistical coverage for countries of interest. In particular, comparability to regional performance and innovation indicators are not provided at a lower territorial specification yet.

The paper is then structured as follows. Next section reflects on the importance of considering the spatial dimension in the study of inequality, and how this has been approached by economic geography literature. Second section focuses on the role of production clusters, and provides a brief overview of the relevant contributions to their study and measurement. Third section explains data and methodology applied in the analyses carried out. Fourth section discusses the results of this explorative study, and the last one introduces some conclusions.

1. How Space Matters in the Inequality Analysis.

By its very nature, space is unequal and so does the economic one. But, while historically the geographic diversity mattered most in the determination of this spatial differentiation (e.g. as long as natural resources where the main motivation behind the choice of where to live), it has been considered always less explanatory of the processes that lead some regions to be specialised and rich whilst others to remain underdeveloped and poor. As a matter of fact, it can be said that all of this is mainly caused by socio-economic mechanisms tightly related to industrialisation processes along with the economic system they are part of (Celata, 2009). While spaces of production and consumption were very close to each other in the pre-industrial societies, as well as very much related to the natural space they took place in, the industrialisation progressively split them into two autonomous functions and drew them away from natural constraints. That is how space progressively had come to lose its physical meaning, and to assume an abstract connotation in the economic analysis, which considers it just in terms of distances between places of production, distribution and consumption, and quantifies it mainly in terms of transportation costs. For the same reasons, when territories became more and more shaped by economic forces, economic geography came into being as a response to the needs for a conceptualisation of the geographic space within the economic theory (Celata, 2009). Considered the founder of the *regional studies' school,* Isard (1949) worked on conceiving the space-economy theory drawing on the seminal contributions from the German school of thought on *Raumwirtschaft* from von Thünen (1826), Weber (1929), Lösch (1938), Weigmann (1931), and Predöhl (1925) especially. He devoted efforts to state the importance of considering the variation over space in the economic analysis as much vital as the one over time (1949).

And on the same line, main economic geographers worked hard to model basic concepts of the localisation theory. Agglomeration dynamics of firms were clear to Weber (1929) when studying the localisation choices of production sites. He worked on refining previous models (i.e. Launhardt, 1872), and especially was the first to highlight this tendency to locate close to other firms, potentially to

[52] For at least two reasons: wider and more homogeneous data availability for countries of interest; comparability to regional performance and innovation indicators not available yet at a lower territorial specification.
[53] The issue was first recognized by Gehlke and Biehl (1934) and later described in detail in a famous article by Openshaw (1984) and in the book by Arbia (1988).

exploit common infrastructures and reduce fixed costs. From these reflections moved the entire quantitative geography of 50s and 60s, with the aim to explain the territorial divides implicitly embedded in these logics.

The study of polarised development, where industrial localisation profoundly shapes the territory of location and determines massive development for some poles only, with the consequence of a widely unequal spatial distribution of resources and firms, made clear the policy implications of these research questions, as much as urgent the necessity to give them a response. If firms' location and localisations choices have an impact on the territory, influencing the economic and production specialisation of places, they unavoidably affect lives and choices of people who habit those places. That is the reason why this comes to be a crucial issue in local economic development theory, and has its own relevance in the study of inequality. The economics of inequality should not be blind to spatial connotations of disparities, and disregard the consideration of territorial specific characteristics that can make a difference in explaining the levels of socio-economic inequalities experienced by individuals living in some places more than elsewhere.

Contributions from Myrdal (1957) and Perroux (1961) are milestones in the study of unequal development of places, and their analysis are still relevant to explain processes of local development and polarisation of industrial production. The model of *circular cumulative causation* is still accepted as the main modelling of the effects[54] of firms' agglomerations, and the forces that lead them to develop even more at the expenses of other places, which tend to remain stuck in underdevelopment instead. Perroux focused on the attractiveness that a developed pole is able to generate, attracting financial capitals, workers and resources, enlarging its potential and trickling-down parts of this effects to the surrounding territory. Both authors moved in the frame of a Keynesian paradigm, where the multiplier effect was used to explain this uncontrolled and rising process, and expected to spread out benefits to immediate territories, in a space where factors were free to flow from a developed region to an underdeveloped one, from a central pole to the periphery.

Unfortunately, we know that this is not necessarily the case, and that policies shaped on this view mostly occurred to be a failure (e.g. the growth poles strategies designed by the Cassa del Mezzogiorno in Southern Italy during the 60s and the 70s). The economic policy recommendations derived from these analyses turned out to be wrong because local development was considered as a direct product of industrialisation, without taking into account the local history and specificities. It appears now clear that if surrounding territories do not have the instruments to absorb the effects and externalities generated by the growth poles, these will not be effective in producing the wanted influences. Externalities that could potentially originate from industrial polarisation, and initiate a long-term development, need other local elements to be.

As Alfred Marshall (1920) was able to intuit, proximity of firms[55] is not the whole story, and the process for a long-lasting local development entails other components. This is also about the social climate, the so-called *territorial milieu* that permeates the industrial districts he could observe and describe. Entrepreneurial environment and social norms deeply rooted in the places of industrialisation can make a great difference, and be the trigger for a firms' co-location spot to transform into a Marshallian district, which embed a specific amount of urbanisation and localisation externalities. In a way, the latter can be both causal factors and consequences of the industrialisation process. Geographic space is itself the result of socio-economic dynamics: if truth is that characteristics of places can steer localisation choices of firms and urbanisation externalities can explain their tendency to co-locate and develop unevenly, it is equally true that territories can reorganise to please the located firms in the long run (Celata, 2009).

[54] Which can be either direct, indirect or induced.

[55] The concept of proximity can be intended not just in terms of geographical vicinity, but also of social and institutional ones for example, and it entails a variety of complementary elements. For an in-depth elaboration on this see Boschma, 2005.

Moreover, agglomeration externalities depending on the interactions between co-working firms are useful to explain regional specialisation paths. Specialisation just in a small amount depends on territorial specificities, while a major role is played by industrial dynamics like the localisation ones as Marshall described. Traditional theories are not able to explain neither urbanisation nor agglomeration processes. Lösch (1954) was the first one to distinguish between these two kinds of externality. Urbanisation externalities are about size and density of the urban area, because the more developed this is and the higher the number of other firms located there is, the more the provision of infrastructures, quantity and quality of labour force will be, together with other inputs it is supposed to offer. In particular, relational chances and knowledge exchanges between firms would benefit from proximity. And this kind of externalities can explain the reasons why firms decide to co-locate, even in times of globalisation. Localisation externalities, instead, are external to the enterprise indeed, but internal to the regional production system, and represent the advantages of connections a firm can establish with other actors working in the same economic branch or within the same production process. This explains why *similar* firms tend to co-locate and originate local specialisation in economic production. Their implicit benefits could be either direct or indirect, and the most important one is probably that of being central to the same catchment area. It can be said that once urbanisation externalities have attracted many firms to locate in a vibrant area, localisation ones make it attractive for others to co-locate. And this ignites the reiteration of the cumulative process. In the same way at a certain point of this process, unwanted effects can be generated and externalities turn into negative ones. Main examples are the increase of competition, salaries and rents, pollution and congestion (Celata, 2009).

As a matter of fact, growth poles theories help understand imbalances in the spatial distribution of economic disparities, and have been used to explain the mechanisms behind the replication and persistence of development disproportion. Especially the analysis of Wallerstein's *world-systems* (1974) outlines a model where developed and underdeveloped regions are part of a strict hierarchy of dependency between the two. In the centre-periphery relations theorised by the new economic geography, the underdevelopment of peripheral and semi-peripheral spaces acquires its own functionality to the development of the core areas of the system. This intuition was also behind what has been called the theory of *late development* to explain the North-South dependency in the economic development theory (Gerschenkron, 1952; Stiglitz, 2002; Engerman, Sokoloff, 2002). That vision of the economic world has left pace to a modified territorial logic, which is not just about a North-South opposition. One fundamental concept in the current framework is the *network*: it is a meso-level of analysis that puts the connections among actors at different geographic and organisational scales together (Celata, 2009). The more a region is embedded in international networks, the stronger will be its competitive and innovative ability, notwithstanding the higher dependency from exogenous dynamics and regardless of the stage of regional development. In addition, despite the fact that proximity still matters because of the above mentioned externalities, the concept of distance has acquired different meanings and industrial production appears de-materialised. The space itself appears as de-territorialised, whereas it actually maintains its crucial role and does matter in the understanding of the entire process. Transportation costs are no longer entirely dependent on distance, but mostly on the system technology and its efficiency. When distances are shortened, transportation costs reduced and international interactions multiplied, the interdependency of places is massive as never before. Dependency that is augmented by the degree of globalisation and its new international division of labour, in terms of always more centralised financial control and dispersed production sites. It is a contradictory process, where firms try to exploit geographic differentials to gain competitive advantages in the international markets, which depends on the fact that some factor endowments move fasters than others (e.g. investments and financial flows travel much quicker than people). Places where externalities are more exploitable will be rewarded, and this will reinforce spatial imbalances. The new spatial division of production and labour has social and political consequences, and it has turned the global economy into a flows' network and led the international fragmentation of production at its peak. It is called *compressed development* by Haworth (2013) and

has already been described by Harvey (1982) as a *time-space compression*, where the more important factor endowment is the labour force. That is why much inequality is generated also at the individual level, because of the disproportion of added values and remuneration at different stages of the network. A key indicator is the degree of autonomy of each element within the global network indeed. Based on this, production systems can be classified referring to the level of dispersion or concentration – both in governance and in space- of its components. When there is high autonomy in the governance of single stages of production process together with high dispersion of its geography, we are in the event of transnational network of production- the so-called Global Value Chains (GVCs). Compared to traditional multinational firms, here the vertical integration of production functions has given way to fragmentation of power relations internal to the firm.

In this new world configuration, the focus actually shifts from the localisation choices to the spatial division of labour, which deals with the international fragmentation of the production cycle, in a tangle of relationships both internal and external to firms always more geographically dispersed. The reasons why firms decide to structure their relational flows are to be searched in the extent of internal and external economies of scale and scope (for a detailed categorisation of input-output systems based on this, see Storper-Harrison, 1992). This geography is not determined by market conditions or places' characteristics anymore, but it comes to be truly an extension of the business strategies and the relations they manage to establish (Porter, 1990, 1998). Production and supply chains can take on different forms, which originates a specific technical and social division of labour, which itself produces the spatial one. Places have an *active* role in determining how favourable a location is to attract investments and firms' location, and also a *passive* one in undergoing the strategies of firms who decide to locate and contribute to some specialisation there (Celata, 2009).

In this global scenario, an apparently counter-trend is the one of clusters of firms and industrial districts, and studying their dynamics appears vital to understand spatial disparities.

2. The Role of Clusters of Firms.

In the described framework, local production districts have acquired a renewed role for regional development systems. Following the economic crisis and associated instability in the '70s, production systems shifted towards more flexible and disintegrated organisations. Made up of a multitude of small and medium size firms, highly independent but interactive at the same time, this local system obtains the same territorial gains of a large enterprise combined with benefits from higher flexibility and specialisation. With a division of labour external to the firm and made up of networks of specialised and autonomous production units closely located, post-fordist enterprises set up in *clusters* manage to share the risk of technological change (Celata, 2009). Single elements of the production network are always more interdependent, but the system as a whole is more resilient to external shocks. The case study that originated reflections in this regard is the one of Italian industrial districts, those identified even in the collective imagination with the *Made in Italy*. Also explicitly defined by the Italian Law in 1991[56], they have been widely studied by many (Bagnasco, 1977; Becattini, 1979, 1989, 1995; Bellandi, 2009; Sforzi, 2008; Putnam; 1993). An extensive social division of labour brought to self-contained local system, whose external relations pertained solely to the acquisition of production inputs and the trade of final products. They flourished in sectors with high competition and low entry barriers, based on standard and easily replicable technologies. That is why firms must innovate products and flexibly adapt to their demand. The need for a continuous innovation process and knowledge exchange, as well as for balance between cooperation and competition amongst firms

[56] Defined by the *L. 5 ottobre 1991, n. 317* "Interventi per l'innovazione e lo sviluppo delle piccole imprese", Capo VII, Art. 36 (Distretti industriali di piccole imprese e consorzi di sviluppo industriale), comma 1: as "the local territorial areas characterised by high concentration of small firms, with particular reference to the ratio between presence of firms and residing population as well as the production specialisation of the firms jointly". Available online at http://www.gazzettaufficiale.it/eli/id/1991/10/09/091G0361/sg

within the district, were some of the problems this new industrial methods had to face, as highlighted also by Sabel and Piore (1984). Differently than previous models, the two scholars suggested that the local society as a whole would be the response to these criticalities, developing common services and infrastructures, externalising innovation and related knowledge. The Italian districts managed to do so thanks to a significant heritage of craft production's methods, which developed driving up the complexity of the relationships among firms instead than the size of plants or the intensity of production. A high interpenetration between production system and society, thanks to a multilevel societal organisation that worked as social absorbers of competitiveness, was another element of success (Celata, 2009). One of these districts' strengths is indeed the quality of relationships they manage to establish, which recalls Marshal's *industrial atmosphere*. They actually benefit from the types of localisation externalities he highlighted (1920): a common and qualified labour pool; suppliers specialised in shared service providing; reduced costs for workers' selection and training; development of interdependency among firms. In this way, firms will profit from being part of the district and their innovative capacity will be enhanced, along with the knowledge creation and sharing. At the same time, social and human capital are maximised and become part of the cumulative advantages for all surrounding territories.

Since Marshall precursory studies (1890, 1921), further different approaches have been elaborated in the frame of regional studies' spatial analysis (Becattini, 1990, 2000; Porter 2003, 2013; Gordon, McCann, 2000; Iammarino, McCann, 2006; Boschma, 2014), and the role of firms' clusters as engines of development has so become relevant. The renewed interest in their impact on growth and regional progress became central again especially during the 90s, after Porter's and Krugman's works (1990, 1991). Object of the study had come to be the relation between presence of clusters and local (and national) economic performance, and the positive association between the two has been emphasised. Porter has contributed largely to the generalisation of the industrial district concept, starting from a purely business strategy point of view. Contrarily to the reinterpretation of the Marshall perspective in the light of transaction costs' dynamics that see externalities of agglomeration economies in terms of co-location reducing costs (e.g. Scott and Storper, 1992), Porter (1990, 1998) focuses more on the increase of productivity factors than the reduction of costs. In his theory of clusters of firms, their relational network is one fundamental element of the business strategy: competitive advantages are not so much dependent on internal size, but mostly on the degree of openness to external relations that favour knowledge exchange and circulation. That is why geographic location of industrial production has its own relevance, to the extent that it influences the quality of factor endowments, both material and immaterial (Celata, 2009). In this framework, the cluster is defined as a "concentration of interconnected firms, specialised providers, services' suppliers, firms in related sectors and concerned institutions (e.g. universities, standards agencies, trade associations), which compete and cooperate at the same time" (Porter, 1998, pg. 197). This definition is wider than the industrial district one, but the theory synthesises it into three pillars: concentration, specialisation, inter-firms' linkages. Despite this analytical clarity has made it suitable to policy making, the *Porter's school* is considered imperfect by some (for a revision of different typologies of local systems of production see Markusen, 1996; Celata, Rossi, 2009). Alternative contributions have been produced in the frame of the *evolutionary* economic geography, which stress the role of innovation, knowledge creation, and different types of interaction related to transaction costs and proximity path dependency- those that Porter's analysis has not taken into account (for a review see Iammarino, McCann, 2006). One of their critics to it is that the balance between the costs involved in locating at any particular distance away from a cluster is never specified by Porter, and his identification of the cluster itself is solely product and employment based. At the same time, it can appear unsuccessful in addressing counter arguments related to the urban context, because it operates within a regional scale- while classical Marshallian districts are typical of urban agglomerations, and the sole barrier to entry is represented by the real estate value (Iammarino, McCann, 2006). Nevertheless, at the same time these are probably the very reasons why it is more favourable to an institutional setting, and has been adopted both in the US and the EU as framework to cluster

mapping's exercises (which to date are still the only available homogeneous source of statistics on regional production clusters[57]).

All these academic contributions are significantly relevant for their policy implications indeed. In Europe, when talking about regional disparities and policy interventions tackling them, the EU Cohesion Policy is actually the related tool for European regions. Always more oriented towards a place-based approach since the Barca report (2009), its main objective is stated as helping the less developed regions to catch up and "to reduce the economic, social and territorial disparities that still exist in the EU" (EC, 2014). Recently, it has been always more concerned with innovative industries indeed, and their role within place-based Smart Specialisations Strategies (S3). Currently intended as the mainstream for regional planning, these are a novelty from the latest wave of interventions, as well as the necessary step to get access to related communitarian funding in Europe (EC, 2014. Further details about S3 and their application to the EU Cohesion Policy are provided by McCann., Ortega-Argilés, 2011). This policy framework is here relevant for at least three reasons. First of all, it provides the reference to the need for *innovative* development policies at the regional level, emphasizing the innovation dimension as a good way to lever lagged regions. Based on this, regions are called on always more attention to locally established strong specialisation and innovations, and may be classified in leaders and followers according to their innovation pace (Regional Innovation Scoreboard, 2014). But what about the effects on the multidimensional inequalities within the regions these industries are located in? Second of all, it is tightly linked to the cluster policies already in place. Despite some substantive differences in theory and scope of the two, S3 and clusters show undoubted similarities. Existing clusters in many cases embed important elements of the entrepreneurial discovery process that S3 aim at fostering (Aranguren, Wilson, 2013). At the same time, it has been recognised as innovative clusters are a classic outcome (or an emergent property) of S3 (Foray et al., 2011). Third, elements of the *territorial milieu* come to be here central once again. As a matter of fact, a main feature of S3 is their being an outcome of an entrepreneurial discovery process, emerging from a consultation among local stakeholders like firms, universities, higher education institutes, independent inventors and innovators (Foray et al., 2011). And the kind and the strength of social networks, working environments and reciprocity norms, could definitely turn the tide of the process, subject to the quality of local institutions in pursuing their supporting role as well.

Finally, it has been in this ground that some interesting contributions specific to the role of clusters in a sustainable regional growth in the EU have been produced (Ketels, Protsiv, 2013). In the direction of a compound approach, they aimed at jointly considering different dimensions of analysis and coming up with useful policy recommendations. Furthermore, a big effort in this work has been put on establishing a new comprehensive database for European NUTS2 regions with the European Cluster Observatory, and designing a new Regional Competitiveness Index (Annoni, Dijkstra, 2013). This measure is intended to assess "the ability of a region to offer an attractive and sustainable environment for firms and residents to live and work" and so to better summarise the business environments of regions, going beyond the mere economic productivity of their business structures (Dijkstra et al, 2011).

3. Data and Methodology.

Data used in this study come from several sources and regional databases.

As regards the production structure, indicators of local labour market and distribution of employment have been selected among Eurostat regional databases[58]. In particular, the rates of long term unemployment and female employment, percentage of part-time employment; the participation

[57] U.S. Cluster Mapping in the USA, and Cluster Mapping Tool in the EU.
[58] Updated in April 2018.

rate in lifelong learning; the percentage of human resources allocated in science and technology, and in knowledge intensive services[59]; along with the share of EU patents applied by within each region, and the value added in manufacturing, professional and non-market services. These regional characteristics are used to synthesise information about the degree of development of the production structure and the labour market, in terms of favourability to innovation of the working environment too.

As regards the regional specialisation, the distribution of employment across sectors and industries was selected among the available business structure statistics, and especially looking at regional diversification and clusters' specialisation. Specific data about forty-one production clusters collected by the ECO are available at the level of detail of 4-digits NACE2 industries per region. Related *location quotients* (LQs) help explore territorial paths of economic production, to discover if a region has developed one or more core industries over time, and in which sector[60].

As regards regional inequalities, the main measure here used as proxy for multidimensional inequality (MDI) is the percentage *loss in human development* due to the inequalities present in the society (Alkire and Foster, 2010; HDR, 2016). Matching OECD and Eurostat databases with EU-SILC survey, it was calculated yearly in the time range 2000-2011 per 205 selected regions (Parente, forthcoming) comparing the estimated Human Development Index (HDI) to its adjustment to *within-region* inequalities (Kovacevic, 2010).

When available[61], two other regional indices were used to compare with regional traits and explain the findings of the analyses performed on core variables. The Regional Innovation Scoreboards (RIS, 2009, 2012) and the Regional Competitiveness Index (RCI, 2014).

The territorial unit of analysis has been set at the Eurostat NUTS2 regions, within the EU15 only and excluding the extra-continental regions (French, Spanish and Portuguese oversea departments).

The applied methodology is an exploratory factor analysis by Principal Component Analysis (PCA) method. Drawing on the social research methods, the PCA uses multivariate analysis' techniques to synthesise variance of processed variables into a reduced number of factors (Di Franco, Marradi, 2013). Underling hypothesis is that selected variables have a substantial degree of association and especially share a common semantic meaning. For these reasons, extracted components can be used as synthetic indicators for shared latent variables that capture denser information about them.

Extraction procedure is based on matrix algebra, and it is the result of identifying the eigenvalues of the characteristic equation associated with the square matrix of correlations amongst variables. It is thus performed by means of subsequent linear combinations of the column-vectors associated to each variable in the starting matrix to be reduced. Given the initial matrix $\mathbf{A}_{(c,v)}$ where $_{(c)}$ stands for the number of cases and $_{(v)}$ for that of variables, the result will be a new matrix in the form $\mathbf{B}_{(c,p)}$ where $_{(p)}$ stands for the number of principal components. Each $_{(p)}$ is constituted by a latent root (i.e. the eigenvalue) and is associated to a vector (i.e. the eigenvector) whose elements express the correlation between the original variables and the component itself. So that a general extracted component can be expressed as:

$$C^p = u_1^p x_1 + u_2^p x_2 + u_3^p x_3 + \cdots + u_v^p x_v$$

where $_{(1,\ldots,v)}$ are the original variables and (u_v) the component loadings. The latter qualify as correlations between the component and each of the *(v)* variables. That is why they are fundamental in

[59] Labelled with the KIS code in the NACE rev. 2, meaning the total of Knowledge Intensive Services.
[60] LQ considers the level of employment in a "x" sector in the selected region compared to the national level in the same sector. If the measure is: lower than 0, that sector is not present in the region; equal to 1, region and country specialised at the same level; higher than 1, the region is specialised; over 2, the region is highly specialised.
[61] From 2009 to 2011.

the interpretation of the meaning of the extracted components: the higher the absolute value of a component loading, the more the variable will be relevant for that dimension[62]. The sum of their squared values (h^2) are called instead communalities and represent the share of variance of each variable reproduced by the whole of extracted components[63]. Once the matrix eigenvalue has been identified, vectors of component loadings are obtained by multiplying each element of the eigenvector (i.e. the weights to be attributed to the variables in the linear combination that produces the component) by the root of the related eigenvalue (Di Franco, Marradi, 2013). Besides maximising the variance and normalising the eigenvector, extractions from the second principal component on impose also the constraint of orthogonality with the previous ones[64]. Finally, it is possible to define the component scores, attributing a value to each case ($_c$ in the original $\mathbf{A}_{(c,v)}$ matrix) on each of the identified components. Calculation of these scores are performed by the following equation in the matrix form:

$$\underline{y}_{ij} = \underline{u}_j' \underline{X}_i$$

where $\underline{u}_j'$ is the transposed eigenvector associated with the $_{(j\text{-th})}$ characteristic square root and $\underline{X}_i$ is the $_{(i\text{-th})}$ column of the matrix of standardised values for $_{(n)}$ cases of the X variable (Di Franco, Marradi, 2013). The obtained scores are those actually constituting the new variable produced by the PCA and will be used to inform on the pattern of the synthesised dimension across the initial matrix cases.

As for the number of components to be extracted and used to represent the underlying common factor, different criteria are available. One is to select only components whose eigenvalues is higher than 1. Another one is to consider the share of cumulative reproduced variance of components, and accept the extraction starting from the 60% threshold. A third criterion is based on the graphical analysis of the eigenvalues by the so-called scree test[65]. It is very much likely that these two approaches will provide either too many or too few components respectively. It should also be borne in mind that the search for a shared common factor, and its semantic meaning, should remain the guiding method in the interpretation of algebra results. The graphical representation of the eigenvalues allows to select components based on the relevance of their contribution to the identification of the underlying dimension.

PCA was originally conceived by psychologists and is still much used by social researchers to construct indices of attitudinal, behavioural and cognitive variables from survey data (OECD, 2017; Puntscher et al, 2016; Somarriba, Pena, 2009). Nevertheless, it has also often been used to derive synthetic measures from ecological variables (JRC, 2014; Pasquariello et al., 2011). In the case of this article, it has been applied on two separate subsets of data. In both of them, the $_{(c)}$ cases of the initial matrices represent the 205 EU regions. As regards the $_{(v)}$ variables instead, they are the forty-one ecological variables for the production specialisation one (i.e. location quotients per each available cluster category), and nine characteristics of local production structure for the other one.

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[62] There are no fixed rules to ascertain the threshold for significance of loadings, and it is generally fixed case by case- being more demanding for saturation on the first component than on the others. Many studies suggest to keep it around $\pm$0,30 (Klett, 1972; Kline, 1994).

[63] (h^2) will be 1 when 100% of the total variance of each variable is reproduced by the set of extracted components. The sum of communalities equals that of the eigenvalues of the considered components.

64 That is because each component is extracted from the matrix of residual correlations, so after that a share of variance has been eliminated by the components already extracted (Di Franco, Marradi, 2013).

[65] Due to the erosion debris that gather at the foot of mountains. The chart shows this kind of shape indeed, with a line shrinking from the first component down to the subsequent ones. No matter their eigenvalue is above 1 or not, their pattern will highlight the more relevant ones and make clear which ones are in the tail of the line and can therefore be ignored (Di Franco, Marradi, 2013). According to Harman (1967), only components whose eigenvalue is at the top of the plot line and more distant from its breaking point are to be considered. Cattel (1966) suggested to include the one at the edge too.

4. Some Results from Explorative Analyses.

Considered databases have been explored first of all at the aggregated level of the EU15. Employment data per economic activities provided by Eurostat for the selected geography offers an overall picture of the distribution of resources amongst economic sectors, and so of the production structure and its trend over the considered period of time (Fig. 1).

Figure 1. Composition of employment structure, percentage of total economic activities, EU15

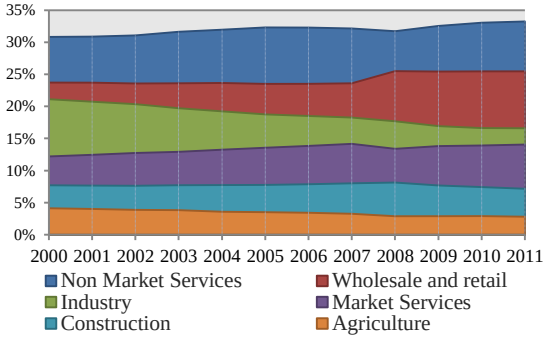
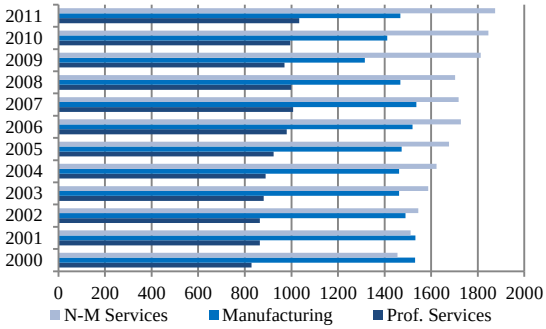


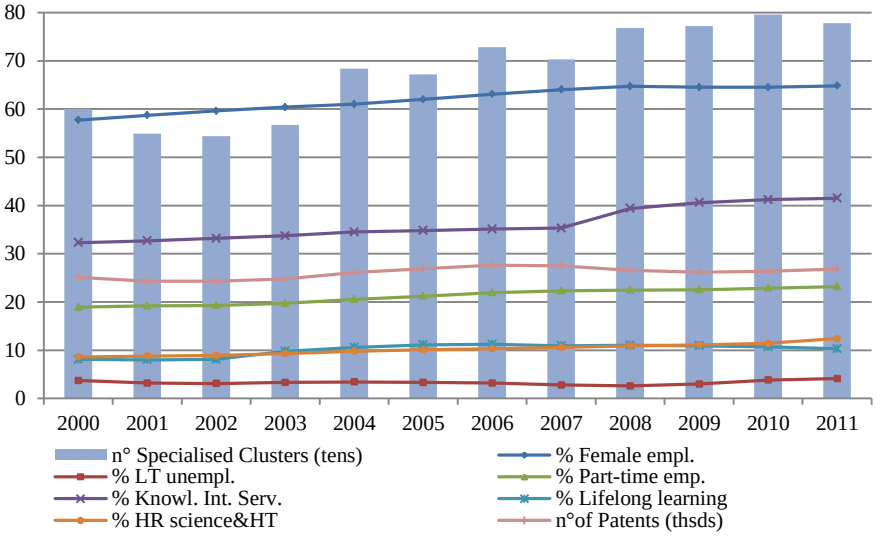
Figure 2. Value Added in Manufacturing, Professional and Non-Market Services, thousands € PPS, EU15



What can be seen is a progressive reduction of the share of industry over the total (-4.5%), to the gains of all service categories, and especially the non-market ones that still hold the highest share at the end of the period (+2.4% on 2000 level). Looking at the value added per economic activities, it is interesting to note how that of manufacturing, which was slightly over the non-market services at the beginning of the period, has remained quite stable and appears reduced of four percentage points in 2011, while the highlighted services have increased of 24% and 28% respectively (Professional and Non-Market Services in Fig. 2).

Another look at the considered database is provided by Fig. 3. It shows the employment in knowledge intensive services and in science and high-tech sectors has increased (+9.2 and +3.8 respectively). The overall number of specialised clusters – calculated as that of production clusters in which regions score a location quotient higher than 2, based on the European Cluster Observatory

Figure 3. Trends of considered indicators



dataset- has also increased of 30%, together with the number of patents' applications too (+6.8%). Finally, the labour market indicators displayed tell of an increased female employment (+7%), even if at a rate slowed down by the 2008 crisis; as well as of a long term unemployment that similarly has started to raise again after the lower value registered in the same year (2.6%) up to 4.1% in 2011

(which is the highest value within the considered period: +0.4% with respect to 2000). Part-time employment has increased progressively instead, possibly as a response to labour market uncertainty.

Nevertheless this general picture of the EU15 as a whole conceals the regional disparities that this piece of research is interested in. The divide in terms of all considered indicators can be significant indeed, and paired with the levels of multidimensional inequalities (MDI hereafter) previously investigated (Parente, forthcoming) can help better describe the regional characteristics of the selected 205 regions. As the following Charts 1. to 7. show for the 2011, a first comparison between the MDI measure and the values of selected predictors reveals that relations in place are not necessarily linear, and some State-effects may also be considerable. For some variables, like part-time and female employment, the kind of the national regulation on welfare can play a crucial role indeed; and also the participation rate in lifelong learning appears still highly influenced by State-level settings.

Figure 4. Female Employment and MDI

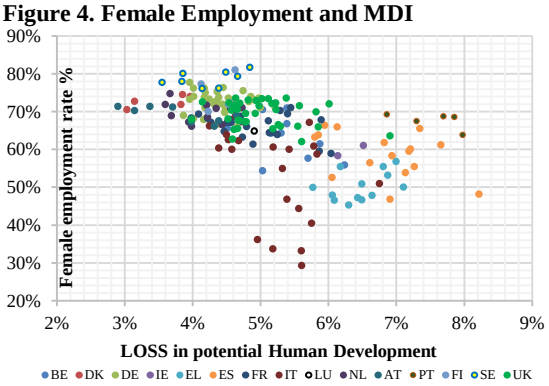
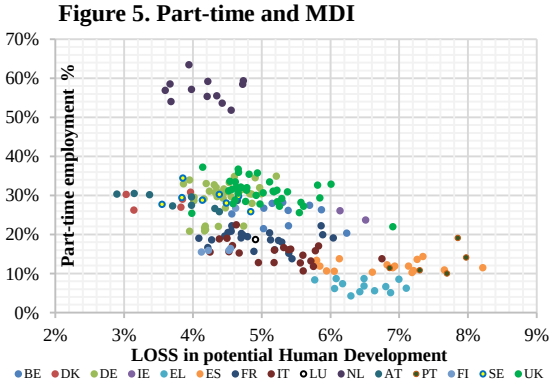


Figure 5. Part-time and MDI



The percentage of part-time employment is unsurprisingly very higher in The Netherlands, whose regions stand all as outliers for this variable. Nevertheless, it is clearly recognisable an inverse relation with inequality, which is higher in regions where flexible working times are still a small amount of the total employment. Similarly, female participation in the labour market is below the EU15 average in southern European regions with higher levels of inequality, and of long term unemployment rates.

Figure 6. Long term unemployment and MDI

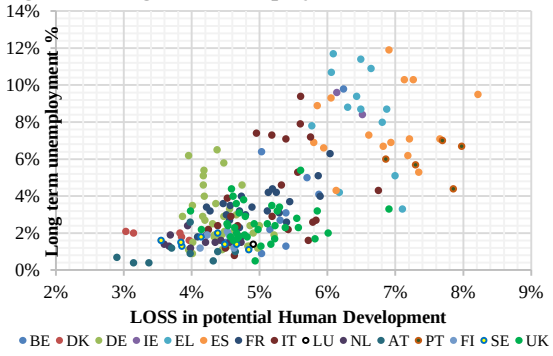
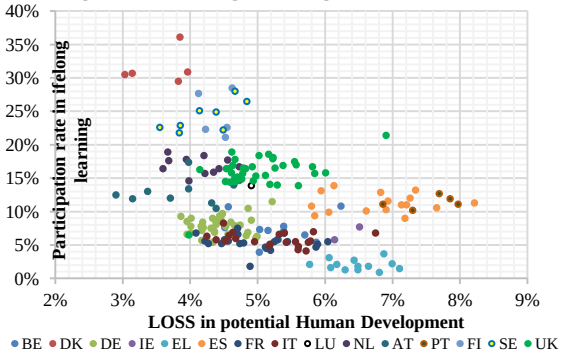


Figure 7. Lifelong learning and MDI



At the same time, there is no clear relation with the allocation of human resources in science and technology sectors, as similarly to the number of those in knowledge intensive services. The overall picture of 205 regions returns a scattered image making think of an inverse relationship with inequality. A closer look to State-level groups suggests a different behaviour: inequality might have an increasing tendency directly proportional to the employment in knowledge intensive services. As a matter of fact, it can also be recognised as the regions leading the band upwards are often the capital ones, which may lend credence to the intuition. For science sectors, the inverse seem confirmed.

Figure 8. Knowledge intensive services and MDI

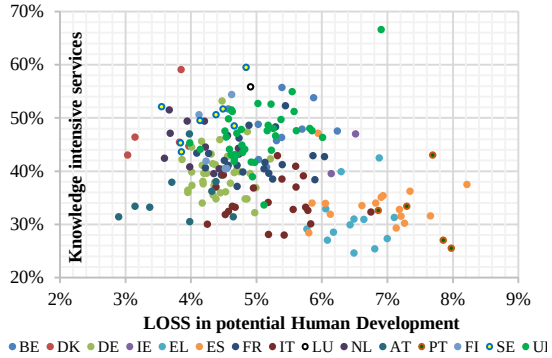
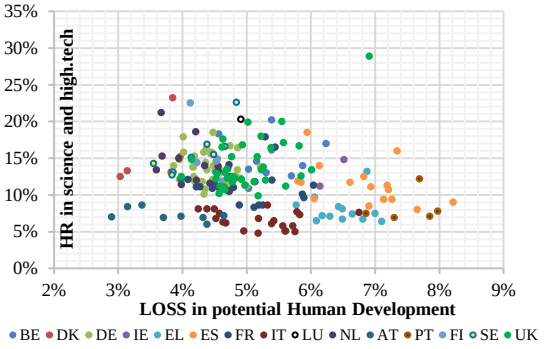


Figure 9. HR in Science&High-Tech and MDI



Looking instead at patents applications, a non-linear relationship clearly appears. It seems that levels of innovation are not influencing those of inequality: low inequalities bring either low or high shares of patents. But it may be thought true of the contrary: over a certain threshold, inequality may be harmful to innovation, as regions with MDI levels above the EU15 average, only show poor performances in terms of patents and knowledge intensive employment. Finally looking at the monetary outputs, value added in considered branches of services share a flatter distribution common to most regions, with a few outliers. In the case of professional, scientific and technical activities, Paris (FR10, 91,026k€pps) and London (UKI1, 54,846k€pps) are far over the others, whose distribution actually starts with Milan (ITC4, 26,556k€pps) and progressively decrease up to the Finnish Aaland (FI20, 30k€pps). In the case of public administration, defence, education, human health and social work activities, Paris stands alone (79,765k€pps) followed by London (36,465k€pps), Rhône-Alpes (FR71) and Provence – Alpes – Côte d'Azur (FR82), and the rest of regions restarts with Milan (26,079k€pps) up to the Aaland (252k€pps) again. The one of manufacturing, on the contrary, shows more heterogeneity (here the wider gap at the top rankings is just of 7,486k€pps, between the second and the third values – Milan with 47,843k€pps and Stuttgart with 40,348k€pps respectively –, which progressively slow down to the Greek Ionian Islands – EL22 with 52k€pps), and a non-linear relation once again, apparently inverse.

Figure 10. Patents and MDI

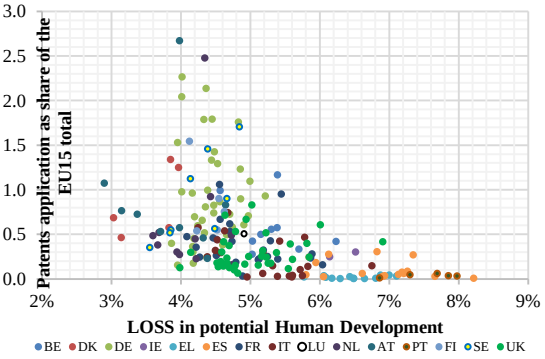


Figure 12. VA in Prof. Services and MDI

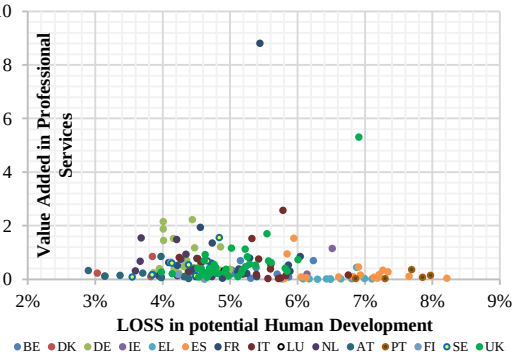


Figure 11. VA in Manufacturing and MDI

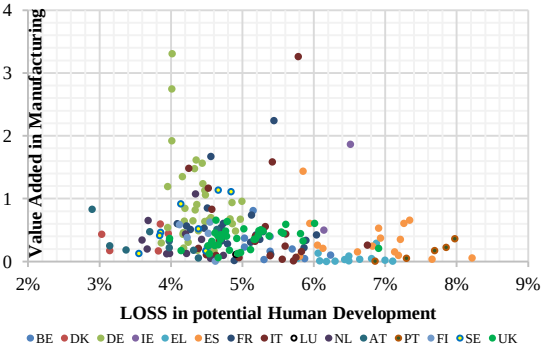
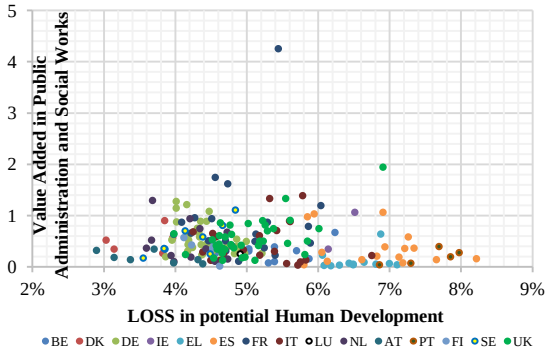


Figure 13. VA in non-market services and MDI



To summarise this section, considered indicators describe how regions where levels of employment performances are higher than average also tend to have lower values of loss in human development; while for those below the average, the performances in inequality are bad only. Regions where the quality of the labour market is a better one, show concentration of multidimensional inequality below its average; while the pattern is more scattered and a slightly negative correlation emerges for those below the mean value. Still with some probable State-effect different dynamics, higher level of inequality tends to appear in regions where the performances in terms of economic productivity and innovation are poorer. In order to look into the latent factors of explored dimensions, a factor analysis by Principal Component Analysis method (ACP) has been applied to the two considered datasets, in order to construct synthetic measures summarising main traits of regional characteristics based on production structures and specialised clusters' presence.

4.1. The extracted Principal Components.

The nine[66] items selected among the regional labour market and structural business statistics, considered within the period 2000-2011, have been reduced to three principal components. They reproduce around 80% of the variance of selected variables, and pertains to different traits of the production structure. The first extracted component was interpreted as a general indicator of the employment factor. The second one relates to the quality of this employment, and has a double polarity[67] opposing the more physical outputs, like value added and patents, to the immaterial inputs of it, like knowledge intensity and the quality of the labour market. The third one appears as a further expansion of the second, digging more in depth into productivity and competitiveness of either industry or services. Their semantical meaning has been interpreted based on the component matrix and the scores of extracted components on each of considered items, and compared to their spatial distributions across regions. To clarify, a graphical representation of regional scores here follows.

Figure 14. Extracted principal components 1 and 2

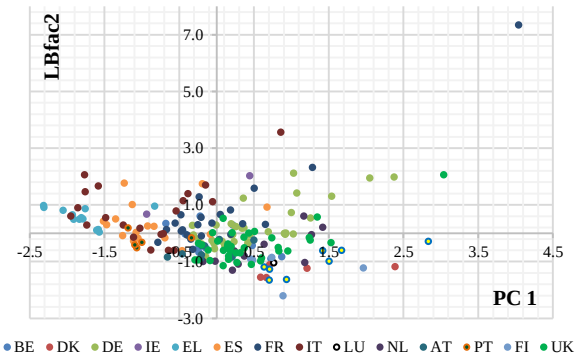
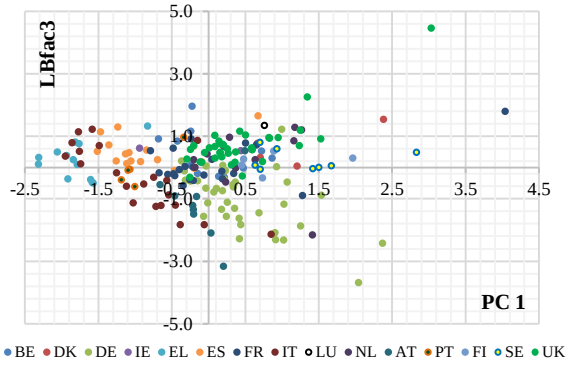


Figure 15. Extracted principal components, 1 and 3



In Fig. 14, the right hand side represents the positive pole of employment dimension, and the upper section is for higher focus on outputs' competitiveness than inputs' quality. In Fig. 15 the regions falling into the portion of negative employment are still mostly those of Southern Europe, while the vertical axis distinguishes between the prominence of industrial over service activities (i.e. negative vs positive). Indeed, the second component positively saturates on the number of patents and the value added shares; the third one has on its negative pole the number of patents and the value added in manufacturing only.

Along the line of recent similar applications to the Italian case (Faggian et al., 2018), a second PCA was performed separately on the clusters LQs database. This reduced the original number of forty-one variables (e.g. the 41 cluster categories) and provided synthetic measures summarising main traits of regional production. In this case, the first two components extracted reproduce one third of the variance of selected variables together, so are not sufficient to provide a comprehensive picture of the regional business structure alone; but are already informative on its underlying shared characteristics. Number of components to be

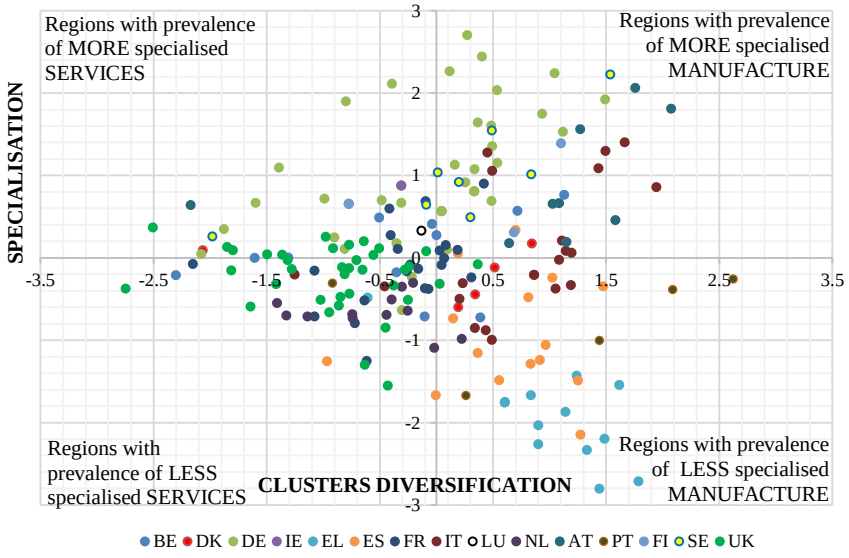
[66] The information on part-time employment was omitted because of very low communality in all extractions.

[67] A component is said bipolar when it is highly saturated by some variables on positive values, and by other on the negative ones. This usually help denominate its dimension by means of the contrast between the poles.

extracted was decided combining the eigenvalue criterion with and the scree test[68]. The components have been interpreted based both on the loading components[69] recorded on each of the 41 clusters, and on the measured correlation to regional characteristics[70]. The first component seems to relate to the degree of diversification of regional business structures, and its double polarity to oppose manufacture to services. Its correlation with the count of industries in which regions have LQ values higher than 2 is 60%. The second component pertains more to the business environment features, and probably ranging from low to higher content of innovation. It shows a strong correlation with both the Regional Innovation Scoreboard (55%) and the number of patents (43%, when the correlation between these two is 50%).

Drawing on this, Fig. 15. can be read looking at the combinations of the characteristics of the two components resulting in the plane quarters, and the relative placement of analysed regions.

Figure 15. First two components extracted by PCA on clusters' LQs, 2011



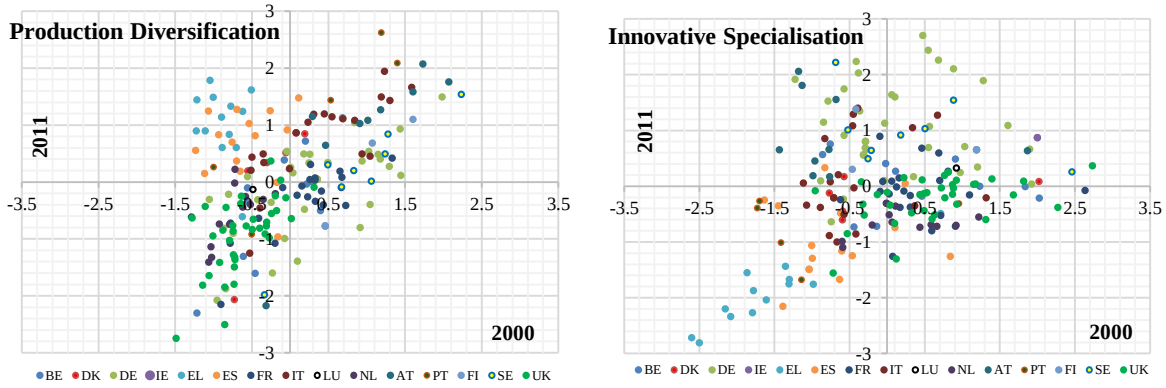
Running the analysis on each year, and comparing the scores of extracted factorial components at the beginning to the end of the considered period, the variation seems in line with the given interpretation. Production diversification is relatively stable and regions tend to maintain their core industries, while the degree of specialisation and innovation in clusters has changed more- even in a relatively short period of twelve years. This seems to hold with the exception of Greece and Spain: despite scores permanently poor on the second component, they show the highest change on the first one. Plotted data are shown in the following Fig. 16. and 17.

[68] The number of relevant components slightly differs from year to year, and the recurrent ones only have been selected.

[69] The component scores are standardised values obtained through linear combination of all the variables included in the analysis and represent the best possible synthesis of the data (Di Franco, 2015).

[70] Being the set of variables saturating the two components not enough for a simple denomination itself, subsequent refinements for a two-stage PCA have been applied. A repeated analysis was run by first excluding from the initial matrix those variables whose saturation was close to 0 in both components per each year. In addition, the same has been done by a stricter threshold of significance of the component loadings (±0,40), and by a Varimax technique. The latter applies an orthogonal rotation that modifies the column-vector of the matrix of component loadings in order to more clearly focus the variable saturating each component (Di Franco, 2013).

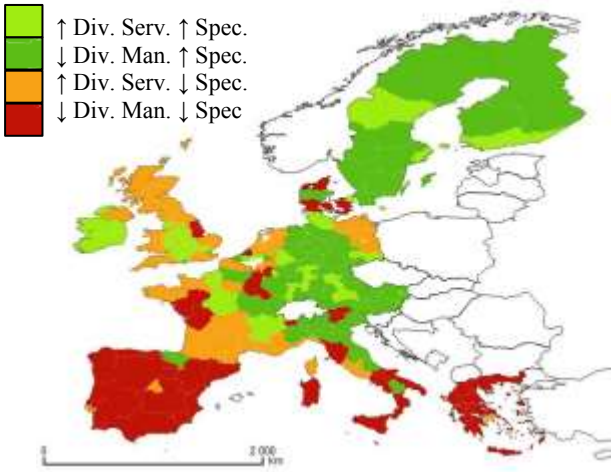
Figure 16. First and second component respectively, in 2000 and 2011



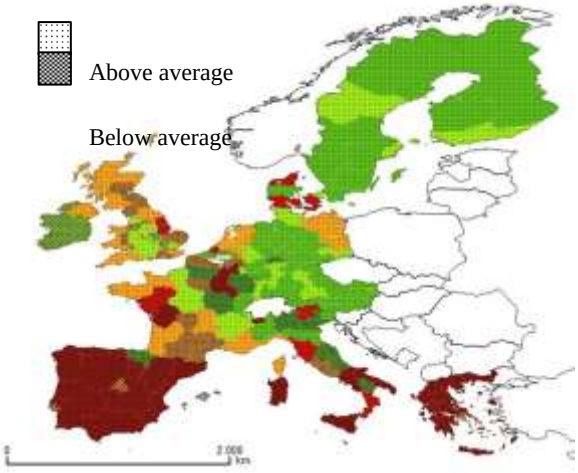
4.2. Clusters' localisation and distribution of inequalities

Plotted regional PCA scores (Fig. 16) provide a first picture of the spatial distribution of some production structure characteristics in 2011. Map 1 displays the spatial pattern of the groupings based on the four combinations of the two PCs extracted from the clusters' LQs dataset, as shown by the plane quadrants in previous charts of Fig. 15. In addition, the multidimensional inequality introduced in the previous paragraph was integrated by a grid (Figure 2).

Map 85. Clusters' PCs-based groupings



Map 2. Clusters and MDI



This exercise can allow the search for common typologies to group regions based on their production structure characteristics, and so may serve as a first basis to recognise shared spatial patterns. The adherence to inequality categories (split by distribution's quartiles) appears to be not perfectly exact, but some traits to be further explored can be traced. More unequal regions are those of southern Europe (thicker grid in Map 2.), and correspond mainly to territories with low production diversification and weak innovative specialisation (in red in Map 1.). Regions with lower level of inequality (coarser grid in Map 2.) instead, generally presents higher values of industries diversification and cluster specialisation (in light green in Map 1.).

Conclusions.

Literature contributions within several disciplines have suggested and variously investigated the relations between production structure, territorial characteristics and spatial inequalities. The work presented in this paper is an exploratory analysis of these possible relations in place at the regional level within the EU. Data here used to characterise the business structures of analysed regions are about production specialisation, labour market, and the presence of clusters of firms, as collected by Eurostat and the European Cluster Observatory. Information about 41 clusters have been reduced by a PCA, and a first exercise on the first two factorials component extracted tells something about the level of cluster diversification and the innovative specialisation in the regions. The other considered characteristics of local production structures served instead to trace some common traits of the economic specialisation of regions. The comparison between these two orders of information, and the previously estimated measure of multidimensional inequality (i.e. the loss in regional human development) tell us of a highly heterogeneous Europe, and of non-trivial patterns of specialisation. Besides the well-known divide between a two wider North and South, the intersection of considered indicators suggests the existence of concealed further spaces of disparity.

Mappings of their spatial distributions show that there is room for a more in depth analysis of the selected data, since these results only give an intuition of the complex pattern in place between the considered domains. What emerges from the exploration here presented is indeed that regions with lower levels of inequality show also a more balanced labour market setting and advanced economic specialisation. In regions where inequality is at its highest levels, the production diversification tends to be lower indeed. But for all those regions falling in between of the two, many paths and reasons behind them are open. In order to better capture the underlying factors of the explored spatial dynamics, some further research is needed. The following steps foresee the application of econometric methodologies to estimate quantitative models using inequality as a dependent variable, and the explored predictors as explanatory variables.

In the light of the links between production structure, territorial milieu, and spatial disparity suggested in the literature, some first hypothesis to be tested suppose that relations between multidimensional inequality and regional economic specialisation may be mediated by the sort and magnitude of local social capital. In particular on: the social relations and cultural effects that different production specialisation allows to foster; the spatial interactions that these effects can engender within the concerned territories; the impact that land use, degree of urbanisation and infrastructures' asset can have in changing the pattern-lowering or increasing inequalities, depending on the level of inclusiveness and relatedness they can facilitate.

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ANNEX.

List of 41 cluster categories identified by the ECO (§ 3)

Table 3. Cluster Categories*

Cluster	NACE	NACE name
Aerospace	30.30	Manufacture of air and spacecraft and related machinery
Agricultural Products	01.61	Support activities for crop production
Agricultural Products	01.62	Support activities for animal production
Agricultural Products	01.63	Post-harvest crop activities
Agricultural Products	01.64	Seed processing for propagation
Agricultural Products	10.41	Manufacture of oils and fats
Agricultural Products	10.81	Manufacture of sugar
Agricultural Products	11.01	Distilling, rectifying and blending of spirits
Agricultural Products	11.02	Manufacture of wine from grape
Agricultural Products	11.03	Manufacture of cider and other fruit wines
Agricultural Products	11.04	Manufacture of other non-distilled fermented beverages
Agricultural Products	81.30	Landscape service activities
Apparel	13.30	Finishing of textiles
Apparel	13.91	Manufacture of knitted and crocheted fabrics
Apparel	14.12	Manufacture of workwear
Apparel	14.13	Manufacture of other outerwear
Apparel	14.19	Manufacture of other wearing apparel and accessories
Apparel	14.31	Manufacture of knitted and crocheted hosiery
Apparel	14.39	Manufacture of other knitted and crocheted apparel
Automotive	22.19	Manufacture of other rubber products
Automotive	23.11	Manufacture of flat glass
Automotive	23.12	Shaping and processing of flat glass
Automotive	29.10	Manufacture of motor vehicles
Automotive	29.20	Manufacture of bodies (coachwork) for motor vehicles manufacture of trailers and semi-trailers
Automotive	29.32	Manufacture of other parts and accessories for motor vehicles
Automotive	30.40	Manufacture of military fighting vehicles
Biotech	72.11	Research and experimental development on biotechnology
Building Fixtures	16.29	Manufacture of other products of wood manufacture of articles of cork, straw and plaiting materials
Building Fixtures	22.21	Manufacture of plastic plates, sheets, tubes and profiles
Building Fixtures	22.23	Manufacture of builders' ware of plastic
Building Fixtures	23.41	Manufacture of ceramic household and ornamental articles
Building Fixtures	23.52	Manufacture of lime and plaster
Building Fixtures	23.61	Manufacture of concrete products for construction purposes
Building Fixtures	23.64	Manufacture of mortars
Building Fixtures	23.65	Manufacture of fibre cement
Building Fixtures	23.69	Manufacture of other articles of concrete, plaster and cement
Building Fixtures	25.12	Manufacture of doors and windows of metal
Building Fixtures	25.21	Manufacture of central heating radiators and boilers
Building Fixtures	28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
Building Fixtures	28.21	Manufacture of ovens, furnaces and furnace burners
Building Fixtures	31.02	Manufacture of kitchen furniture
Building Fixtures	31.03	Manufacture of mattresses
Building Fixtures	35.30	Steam and air conditioning supply
Business Services	62.02	Computer consultancy activities
Business Services	62.03	Computer facilities management activities
Business Services	62.09	Other information technology and computer service activities
Business Services	63.11	Data processing, hosting and related activities
Business Services	70.22	Business and other management consultancy activities
Business Services	77.33	Renting and leasing of office machinery and equipment (including computers)
Business Services	78.10	Activities of employment placement agencies
Business Services	78.20	Temporary employment agency activities
Business Services	80.30	Investigation activities
Business Services	82.11	Combined office administrative service activities
Business Services	82.19	Photocopying, document preparation and other specialised office support activities
Business Services	82.20	Activities of call centres
Business Services	82.30	Organisation of conventions and trade shows
Chemical products	15.11	Tanning and dressing of leather dressing and dyeing of fur
Chemical products	20.11	Manufacture of industrial gases
Chemical products	20.12	Manufacture of dyes and pigments
Chemical products	20.13	Manufacture of other inorganic basic chemicals
Chemical products	20.14	Manufacture of other organic basic chemicals
Chemical products	20.20	Manufacture of pesticides and other agrochemical products
Chemical products	20.41	Manufacture of soap and detergents, cleaning and polishing preparations
Chemical products	20.52	Manufacture of glues
Chemical products	20.53	Manufacture of essential oils
Chemical products	20.59	Manufacture of other chemical products n.e.c.
Chemical products	23.14	Manufacture of glass fibres
Chemical products	23.20	Manufacture of refractory products
Chemical products	23.91	Production of abrasive products
Chemical products	24.46	Processing of nuclear fuel

Construction materials	82.91 Activities of collection agencies and credit bureaus
Construction materials	94.12 Activities of professional membership organisations
Construction	08.12 Operation of gravel and sand pits mining of clays and kaolin
Construction	20.51 Manufacture of explosives
Construction	23.32 Manufacture of bricks, tiles and construction products, in baked clay
Construction	23.51 Manufacture of cement
Construction	25.11 Manufacture of metal structures and parts of structures
Construction	28.14 Manufacture of other taps and valves
Construction	41.20 Construction of residential and non-residential buildings
Construction	42.11 Construction of roads and motorways
Construction	42.12 Construction of railways and underground railways
Construction	42.13 Construction of bridges and tunnels
Construction	42.91 Construction of water projects
Construction	43.11 Demolition
Construction	43.12 Site preparation
Construction	43.31 Plastering
Construction	77.32 Renting and leasing of construction and civil engineering machinery and equipment
Distribution	46.16 Agents involved in the sale of textiles, clothing, fur, footwear and leather goods
Distribution	46.31 Wholesale of fruit and vegetables
Distribution	46.32 Wholesale of meat and meat products
Distribution	46.34 Wholesale of beverages
Distribution	46.35 Wholesale of tobacco products
Distribution	46.37 Wholesale of coffee, tea, cocoa and spices
Distribution	46.38 Wholesale of other food, including fish, crustaceans and molluscs
Distribution	46.41 Wholesale of textiles
Distribution	46.42 Wholesale of clothing and footwear
Distribution	46.45 Wholesale of perfume and cosmetics
Distribution	46.46 Wholesale of pharmaceutical goods
Distribution	46.48 Wholesale of watches and jewellery
Distribution	47.91 Retail sale via mail order houses or via Internet
Education and Knowledge Creation	72.19 Other research and experimental development on natural sciences and engineering
Education and Knowledge Creation	72.20 Research and experimental development on social sciences and humanities
Education and Knowledge Creation	73.20 Market research and public opinion polling
Education and Knowledge Creation	85.41 Post-secondary non-tertiary education
Education and Knowledge Creation	85.42 Tertiary education
Education and Knowledge Creation	91.01 Library and archives activities
Education and Knowledge Creation	91.02 Museums activities
Education and Knowledge Creation	91.03 Operation of historical sites and buildings and similar visitor attractions
Education and Knowledge Creation	91.04 Botanical and zoological gardens and nature reserves activities
Entertainment	32.20 Manufacture of musical instruments
Entertainment	59.11 Motion picture, video and television programme production activities
Entertainment	59.12 Motion picture, video and television programme post-production activities
Entertainment	59.13 Motion picture, video and television programme distribution activities
Entertainment	59.20 Sound recording and music publishing activities
Entertainment	90.02 Support activities to performing arts
Entertainment	90.04 Operation of arts facilities
Entertainment	93.11 Operation of sports facilities
Entertainment	93.12 Activities of sport clubs
Entertainment	93.19 Other sports activities
Entertainment	93.29 Other amusement and recreation activities
Farming and Animal Husbandry	01.11 Growing of cereals (except rice), leguminous crops and oil seeds
Farming and Animal Husbandry	01.13 Growing of vegetables and melons, roots and tubers
Farming and Animal Husbandry	01.24 Growing of pome fruits and stone fruits
Farming and Animal Husbandry	01.25 Growing of other tree and bush fruits and nuts
Farming and Animal Husbandry	01.30 Plant propagation
Farming and Animal Husbandry	01.41 Raising of dairy cattle
Farming and Animal Husbandry	01.42 Raising of other cattle and buffaloes
Farming and Animal Husbandry	01.45 Raising of sheep and goats
Farming and Animal Husbandry	01.46 Raising of swine/pigs
Farming and Animal Husbandry	01.47 Raising of poultry
Farming and Animal Husbandry	01.49 Raising of other animals
Farming and Animal Husbandry	77.31 Renting and leasing of agricultural machinery and equipment
Financial Services	64.11 Central banking
Financial Services	64.19 Other monetary intermediation
Financial Services	64.20 Activities of holding companies
Financial Services	64.30 Trusts, funds and similar financial entities
Financial Services	64.91 Financial leasing
Financial Services	64.92 Other credit granting
Financial Services	64.99 Other financial service activities, except insurance and pension funding n.e.c.
Financial Services	65.11 Life insurance
Financial Services	65.12 Non-life insurance
Financial Services	65.20 Reinsurance
Financial Services	66.11 Administration of financial markets
Financial Services	66.12 Security and commodity contracts brokerage
Financial Services	66.19 Other activities auxiliary to financial services, except insurance and pension funding
Financial Services	66.30 Fund management activities
Financial Services	84.30 Compulsory social security activities

Footwear	15.20 Manufacture of footwear
Furniture	16.21 Manufacture of veneer sheets and wood-based panels
Furniture	16.22 Manufacture of assembled parquet floors
Furniture	23.49 Manufacture of other ceramic products
Furniture	31.09 Manufacture of other furniture
Heavy Machinery	28.25 Manufacture of non-domestic cooling and ventilation equipment
Heavy Machinery	28.30 Manufacture of agricultural and forestry machinery
Heavy Machinery	28.92 Manufacture of machinery for mining, quarrying and construction
Heavy Machinery	29.31 Manufacture of electrical and electronic equipment for motor vehicles
Heavy Machinery	30.20 Manufacture of railway locomotives and rolling stock
Instruments	26.51 Manufacture of instruments and appliances for measuring, testing and navigation
IT	26.11 Manufacture of electronic components
IT	26.12 Manufacture of loaded electronic boards
IT	26.20 Manufacture of computers and peripheral equipment
IT	58.21 Publishing of computer games
IT	58.29 Other software publishing
IT	62.01 Computer programming activities
Jewellery and Precious Metals	25.71 Manufacture of cutlery
Jewellery and Precious Metals	32.11 Striking of coins
Jewellery and Precious Metals	32.12 Manufacture of jewellery and related articles
Jewellery and Precious Metals	32.13 Manufacture of imitation jewellery and related articles
Leather products	14.11 Manufacture of leather clothes
Leather products	14.20 Manufacture of articles of fur
Leather products	15.12 Manufacture of luggage, handbags and the like, saddlery and harness
Lighting and Electrical Equipment	27.12 Manufacture of electricity distribution and control apparatus
Lighting and Electrical Equipment	27.40 Manufacture of electric lighting equipment
Maritime	01.70 Hunting, trapping and related service activities
Maritime	03.11 Marine fishing
Maritime	03.12 Freshwater fishing
Maritime	03.21 Marine aquaculture
Maritime	03.22 Freshwater aquaculture
Maritime	10.20 Processing and preserving of fish, crustaceans and molluscs
Maritime	13.94 Manufacture of cordage, rope, twine and netting
Maritime	25.29 Manufacture of other tanks, reservoirs and containers of metal
Maritime	30.12 Building of pleasure and sporting boats
Maritime	47.23 Retail sale of fish, crustaceans and molluscs in specialised stores
Media and Publishing	17.23 Manufacture of paper stationery
Media and Publishing	18.11 Printing of newspapers
Media and Publishing	18.12 Other printing
Media and Publishing	18.13 Pre-press and pre-media services
Media and Publishing	18.14 Binding and related services
Media and Publishing	18.20 Reproduction of recorded media
Media and Publishing	58.11 Book publishing
Media and Publishing	58.12 Publishing of directories and mailing lists
Media and Publishing	58.14 Publishing of journals and periodicals
Media and Publishing	58.19 Other publishing activities
Media and Publishing	63.12 Web portals
Media and Publishing	63.91 News agency activities
Media and Publishing	70.21 Public relations and communication activities
Media and Publishing	73.12 Media representation
Media and Publishing	90.01 Performing arts
Media and Publishing	90.03 Artistic creation
Medical Devices	26.60 Manufacture of irradiation, electromedical and electrotherapeutic equipment
Medical Devices	32.50 Manufacture of medical and dental instruments and supplies
Metal Manufacturing	24.10 Manufacture of basic iron and steel and of ferro-alloys
Metal Manufacturing	24.20 Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
Metal Manufacturing	24.31 Cold drawing of bars
Metal Manufacturing	24.32 Cold rolling of narrow strip
Metal Manufacturing	24.33 Cold forming or folding
Metal Manufacturing	24.34 Cold drawing of wire
Metal Manufacturing	24.51 Casting of iron
Metal Manufacturing	24.52 Casting of steel
Metal Manufacturing	24.53 Casting of light metals
Metal Manufacturing	24.54 Casting of other non-ferrous metals
Metal Manufacturing	25.40 Manufacture of weapons and ammunition
Metal Manufacturing	25.50 Forging, pressing, stamping and roll-forming of metal powder metallurgy
Metal Manufacturing	25.61 Treatment and coating of metals
Metal Manufacturing	25.62 Machining
Metal Manufacturing	25.72 Manufacture of locks and hinges
Metal Manufacturing	25.73 Manufacture of tools
Metal Manufacturing	25.93 Manufacture of wire products, chain and springs
Metal Manufacturing	25.94 Manufacture of fasteners and screw machine products
Metal Manufacturing	25.99 Manufacture of other fabricated metal products n.e.c.
Metal Manufacturing	26.52 Manufacture of watches and clocks
Metal Manufacturing	27.51 Manufacture of electric domestic appliances
Metal Manufacturing	28.13 Manufacture of other pumps and compressors
Oil and Gas	09.10 Support activities for petroleum and natural gas extraction

Oil and Gas	19.20	Manufacture of refined petroleum products
Oil and Gas	49.50	Transport via pipeline
Paper products	16.23	Manufacture of other builders' carpentry and joinery
Paper products	17.11	Manufacture of pulp
Paper products	17.12	Manufacture of paper and paperboard
Paper products	17.21	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
Paper products	17.22	Manufacture of household and sanitary goods and of toilet requisites
Paper products	17.24	Manufacture of wallpaper
Paper products	17.29	Manufacture of other articles of paper and paperboard
Paper products	22.22	Manufacture of plastic packing goods
Paper products	28.95	Manufacture of machinery for paper and paperboard production
Pharmaceuticals	20.42	Manufacture of perfumes and toilet preparations
Pharmaceuticals	21.10	Manufacture of basic pharmaceutical products
Pharmaceuticals	21.20	Manufacture of pharmaceutical preparations
Plastics	20.16	Manufacture of plastics in primary forms
Plastics	20.17	Manufacture of synthetic rubber in primary forms
Plastics	20.30	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
Plastics	22.29	Manufacture of other plastic products
Power Generation and Transmission	23.43	Manufacture of ceramic insulators and insulating fittings
Power Generation and Transmission	27.11	Manufacture of electric motors, generators and transformers
Processed food	10.31	Processing and preserving of potatoes
Processed food	10.32	Manufacture of fruit and vegetable juice
Processed food	10.39	Other processing and preserving of fruit and vegetables
Processed food	10.41	Manufacture of oils and fats
Processed food	10.42	Manufacture of margarine and similar edible fats
Processed food	10.51	Operation of dairies and cheese making
Processed food	10.52	Manufacture of ice cream
Processed food	10.61	Manufacture of grain mill products
Processed food	10.62	Manufacture of starches and starch products
Processed food	10.72	Manufacture of rusks and biscuits manufacture of preserved pastry goods and cakes
Processed food	10.73	Manufacture of macaroni, noodles, couscous and similar farinaceous products
Processed food	10.81	Manufacture of sugar
Processed food	10.82	Manufacture of cocoa, chocolate and sugar confectionery
Processed food	10.83	Processing of tea and coffee
Processed food	10.84	Manufacture of condiments and seasonings
Processed food	10.85	Manufacture of prepared meals and dishes
Processed food	10.86	Manufacture of homogenised food preparations and dietetic food
Processed food	10.89	Manufacture of other food products n.e.c.
Processed food	10.91	Manufacture of prepared feeds for farm animals
Processed food	10.92	Manufacture of prepared pet foods
Processed food	11.01	Distilling, rectifying and blending of spirits
Processed food	11.02	Manufacture of wine from grape
Processed food	11.03	Manufacture of cider and other fruit wines
Processed food	11.04	Manufacture of other non-distilled fermented beverages
Processed food	11.05	Manufacture of beer
Processed food	11.06	Manufacture of malt
Processed food	11.07	Manufacture of soft drinks production of mineral waters and other bottled waters
Production Technology	25.30	Manufacture of steam generators, except central heating hot water boilers
Production Technology	28.15	Manufacture of bearings, gears, gearing and driving elements
Production Technology	28.22	Manufacture of lifting and handling equipment
Production Technology	28.24	Manufacture of power-driven hand tools
Production Technology	28.29	Manufacture of other general-purpose machinery n.e.c.
Production Technology	28.41	Manufacture of metal forming machinery
Production Technology	28.49	Manufacture of other machine tools
Production Technology	28.91	Manufacture of machinery for metallurgy
Production Technology	28.96	Manufacture of plastics and rubber machinery
Production Technology	28.99	Manufacture of other special-purpose machinery n.e.c.
Production Technology	30.99	Manufacture of other transport equipment n.e.c.
Stone Quarries	08.11	Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate
Telecom	26.30	Manufacture of communication equipment
Telecom	27.31	Manufacture of fibre optic cables
Telecom	27.32	Manufacture of other electronic and electric wires and cables
Telecom	27.90	Manufacture of other electrical equipment
Telecom	28.23	Manufacture of office machinery and equipment (except computers and peripheral equipment)
Telecom	61.10	Wired telecommunications activities
Telecom	61.20	Wireless telecommunications activities
Telecom	61.30	Satellite telecommunications activities
Telecom	61.90	Other telecommunications activities
Textiles	13.10	Preparation and spinning of textile fibres
Textiles	13.20	Weaving of textiles
Textiles	13.92	Manufacture of made-up textile articles, except apparel
Textiles	13.93	Manufacture of carpets and rugs
Textiles	13.95	Manufacture of non-wovens and articles made from non-wovens, except apparel
Textiles	13.96	Manufacture of other technical and industrial textiles
Textiles	13.99	Manufacture of other textiles n.e.c.
Textiles	14.14	Manufacture of underwear
Textiles	20.60	Manufacture of man-made fibres

Textiles	28.94	Manufacture of machinery for textile, apparel and leather production
Tobacco	12.00	Manufacture of tobacco products
Tourism	49.32	Taxi operation
Tourism	55.10	Hotels and similar accommodation
Tourism	55.20	Holiday and other short-stay accommodation
Tourism	55.30	Camping grounds, recreational vehicle parks and trailer parks
Tourism	55.90	Other accommodation
Tourism	77.11	Renting and leasing of cars and light motor vehicles
Tourism	92.00	Gambling and betting activities
Tourism	93.21	Activities of amusement parks and theme parks
Transportation and Logistics	30.11	Building of ships and floating structures
Transportation and Logistics	33.15	Repair and maintenance of ships and boats
Transportation and Logistics	33.16	Repair and maintenance of aircraft and spacecraft
Transportation and Logistics	49.31	Urban and suburban passenger land transport
Transportation and Logistics	50.10	Sea and coastal passenger water transport
Transportation and Logistics	50.20	Sea and coastal freight water transport
Transportation and Logistics	50.30	Inland passenger water transport
Transportation and Logistics	50.40	Inland freight water transport
Transportation and Logistics	51.10	Passenger air transport
Transportation and Logistics	51.21	Freight air transport
Transportation and Logistics	52.10	Warehousing and storage
Transportation and Logistics	52.21	Service activities incidental to land transportation
Transportation and Logistics	52.22	Service activities incidental to water transportation
Transportation and Logistics	52.23	Service activities incidental to air transportation
Transportation and Logistics	52.24	Cargo handling
Transportation and Logistics	53.10	Postal activities under universal service obligation
Transportation and Logistics	53.20	Other postal and courier activities
Transportation and Logistics	77.34	Renting and leasing of water transport equipment

* Last update: 2014.

Pro and cons on the use of LQ to measure production specialisation (§ 3)

In order to get a sound understanding of knowledge- or capital- intensive cluster categories, it would be preferable the use of information on sector wage, productivity, or added value. Unfortunately, these statistics are still not available at length for the EU, so the categorisation currently available on the ECO is obtained by the use of employment data. While this characterisation can be useful to draw upon, it has to be born in mind that it can even create a certain bias towards employment-intensive clusters. Only the measure for specialisation obtained by LQs is unaffected by differences of employment intensity across cluster categories.

As a further measure of clusters' specialisation, the measure of strength that Protsiv- Ketels use in analysing cluster relation to the New Growth Path (2013) can be calculated too and used to test the interpretation of the first extracted Principal Component. It is based on a formulation from Delgado et al. (2012), and considers strong clusters those whose values fall within the top20% of clusters sorted by their LQs and concurrently within the top80% of clusters ranked by employment. These two filters should provide a more solid basis to account for cluster strength than the sole threshold of 2 of LQ values.

Data treatment of variables used in the first PCA (§ 4.1)

Female employment, long term unemployment, life-long learning participation, human resources in science and high-tech, and knowledge intensive services are all expressed in percentage. The first three are percent rates, the fourth is a percent share of total population, the last of total employment. The number of patents has been converted in percentage too, by computing the regional share of the total EU15 amount.

As for value added data (either in manufacturing, in professional services, or in non-market services – respectively C, M-N, O-U in terms of NACErev2 sectors), additional refinements were needed. Statistics were downloaded as million euros of gross value added at basic prices. First, values have been deflated by means of the price index per value added (total, implicit deflator), with base year 2000=100. Then, purchasing power parities (ppp) with EU15=1 have been applied, in order to deflate over space besides than over time, and so making comparable regions across different Member States. Finally, the obtained deflated euros in purchasing power standards (pps) have been converted in percentages as regional share of total EU value added.

Extracted Principal Components (§ 4.1)

Production structure and labour market

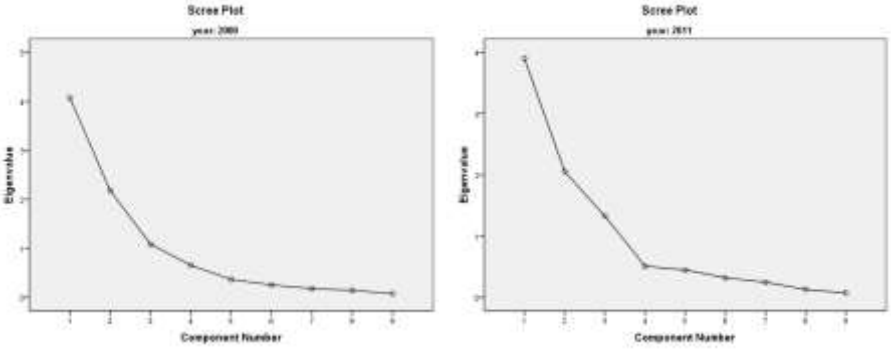


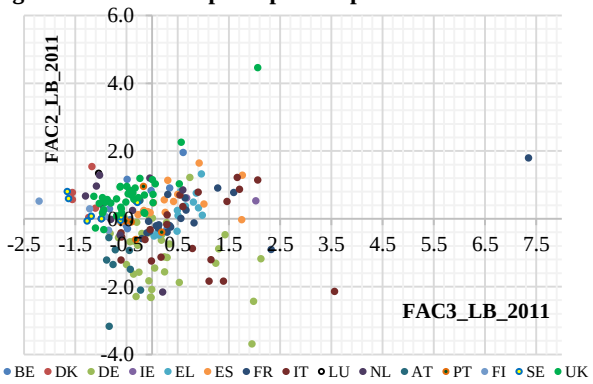
Table 7. Employment structure, Component Matrix[a,b]

Total Variance Explained							
Component		Initial Eigenvalues			Extraction Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
	1	3.900	43.334	43.334	3.900	43.334	43.334
	2	2.055	22.832	66.166	2.055	22.832	66.166
	3	1.326	14.738	80.904	1.326	14.738	80.904
	4	.508	5.649	86.553			
	5	.446	4.959	91.512			
	6	.320	3.551	95.063			
	7	.246	2.731	97.794			
	8	.128	1.423	99.217			
	9	.070	.783	100.000			

Table . Component Matrix and Communalities, Employment structure

Component Matrixa,b					Communalities	
	Component					
	1	2	3		Initial	Extraction
Long term unemployment %	-.651	.437	.364		1.000	.746
Lifelong learning % participation rate	.567	-.525	.286		1.000	.679
Knowledge intensive services %employm.	.713	-.174	.554		1.000	.847
HR in science and high-tech %	.807	-.149	.319		1.000	.775
N° of Patents (as share oft he EU15 total)	.652	-.017	-.582		1.000	.765
VAin C(as share oft he EU15 total)	.530	.584	-.466		1.000	.839
VAinMN (as share oft he EU15 total)	.606	.695	.190		1.000	.887
VAinOQ (as share oft he EU15 total)	.599	.723	.211		1.000	.925
Female employment %	.750	-.436	-.257		1.000	.819

Figure 17. Extracted principal components 2 and 3



The x-axis represents the third Principal Component extracted, a further specification of the second one about the quality of labour market represented on the y-axis.

Clusters'

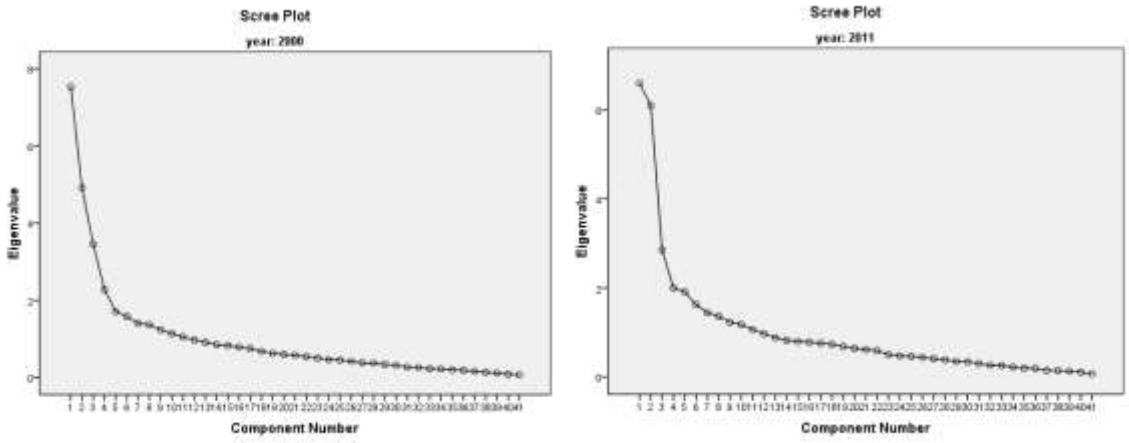


Table 7. Cluster Categories, Component Matrix[a,b]

	1[a]	2[a]	1[b]	2[b]		1[a]	2[a]	1[b]	2[b]
lqaer	,029	,356	-,257	,047	lqlea	,083	-,153	,151	-,154
lqagr	-,235	-,533	,404	-,568	lqlig	,679	,092	,213	,508
lqapp	,402	-,177	,432	,035	lqmar	-,039	-,203	,241	-,420
lqaut	,394	,019	,202	,526	lqme	,476	,584	-,485	,254
lqbio	-,196	,596	-,582	,093	lqmed	,703	,247	,056	,554
lqbui	,767	-,285	,716	,344	lqmet	,611	-,008	,365	,665
lqbus	-,222	,661	-,682	,439	lqoil	-,130	,029	-,080	-,213
lqche	,481	,153	-,004	,237	lqpap	,594	-,094	,424	,423
lqco	,114	-,615	,615	-,315	lqpha	,385	,409	-,208	,139
lqcon	,429	-,355	,550	-,007	lqpla	,633	,097	,247	,628
lqdis	,046	,195	-,005	,060	lqpow	,428	,122	,110	,528
lqedu	-,432	,459	-,716	-,100	lqprf	,711	-,155	,603	,126
lqent	-,473	,435	-,633	-,110	lqpro	,590	,063	,266	,771
lqfar	-,295	-,507	,341	-,590	lqspo	,432	-,087	,073	,041
lqfin	-,093	,561	-,570	,222	lqsto	,153	-,233	,298	-,385
lqfoo	,161	-,176	,282	-,027	lqtel	,347	,606	-,423	,351
lqfur	,580	-,323	,595	,227	lqtex	,479	-,117	,423	,244
lqhea	,706	,000	,379	,699	lqtob	-,174	-,423	,356	-,588
lqins	,269	,309	-,094	,505	lqtou	-,050	-,211	,127	-,173
lqit	,565	,487	-,327	,532	lqtra	-,274	,466	-,516	-,073
lqjew	,329	,101	,048	-,072					

Extraction Method: Principal Component Analysis. a. year = 2000 b. year = 2011

Table 8. Cluster Categories, Total Variance Explained of extracted components

PCs	2000						2011					
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulat. %	Total	% of Variance	Cumulat. %	Total	% of Variance	Cumulat. %	Total	% of Variance	Cumulat. %
1	7.533	18.373	18.373	7.533	18.373	18.373	6.846	16.698	16.698	6.846	16.698	16.698
2	4.920	12.000	30.374	4.920	12.000	30.374	5.432	13.249	29.948	5.432	13.249	29.948
3	3.451	8.416	38.790	3.451	8.416	38.790	3.017	7.357	37.305	3.017	7.357	37.305
4	2.278	5.557	44.347	2.278	5.557	44.347	2.573	6.275	43.580	2.573	6.275	43.580
5	1.712	4.177	48.524	1.712	4.177	48.524	1.735	4.233	47.812	1.735	4.233	47.812
6	1.583	3.861	52.384	1.583	3.861	52.384	1.501	3.661	51.474	1.501	3.661	51.474
7	1.407	3.431	55.815	1.407	3.431	55.815	1.430	3.488	54.961	1.430	3.488	54.961
8	1.370	3.342	59.157	1.370	3.342	59.157	1.311	3.196	58.158	1.311	3.196	58.158
9	1.237	3.016	62.173	1.237	3.016	62.173	1.264	3.082	61.240	1.264	3.082	61.240
10	1.139	2.779	64.951	1.139	2.779	64.951	1.113	2.714	63.953	1.113	2.714	63.953
11	1.051	2.564	67.515	1.051	2.564	67.515	1.015	2.475	66.428	1.015	2.475	66.428
12	.976	2.381	69.896				.943	2.299	68.727			
13	.911	2.223	72.119				.868	2.118	70.845			
14	.852	2.078	74.196				.843	2.057	72.902			
15	.829	2.023	76.219				.810	1.975	74.877			
16	.789	1.925	78.144				.792	1.931	76.808			

17	.753	1.836	79.980		.716	1.745	78.553
18	.678	1.653	81.633		.677	1.650	80.203
19	.629	1.534	83.167		.674	1.643	81.846
20	.598	1.458	84.625		.628	1.532	83.378
21	.578	1.410	86.035		.597	1.455	84.833
22	.543	1.323	87.358		.578	1.410	86.243
23	.506	1.235	88.593		.521	1.272	87.514
24	.464	1.132	89.725		.507	1.236	88.750
25	.452	1.104	90.828		.489	1.192	89.943
26	.419	1.022	91.850		.466	1.137	91.079
27	.382	.931	92.781		.412	1.004	92.083
28	.372	.908	93.689		.380	.926	93.009
29	.337	.823	94.512		.374	.913	93.922
30	.315	.769	95.281		.337	.822	94.745
31	.269	.656	95.937		.294	.718	95.463
32	.258	.629	96.566		.277	.675	96.138
33	.230	.561	97.127		.241	.588	96.726
34	.222	.542	97.669		.236	.576	97.302
35	.200	.489	98.158		.205	.500	97.802
36	.186	.453	98.611		.200	.488	98.290
37	.162	.395	99.005		.174	.424	98.714
38	.136	.332	99.338		.154	.375	99.089
39	.116	.283	99.621		.147	.358	99.447
40	.087	.213	99.833		.126	.307	99.754
41	.068	.167	100.000		.101	.246	100.000

Table 9. Cluster Categories, Communalities

	Initial	Extraction[a]	Extraction[b]		Initial	Extraction[a]	Extraction[b]
lqaer	1.000	.712	.510	lqlea	1.000	.530	.624
lqagr	1.000	.820	.861	lqlig	1.000	.513	.490
lqapp	1.000	.751	.771	lqmar	1.000	.588	.611
lqaut	1.000	.565	.571	lqme	1.000	.809	.782
lqbio	1.000	.591	.411	lqmed	1.000	.866	.832
lqbui	1.000	.719	.727	lqmet	1.000	.699	.702
lqbus	1.000	.723	.656	lqoil	1.000	.658	.719
lqche	1.000	.652	.671	lqpap	1.000	.671	.702
lqco	1.000	.689	.694	lqpha	1.000	.596	.498
lqcon	1.000	.552	.535	lqpla	1.000	.617	.671
lqdis	1.000	.616	.677	lqpow	1.000	.472	.507
lqedu	1.000	.795	.757	lqprf	1.000	.718	.733
lqent	1.000	.776	.733	lqpro	1.000	.720	.758
lqfar	1.000	.888	.891	lqspo	1.000	.651	.619
lqfin	1.000	.596	.582	lqsto	1.000	.582	.511
lqfoo	1.000	.597	.621	lqtel	1.000	.800	.748
lqfur	1.000	.588	.624	lqtex	1.000	.627	.554
lqhea	1.000	.654	.648	lqtob	1.000	.844	.822
lqins	1.000	.760	.731	lqtou	1.000	.668	.640
lqit	1.000	.809	.740	lqtra	1.000	.801	.731
lqjew	1.000	.398	.571				

a. year = 2000 b. year = 2011

Missing data for clusters' specialisation database

The European Cluster Observatory database, despite being the best source of information about production clusters around the EU, still does present some missing data. The following table shows them.

Table 13. Cluster categories, percentage of missing data per cluster by year.

Variable	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
lqAER	2.97	2.97	2.97	2.97	1.42	1.26	0.73	1.06	1.63	1.50	0.53	0.53
lqAGR	2.93	2.93	2.93	2.97	1.42	1.22	0.69	0.69	0.04	0.04	0.04	0.04
lqAPP	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	0.04	-	-	-
lqAUT	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
lqBIO	3.05	3.05	3.09	3.05	1.46	1.34	1.06	1.22	-	1.02	0.53	0.53
lqBUI	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
lqBUS	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
lqCHE	3.17	3.17	3.13	3.17	1.63	1.34	0.85	0.89	0.20	0.20	0.08	0.08
lqCO	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
lqCON	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
lqDIS	3.01	3.01	3.01	3.01	1.46	1.26	0.73	0.73	-	-	-	-
lqEDU	3.01	3.01	3.01	3.01	1.46	1.26	0.73	0.73	-	-	-	-
lqENT	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
lqFAR	3.17	3.50	3.46	3.46	2.03	1.79	1.26	1.38	0.57	0.49	0.49	0.49
lqFIN	3.01	3.01	3.01	3.01	1.67	1.46	0.98	0.93	0.33	0.33	0.33	0.33
lqFOO	4.27	4.27	4.39	4.39	3.54	3.54	3.46	3.41	3.17	3.17	2.24	2.24
lqFUR	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
lqHEA	2.93	2.93	2.93	2.97	1.38	1.18	0.65	0.65	0.04	0.08	-	-
lqINS	2.97	2.97	2.93	3.01	1.42	1.22	1.10	1.10	0.49	0.49	0.45	0.45
lqIT	2.93	2.93	2.93	2.93	1.38	1.18	0.77	0.77	0.12	0.12	0.12	0.12
lqJEW	3.01	3.01	3.01	3.01	1.42	1.26	0.77	0.77	0.08	0.08	0.08	0.08
lqLEA	3.86	3.82	3.90	3.86	2.76	2.60	2.44	2.44	1.91	1.91	1.71	1.71
lqLIG	3.01	3.01	3.01	3.01	1.42	1.26	0.93	0.93	0.28	0.28	0.24	0.24
lqMAR	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
lqME	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
lqMED	2.93	2.93	2.93	2.93	1.38	1.18	0.77	0.77	0.12	0.12	0.12	0.12
lqMET	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
lqOIL	5.08	5.16	5.20	5.37	3.94	3.70	3.41	3.54	2.68	2.60	1.91	1.91
lqPAP	2.93	2.93	2.93	2.93	1.38	1.22	0.65	0.65	0.04	0.04	-	-
lqPHA	3.21	3.21	3.17	3.17	1.63	1.42	1.10	1.18	0.69	0.61	0.33	0.33
lqPLA	2.97	2.97	2.97	2.97	1.42	1.18	0.77	0.77	0.12	0.12	0.12	0.12
lqPOW	3.01	3.01	3.05	3.01	1.59	1.38	0.98	0.89	0.24	0.28	0.24	0.24
lqPRF	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
lqPRO	2.93	2.93	2.93	2.93	1.38	1.18	0.69	0.73	0.04	0.04	0.04	0.04
lqSPO	3.29	3.29	3.33	3.37	1.87	1.54	1.59	1.63	0.98	1.02	0.61	0.61
lqSTO	3.66	3.62	3.50	3.54	2.44	2.36	1.91	2.03	1.22	1.26	1.14	1.14
lqTEL	2.93	2.93	2.93	2.93	1.38	1.18	0.69	0.69	0.04	0.04	0.04	0.04
lqTEX	2.93	2.97	2.97	2.93	1.38	1.18	0.69	0.69	0.04	0.04	0.04	0.04
lqTOB	3.78	4.07	3.94	4.02	3.21	2.97	2.44	2.89	3.86	3.74	2.44	2.32
lqTOU	3.01	3.01	3.01	3.01	1.46	1.26	0.73	0.73	-	-	-	-
lqTRA	2.93	2.93	2.93	2.93	1.38	1.18	0.65	0.65	-	-	-	-
TOT	**3.12**	**3.14**	**3.14**	**3.14**	**1.67**	**1.47**	**1.03**	**1.06**	**0.96**	**0.95**	**0.81**	**0.98**

Since the presence of missing data may affect the final result of research, as well as impede the application of analysis technique at all, this is a criticality that should be properly addressed. When percentage of missing data is between 1 and 4, it is considered a relatively small portion of the whole, and the easiest procedure is to delete the concerned variable from the matrix. When variables cannot be excluded or the magnitude of lack is higher, some data treatment are necessary before to perform the statistical analysis (Di Franco, 2015). In the case of the clusters specialisation variables taken from the European

Cluster Observatory, percentages of missing data are of minor size. As shown in Table 1, the overall amount of missing data is always acceptable (max value equal to 3.14% of 2460 observation). Specifically looking at the variables shares of these amounts per year, worst cases are those of the Oil and Gas, and Footwear- the only sectors exceeding the 4% threshold in the first four years of the considered period.

The nature of missing data can be here considered systematic, since it regards recurrent sectors or country per specific years. No variables could be excluded though. Firstly because the resulting complete matrix would not be a random sub-set of the original sample. Second, because each of them is specific to a production cluster, being at the same time the only information available at this level of detail for EU regions. For this very reason, no imputation based on instrumental variables can be applied in this case, due to their unavailability. A procedure to substitute missing data had to be chosen between the two alternative techniques generally proposed to the elimination of this issue[71]. The easiest move is to assign values by imputing means of available cases. This was the first attempt here made. Problem with this option is that it is ok to be used when the variable distribution is a symmetrical one only, to not distort it. To avoid this risk, multiple central values can be calculated on subsamples based on common characteristics.

Summary of used variables.

Table14. Descriptive statistics

Variable	Source	Description	Obs.	Mean	Std. Dev.	Min	Max
Female employment	Eurostat	Percent rate	2460	63.2	9.7	25.6	85.7
Long term unemployment	Eurostat	Percentage	2460	3.0	2.6	0.0	17.6
Part-time employment	Eurostat	Percent rate	2460	22.6	13.0	0.0	191.6
Life-long learning	Eurostat	Percentage	2460	11.2	7.9	0.1	36.1
Employment in knowledge intensive services	Eurostat	Percentage of employment	2460	10.0	3.5	2.7	28.9
HR in science& high-tech	Eurostat	Percent rate	2460	35.6	8.7	11.5	66.6
Value Added in C	Eurostat	-thsd € ppp defl -share of EU15	2460	7184.2	7192.8	38.8	53954.1
Value Added in M-N	Eurostat	thsd € ppp defl -share of EU15	2460	4568.2	7500.8	15.1	91628.1
Value Added in O-U	Eurostat	thsd € ppp defl -share of EU15	2460	8164.3	7319.8	155.6	79764.9
LQ in Aerospace	ECO	LocationQuotient	1955	1.000368	1.853061	0	16.98
LQ in Agricult. products	ECO	LocationQuotient	2068	1.133453	1.183438	0.03	10.4
LQ in Apparel	ECO	LocationQuotient	2076	0.6139451	1.071524	0	13
LQ in Automotive	ECO	LocationQuotient	2077	0.9885845	1.093252	0	6.5
LQ in Biotech	ECO	LocationQuotient	1953	0.882043	1.035469	0	19.37
LQ in Building fixtures	ECO	LocationQuotient	2077	1.027771	0.6504144	0.01	5.6
LQ in Business Services	ECO	LocationQuotient	2077	0.9562542	0.4719674	0.03	2.87
LQ in Chemical products	ECO	LocationQuotient	2019	1.031654	1.074679	0	8.74
LQ in Construction	ECO	LocationQuotient	2077	1.052191	0.52665	0.2	3.87
LQ in Construct. materials	ECO	LocationQuotient	2077	1.038763	1.058684	0.01	9.23
LQ in Distribution	ECO	LocationQuotient	2061	0.9156429	0.4255709	0.18	2.92
LQ in Education and Knowledge creation	ECO	LocationQuotient	2061	0.8722222	0.6714107	0	3.55
LQ in Entertainment	ECO	LocationQuotient	2077	0.9094608	0.5447107	0.02	2.46
LQ in Farming	ECO	LocationQuotient	1917	1.37868	2.424803	0	21.86
LQ in Financial Services	ECO	LocationQuotient	2008	0.9421863	0.4724671	0.04	4.13
LQ in Footwear	ECO	LocationQuotient	1425	0.9777333	2.860021	0	35.24

[71] The literature dealing with missing data substitution is ample and rapidly evolving. For further details see, among others, Enders (2010), Holenberghs and Kenward (2007), Chantala and Suchindran (2003), Akritas et al. (2002), Little and Rubin (2002), Allison (2001), Huisman et al. (1998), Little (1997) and Little and Schenker (1994), (Di Franco, 2015).

LQ in Furniture	ECO	LocationQuotient	2077	0.9463698	1.030131	0.03	7.88
LQ in Heavy Machinery	ECO	LocationQuotient	2073	0.9925036	0.8310871	0	5.22
LQ in Instruments	ECO	LocationQuotient	2003	1.006156	1.14341	0	8.99
LQ in IT	ECO	LocationQuotient	2059	0.9528946	0.9062108	0	8.74
LQ in Jewellery and precious metals	ECO	LocationQuotient	2052	1.039849	1.944707	0	17.61
LQ in Leather products	ECO	LocationQuotient	1650	1.076988	3.78769	0	63.38
LQ in Lighting and Electr.	ECO	LocationQuotient	2026	0.9532527	0.8800308	0	5.84
LQ in Maritime	ECO	LocationQuotient	2077	1.225927	1.996527	0.02	20.59
LQ in Media & publishing	ECO	LocationQuotient	2077	0.9035869	0.5092592	0.14	5.08
LQ in Medical devices	ECO	LocationQuotient	2059	1.183837	2.175013	0	29.54
LQ in Metal Manufactur.	ECO	LocationQuotient	2077	1.009923	0.8168013	0.01	5.04
LQ in Oil and Gas	ECO	LocationQuotient	1365	1.248828	3.202593	0	35.73
LQ in Paper products	ECO	LocationQuotient	2074	1.229441	1.142777	0.03	7.93
LQ in Pharmaceuticals	ECO	LocationQuotient	1967	1.0585	1.859156	0	21.6
LQ in Plastics	ECO	LocationQuotient	2054	1.02334	0.719254	0.03	5.59
LQ in Power Generation	ECO	LocationQuotient	2019	1.017618	1.779594	0	27.7
LQ in Processed Food	ECO	LocationQuotient	2077	1.086351	0.6880944	0.1	7.4
LQ in Production Techno.	ECO	LocationQuotient	2070	1.023169	1.038019	0.02	7.42
LQ in Sporting goods	ECO	LocationQuotient	1891	1.102634	1.762912	0	12.28
LQ in Stone quarries	ECO	LocationQuotient	1776	1.470557	1.948258	0	19.96
LQ in Telecom	ECO	LocationQuotient	2071	0.9107195	0.6177009	0.02	5.04
LQ in Textiles	ECO	LocationQuotient	2069	0.8037651	1.167579	0.01	10.83
LQ in Tobacco	ECO	LocationQuotient	1484	1.751765	3.750449	0	35.74
LQ in Tourism&Hospital.	ECO	LocationQuotient	2061	1.253906	1.150499	0.18	11.18
LQ in Transport&Logistic	ECO	LocationQuotient	2077	0.9210881	0.4666625	0.07	3.49
Cluster diversification	own elaboration on ECO data	1°PC on LQs, normalised	2460	-8.53E-09	0.9977608	-2.7452	6.61896
Innovative specialisation	own elaboration on ECO data	2°PC on LQs, normalised	2460	7.87E-09	0.9977608	-3.1532	2.77842
Loss in Human Development	own elaboration on Eurostat	Percentage	2460	0.0536512	0.0118929	0.02366	0.10432
Innobarometer	Eurostat	Composite indicator	2448	0.5015196	0.1087725	0.25	0.76
Patents	Eurostat	-Number per mln inhabitants -Share of the EU15 total	2460	127.1	131.2	0.0	1018.9
Employment in Agricult., Forestry, and Fishery	Eurostat	Percent. of tot employment	12[(1)]	0.0342	0.0048	0.0280	0.0412
Employment in Industry	Eurostat	Percent. of tot employment	12[(1)]	0.1871	0.0157	0.1659	0.2112
Employment in Construction	Eurostat	Percent. of tot employment	12[(1)]	0.0770	0.0025	0.0715	0.0813
Employment in Wholesale and Retail, information	Eurostat	Percent. of tot employment	12[(1)]	0.2423	0.0092	0.2351	0.2550
Employment in Finance, Professionals	Eurostat	Percent. of tot employment	12[(1)]	0.1335	0.0065	0.1219	0.1416
Employment in Non-Market Services	Eurostat	Percent. of tot employment	12[(1)]	0.3198	0.0079	0.3084	0.3325

[(1)] These variables were considered in their aggregate EU15 value only, in the 12 years from 2000 to 2011.

SOCIAL CAPITAL AND INEQUALITIES IN THE EU REGIONS

Abstract: This paper focuses on the interactions between social capital and production structure in their relation with regional inequality. Combining survey data with available regional databases for the EU15, it aims at providing a panel data analysis of multidimensional inequalities based on the idea that social capital is a fundamental factor determining its regional levels, along with the economic specialisation of regions. Results confirm an inverse relation between inequality and social capital. At the same time, they highlight the positive impact of production clusters on the regional environment. Findings suggest that the joint effect of predictors is ambiguous though, and may so be dependent on the different sorts of local specialisation and social capital endowment.

Keywords: European Union, inequality, region, production specialisation, social capital.

Introduction.

The proposed paper intends to contribute to the debate on regional disparities, and how they can possibly be reduced. Drawing upon both economic and sociological literature, it aims at providing a multidimensional study of the role of social capital in the socioeconomic dynamics of regions.

Many previous analyses of inequality have inferred on its interaction with social capital endowments. The direction of the relation is still not clear, but an inverse one has often been recognised to be in place (d'Hombres et al., 2013; de Blasio, Nuzzo 2005, 2012; Barone, Mocetti, 2013). As a matter of fact, social capital is still a vaguely defined concept, which in socioeconomic literature identifies a complex variety of elements, such as the civic involvement and participation of citizens (Putnam, 1993); the level of trust (Fukuyama, 1995); and different kinds of social relations (Bourdieu, 1986; Coleman, 1988).

The sociological analysis has naturally devoted a higher concern to the conceptual definition of the theoretical construct. This involves several dimensions and level of analysis, which can be either micro, macro, or meso levels. Moreover, it has often been explained referring to its relation with other concepts – especially that of *social networks* (Burt, 1992; Baker, 1990)– as well as by means of the values its components pertain to, they being either universalistic or particularistic values. On the one hand, it is meant general ethic norms to be universally applied; on the other, social behaviours are different based on the network within they take place- e.g. inside or outside the family ties (De Blasio et al., 2014). On these same strands, a more basic division distinguishes between *bridging* and *bonding* type of the social relations involved (Putnam, 2000; Narayan, 2002).

The economic analysis, instead, has generally been more focused on the connections in place between either social networks, civic and reciprocity norms, or trust and economic variables (Barone et al., 2014). As a matter of fact, many scholars have studied social capital in its positive effects on growth (Helliwell, Putnam, 1995; Whiteley, 2000; Beugelsdijk, van Schaik, 2001). At the regional scale, this often translated in digging into the ties social capital has been proved to have with regional production structure, especially with clusters of industries and their impulse on local virtuous dynamics (Rodriguez-Pose, 1998; Crescenzi, 2008; Knack, Keefer, 1997; Beugelsdijk et al. 2005, 2009). Social capital facilitates production diversification indeed, and industries' relatedness to form clusters (Boschma, 2016) - which are assumed to boost regional performance substantially (Porter, 1990). One aspect that is still mostly unclear is the trigger for a favourable environment to turn into a successful cluster location. And here the local endowments of social capital come into play: its importance as driver of the performance difference across locations has been increasingly recognised (Rodriguez-Pose, Crescenzi, 2008). In the end, all of its constituting elements have an impact on either the public or private actors, both at the individual and collective level, and eventually seem to make it more likely that "mere co-location is leveraged through active collaboration and that beneficial local conditions are strengthened through coordinated or joint action" (Ketels, Protsiv, 2013). Furthermore, as Rodriguez-Pose (1998) also wrote decades ago about the role of "local social structures" in explaining the persistence of regional disparities in Europe: the existing social conditions may play an essential role in an area's receptivity to and assimilation of technological change and economic processes.

These complementary research interests have, however, rarely been combined in regional studies.

On the one hand, most of the inequality studies dealing with the link between social capital (i.e. there principally intended with regards to its *social network* definition) and economic inequalities often search for their drivers into the labour market structure and its functionings. Their focus is mainly the labour *supply* side though, investigating on wage inequalities and top income shares, investments in human capital and returns to education, welfare institutions and workers, just to name a few examples. A lot has been written about how the labour force performs, how it allocates and relocates, how it is employed and rewarded, which are the mechanisms governing social networks, or intergenerational transmission of wage inequality (Granovetter, 1974; Atkinson, 2007, 2013; Flap, 1991). Less has been studied about the influence of the labour *demand* side on different sort of inequalities. Moreover, Atkinson himself (1983), renowned as one of the main scholars of economics of inequality in Europe, who devoted his work largely to the analysis of the

labour supply, recognised the importance of looking at the demand side too in order to fill our gaps in knowledge about the economic inequality mechanisms and its drivers.

On the other hand, the studies exploring the relation between social capital and growth are still intrigued mostly by regional employment and production structures, looking into the possible ways for boosting economic growth towards regional convergence, rather than jointly considering further social implications related to inequality. In addition, especially when it comes to territorial disparities, also the policy makers are always more concerned with innovative clusters as a good way of boosting growth, promoting local development and so leveraging lagged regions (e.g. the EU regional Cohesion Policy and the Smart Specialisation Strategies: EC, 2014, 2017). Can we say these growth spillovers are actually inclusive though? If we agree that places are made of people and they are the last recipients of any policy intervention in the end, the development of a territory can be considered equitable or not based on the implications for citizens' well-being, and tackling spatial imbalances should not disregard the individual level of related inequalities.

This piece of research provides an attempt to reconcile these close themes. The underlying hypothesis lies in the intuition that the effects social capital has, inversely with inequality on one side, and directly with growth on the other side, may be further researched by exploring the nexus between its regional endowments and the locally associated economic specialisation. Therefore, main research questions ask what are the effects of specific regional characteristics, alike social capital endowments, on multidimensional inequality in the EU15; and what is the role of production structure within this connection.

Due to the several approaches available for the definition of these complex concepts, it is worth clarifying how they have been here measured. Inequality is intended as that of outcomes, specifically with regards to the multidimensional framework of human development economics and capability approach (Sen, 1987; Alkire, 2010). An attempt to consider at least the trust (Fukuyama, 1995) and networks (Putnam, 1993) components of social capital together was done. The definition of production clusters here assumed refers to the concept of agglomeration of firms, and especially to the extensive research carried out by the Center for Strategy and Competitiveness (CSC) at the Stockholm School of Economics (Ketels et al., 2008; Ketels, Protsiv, 2013). The territorial unit of analysis is set at the Eurostat NUTS2[72] regions[73], within the EU15 only.

Previous exploratory analyses[74] of considered variables have provided evidence of the fact that regions where social capital endowments are higher (lower) than average also have lower (higher) level of loss in human development. Lower level of multidimensional inequality appears in regions where the quality of local institutions[75] is higher. Regions with higher level of inequality at the same time show lower level of GDP and of innovation[76]. All of this seems to be more or less regardless of the degree of urbanisation of regions.

Some subsequent hypotheses see local specialisations to influence the levels of inequality differently, based on: *a)* the sort of social relations and cultural effects that productive specialisation allows to foster; *b)* the spatial interactions that these effects can engender within the related territories. In order to test these relations, a longitudinal analysis on data about 205 regions in the time period 2000-2011 has been applied.

The article is then structured as follows. First section provides a more detailed discussion of the theoretical structure assumed behind investigated variables. Second section explains data and methodology used. Third section shows results obtained by econometric analyses. Fourth and last section summarises the findings and draws some conclusions.

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[72] According to the 2010 classification, and excluding the French, Spanish and Portuguese oversea departments.

[73] For at least two reasons: wider and more homogeneous availability of human development variables for countries of interest; comparability to regional performance and innovation indicators not available yet at a lower territorial specification.

[74] As part of the same PhD dissertation this article pertains to, preliminary findings were discussed and published within the 13th International Post-Graduate Research Conference at University of Salford (Parente, 2017).

[75] As measured by the European Quality of Institutions produced by the Quality of Government Institute at the University of Gothenburg (2010, 2013).

[76] As measured by both the Innobarometer, calculated by DG REGIO (2014), and patents per thousand habitants (OECD).

1. The Role of Regional Social Capital.

The underlying hypotheses to this study assume more liveable regions to be those with lower level of inequality, and higher level of (elements of[77]) social capital (Putnam, 1993; Alesina, La Ferrara, 2002). In case of low inequality and high social capital, more flexible and adaptive business environments and production structures may occur on one side, and more cohesive and reactive social infrastructures and networks on the other side. All of this can hold also subject to other regional characteristics, like the quality of institutions and infrastructures. Especially in the literature on urban sociology and city planning, the role of physical space and infrastructure endowments is recognised as relevant in determining differentials of individuals' quality of life and community's socioeconomic development (Park et al., 1925; Lefebvre, 1991; Pastor et al., 2015; Iacofano, Goltsman 2007).

Despite the increasing attention it has captured in social sciences, social capital remains a not totally clearly defined concept (Portes, 1998). It represents a set of components like interpersonal trust, reciprocity norms, and social networks. Nevertheless, it remains unclear if these components are all on the same level, or if they are self-reinforcing and cumulative. Major studies and attempts of conceptualisation came from Bourdieu (1980), Coleman (1988), Putnam (1993, 2000), and Fukuyama (1995). A main distinction in their theorisations can be found, first of all, in the reference to the individual or collective level. Bourdieu was the first one to thoroughly define social capital as the set of effective and potential resources deriving from a stable social network. Similarly, Coleman identifies it with the structure of the networks between people itself, quantifiable with the skills deriving from socialisation. Otherwise, Putnam and Fukuyama emphasised the collective resources of social capital. Even if Fukuyama places the accent more on the moral aspect of it and the values of trust, both of them imply that social capital is something related to the elements of a better society as a whole. Civic virtue and civicness, associationism, trustworthiness and organisational efficiency: they all come from shared reciprocity norms and collective initiatives taken by mutual agreement (Vergati, 2014).

In spite of their different focus on diverse aspects of this multifaceted phenomenon, all authors agree on qualifying social capital as the basic prerequisite for the well-functioning of collective actions and social cooperation, strengthening connectedness among people and favouring the emergence of a wide variety of social relations (van Schaik, 2002). The solely existence of these relations is the essence of the dimension of social cohesion, while the possibility for the network of circulating resources -together with the ability of the individual to activate them- are the typical elements needed for it to be considered as social capital (Di Franco, 2014).

Especially Putnam (2000) insisted on the central relevance of such elements as mutual trust and social networks to favour prosperity at individual, firm, neighbourhood, and country level. In addition, he considers it as the basis for democracy to work (1993), and as directly related to the quality of the institutions and of the social cohesion to which the society might aim at (2004). However, what is the effect of different kinds of social capital on the level of inequality? Moreover, how does the extent of inequality affect the formation of social capital in a region? Here a generally negative association has been suggested, with higher levels of inequality accompanied by lower performances in social capital. The direction of the relation results less clear, and the *kind* of social capital investigated does matter a great deal. Distinction between *bridging* and *bonding* functional effects have been highlighted (Putnam, 2000; Narayan et al, 2002). The first one embodies horizontal connections, among equals within a community (likewise said *cohesiveness*); whereas the bridging one is vertical between communities. Higher endowments of bonding networks may easily lead to an inverse relation with inequality within the community members only, resulting in an augmented overall inequality between members of different communities (e.g. socio-economic classes, hampering social

[77] As already touched upon in the introduction, a specification is due about the distinction between different components of social capital. While for elements such as trust there is wide consensus on the inverse relation with inequality, for those about social networks' endowments it is more vague and ambiguous- strictly depending on the *kind* of considered relations.

mobility and increasing inequality in its sociological definition. Good example is Banfield, 1953. For a review see Vergati, 2000, and Portes, 1998). Stronger bridging networks appear to be always positively beneficial instead (Narayan, 2002; Putnam, 1993).

De Blasio and Nuzzo have produced interesting evidence in both sense about Italian regions (2005, 2012). They found a significant association between several inequality measures and social capital indicators, highlighting that different social capital definitions may produce different results: the relation is negative in the case of bridging and linking ones, while positive for the bonding networks- which, favouring their members only, may foster the persistence of existing disparities. An interesting aspect is that these associations seems to pass through –and be then more evident in- the labour market. There could be several drivers, which can explain the negative association that goes from low level of social capital (or a bonding one stronger than the bridging/linking ones) to higher level of inequality. These may be, for example, a lower productivity due to professionally unfair behaviour and higher costs borne by firms to counter them; inefficient job-matching because of the prominent use of personal network in the job search; poor propensity to entrepreneurship in an unfavourable business environment; strong family ties that hampers women's employment. Even on the other side, when inequality is lower, pro-social behaviours are more likely to occur. Macro studies usually conclude that income inequality depresses social capital, while micro studies seem to produce more contrasted results (d'Hombres et al., 2013).

Looking more closely at social endowments in regions and their relation with local economic structure, an interesting recent piece of research by Boschma et al. (2016) tries to infer the role of different kinds of social capital on regional diversification and production specialisation. Drawing on previous work about the different economic payoffs of either bridging or bonding social capital by Knack and Keefer (1997) and Beugelsdijk et al. (2005, 2009), they analyse the role of informal institutions in more than one hundred European regions from 2004 to 2012. First of all, they find the relatedness of regional specialisations to be positively linked to existing strong industries in the region. Second of all, they show that informal institutions have a big play in this development path, and that bridging social capital is a key driver for regional diversification with significant levels of 'trust and active participation in bridging type of groups increase the probability of regions to diversify into new sectors' (Boschma et. al., 2016, p. 24). Bonding social capital, instead, seems to have no impact- or even a negative one where the quality of local government is poor.

Finally, about the specific impacts of cluster-based policies in the overall EU strategy for a New Growth Path (i.e. more sustainable and balanced between economic, social and environmental domains), Ketels and Protsiv provided some background research to the WWWforEurope project in 2013. Beside previous relevant studies they produced (Ketels et al., 2008), here they have specifically contributed to the evaluation of the role of clusters. Drawing upon related US literature and evidence framework (Porter, 2003), their goal was to test if European regions where clusters and cluster initiatives are present have better performance in environmental and social outcomes, besides the economic ones. They found confirmed that average wages are significantly and positively influenced by the presence of clusters in the regions, suggesting that specialisation and industry concentration have a role in lifting economic performance. Specifically looking at the implications for social and environmental components, they were able to draw six different typologies of regions, based on the combinations between performances in the three domains. A general conclusion is that regions with strong clusters tend to follow a more balanced development path. Nevertheless, clusters can be considered just as indicator of conditions that contribute to the outcomes of a more sustainable growth-path, not their root cause.

The following sections will explain the effort here made to further research on these regional dynamics.

2. Data and Methodology.

To carry out the empirical analyses presented in this paper, data from different sources have been merged.

The European Social Survey (ESS,2003, 2005, 2006, 2007, 2009, 2011, 2013)[78] was used as primary source for social capital endowments. It is a large scale, cross-country and repeated survey that provides information on the socioeconomic characteristics, beliefs, preferences, and values of people in the surveyed countries[79]. Considered survey items relate to two aspects of social capital: interpersonal trust and social networks. These were proximate by five variables: reported level of trust, of fairness and of helpfulness for the first concept; people stating unpaid work in organisations or political parties, for the second one.

Original microdata from the ESS responses have been previously treated. Reported levels of trust were collapsed by regional medians, and then aggregated by means of a simple arithmetic mean. Percentage average of respondents above the identified level of trust has been considered as the regional indicator for it. As for unpaid work for political party and other organisations, affirmative answers were reshaped in the form of percentage values and then aggregated by regional averages too[80].

The seven available survey waves[81] have been taken with a time lag of two years[82] in relation to dependent variable, so to limit the risk of reverse causality and of endogeneity in the model [83]. As referred to above, social capital is assumed to have a relation of ambiguous direction with the levels of inequality. That is why its lagged values were preferred, in order to exclude from the analysis the simultaneous effects inequality may have on social capital.

As regards regional production specialisations, these have been considered by means of the results of previous exploratory analysis of the European Cluster Observatory database[84]. Data about specialisations in clusters of related industries[85] were extracted in the form of Location Quotients[86]. Information about 41 clusters' categories[87] were reduced to two indicators by means of Principal Components Analysis (Parente, 2017). These synthesise the diversification and specialisation of the regional production structure in related clusters.

As regards regional inequalities, the main measure here used as proxy for multidimensional inequality is the percentage *loss in human development* due to the inequalities present in the society (Alkire, Foster, 2010; HDR, 2016). Matching OECD and Eurostat databases with EU-SILC survey and following Kovacevic (2010), it was calculated yearly in the time range 2000-2011 per 205 selected regions comparing the estimated Human Development Index (HDI) to its adjustment to *within-region* inequalities (Parente, forthcoming). Furthermore, a Gini and Atkinson indices were calculated for the income inequality distribution alone. Atkinson measures of inequality in the additional achievements covered by the

[78] The average country sample size is approximately 1900 (being 1500 for the EVS instead). In each country the sample is representative of resident citizens of 18 years and older living within private households, irrespective of nationality, citizenship or language.

[79] Many previous cross-section studies draw on the European Values Study (EVS, e.g. JRC, 2013; Boschma, 2016). The ESS was here preferred because of at least two reasons. It ensures more homogeneous territorial coverage on a closer time basis to match with other selected variables (the only EVS wave providing a regional coverage wider than ESS ones is that from 2008). Moreover, the construction of related questions in the survey allows to extract numeric instead of categorical variables. Where the ESS answer is a value ranging from zero to ten (whose the highest means that people can be trusted), the same question in the EVS has a response of yes/no nature. A more detailed description of the chosen questions and answers is provided in the Annex.

[80] A more detailed description of applied data treatment is provided in the Annex.

[81] The first one is from 2002 (ESS1), the last one of 2014 (ESS7), with a regular time delta of two years.

[82] Estimates with no time lag or 1-year delta were produced too.

[83] ESS1 for 2000-2004, ESS2 for 2005-2006, ESS3 for 2007-2008 and so on. The analysis was also run with contemporary or following years matching, and results did not differ significantly. The reason has been considered the nature of the variable itself, which needs a considerable length in time to produce any significant variation in values.

[84] Normalised in order to make their values range between zero and one, like others predictors.

[85] Based on the NACE Rev. 2 classification system, it combines industries from different production sections into groups that can therefore include both manufacturing and service industries related to a specific specialisation.

[86] More about LQ definition and interpretation, and other measures for cluster strength are provided in the Annex.

[87] A detailed definition of considered categories, and a list of which of 4-digit industries they are made up of, is available on the Observatory website.

multidimensional Loss in human development (i.e. education and health) were considered as well, both separately and along with their aggregated measure (i.e. the Coefficient of human inequality[88])

Finally, two additional variables were used to control for specific regional traits: the quality of institutions and the local geography to spatially characterise the regions. The first one, as captured by the European Quality of Governance Index (EQI) produced by the Quality of Government Institute (2013). Absent any related indicator at the considered regional level[89], the second one was included by means of the degree of urbanisation. The reason for this is the implicit amount of information that this variable communicates, related to urbanisation externalities[90] and agglomeration dynamics.

A first descriptive assessment of correlations between considered variables confirms the conclusions suggested by the literature. Social capital is negatively associated with inequality indices (significantly up to -61%) and positively with quality of government measures (around 65%). Differences emerge when considered with distinction between domains. The social networks component follows different patterns. Bridging relational ties are inversely associated with inequality (around 45% for the income one), while the bonding ones are always directly correlated instead. Interesting differences emerge for other predictors too.

Table 1. Correlation between separate social capital variables, inequality indices, and quality of government.

	Trust	Social Networks	Work, politic. parties	Work, other organ.	Loss in HD	HI coeff.	Atkins. Income	Gini Income	Clusters Diversif	Clusters Special.	QoG	Urban.
Trust	1											
Social Networks	0.39	1										
Work, pol parties	-0.10	0.02	1									
Work, other org.	0.34	0.59	0.37	1								
Loss in HD	-0.55	-0.37	0.13	-0.31	1							
Human Ineq. coeff.	-0.61	-0.40	0.13	-0.35	0.90	1						
Atkinson Income	-0.57	-0.48	0.11	-0.42	0.80	0.88	1					
Gini Income	-0.59	-0.51	0.10	-0.45	0.80	0.89	0.99	1				
Clusters Diversif.	-0.11	0.13	0.12	0.17	0.00	-0.02	-0.08	-0.07	1			
Clusters Special.	0.37	0.18	-0.08	0.20	-0.42	-0.46	-0.35	-0.37	0.00	1		
Quality of Gov.	0.65	0.36	-0.14	0.24	-0.50	-0.57	-0.57	-0.59	-0.11	0.37	1	
Urbanisation	0.16	-0.06	-0.10	-0.02	-0.01	0.00	0.04	0.02	-0.22	0.20	0.08	1

The applied methodology is a longitudinal analysis, where selected 205 NUTS2 regions were considered the panel entities. According to a stepwise approach by a forward selection, an OLS model has been specified first following the considerations presented in the introduction (Wooldridge, 2002).

Some hypotheses on the relations among selected predictors have been formulated and tested.

H1: the inverse relation, generally accepted by the literature, between income inequality and (many elements of) social capital can be extended to the case of a *multidimensional* measure of inequality.

[88] Defined as the simple arithmetic mean of the Atkinson measures estimated in the three distributions of achievements- in income, education and health (Alkire, Foster, 2010).

[89] Information about land use, infrastructure, and accessibility of regions would have been relevant for our scope as well, but they are discontinued in Eurostat's database and the EEA Corine Land Cover. Urbanisation is instead homogeneously available per each region in the considered span of time.

[90] Also said *Jacobs externalities* from the studies developed by the American urbanist Jane Jacobs (1969), these are related to the proximity of firms from *different* industries, and the knowledge spillovers promoting innovation and growth, which their variety facilitates. They differ from the classic MAR (Marshall, Arrow, Romer) externalities because these ones focus on the proximity of firms from *common* industries. Other relevant speculations in this regards have been produced, especially by Porter (1990) and more recently Boschma (i.e. the *related* variety; see Frenken et al., 2004). For a review see Gleaser et al. (1992).

H2: the relation tested by H1 may be boosted by higher levels of both diversification into industrial clusters and specialisation of clusters' business environment.

H3: institutional environment is relevant and good local governance can help reducing inequalities, e.g. by providing an equal setting of opportunities.

H4: degree of urbanisation, land use and infrastructures' asset can change the patterns, lowering or increasing inequalities depending on the level of inclusiveness and relatedness they can facilitate.

The effect of social capital on the estimated measure of multidimensional inequality has been considered first in the specification. Then, variables on production structure were added, and taken in their interaction with social capital. Subsequently, a variable controlling for institutional environment has been included. Degree of urbanisation was considered as the proxy for spatial characteristics. The final specification of the model is the following:

$$y_{i,t} = \alpha_0 + Sc_{i,t}\beta + Ps_{i,t}\gamma_{i,t} + (Sc_{i,t} * Ps_{i,t})\varphi + I_{i,t}\delta + G_{i,t}\vartheta + \varepsilon_{i,t} \qquad (1)$$

where *Sc* stands for the Social Capital pair of constructed indicators; *y* is the inequality here proximate by the estimated multidimensional index; *Ps* accounts for the diversification and specialisations in industrial clusters, quantified by means of the two principal components previously extracted; *I* stands for the quality of institutions and is measured by the EQI values; *G* stands for the geography summarised by the regional degree of urbanisation; and ε is the error term.

Control factors accounting for time and country-specific characteristics have been included too.

This specification was replicated by means of both fixed effects and generalised least square regression with random effects. This allowed to assess the validity of estimated coefficients, the consistency of the specified model, and to search for the most efficient estimates. The equation (1) in matrix form then becomes the following:

$$y_{i,t} = \boldsymbol{X}_{i,t}\beta + \alpha_i + u_{i,t} \qquad (2)$$

for FE, where $\boldsymbol{X}_{i,t}$ is the time-invariant $1 \times k$ regressor matrix, α_i is the unobserved time-invariant entity effect (i.e. the region-specific intercept) and $u_{i,t}$ is the error term.

$$y_{i,t} = \boldsymbol{X}_{i,t}\beta + a + u_{i,t} + \varepsilon_{i,t} \qquad (3)$$

for the RE, which adds the possibility to distinguish among the *between-entity* error $u_{i,t}$and *within-entity* error $\varepsilon_{i,t}$. It assumes that differences across regions are uncorrelated with the regressors.

A crucial distinction between fixed and random effects is whether the unobserved entity effect includes elements that are correlated with the regressors indeed (Greene, 2008). The first model is designed to study the causes of changes within a person or entity, hence it will account for variations *within*-regions. A time-invariant characteristic cannot cause such a change, because it is constant for each unit, and that is why it is omitted from the analysis (Kohler, Kreuter, 2009). Here this was the case of the Quality of Government index. This is one of the reasons why the random effects specification may be considered more appropriate here. Furthermore, it can be showed that the random effects specifications produce the more efficient estimators (Greene, 2000). Also, it allows to generalize the inferences beyond the sample used in the model.

Key issue with respect to model choice is therefore $E(u_{i,j}|x_{i,t}) = 0$, which can be checked using the Hausman specification test, comparing the coefficient vectors from two estimators[91] (Stock, Watson). It is therefore used to check for endogeneity, and in case of panel data analysis it is useful to detect which is better between random and fixed effect specifications. The null hypothesis being the absence of correlation,

[91] If they are both consistent, their point estimates should not differ greatly. If one of the estimators is inconsistent, its point estimates are likely to differ widely from those of a consistent one. The FE estimator is always consistent, but inefficient under the null hypothesis that $cov(x_{i,t}, a_i) = 0$. RE is both consistent and relatively efficient under that null hypothesis, but inconsistent under the alternative. The null hypothesis for the Hausman test is that RE is consistent and should be preferred. If we reject that null, RE is inappropriate and FE should be used instead.

fixed effects are therefore the best fit in case it is rejected. It has been thus performed on the models specified by the equations (2) and (3), and it failed to reject the null hypothesis[92].

Another fundamental assumption of the regressions model is that the error terms are normally distributed like $\varepsilon_{i,t} \sim N(0;\sigma)$. In this specific case though, distribution of residual cannot be normal because the dependent variable does not range on the entire real numbers' axis. Since the estimated measure of multidimensional inequality (i.e. the dependent variable in the model) is limited on the [0-1] interval by construction, so will be the distribution of errors. To account for this constraint, a further specification of the model was run in order to check for its consistency. A truncated regression, limited on the pertaining interval, was estimated. Significance of results did not change, and outputs are shown together with the previous specifications' ones in the following sections.

Finally, the risk of endogeneity has to be addressed. The level of inequality in a region may be thought to inversely affect trust or social network too. Hence due to these characteristics of the included variables, some additional specific tests were performed in order to check for this occurrence. Significant correlation of residuals to other predictors of the model, and their interactions, were both excluded[93]. Also omitted variables bias was checked by the total variance inflation factors, and gave negative results.

3. Results.

Besides the estimated measure of multidimensional inequality, the specified model presented in the previous section was run on several dependent variables in order to assess the consistency of the specification itself. The following table summarises these results, reporting the regression coefficients and related (robust) standard errors[94].

Table 2. Regressions estimates, on all dependent variables

	TRUNCreg	OLS (1)					
	Loss	**Loss**	**HI**	**GINI**	**ATK**	**ATKed**	**ATKhe**
Trust	-0.015***	-0.015***	-0.013***	-0.046***	-0.032***	-0.002*	-0.004*
Std. Err.	*0.004*	*0.004*	*0.003*	*0.011*	*0.008*	*0.004*	*0.003*
Cluster diversification	-0.023***	-0.023***	-0.022***	-0.073***	-0.055***	-0.009*	-0.002*
	0.007	*0.007*	*0.004*	*0.016*	*0.011*	*0.006*	*0.003*
Int.eff_Trust&clusters	0.033***	0.033***	0.029***	0.091***	0.071***	0.013*	0.005*
	0.011	*0.011*	*0.008*	*0.029*	*0.020*	*0.009*	*0.006*
Social Networks	-0.028***	-0.028***	-0.012**	-0.059**	-0.040**	0.000*	0.002*
	0.009	*0.009*	*0.006*	*0.024*	*0.017*	*0.011*	*0.006*
Cluster specialisation	-0.006***	-0.006***	-0.003**	-0.013***	-0.007*	-0.002*	0.000*
	0.002	*0.002*	*0.001*	*0.005*	*0.004*	*0.002*	*0.001*
Int.eff_SN&specialisation	0.047***	0.047***	0.032***	0.114***	0.090***	0.019*	-0.013*
	0.016	*0.016*	*0.011*	*0.040*	*0.029*	*0.017*	*0.011*
Quality of Government	-0.013***	-0.013***	-0.016***	-0.071***	-0.046***	0.003*	-0.004**
	0.002	*0.002*	*0.002*	*0.007*	*0.005*	*0.002*	*0.002*
Degree of urbanisation	0.001*	0.001*	0.001**	0.002*	0.002*	0.000*	0.002**
	0.001	*0.001*	*0.001*	*0.003*	*0.002*	*0.001*	*0.001*
R-squared	-	0.746	0.933	0.888	0.866	0.955	0.609
N. of obs.	2244	2244	2244	2244	2244	2244	2244

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

All coefficients are always significant[95], except for the degree of urbanisation. The variables seem to confirm the result of the exploratory analysis, showing the relevance of considered relations with the exception of the degree of urbanisation indeed. Results confirm major findings from the literature as well. The relation between social capital variables and inequality appears to be always an inverse one. Hypothesis of H1 comes

[92] Results are shown in the Annex.
[93] Results of bivariate regressions are reported in the Annex.
[94] To control for heteroskedasticity, and clustered per region.
[95] At 95% confidence interval.

to be significant, with the model allowing for the extension of main findings on the income inequality alone to the multidimensional one here used. It is confirmed for both the Loss in human development and the Human inequality coefficient indeed. A more relevant effect seems to be the one of social networks.

Looking at H2 about the production structure and clusters diversification, their coefficients report an inverse relation with inequality as well. When production specialisation occurs through clusters and innovative business environments, inequality reduces of two units. Diversification may be facilitated by better endowments of trust on one side. Higher levels of specialisation and more dynamic business environment may facilitate social capital's spill-overs through voluntary work and informal exchanges on the other side. In fact, considering the interaction effect between the two blocks of predictors, results say it is significant too. Recalling the model equation (1), the explicit form of the interaction effects becomes the following:

$$y_{i,t} = \alpha_0 + Sc_{i,t}\beta + Ps_{i,t}\gamma_{i,t} + (Sc_{i,t} * Ps_{i,t})\varphi + I_{i,t}\delta + G_{i,t}\vartheta + \varepsilon_{i,t} \qquad (4)$$

The presence of a significant interaction indicates that the effect of one predictor variable on the response variable is different at different values of the other predictor. If there was no interaction term, β would be interpreted as the unique effect of trust on inequality. While β is now interpreted so only when clusters diversification is equal to zero, and the effect of trust on inequality is now $(\beta + \varphi)$. Because of the interaction, the effect of having higher levels of trust is different if a region has more or less diversification of production structure into clusters of related industries[96]. γ is instead the effect of production diversification when trust is equal to zero. $(\gamma + \varphi)$ is different at every one of the infinite values of trust. The empirical relationship between production structure and inequality may be ambiguous then. Previous hypotheses assumed it to be dependent on the kind of social capital (bridging or bonding) related to the nature of the specialisation spillovers.

Results seem to support H3. Increase in the quality of local government may mean a decrease in the level of inequality. Outcome for H4 fails to be significant instead. Despite evidence of the fact that more highly densely populated areas usually embed higher levels of inequality (Glaeser et al., 2008), the regional scale of data may make it less effective in capturing the information of interest, because it misses the spatial concentration dynamics associated with it. To address this shortage, other two options where considered. First, degree urbanisation was included together with the interaction of a dummy variable about the presence of a capital city in the region or not. Second, it was replaced by an indicator for urban agglomeration dynamics constructed as the ratio between population of most populous city per each region and the total population within EU15. However, none of them produced better results.

Goodness of fit measured by R^2 is always over 0.60, and then meaning the amount of variance of inequality explained by selected predictors is significant enough[97].

[96] Another way of saying this is that the slopes of the regression lines between inequality and trust are different for the different categories of production clusters' structure. φ indicates how different those slopes are.

[97] Root MSE is close to zero.

Table 3. Random and Fixed Effects compared

	RE (3)			FE (2)		
	Loss	**HI**	**GINI**	**Loss**	**HI**	**GINI**
Trust	-0.015***	-0.010***	-0.029***	-0.012**	-0.009***	-0.023***
Std. Err.	*0.004*	*0.002*	*0.008*	*0.005*	*0.002*	*0.008*
Cluster diversification	-0.023***	-0.021***	-0.055***	-0.020***	-0.019***	-0.047***
	0.007	*0.004*	*0.010*	*0.007*	*0.003*	*0.010*
Int.eff_Trust&clusters	0.037***	0.031***	0.077***	0.036***	0.029***	0.065***
	0.011	*0.007*	*0.023*	*0.012*	*0.007*	*0.022*
Social Networks	-0.035***	-0.021***	-0.102***	-0.041***	-0.022***	-0.105***
	0.010	*0.006*	*0.019*	*0.011*	*0.006*	*0.019*
Cluster specialisation	-0.007***	-0.004***	-0.017***	-0.008***	-0.004***	-0.017***
	0.002	*0.001*	*0.003*	*0.002*	*0.001*	*0.003*
Int.eff_SN&specialisation	0.058***	0.050***	0.199***	0.070***	0.051***	0.203***
	0.016	*0.009*	*0.031*	*0.018*	*0.010*	*0.031*
Quality of Government	-0.013***	-0.016***	-0.072***	-	-	-
	0.002	*0.002*	*0.007*	-	-	-
Degree of urbanisation	0.002*	0.003***	0.009***	0.010***	0.008***	0.026***
	0.001	*0.001*	*0.003*	*0.003*	*0.001*	*0.005*
rho	0.120	0.570	0.605	0.768	0.970	0.955
N. of obs.	2244	2244	2244	2244	2244	2244

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

RE coefficients include both the *within*-region and *between*-region effects. In the case of social capital, it would mean that for each change of one unit of trust across years and between regions inequality would decrease of 1% on average per one percent more of people reporting a level of trust higher than the regional median value, and per three percent more of people working in voluntary organisations.

Table 4. RE and FE on Atkinson measures in single dimensions

	RE (3)			FE (2)		
	ATK	**ATKed**	**ATKhe**	**ATK**	**ATKed**	**ATKhe**
Trust	-0.024***	-0.006**	0.000*	-0.020***	-0.005**	-0.001*
Std. Err.	*0.006*	*0.003*	*0.001*	*0.006*	*0.003*	*0.001*
Cluster diversification	-0.048***	-0.014***	-0.002*	-0.042***	-0.013**	-0.003*
	0.008	*0.005*	*0.002*	*0.008*	*0.005*	*0.002*
Int.eff_Trust&clusters	0.068***	0.022**	0.006*	0.060***	0.020***	0.006*
	0.017	*0.008*	*0.003*	*0.017*	*0.008*	*0.003*
Social Networks	-0.073***	0.009*	-0.001*	-0.075***	0.010***	-0.001*
	0.014	*0.008*	*0.002*	*0.014*	*0.008*	*0.002*
Cluster specialisation	-0.013***	-0.002*	0.001**	-0.012***	-0.002***	0.001**
	0.002	*0.001*	*0.001*	*0.002*	*0.001*	*0.001*
Int.eff_SN&specialisation	0.146***	0.002*	0.004*	0.149***	-0.001*	0.004*
	0.023	*0.011*	*0.004*	*0.023*	*0.011*	*0.004*
Quality of Government	-0.045***	0.004*	-0.006***	-	-	-
	0.005	*0.002*	*0.002*	-	-	-
Degree of urbanisation	0.008***	0.002**	-0.001*	0.021***	0.005***	-0.003***
	0.002	*0.001*	*0.001*	*0.003*	*0.002*	*0.001*
rho	0.588	0.542	0.872	0.943	0.979	0.941
N. of obs.	2244	2244	2244	2244	2244	2244

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

In FE, the impact of social networks appears slightly increased and the one of trust reduced. Due to time invariant availability of data though, this model specification fails in accounting for quality of institutions.

Also, the errors u_i are here assumed to be correlated with the regressors, and the sd within their groups is always low while a very high intraclass correlation suggests wide disparities across panels.

Goodness of fit measured by F and Wald χ^2 tests accounting for coefficients in the model to be different from zero are always significant, meaning that the specification is relevant.

Based on all of this, the model specification under equation (1) can be considered significant, and according to performed statistical tests the RE one specified by equation (3) should be assumed the best fit.

Conclusions.

This paper focused on the interactions between social capital and production structure in their relation with regional inequality. Combining survey data with available regional databases for the EU15, it aimed at providing a panel data analysis of multidimensional inequalities based on the intuition that social capital is a fundamental factor determining its regional levels, along with the economic specialisation of regions.

Results confirm an inverse relation between inequality and social capital. At the same time they highlight the positive impact of production clusters on the regional environment. Findings suggest that the joint effect of predictors is ambiguous though, and may so be dependent on several elements related to selected variables. The initial intention was actually to distinguish between different kinds of social capital and their relation with different kinds of specialisation. H2 was originally formulated to account separately for: a) specialisations that foster *bonding* social capital and *low* interest in *space creation* associating with higher inequality (e.g. high-tech & knowledge intensive clusters ⇾ also due to their selective requirements in terms of employment); b) specialisations that foster *bridging social capital* and *high* interest in *space creation* relating to lower inequality (e.g. creative industries & knowledge creation clusters ⇾ thanks to engendered spill-overs in terms of social relations and cultural effects). Finally in this regards, it could be relevant the evidence provided by Glaeser et al. (2002) about the higher personal investments in social capital by individuals who are employed in more sociable occupations (e.g. knowledge intensive services). Impossibility to derive a significant indicator for separate levels of the variables, and a substantive lack of detailed data about organisations where unpaid work was conducted by surveyed people made it not possible in this exercise[98].

Besides the evident need for a more accuracy in the production of data about specialisations clusters and social capital data, the scale of analysis may have played a role in the understanding of considered dynamics too. Interactions associated to the kind of production specialisation, and evidence of the effects of social capital of individuals, are more tangible elements in a urban environment for sure. Also, the spatial effects of these phenomenon were lost within the wider regional level. Infrastructure accessibility and land use patterns would have provided a more solid basis to interpret the studied relations (Ganong, Shoag, 2017).

Although the mentioned limits, the analysis presented in this paper proves the possibility to profitably combine sectorial approaches to the study of regional inequalities, extending to multidimensional measure of socio-economic inequalities the findings generally accepted about the sole income one. Due to the questions it leaves unanswered, further research is needed of course. These results may be integrated by a qualitative analysis at a lower territorial level for instance, to match them with more punctual information covering sparse (or missing) dimensions. Also, to more effectively account for the territorial characteristics of analysed concepts and their dynamics, a spatial analysis in the form of a geographically weighted regression may provide additional insights (Fotheringham et al., 2002). Allowing the spatial variation of the coefficient across different regions, it would properly account for regional specific traits and dig more in depth into the relations among predictors at the local level. A viable attempt may be tested through the 2013 wave of EU-Silc. Per each respondent, it provides information on all the dimensions here measured at the regional level, including the level of trust. Without aggregating individual data into regional units, more direct relations between production sectors of employment, social capital endowments and inequality experienced may be inferred.

[98] The only ESS wave reporting such detail, distinguishing 10 sorts of voluntary organisations, is that from 2002.

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ANNEX.

ESS questions (§2)

Selected questions from the survey were the following:

Literal Question:A3. Using this card, generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?

Literal Question:A4. Using this card, do you think that most people would try to take advantage of you if they got the chance, or would they try to be fair?

Literal Question: A5. Would you say that most of the time people try to be helpful or that they are mostly looking out for themselves?

The answer to the A 3-5 were in the shape of a 0-10 scale, where 0 means you can't be too careful/ people will try to take advantage of you/ people are mostly looking out for themselves, and 10 means that most people can be trusted/ they try to be fair/ they try to be helpful.

Literal Question: B11-17. There are different ways of trying to improve things in [country] or help prevent things from going wrong. During the last 12 months, have you done any of the following? Have you ...

-worked in political party or action group last 12 months
-worked in another organisation or association last 12 months

The answer to B11-B17 gave the respondent the chance to confirm, deny, or refuse the question.

ESS answers and related data treatment (§2)

Among used variables, these items are the only ones coming from primary survey sources, in the form of microdata. In order to make them comparable with the rest of deployed regional database, some calculations were necessary. Data about the three items of trust were in the shape of cardinal variable. In order to transform them into continuous ones, the regional median of responses was calculated separately per each item per year. Number of people whose answer was equal to or higher than the identified threshold was divided by the total number of respondent per region. Obtained percentage values for each of the three items were aggregated by means of a simple arithmetic mean. This allowed to have unique averaged values of reported trust, fairness and helpfulness per each region.

Data about the two items of social relations were in the form of a yes/no answer. Number of people answering yes to the questions on voluntary unpaid work was divided by the total number of respondent per region. Obtained percentage values for each of the two items were aggregated by means of a simple arithmetic mean. Missing observations and refusals in the answers were excluded. A post-stratification weight including design weight has been applied (Weighting ESS Data, 2014).

Answers presented a total of 5% of missing data between ESS1 and ESS7. UK and DE were always available at NUTS1 level only. Therefore, NUTS2 regions were assumed to be equal to their overall NUTS1 reference. Where NUTS2 where available for some years only, like the case of FR and BE, their percentage incidence on the above NUTS1 was used to estimate NUTS2 from available NUTS1 in the missing years.

Location quotients and cluster strength (§2)

In order to get a sound understanding of knowledge- or capital- intensive cluster categories, it would be preferable the use of information on sector wage, productivity, or added value. Unfortunately, these statistics are still not available at length for the EU, so the categorisation currently available on the ECO is obtained by the use of employment data. While this characterisation can be useful to draw upon, it has to be borne in mind that it can even create a certain bias towards employment-intensive clusters. Only the measure for specialisation obtained by LQs is unaffected by differences of employment intensity across cluster categories. LQs are calculated by means of the following equation:

$$\frac{Employed\ in\ sector\ within\ Region \Big/ Tot.\ Employed\ within\ Region}{Employed\ in\ sector\ within\ Country \Big/ Tot.\ Employed\ within\ Country}$$

Obtained results have been interpreted as follows:

- LQ=0 : the sector is not present in the considered region
- •0< LQ <= 1 : the region, compared to country, is not specialised in the sector
- • LQ = 1 : the sector is present as in the same amount in the region as in the country

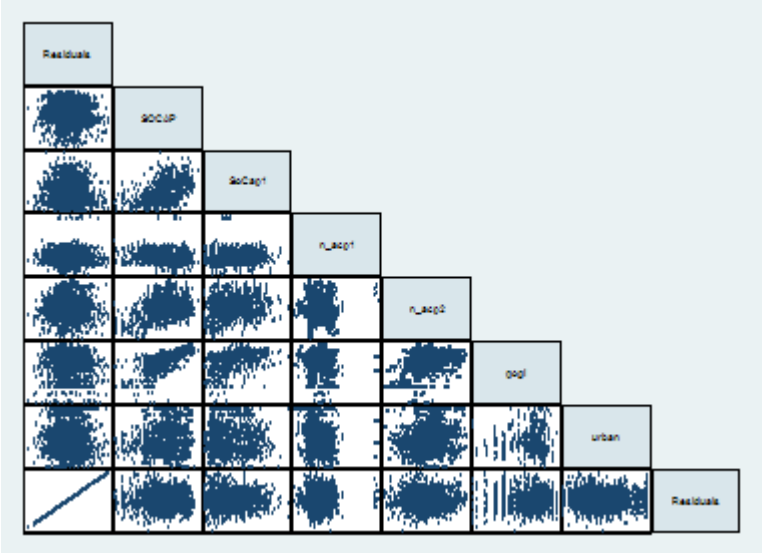
- •1< LQ <= 2 : the region, compared to country, is specialised in the sector
- •2< LQ <=10 : the region, compared to country, is highly specialised in the sector

Results of endogeneity tests (§2)

Table 4. Truncated Regression Residuals regressed on Predictors

	Trust	Social Networks	Cluster diversification	Cluster specialisation	Quality of Government	Degree of urbanisation
Coeff.	3.39E-11	7.36E-11	1.94E-11	4.74E-11	2.96E-11	2.64E-11
St. Errors	*0.00088*	*0.00226*	*0.00120*	*0.00076*	*0.00077*	*0.00054*
R-squared	0	0	0	0	0	0
N. of obs.	2244	2244	2244	2244	2244	2244

Results of graphic analyses of OLS residuals (§2)



Summary of used variables

Table 6. Descriptive statistics

Variable	Source	Obs.	Mean	Std. Dev.	Min	Max
Loss in Human Development	own elaboration on Eurostat	2460	0.0536512	0.0118929	0.0236553	0.1043195
Human Inequality Coefficient	own elaboration on Eurostat	2460	0.0529438	0.0103841	0.0352967	0.0822167
GINI Index	own elaboration on Eurostat	2460	0.23146	0.0311632	0.16176	0.31326
Atkinson on Income	own elaboration on Eurostat	2460	0.0865701	0.0200392	0.04784	0.14611
Atkinson on Education	own elaboration on Eurostat	2460	0.0569192	0.0169023	0.02916	0.10241
Atkinson on Health	own elaboration on Eurostat	2460	0.0153422	0.0040907	0.0067	0.03552
Trust	ESS survey	2460	0.5836829	0.1456369	0.08	0.92
Social Networks	ESS survey	2460	0.1004959	0.0571756	0	0.31
Cluster Diversification	own elaboration on ECO	2460	0.2931633	0.1065506	0	1
Cluster Specialisation	own elaboration on ECO	2460	0.5315893	0.1682114	-1.83E-08	1
Quality of Government	EQI	2255	0.7205366	0.1649555	0.09	1
Degree of urbanisation	Eurostat and ECO	2448	0.4726225	0.2384658	0	1

Comparing Fixed and Random Effects (§2)

Table 5. Results of Hausman test, FE RE

	FE (b)	RE (B)	Difference (b-B)	S.E. sqrt(diag(V_b-V_B))
Trust	-0.0121091	-0.0145196	0.0024106	0.0017158
Cluster diversification	-0.02043	-0.0234656	0.0030356	0.002261
Int.eff_Trust&clusters	0.0364226	0.0374755	-0.0010529	0.0039094
Social Networks	-0.0408051	-0.0345927	-0.0062124	0.0035404
Cluster specialisation	-0.0078639	-0.0071242	-0.0007397	0.000764
Int.eff_SN&specialisation	0.0697965	0.0584637	0.0113328	0.0064247
Degree of urbanisation	0.0098137	0.0016467	0.008167	0.0030884
2001bn.year	*0.0010325*	*0.0010697*	*-0.0000372*	.
2002.year	*0.0010069*	*0.0010861*	*-0.0000791*	.
2003.year	*0.0001047*	*0.0002507*	*-0.000146*	*0.0000213*
2004.year	*-0.0004465*	*-0.000328*	*-0.0001186*	.
2005.year	*-0.0020784*	*-0.001918*	*-0.0001605*	*0.0000288*
2006.year	*-0.0017887*	*-0.001551*	*-0.0002377*	*0.0000649*
2007.year	*-0.003183*	*-0.0029579*	*-0.0002252*	*0.0000592*
2008.year	*-0.003885*	*-0.0034998*	*-0.0003852*	*0.0001247*
2009.year	*-0.004*	*-0.0041943*	*0.000*	*0.0000563*
2010.year	*-0.0050927*	*-0.0048925*	*-0.0002002*	*0.0000662*

b=consistent under Ho and Ha; obtained from xtreg

B= inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(17) = (b-B)'[(V_b-V_B)^(-1)](b-B)= 18.71

Prob>chi2 = 0.3456

(V_b-V_B is not positive definite)