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EU Regional Competitiveness Index 2010

Paola Annoni and Kornelia Kozovska

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EU REGIONAL COMPETITIVENESS INDEX

RCI 2010

Paola Annoni and Kornelia Kozovska

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Any inaccuracies of fact or faults in reasoning are our own and accordingly we take full responsibility.

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EXECUTIVE SUMMARY

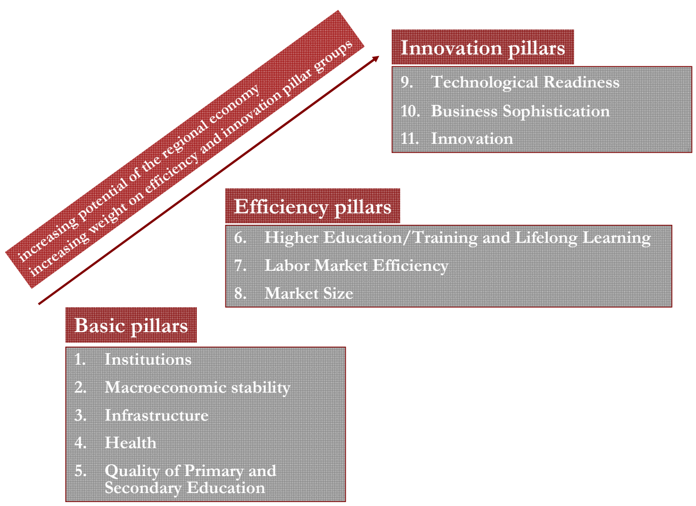
The concept of competitiveness has in the last decades extended from the micro-level of firms to the macro-level of countries. Between the two levels stands the concept of regional competitiveness which is the focus of the **"EU Regional Competitiveness Index",** RCI hereafter, a joint project between DG Joint Research Centre and DG Regional Policy.

The final goal is measuring the competitiveness of European regions at the NUTS2 level by developing a composite index. But, why measuring regional competitiveness is so important? Because "*if you can not measure it, you can not improve it*" (Lord Kelvin). A quantitative score of competitiveness will facilitate Member States in identifying possible regional weaknesses together with factors mainly driving these weaknesses. This in turn will assist regions in the catching up process.

The study starts from the review of the latest literature contributions to the concept of 'regional competitiveness' and of some well-known existing competitiveness indices at country and regional level (NUTS1 and NUTS2). At the country level, the Global Competitiveness Index by the World Economic Forum, and the World Competitiveness Yearbook by the Institute for Management Development (IMD) are presented. At the regional NUTS1 level, the European Competitiveness Index by the University of Wales Institute is discussed. A simpler but more detailed geographical description of competitiveness is offered by the 'Altas of Regional Competitiveness' (Eurochambers),, reflecting the international recognition of the importance of analysis at the regional NUTS2 level. Specific examples of competitiveness measures at the regional level in some European countries are also discussed.

The WEF Global Competitiveness Index – GCI – has been the main reference framework for the construction of the RCI. This choice has been driven by the fact that GCI is the most internationally recognized and acclaimed index in the field of competitiveness and its framework covers a very comprehensive set of aspects relevant to competitiveness. There are, however, some key differences that distinguish the RCI from GCI due to the RCI European and regional dimension.

Eleven pillars are included in the RCI with the objective of describing different dimensions of the level of competitiveness. The pillars are designed to capture short- as well as long-term capabilities of the region. They are classified into three major groups: the pillars Institutions, Macro-economic stability, Infrastructure, Health and Quality of Primary & Secondary Education are included in the first group and represent the key basic drivers of all types of economies. As the regional economy develops, other factors enter into play for its advancement in competitiveness and are grouped in the second group of pillars – Higher Education/ Training and Lifelong Learning, Labor Market Efficiency and Market Size. At the most advanced stage of development of a regional economy, key drivers for regional improvement are factors related to Technological Readiness, Business Sophistication and Innovation, included in the third group.



RCI general framework

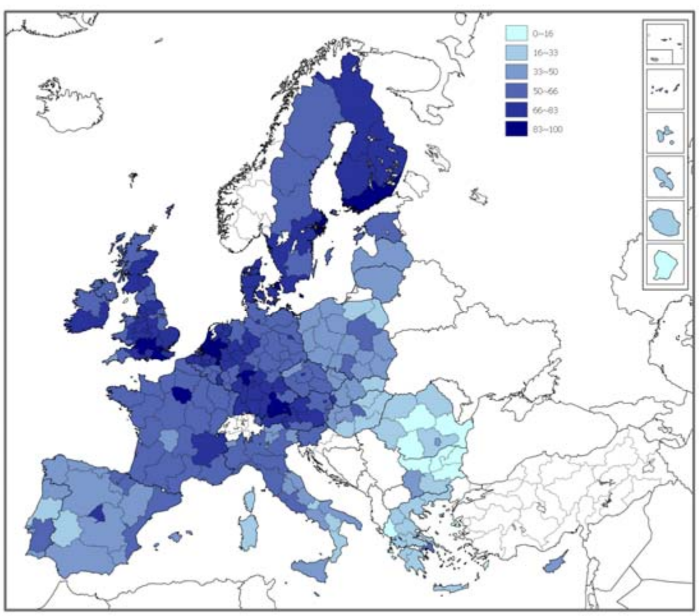
The set of indicators which populate each pillar is carefully chosen according to the literature review, experts' opinion and data availability. The major data source is Eurostat with some additional official sources - OECD-PISA, OECD Regional Patent database, European Cluster Observatory, World Bank Governance Indicators and Ease of Doing Business Index - where appropriate data was not directly available from Eurostat.

Most recent data have been used for all indicators, with a temporal range for most indicators between 2007 and 2009.

A detailed statistical analysis is carried out separately for each pillar with the aim of assessing the consistency of the proposed framework both at the level of indicators and of pillars. The analysis is twofold: a univariate analysis indicator by indicator and a multivariate analysis on each pillar as a whole. The former allows for detecting possible problems with: i) missing data; ii) distribution asymmetry and outliers and iii) different measurement scales. These problems are addressed by adopting: i) specific imputation methods; ii) power-type transformations to correct for skeweness; iii) standardization. The multivariate analysis is carried out at the pillar level on the set of indicators as a whole. The aim is to assess their contribution in describing the latent dimension behind each pillar. 'Anomalous' indicators are in some cases detected and excluded from further analysis.

The final RCI is composed of a total number of 69 indicators, chosen by a starting set of 81 candidate indicators. The statistical analysis showed as most consistent pillars Institutions, Quality of Primary and Secondary Education, Labor Market Efficiency, Market Size and Innovation.

The key driver for the computation of the RCI has been to keep it simple, to be easily understood by non-statisticians, and at the same time robust and consistent. For each pillar, RCI sub-scores are computed as a simple average of the transformed/normalized indicators. Scores at the pillar group level (sub-indexes) are computed as an average of the corresponding sub-scores. The overall RCI score is the result of a weighted aggregation of the three sub-indexes. For the final aggregation we follow the approach that the World Economic Forum adopts for the GCI with the aim of taking into account the level of heterogeneity of European regions, especially after the 2004 and 2007 enlargements. The set of weights adopted for aggregating the sub-indexes depend on the level of development of the regions, classified into medium, intermediate and high stage on the basis of their GDP value. Regions in the medium stage are assigned more weight to the basic and efficiency pillars in comparison to the innovation pillars. The level of competitiveness of more developed economies, on the

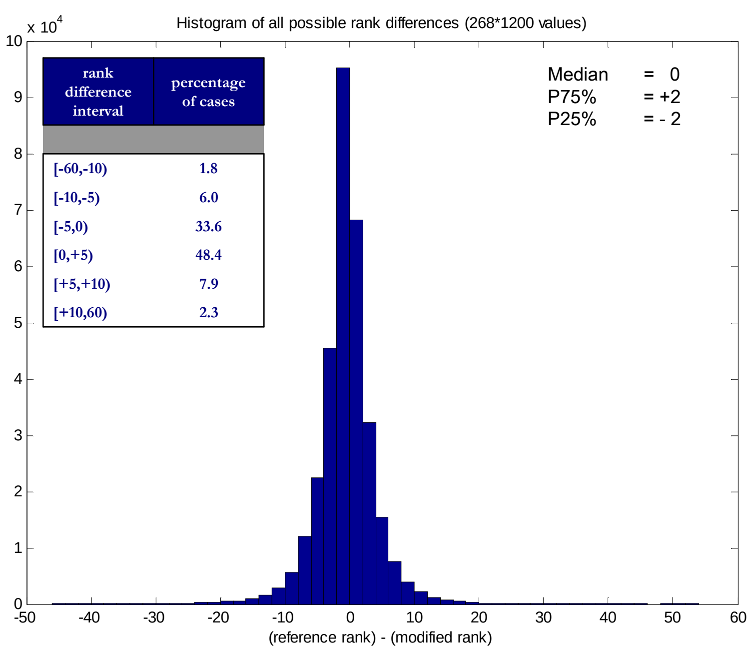


Geographical distribution of RCI score

other hand, takes into account to a larger extent their innovation capability as a key driver for their advancement. The weighting scheme of pillar groups has the effect of not penalizing regions on factors where they lay too far behind. The RCI message is then more constructive: the index provides a measure of competitiveness which allows for fair comparison of European regions and highlights realistic areas of improvement. The final RCI shows a heterogeneous situation across EU regions with Eastern and Southern European regions showing lower performance while more competitive regions are observed in Northern Europe and parts of Continental Europe.

As for almost every composite indicator, the procedure followed for the setting up of the RCI is affected by a certain degree of subjectivity. A full robustness analysis is then performed to check the sensitivity of the index with respect to these choices. The variation in score and ranks of the regional RCI is assessed on the basis of the following scenarios:

- Different sets of weights chosen by random selection within a selected range of variation plus different GDP levels for the classification of the region's development stage;
- Different composition of the index by discarding one dimension (pillar) at a time to verify whether the pillar contribution to the RCI framework is well balanced;
- Different types of aggregation based on fully or non-compensatory operators (Ordered Weighted Operators).



RCI robustness analysis

A Monte-Carlo type analysis is carried out for a total number of 1200 different simulations. Overall, the distribution of the shift in rank for all the simulations and all the regions clearly shows a pick around zero. A closer look at the distribution highlights that in more than 80% of the cases the shift in rank is at most of 5 positions. The RCI index proves to be rather robust with only a very small fraction of regions with 'volatile' rankings.

The analysis of the impact of each pillar on the final score shows that the most influential pillars are Higher Education/Training and Lifelong Learning, Labor Market Efficiency and Market Size. This is in line with the fact that these three pillars are assigned, on average across the three development stages, the highest weights.

RCI represents the first measure of the level of competitiveness at the regional level covering all EU countries. It takes into account both social and economic aspects, including the factors which describe the short and long term potential of the economy. A statistical analysis has been used to support and, in some cases, to correct the ideal framework of the index, which is characterized by a simple and, at the same time, multifaceted structure. A series of tests have been used to 'stress' the index, which proved to be rather consistent with respect to a set of key (at least to our judgment) sources of subjectivity and uncertainty. The RCI provides a synthetic picture of the level of competitiveness of Europe at the NUTS2 level representing, at the same time, a well balanced plurality of different fundamental aspects.

1 Defining regional competitiveness

The concept of 'competitiveness' has been largely discussed over the last decades. A broad notion of competitiveness refers to the inclination and skills to compete, to win and retain position in the market, increasing market share and profitability, thus, being commercially successful (Filó, 2007).

An important aspect is the level at which the concept of competitiveness is defined; in most cases the micro and macroeconomic level are considered, which are strictly interrelated. The former is relatively clearly defined and is based on the capacity of firms to compete, grow and be profitable (Martin et al., 2006). The latter is, instead, subject to debate and is generally viewed and measured at the country level. One of the most important definitions of macroeconomic competitiveness is given by the World Economic Forum which states that competitiveness is the "set of institutions, policies and factors that determine the level of productivity of a country" (Schwab and Porter, 2007). The link between the two levels is straightforward: a stable context at the macro level improves the opportunity to produce wealth but does not create wealth by itself. Wealth is created by utilizing at best human, capital and natural resources to produce goods and services, i.e. 'productivity'. But productivity depends on the microeconomic capability of the economy which ultimately resides in the quality and efficiency of the firms (Schwab and Porter, 2007).

Despite the strict linkage between micro (firm) and macro (country) competitiveness, much criticism to the notion of national competitiveness has been raised, mainly due to the existence of an analogy between firms and nations. This is in contrast to the fact that: a) an unsuccessful firm will be expunged from the business whilst this cannot be the case for an underperforming nation; b) the competition among firms is a zero-sum game where the success of one firm destroys opportunities of the others whilst the success of one country may be of benefit for the others (Krugman, 1996). Many authors, with Krugman (1996) and Porter (Porter and Ketels, 2003) among others, agree on the definition of competitiveness as productivity, which is measured by the value of goods and services produced by a nation per unit of human, capital and natural resources. They see as the main goal of a nation the production of high and raising standard of living for its citizens which depends essentially on the productivity with which a nation's resources are employed.

Between the two levels of competitiveness stands the concept of regional competitiveness which has gained more and more attention in recent years, mostly due to the increased attention given to regions as key in the organization and governance of economic growth and the creation of wealth. An important example is the special issue of *Regional Studies* 38(9), published in 2004, fully devoted to the concept of competitiveness of regions. Regional competitiveness is not only an issue of academic interest but of increasing policy deliberation and action. This is reflected in the interest devoted in the recent years by the European Commission to define and evaluate competitiveness of European regions, an objective closely related to the realization of the Lisbon Strategy on Growth and Jobs.

Regional competitiveness cannot be regarded as neither macroeconomic nor microeconomic concept. A region is neither a simple aggregation of firms nor a scaled version of nations (Gardiner et al., 2004) and the meso-level it characterizes is to de duly described. Hence, competitiveness is not simply resulting from a stable macroeconomic framework or entrepreneurship on the micro-level. New patterns of competition are recognizable, especially at regional level: for example, geographical concentrations of linked industries, like clusters, are of increasing importance and the availability of knowledge and technology based tools show high variability within countries. An interesting broad definition of regional competitiveness is the one reported by Meyer-Stamer (2008, pg. 7):

> *"We can define (systemic) competitiveness of a territory as the ability of a locality or region to generate high and rising incomes and improve livelihoods of the people living there."*

This definition focuses on the close link between regional competitiveness and regional prosperity, characterizing competitive regions not only by output-related terms such as productivity but also by overall economic performance such as sustained or improved level of comparative prosperity (Bristow, 2005). Huggins (2003) underlines, in fact, that "true local and regional competitiveness occurs only when sustainable growth is achieved at labour rates that enhance overall standards of living."

The complexity of competitiveness was interestingly decomposed by Esser et al. (1995) into four analytical levels as shown in Fig. 1.1 where different types of determinants drive competitiveness. Apart from the meta level, which regards basic orientations of a society and other 'slow' variables that are not of primary interest here, the micro- meso- and macro-levels of competitiveness are clearly described. The meso-level is between the macro- and micro-level and aims at designing specific environment for enterprises. At this level it is highly important that physical infrastructure (such as transport, communication and power distribution systems) and sector policies (such as those regarding education and R&D policies) are oriented towards competitiveness.

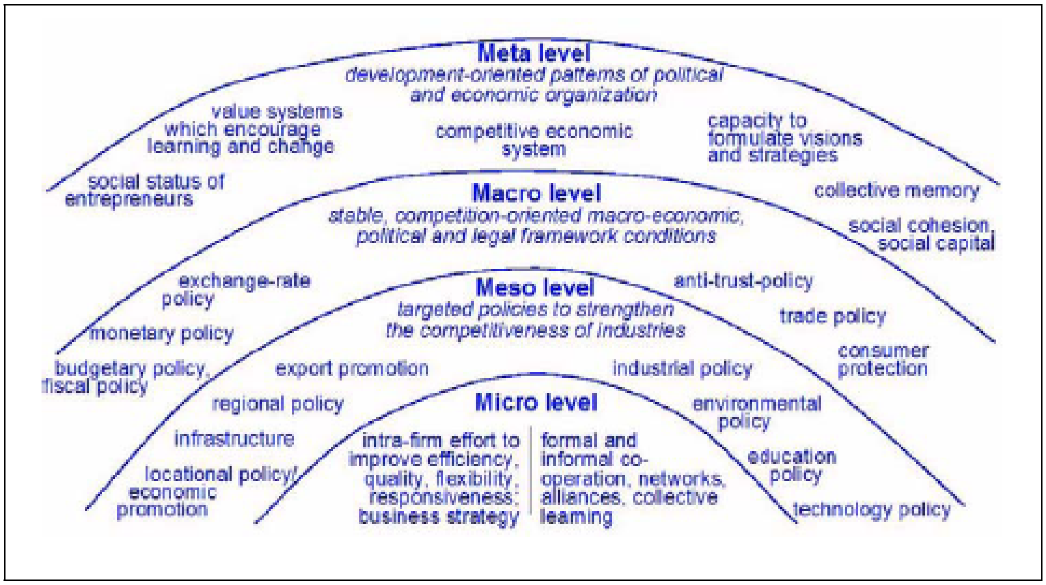


Figure 1-1: Determinants of competitiveness at different levels (from Meyer-Stamer, 2008; pag. 3)

As stated in the *Sixth Periodic Report on the Region* (DG Regional Policy, 1999), the challenge is to capture into a competitiveness index the notion that every region has common features which affect and drive the competitiveness of all the firms located there, even if the variability of competitiveness level of the firms within the region may be very high. These features should describe physical and social infrastructure, the skills of the work force and the efficiency and fairness of the institutions.

The final goal of the present contribution is to develop a competitiveness index for EU NUTS 2 regions which captures all these aspects and describes in synergy the complex nature of economic and social development.

In the following section a review of recent competitiveness indices both at national and regional level is due.

2 Literature review

As discussed in the previous section, the complexity in defining competitiveness leads to difficulties in its measurement. Nevertheless, there are examples of well-established studies which apply specific methods for the measurement of the level of competitiveness at national and, more recently, at regional level.

In the following section a brief discussion of selected studies on the theme is provided.

At the country level, the Global Competitiveness Index, prepared by the World Economic Forum (Schwab and Porter, 2007), and the World Competitiveness Yearbook by the Institute for Management Development (IMD, 2008) are by far the most influential and best known indices.

With regards to regional competitiveness, the European Competitiveness Index, computed by the University of Wales Institute, for European regions at the NUTS1 level is discussed (Huggins and Davies, 2006). A simpler but more detailed geographical description of competitiveness is addressed in the very recent 'Altas of Regional Competitiveness' presented in 2007 by the Association of European Chambers of Commerce and Industry (EUROCHAMBERS, 2007), which reflects the international recognition of the importance of analysis at the regional NUTS 2 level. Finally, specific examples of measurement of regional competitiveness in some European countries are given.

2.1 The Global Competitiveness Index – World Economic Forum

One of the most known competitiveness indices is the Global Competitiveness Index (GCI), published yearly by the World Economic Forum – WEF (Schwab and Porter, 2007). It covers a large amount of countries, a total of 131 economies in 2007, and is based on over 100 indicators which describe 12 major pillars of competitiveness.

The GCI is intended to measure competitiveness at the national level, taking into account both micro- and macroeconomic foundations of competitiveness. The following definition of competitiveness is the starting point of the WEF index:

"*Competitiveness (is) the set of institutions, policies and factors that determine the level of productivity of a country. The level of productivity, in turn, sets sustainable level of prosperity that can be earned by an economy*".

The notion of competitiveness implicit in the GCI is, therefore, a mixture of static and dynamic factors including the concept of a country's potential: high levels of current productivity lead to high levels of income and high levels of returns to investment which, in turn, are one of the major determinants of growth potential. This is why a more competitive economy is likely to grow faster over the medium-long run.

Different dimensions described

To describe the complex notion of competitiveness, the World Economic Forum analyses twelve major pillars (dimensions in statistical terminology) briefly described here.

1. *Institution*

   Private individuals, firms and governments interact with each other in an environment created by both private and public institutions. The Institution pillar aims at describing the legal framework, level of bureaucracy, regulation, corruption, fairness in handling public contracts, transparency, political (in)dependence of the judiciary system. The private sector is also represented as private counterpart of the health of an economy.

2. *Infrastructure*

   High quality infrastructure is obviously critical for efficient functioning of the economy. The pillar describes roads, railroads, ports and air transport as well as the quality of power supply and telecommunications.

3. *Macro-economy*

   It describes the macroeconomic stability with variables such as government surplus/deficit and debt, saving rate, inflation and interest rate spread.

4. *Health and primary education*

   Health of workforce and basic education received by the population are clearly key aspects of a productive and efficient economy. This pillar aims to measure the incidence of major invalidating illnesses, infant mortality, life expectancy and the quality of primary education.

5. *Higher education and training*

If basic education is the starting point of a ductile and efficient workforce, higher education and continuous training are crucial for economies not restricted to basic process and products. This pillar describes secondary and tertiary education together with the extent of staff training.

6. *Goods market efficiency*

The ideal environment for the exchange of goods is the one which features the minimum of impediments to business activity through government intervention. The three main aspects described by the pillar are: distortions, competition and market efficiency.

7. *Labour market efficiency*

This pillar measures efficiency and flexibility of the labour market, as well as the equity in the business environment between women and men.

8. *Financial market sophistication*

A well-functioning financial sector provides the right framework for business growth and private sector investments. It mainly describes the sophistication of financial market, the easiness for accessing loans, the strength of investor protection and other similar variables.

9. *Technological readiness*

A regulatory framework which is friendly to Information and Communication Technology (ICT) together with ICT penetration rates are of key importance for the overall competitiveness of a nation. Representative variables describing this dimension are for instance internet and mobile telephone subscribers, personal computers, availability of latest technologies and laws relating to ICT.

10. Market size

The size of the market determines at which level firms may exploit economies of scale. Firms which operate in large markets have more possibility of exploiting scale economies. Both domestic and foreign markets are taken into account in order to avoid discrimination against geographic areas.

11. Business sophistication

This pillar concerns the quality of the business networks of the country and the quality of individual firms' operations and strategies. These aspects are measured using variables on the quality and quantity of local suppliers, the marketing extent and the production of sophisticated unique products.

12. Innovation

The pillar refers to technological innovation which, similar to the technological readiness pillar, is a dynamic factor of competitiveness. This pillar is particularly important for more advanced countries which have already reached a higher stage of development. Such countries cannot improve their productivity by 'simply' adopting existing technologies but must invent innovative products and processes to maintain and improve their productivity level.

The 12 pillars taken into account are described by a variety of observable qualitative and/or quantitative variables (indicators). Each pillar is described from a minimum of 2 variables (Market size) to a maximum of 18 variables (Institutions). See Table A.1 in Appendix A for the complete list.

Data sources

Indicators used for GCI come from two basic data sources called *survey* data and *hard* data.

The survey data are drawn from a survey, specifically designed by the World Economic Forum, called Executive Opinion Survey. The survey is completed yearly by over 11,000 top management business executives and gathers qualitative data in order to capture information on a wide range of variables for which sources are scarce or inexistent. With this survey the WEF aims at collecting information not covered by quantitative data provided by official public sources.

Hard data are composed of (quantitative) indicators, such as GDP, number of personal computers or life expectancy, coming from a variety of sources. Examples of data sources are international organizations, such as the International Monetary Fund, the World Bank, United Nations agencies, the International Telecommunication Union, and, when necessary, other sources at national level.

The role of a country's stage of development

The first step of the aggregating technique for the development of the GCI consists in the definition of the development stage of a country. In fact, different pillars affect different countries in different ways. Three major stages of development are defined.

1. Factor-driven economy

At the lower stage of development the economy is called *factor*-driven and is mainly driven by unskilled labour and natural resources. The first four pillars (Institutions, Infrastructure, Macroeconomic stability, and Health and Primary Education) are the ones which can affect the productivity level at this stage and are thus, included in the factor group.

2. Efficiency-driven economy

As countries move along the development path, wages tend to increase and countries can be classified as *efficiency*-driven. Aspects related to higher education, well-functioning labour markets, large domestic and foreign markets come into play. Pillars from 5^{th} to 10^{th} are included in the efficiency group (Higher education and Training, Goods market efficiency, Labor market efficiency, Financial market sophistication, Technological readiness, Market Size).

3. Innovation-driven economy

At the highest level of development countries are defined as *innovation*-driven. They are able to sustain higher wages only if their businesses are able to exploit the innovation capability of the workforce, developing new products using sophisticated processes. The last two pillars belong to the innovation group (Business sophistication and Innovation).

To take into account the different role various pillars play in the competitiveness definition, GCI developers introduce a weighting scheme for the three sub-indices critical to a particular stage of development.

The stage of development of a country is defined on the basis of two criteria: 1. the level of GDP per capita at market exchange rates; 2. the share of exports of primary goods with respect to total exports of goods and services. The first criterion aims at approximating the wage level of a country, which is not always available worldwide. The second criterion is used to define a threshold: countries which export more than 70% of primary products are defined to be factor-driven.

Table 1 reports the different weights which are assigned to the three pillar groups (factor, efficiency and innovation groups) and consequently to the countries belonging to each of the different stages of development. Reading the table column by column it is evident that in factor-driven economies basic pillars are assigned the highest weight (60%), while weights decrease for intermediate and innovation pillars. In countries with efficiency-driven economy, basic and intermediate pillars weight almost equally (40% and 50 %, respectively) with innovation pillars weighting 10%. Finally, more innovative economies are assigned the lowest weight to basic pillars (20%) and weights of 50% and 30% to intermediate and innovative pillars.

Table 1: Different weights given to the three pillar groups in countries at different development stages

Pillar group (sub-index)	Pillars included in the group	Weight for 1st stage %	Weight for 2nd stage %	Weight for 3rd stage %
Factor-driven (basic)	1 – 4	60	40	20
Efficiency-driven (intermediate)	5 – 10	35	50	50
Innovation-driven (innovative)	11 – 12	5	10	30

The final index is also tested for sensitivity to different weighting schemes. In short, for each country *i* the GCI is firstly computed using the weighting scheme of Table 1 (GCI_i), then it is computed using more than one million different weighting schemes with weights α_1, α_2 and $\alpha_3 = 1 - \alpha_1 - \alpha_2$; $\alpha_1, \alpha_2 \in (0,1)$. The steps of the sensitivity analysis are:

1. randomly choose $\alpha_1, \alpha_2 \in (0,1)$;

2. for each country *i*, compute the GCI for the particular (random) weighting scheme in step 1, $GCI_{\alpha,i} = GCI_i(\alpha_1, \alpha_2, 1\text{-}\alpha_1\text{-}\alpha_2)$;
3. regress GCI_i on $GCI_{\alpha,i}$ and store the regression goodness of fit R^2;
4. repeat steps 1-3 (in the specific case over one million of regressions are computed).

For the 2007 GCI, the analysis shows that the index is not very sensitive to the actual numbers used for weighting the three super-pillars.

In addition to the differential weighting procedure, GCI authors adopt a *moving average* technique with the aim of improving robustness of the data. For each indicator the weighted average of the country average response in 2007 and 2006 is computed. This should improve the stability of responses and reduce the impact of random variations in the sample. For details, see the following section.

The definition of different development stages is a very interesting approach which will also be adopted for the setting-up of the EU Regional Competitiveness Index, as will be illustrated in Sect. 3.12.

Computation of GCI

Each indicator q_i is rescaled on a 1-7 scale[1]. Let *c* denote the country, while T_1 and T_2 denote the two years of interest (T_1=2006, T_2=2007). Then for country *c* each indicator is computed as:

$$q_{i,c}^{T_1T_2} = w_c^{T_1} \times \overline{q}_{i,c}^{T_1} + w_c^{T_2} \times \overline{q}_{i,c}^{T_2}$$

where

$$\overline{q}_{i,c}^{T_j} = \frac{1}{N_c^{T_j}} \sum_{k=1}^{N_c^{T_j}} q_{k,i,c}^{T_j} \qquad j = 1,2$$

$N_c^{T_j}$ = sample size in country c at time T_j

$q_{k,i,c}^{T_j}$ = response of unit k for indicator i in country c

[1] Qualitative indicators from the Executive Opinion Survey are treated as quantitative as such.

If the indicator value is the same for the whole country (as for indicators from hard data) there is no need to compute the country average $\overline{q}_{i,c}^{T_j}$.

Weights $w_c^{T_2}$ and $w_c^{T_2}$ are defined according to a certain criterion which will not be detailed here (for further details see Schwab and Porter, 2007, pg. 96).

Let $\overline{q}_c^{m}$ be the average value for $q_c^{T_1T_2}$ computed for all the indicators describing pillar *m* (*m*=1... 12).[2] Each pillar is then grouped into macro-pillars according to the development stage of the country as previously described. Macro-indicators for basic-, efficiency and innovation-driven economy are then computed as:

$$Q_c^{\text{basic}} = \frac{1}{4}\sum_{m=1}^{4} \overline{q}_c^{m}$$

$$Q_c^{\text{efficiency}} = \frac{1}{6}\sum_{m=5}^{10} \overline{q}_c^{m}$$

$$Q_c^{\text{innovation}} = \frac{1}{2}\sum_{m=11}^{12} \overline{q}_c^{m}$$

The final score is computed as the weighted average of Q_c^{basic}, $Q_c^{\text{efficiency}}$ and $Q_c^{\text{innovation}}$ with weights depending on the development stage of the country according to Table 1.

2.2 World Competitiveness Yearbook – Institute for Management Development

The World Competitiveness Yearbook (WCY) is an annual report on the competitiveness of countries, published since 1989 by the Institute for Management Development (IMD), a not-for-profit foundation located in Switzerland (IMD, 2008). It analyses and ranks the ability of countries to create and maintain an environment which sustains the

[2] The Global Competitiveness Report does not detail the computation of the average score within each pillar. It was deduced from the context that simple means are computed from (1-7) scaled indicators which describe the pillar.

competitiveness of enterprises. The 2008 report covers 55 countries, chosen on the basis of their impact on the global economy and the availability of comparable international statistics.

The WCY identifies four main competitiveness pillars (factors): economic performance, government efficiency, business efficiency and infrastructure. Each of these pillars is broken down into five sub-pillars (sub-factors) which describe different facets of competitiveness, for a total of 20 sub-pillars.

In the following section each pillar is discussed.

Different dimensions described

The four competitiveness pillars identified by the WCY are:

1. *Economic performance*
2. *Government efficiency*
3. *Business efficiency*
4. *Infrastructure*

The *Economic Performance* pillar is comprised of 80 variables (criteria) and describes the macroeconomic evaluation of the domestic economy. In particular, it focuses on the following sub-pillars: domestic economy, international trade, international investment, employment, prices.

The *Government Efficiency* pillar is comprised of 73 variables and describes the extent to which government polices are conducive to competitiveness. Its sub-pillars are public finance, fiscal policy, institutional framework, business legislation, societal framework.

The *Business Efficiency* competitiveness pillar is comprised of 70 variables and describes the extent to which the national environment encourages enterprises to perform in an innovative, profitable and responsible manner. Its sub-pillars are productivity, labor market, finance, management practices, attitudes and values.

The *Infrastructure* competitiveness pillar is comprised of 108 variables and describes the extent to which basic, technological, scientific and human resources meet the needs of business. Its sub-pillars are basic infrastructure, technological infrastructure, scientific infrastructure, health and environment and education.

A detailed list of all variables included in each of the pillars is found in Table A.2 of the Appendix A.

Data sources

The data used for the construction of the WCY is a combination of quantitative (hard) and qualitative data (survey). Hard data consist of statistical indicators acquired from international, national and regional organizations, private institutions and the WCY network made of 55 partner institutions. Survey data are drawn from the WCY annual Executive Opinion Survey data sent to executives in top and middle management in all of the economies covered by WCY. The survey is compiled by a panel of 4000 executives from a representative cross-section of the business community in each country. The hard data represents 2/3 of the overall weight in the final rankings while survey data are assigned a weight of 1/3.

Computation of WCY

There are a total of 331 variables in the WCY of which 254 are used to calculate the Overall Competitiveness rankings. The Standard Deviation Method (SDM) is used in order to obtain a comparable standard scale for computing the overall, pillar and sub-pillar results.

To this aim, for each of the 254 variable the standardized value (STD) is computed:

$$STD(x) = \frac{x - \bar{x}}{S}$$

where:

x = original value

$\bar{x}$ = average value of the 55 countries

S = standard deviation of x

The sub-pillar rankings are obtained by computing the weighted average of the STD values for all variables which make up the given sub-pillar. The survey data variables, coming from the Executive Opinion Survey, are weighted so that they account for one-third in the determination of the overall ranking.

In case of missing data for a particular country, the missing values are replaced by a STD value equal to 0.

The sub-scores of each sub-pillar are then aggregated in order to obtain the pillar score. Each sub-pillar, independently of the number of variables it contains, is assigned an equal weight of 5% on the overall score. (20 sub-pillars x 5 = 100)

The STD values of each of the four pillars are aggregated to determine the overall score as the average of the four pillars' scores. The number is then converted into an index with the leading economy given a value of 100.

One of the major differences between the WCY by IMD and the GCI by WEF, described in Section 2.1, is that, first, a higher number of variables are comprised in the WCY and, second, the latter puts more emphasis on survey data while the WCY focuses more on hard statistics. Hard data availability is, in fact, the reason why WCY can cover a lower number of countries (55) with respect to those covered by the GCI (131). On the other hand, survey data are considered by IMD less reliable since they are entirely based on subjective opinion (IMD, 2008).

2.3 The European Competitiveness Index – University of Wales Institute, Cardiff – UWIC

Currently two editions of the Robert Huggins Associates' European Competitiveness Index (ECI) are available, issued in 2004 and 2006. The index' main purpose is to measure, compare and examine the competitiveness of regions and nations.

The 2004 edition of the ECI comprised EU-15 member states as well as Norway and Switzerland, and their regions at the NUTS-1 level The 2006 ECI has been expanded to include EU-25 countries and their respective NUTS-1 regions, in total 116 regions plus Norway and Switzerland (Huggins and Davies, 2006).

The focus on regions reflects and confirms the growing consensus on the relevance of regions as key territorial units for economic analysis. It is well-established that the geographic concentration of specialized inputs, employees, information and institutions favors firms and industries especially in the most advanced economies. This process feeds off itself: the localized productivity advantages of agglomeration push firms to cluster and reinforce these clusters over time. Thus, as globalization tends to nullify traditional forms of advantages, the business environment where firms are located becomes more and more important. In this sense "*globalization is reinforcing localization*" (Huggins and Davies, 2006 pg. 4).

The ECI takes into account three major pillars: creativity, economic performance and infrastructure/accessibility. Two additional pillars, education and knowledge employment, are separately analyzed at regional level in order to ascertain their correlation with the ECI. They are in fact considered as respectively cause and effect of competitiveness rather than its direct measure. The underlying assumption is twofold: i) highly educated population is a key ingredient for business performances; ii) regions which are competitive in terms of creativity, economic performance and accessibility also tend to host high value-added and knowledge-intensive employment. Correlating education expenditure/enrolments with ECI gives an insight into which regions are most effective in converting human capital resources into economic outcomes. Correlation of knowledge employment with ECI gives an insight into which areas are effective in turning their potential into actual high level employment.

In the next Section the dimensions used in the ECI report are detailed.

<u>Different dimensions described</u>

Five different groups of variables are included in the ECI report, but only the first three are included in the computation of the composite ECI:

1. *Creativity*
2. *Economic Performance*
3. *Infrastructure and Accessibility*
4. *Knowledge Employment*
5. *Education*

The *Creativity* dimension is described by 8 quantitative variables mainly related to R&D employment and expenditure by sector. The list of variables is shown in Box 1.

Box 1: Creativity variables (source: Huggins and Davies, 2006, pg. 2)
Creativity R&D Employment in the Business Sector per 1,000 inhabitants R&D Employment in the Government Sector per 1,000 inhabitants R&D Employment in the Higher Education Sector per 1,000 inhabitants R&D Expenditure in the Business Sector per capita R&D Expenditure in the Government Sector per capita R&D Expenditure in the Higher Education Sector per capita Number of Patent Applications per 1 million inhabitants Employment in ICT Services per 1,000 inhabitants

Economic performance is described by GDP, monthly earnings, rates of productivity, unemployment and economic activity (Box 2).

Box 2: Economic performance variables (source: Huggins and Davies, 2006 pg. 2)
Economic Performance GDP per Capita Labour Productivity Unemployment Rate Long-Term Unemployment Rate Mean Gross Monthly Earnings Economic Activity Rate

Quantitative data related to motorways, railways and air transportation of both passengers and freight are considered to describe the transport and infrastructure density. Two variables related to ICT usage, Broadband lines and Secure Servers, are only available at national level (Box 3).

Box 3: Infrastructure and Accessibility variables (source: Huggins and Davies, 2006 pg. 2)
Infrastructure and Accessibility Motorway Length per km² Motorway Length per vehicle Length of Railway per km² Air Freight Disembarked per 1,000 inhabitants Air Passengers Disembarked per 1,000 inhabitants Number of Vehicles per 1,000 inhabitants Broadband Access Lines per 1,000 inhabitants (national data only) Secure Servers per 100,000 inhabitants (national data only)

These three groups of variables form the core for the composite index computation. The methodological approach is detailed in later on in this section.

After the ECI computation, further analysis is provided in the report to get an insight into the level of knowledge economy that can be observed in regions. To this purpose the proportion of knowledge-based employment and the level of education of the population are related to regional ECI.

Knowledge-based employment is described by employment (per 1000 inhabitants) and number of business units (per 1 million inhabitants) by nine sectors, as indicated in Box 4.

Box 4: Knowledge employment sectors

Biotechnology and Chemical
ICT Services
Research and Development
IT and Computer Manufacturing
Telecommunications
Machinery and Equipment Manufacturing
Instrumentation and Electrical Machinery
Automotive and Mechanical Engineering
High-Technology Services

The correlation between ECI and *Education* is based on aggregate data for the number of students per 1000 employees enrolled in secondary and tertiary education, as well as data for secondary and tertiary education at national level (the authors consider data on education expenditure not reliable at the regional level). The choice of aggregating different types of education is driven by the difficulty in comparing data across specific categories of education since the method for students' classification is not homogeneous across countries. Variables for this pillar are listed in Box 5.

Box 5: Education

Number of Students in Upper Secondary Education per employed person
Number of Students in Academic Tertiary Education per employed person
Secondary Education Expenditure per Capita (national data only)
Tertiary Education Expenditure per Capita (national data only)

Data sources

Data comes from different European Institutions, such as Eurostat and DG Regional Policy, as well as country specific organizations. The complete list of data sources is shown in Table A.2 of Appendix A.

Computation of ECI

For the computation of the composite index, data is first standardized. Afterwards, a Factor Analysis (FA) is performed on the whole set of variables in order to extract communalities which represent the common part of variation of the dataset. The "image factoring" is employed as extraction method and the varimax is used to obtain optimally rotated factors. The scores of each region for the common dimensions are interpreted as sub-composite indices. Finally, a single composite is derived from FA sub-indices using Data Envelopment Analysis – DEA (Cherchye, 2001). DEA is a linear programming tool which estimates an efficiency frontier used as a benchmark to measure the relative performance of countries. DEA computes a benchmark (the frontier) and measures the distance between units (regions in this case) and the frontier. The benchmark can be obtained as the solution of a maximization problem or by external definition. In a DEA solution each unit (region) is assigned a set of weights which depend on the distance of the unit from the frontier. Note that both weights and the frontier are country specific and in general there would be no unique frontier (OECD, 2008).

By DEA each region receives a score between 0 and 1 for each sub-composite index. For each region, a composite score is then computed as the geometric mean of all the DEA scores for that region. These scores are finally indexed round the European average giving the ECI.

Further analysis

To explore the assumption of a positive relation between the competitiveness level of a region and its level of knowledge-intensive employment, a correlation analysis between ECI and employment indicators is performed. The strength of this relation is computed with respect to an index of total knowledge employment[3] and to knowledge employment indices separated by sectors. Of the knowledge employment sectors only ICT services are included in the composite ECI so as only a small endogenous correlation effect is expected.

Similarly, the correlation between ECI and education expenditure and enrolments is computed. The ECI versus expenditure analysis is performed at national level whilst ECI versus enrolment analysis is performed at regional level.

2.4 The Atlas of Regional Competitiveness – Eurochambers

The Association of European Chambers of Commerce and Industry has recently published a study which measures and compares regional competitiveness of the 268 EU regions at NUTS2 level (EUROCHAMBERS, 2007). Competitiveness is measured in terms of seven main pillars described by reference indicators. For each Member State and indicator the best performing region is singled out. The result is a comparison of the best performing regions of the 27 Member States.

No composite indicator is computed; instead comparison of regions is discussed separately for each indicator. In this sense the analysis can be seen as a partial view of EU competitiveness as it describes only excellence within each EU country with respect to each dimension.

Despite its simplicity the Atlas of Regional Competitiveness provides a relevant example of competitiveness measurement at a very detailed geographical level giving valuable suggestions for the selection of indicators in the analysis at the NUTS2 level.

<u>Different dimensions described</u>

Seven dimensions (pillars) have been selected for analysis:

1. *Economic Performance*
2. *Employment and Labour Market*
3. *Training and Lifelong learning*
4. *Research and Development/Innovation*

[3] The total knowledge employment index is computed by aggregating employment per capita across all

5. *Telecommunication Networks*
6. *Transport*
7. *Internationalization*

For each dimension a reference indicator is chosen and used for separate comparison of EU regions. Descriptive analysis of other related indicators is provided as well.

The *Economic Performance* is described by means of GDP per capita in Purchasing Power Standard (PPS). A closer look into the economic background is provided by separate analysis of GDP growth rate in 2004 and average annual growth rate between 2000 and 2004. A description of total regional GDP by three sectors (Agriculture, Forestry and Fishing / Industry / Services) is also discussed.

The reference indicator for *Employment and Labour Market* is the employment rate, taken as the rate of number of individuals aged 15 – 64 in employment and the total population of the same age group. The indicator is based on the Eurostat Labour Force Survey. Related descriptive analysis is based on unemployment rate (percentage of unemployed persons in the active population), long-term unemployment (people unemployed for not less than twelve months) and average of hours worked per week. Employment is also analyzed by sector (same three sectors as for Economic Performance).

For the third dimension on *Training and Lifelong learning*, the reference indicator is the education attainment, classified as the percentage of the population with a higher degree[4]. Further analysis is carried out considering the proportion of students in higher education compared to the entire student population and the rate of 25 – 64 years age group having received training in the past twelve months, as an indicator of lifelong learning.

The *Innovation* dimension is described by the number of patent applications to the EPO per million inhabitants. The indicator is supposed to reveal the dynamism of the R&D sector of a region and can be regarded as an output indicator. It is worthwhile to note that when new Member States are considered, the indicator can give rather distorted results since new Members have no tradition of applying for patents with the EPO. Such a comparison could then disadvantage those countries.

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knowledge sectors.

[4] Higher education degrees are levels 5 and 6 according to the ISCED classification.

In case of data availability, R&D expenditure as percentage of GDP and R&D staff as percentage of active population are analyzed both totally and by three sectors (Enterprises, Public Sector and Higher Education).

The reference indicator for *Telecommunications Networks* is the percentage of households and enterprises which have access to internet. Additionally, the analysis of patent applications in the field of telecommunications is provided as an indicator of regional dynamism in the field.

The *Transport* pillar is the only one described by multiple indicators. Specifically:

a. Motorway length and density, in terms of length per million inhabitants;
b. Airfreight transport, in terms of total goods loaded and unloaded;
c. Maritime freight, in terms of total goods loaded and unloaded.

Finally, the last pillar *Internationalization* lacks data at the regional level. This theme has been described only at country level in terms of the following indicators:

a. Exports and Imports by product type and with respect to population size;
b. Average annual growth rate of exports/imports between 2000 and 2004;
c. Incoming Foreign Direct Investment – FDI stocks both in absolute value and as a percentage of GDP;
d. Average of incoming and outgoing flow of FDI in relation to GDP.

Data sources

Data has been extracted from Eurostat and refers to the last available year in September 2007. Figures related to the use of internet by households and enterprises have been taken from the European Spatial Planning Observation Network – ESPON (http://www.espon.eu/).

2.5 Country specific regional indices

Besides international studies on regional competitiveness, in the past years several country specific analyses on the topic were published. Three cases have been selected for discussion: the United Kingdom, Croatia and Finland. They represent valid attempts to describe regional competitiveness with an overall perspective and sound methodology.

United Kingdom

The United Kingdom has a long tradition in competitiveness studies which is testified by the UK Competitiveness Index reports, first introduced and published in 2000. The 2008 edition represents a benchmark of the competitiveness of the UK's regions and localities (Huggins and Izushi, 2008). The concept of competitiveness adopted regards the development/sustainability of businesses and the economic welfare of individuals. Competitiveness is in fact defined as "*the capability of an economy to attract and maintain firms with stable or rising market shares in an activity, while maintaining stable or increasing standards of living for those who participate in it*" (Huggins and Izushi, 2008; pg. 7).

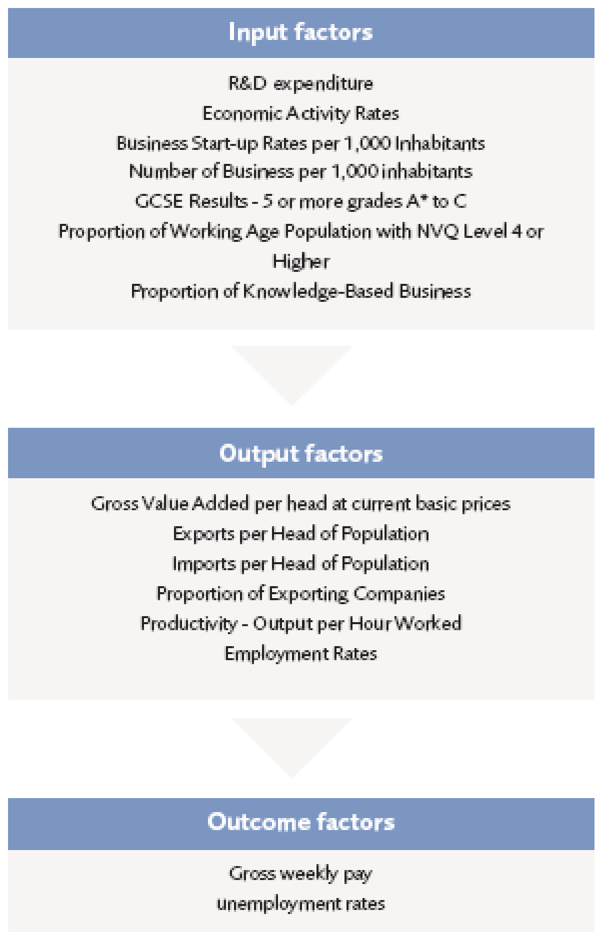
Competitiveness of a region is viewed as the result of a complex interaction between input, output and outcome factors. To this aim, the UK Competitiveness index comprises a series of indicators incorporating data that are available and comparable at the regional level (NUTS1) and at a very detailed local area level.

The conceptual framework underlying the index for regional competitiveness is a 3-factor model (Huggins, 2003) as shown in Box 6. Three major dimensions (factors here) are described with the indicators listed in Box 6 and are assigned different meanings. The input variables, such as firms per 1000 inhabitants and proportion of knowledge-based businesses, are assumed as contributing to the output productivity of a region, which is described in the output dimension. The impact of the input and output factors is given by the level of average earnings and the unemployment rate, which are considered as the only tangible outcomes.

Each of the three dimensions is assigned equal weight in the composite computation, i.e. each dimension has a weight of 0.333. Further, within each dimension this weight is equally distributed among the indicators. This means that, for instance, the two indicators describing the Outcome dimension are assigned a weight of $0.333/2$ each. Three sub-indices are then computed.

Before computing the overall composite, each sub-index is transformed into its logarithmic form to dampen out extremes which may distort the final composite score. Afterwards the composite score is finally anti-logged through exponential transformation in order to reflect as far as possible the scale of difference in competitiveness between regions.

Box 6: UK Regional Competitiveness Index Framework (source: Huggins and Izushi, 2008, pg. 9)



The analysis is carried out for the 12 UK regions at NUTS1 level and for 408 local areas.

<u>Croatia</u>

The Croatian National Competitiveness Council and the Croatian Chamber of Economy recently published the first edition of "The Regional Competitiveness Index of Croatia, 2007" (UNDP, 2008). The definition of competitiveness adopted is the one by the World Economic Forum which defines competitiveness as *"a range of factors, policies and institutions which determine the level of productivity*" (Schwab and Porter, 2007).

The report is based on the methodologies of the World Economic Forum and the National Institute for Management Development. It provides an insight into the competitiveness of Croatia's regions by evaluating the quality of the business sector and business environment. The focus is, thus, specifically on the measurement of the business aspect of competitiveness. The underlying assumption is that wealth is primarily generated at the enterprise level and that the environment in which the enterprise operates can either support or disturb its ability to compete.

The analysis is carried out for the three NUTS 2 regions, newly defined in Croatia, in accordance with the principles of Eurostat, as well as for Croatian counties at the NUTS 3 level.

Two main economic areas are described - the business environment and the quality of the business sector – and are the result of 135 indicators structured into eight sub-groups, as indicated in Box 7. For the complete list of selected indicators, see the entire report which is freely available on-line at www.undp.hr. Most of the indicators are expressed as numbers per person, as an activity trend (index) over several years, or as a percentage.

Indicator values derive from numerous statistical as well as survey data, with a proportion of survey to statistical data of about one third. Statistical data is of quantitative type whilst survey data is of qualitative type. Survey data is analyzed on the basis of the Business Competitiveness Index by the World Economic Forum. Statistical indicators are, instead, analyzed using the International Institute for Management Development – IMD - approach.

Box 7: Major pillars of the Croatian Regional Competitiveness Index 2007 (source: UNDP, 2008)

A. Business environment

Demographics, health and culture
Education
Basic infrastructure and public sector
Business infrastructure

B. Business sector

Investments and entrepreneurial trends
Level of entrepreneurship development
Economic results – level
Economic results – trends

Qualitative data obtained from surveying entrepreneurs' opinions is used to set up two sub-indices for the business sector and the business environment following the WEF approach. Analogously, statistical data is used to set up two quantitative sub-indices following the IMD methodology.

For survey data, a seven categories measurement scale is adopted. The calculation of sub-indices for the business sector and the business environment is carried out using exact weights for individual questions as recommended in the WEF methodology.

The quantitative analysis was based on the IMD methodology using more than one hundred indicators to calculate sub-indices adopting an equal weight scheme. These sub-indices were subsequently used in the calculation of the two main indices, weighting equally the sub-indices.

In the end, each region receives four scores: two survey and two statistical scores for the two business areas. Then two basic indices, survey and statistical, are computed as weighted averages of the two sub-indices. Different weights are given to the business environment and to the quality of the business sector: a greater weight to the former – 0.844 – and a smaller to the latter – 0.166. The weights are computed based on the WEF method.

Finally, the overall regional competitiveness index is computed as the average of the survey and statistical indices, after standardization.

Finland

The Finnish case (Huovari et al., 2001) represents a relevant example of competitiveness measurement at a very detailed geographical level (NUTS4). The definition of regional competitiveness adopted in the study is "*the ability of regions to foster, attract and support economic activity so that its citizens enjoy relatively good economic welfare*". Authors recognize that, despite the existence of well established international studies on competitiveness, they cannot be applied as such to a regional framework since some of the indicators used at country level are either unavailable or meaningless at the regional level. For example indicators which represent the efficiency of public sector or barriers to foreign trade do not vary within a country and are then considered inadequate for regional comparing, especially when a single country is investigated.

In the Finnish case the index is set-up using available indicators at the labour market level as well as indicators which measure the innovativeness and agglomeration of regions. Specifically, four dimensions of competitiveness are defined:

1. *Human Capital*
2. *Innovativeness*
3. *Agglomeration*
4. *Accessibility*

These four major dimensions are described by 16 variables (indicators) at the NUTS 4 level for a total of 85 Finnish sub-regions.

It is interesting to note that no indicator related to economic performance has been included in the index. In fact, indicators of economic performance and well-being, such as per capita GDP and personal income, have been included afterwards via a study of correlation between them and the competitiveness index. The association between the index and short-term outcome indicators, i.e. change in production, employment and population, has been assessed as well. In this sense the measure of competitiveness given here is related to a larger extent to the potential and innovativeness of the region than to its actual economic productivity. The study represents a peculiar view of regional competitiveness which greatly differs from the more common perception of business competitiveness.

Human capital is measured by means of 5 variables: number of highly educated residents; total number of students; number of technical students; size of the working age population (15 – 64); participation rate in the labour market.

Innovativeness is captured by 4 variables: average of the number of patents between 1995 and 1999[5]; R&D expenditures; proportion of establishments which have been innovative during the years 1985 and 1998[6]; proportion of value added produced in high technology sectors.

Agglomeration of firms and economic activity is described with 4 indicators: population density; proportion of workers in sectors where external economies are large (manufacturing,

[5] Since patenting varies strongly between years, the average across 6 years is considered to smooth variation.
[6] This is a very specific indicator developed by the authors (Alanen et al., 2000)

wholesale, retail trade and private services); proportion of workers in business services; size of the largest sector within the sub-region.

Three variables measure *Accessibility*: road distance of each sub-region to every other, weighted by the size of the sub-region; distance from airports, weighted by the size of airports; proportion of firms in a sub-region engaged in foreign trade. It should be noted that rail accessibility has not been taken into account because of data availability at sub-regional level and also because of the dominant role of road and air accessibility for the trade of goods.

To set-up the index all variables are firstly weighted with the relative size of the sub-region with respect to the population. Selected variables are of two types: one comprises variables expressed as absolute numbers, such as number of students; the other comprises variables expressed as proportions, such as proportion of workers in a sector. The weighting method differs for the two types of variables:

$$V_i = 100 \frac{x_i / X}{p_i / P} \qquad \text{for type I variables}$$

$$V_i = 100\, x_i / X \qquad \text{for type II variables}$$

where x_i is the value of variable x for sub-region i, X the value of variable x for the whole country, p_i is the number of inhabitants of sub-region i, P is the number of inhabitants of the whole country.

Standardization is then applied to indicators which generally show high differences in standard deviations.

For each dimension the average sub-index is computed, with equal weights, and the overall competitiveness index is the simple average of the four sub-indices, each with weight 0.25.

3 Developing the RCI: theoretical framework

The main goal of the EU Regional Competitiveness Index (RCI) is to map economic performance and competitiveness at the NUTS 2 regional level for all EU Member States. The expected results are of great variation within each country, with regions with low levels of competitiveness located among strongly competitive regions. Furthermore, a higher degree of heterogeneity is foreseen due to the accession of the 12 new Member States.

The aim of the project is to develop a rigorous method to benchmark regional competitiveness and to identify the key factors which drive the low competitiveness performance of some regions. To this purpose RCI should present an overall but synthetic picture of regional competitiveness.

On the basis of existing competitiveness studies discussed in Section 2, an *ideal framework* for RCI is proposed which includes eleven major pillars. The reference is the well-established GCI by the WEF (Section 2.1) but some variations and adaptations have been considered necessary in order to address the regional dimension of RCI. The main differences between RCI and WEF-GCI are: a) the application of a regional as supposed to country level analysis; b) the exclusion of two pillars (Goods market efficiency and Financial market sophistication); c) the division in two separate pillars of the GCI Health and Primary education pillar; and d) the preference towards hard (quantitative) data with respect to survey data.

The reason for the exclusion of the Goods market efficiency pillar is related to the fact that EU regions are subject to the single market and the customs union. The pillar is then expected to show little if any variation across the EU. Moreover, some of the indicators selected by WEF to describe this pillar have been included in the RCI Institutions pillar (ex. World Bank Ease of Doing Business Index).

Little variation across EU is also expected for the Financial market sophistication pillar. In addition, only few hard data are available to describe this aspect for the EU. These have been the reasons behind the choice of excluding the pillar from the RCI framework as well.

The pillars included in the RCI framework are listed in Box 8.

Box 8: The RCI-2010 framework

RCI pillars
1. Institutions
2. Macroeconomic Stability
3. Infrastructure
4. Health
5. Quality of Primary and Secondary Education
6. Higher Education/Training and Lifelong Learning
7. Labour Market Efficiency
8. Market Size
9. Technological Readiness
10. Business Sophistication
11. Innovation

With respect to the WEF framework, the pillar Health and Primary Education has been slightly modified and split into two different pillars to better distinguish between two distinct aspects of regional competitiveness across the EU. Health – pillar 4 - is described at the regional level while Quality of Primary and Secondary Education – pillar 5 – is described at the country level in terms of achievements and skills of pupils of age 15. In fact, the compulsory education system in force in the EU fixes to either 15 or 16 the ending age of compulsory education for most countries, with the exception of Hungary and the Netherlands where the minimum age is 18.

Pillars may be grouped according to the different dimensions (input versus output aspects) of regional competitiveness they describe. Figure 3-1 shows the classification chosen for the RCI. The terms 'inputs' and 'output' are meant to classify pillars into those which describe driving forces of competitiveness, also in terms of long-term potentiality, and those which are direct or indirect outcomes of a competitive society and economy.

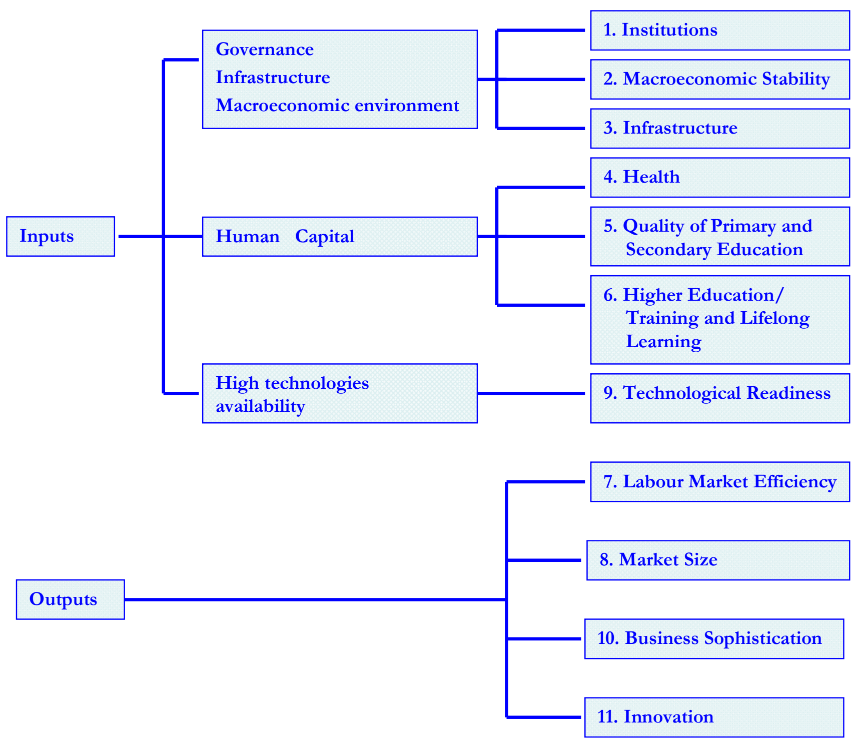


Figure 3-1: Interpretation of the pillars included in the ideal framework for RCI.[7]

As already mentioned, the indicators selected for the RCI framework are all of quantitative type (hard data) and the preferred source has been Eurostat. Whenever information has been unavailable or inappropriate at the required territorial level, other data sources have been explored such as the World Bank, Eurobarometer, OECD, the European Cluster Observatory.

[7]The numbering of the pillars follows their numbering in the text.

Candidate indicators for each pillar are discussed in the current section. The following basic criteria for the initial selection of candidate indicators within each pillar have been applied:

1. experts' opinion and literature review;
2. elimination of overlapping information across pillars;
3. balanced number of indicators across pillars.

The complete list of candidate indicators is listed in Appendix C. The final list of indicators included in the RCI is a subset of the candidate indicators. As it will be detailed in Chapter 4 and 5, two additional criteria have been used to refine the candidate list and arrive at the final choice of the suite of included indicators from those belonging to the ideal framework. :

4. data availability (in terms of missing data – Section 4.2);
5. statistical consistency (multivariate analysis – Section 4.4).

In some cases, applying all criteria has not been possible due to the complex structure of the index and that is why, for example, not all pillars are populated with roughly the 'same' number of indicators.

The following sections provide an overview of each pillar, its relevance in terms of regional competitiveness, the specific aspects to be measured within it and the set of indicators selected to this aim. In the discussion below, we will limit ourselves to outlining only the candidate indicators and their source. Appendix C provides detailed information on the geographical level, unit of measurement and periodicity of all potential indicators.

3.1 Institutions

Why does it matter?

The importance of institutions for economic growth has gained increasing attention in the last decades in search of additional factors impinging on economic development beyond traditional growth theories (Rodriguez-Pose, 2010 and Storper, 2005). Rodrik et al. (2004) go as far as claiming that the quality of institutions is more important than traditional development factors such as geography in determining levels of income and growth prospects. Effective institutions have a number of positive impacts on the competitiveness of a country/region. In an overview of the academic literature on the subject, Rodriguez-

Pose (2010) points out that they improve the provision of public goods, address market failures, improve efficiency (Streeck, 1991), reduce transaction costs (North, 1990), foster transparency (Storper, 2005), promote entrepreneurship and facilitate the functioning of labour markets. Effective local institutions provide the adequate conditions for investment, economic interaction and trade, while reducing the risk of social and political instability (Jütting, 2003). Putnam (2000) points out that solid institutions are the key enables of innovation, mutual learning and productivity growth and puts them as the core of the factors driving economic growth.

The pillar Institutions aims at measuring the quality and efficiency of institutions, the level of perceived corruption and the general regulatory framework within countries. It tries to give an insight into how favorable is the institutional climate for enterprises, how easy it is to open a new business, how much trust people have in their national legislative and regulatory systems and its effectiveness.

There is not much agreement in the academic literature as to the best way of including indicators of institutional quality within competitiveness indices in general and even more so within regional competitiveness indicators. The GCI includes in its institutional pillar private and public institutions with a focus on both firm-level and public implications. The ECI puts as important factors of the institutional structure social capital and the efficiency and effectiveness of the public administration. All of these aspects, however, are not easily measured quantitatively so that to allow for a cross-country comparison. Their variability on regional level is also somewhat problematic as they describe national contexts which hardly present significant differences on the regional level.

Given the fact that regional indicators describing these aspects for EU regions have not been identified, we have opted for using country level data. Even though it does not carry any message as to the variability in the quality of institutions at the regional level, we have chosen to still include this pillar as any description of competitiveness, regardless of the level, needs to take into account the quality and efficiency of institutions as an essential determinant of economic growth.

Given the intrinsic features of the pillar, we propose some indicators which measure citizens' perception of the quality of the institutions. To this aim we considered two recent Eurobarometer studies which offer information on EU 27 citizens' perception of corruption and fraud in their home countries (European Commission, 2009b and 2008). The former is a Special Eurobarometer issue and refers to fieldwork carried out in September-October 2009; the latter is a Flash Eurobarometer and refers to a survey carried out in June 2008.

Further, we have taken into account the *Worldwide Governance Indicators* (WGI) project (http://info.worldbank.org/governance/wgi/index.asp), which is one of the most well-known databases describing the quality of institutions. It reports aggregate and individual governance indicators for 212 countries and territories over the period 1996–2007, for six dimensions of governance: a. Voice and Accountability; b. Political Stability and Absence of Violence; c. Government Effectiveness; d. Regulatory Quality; e. Rule of Law and f. Control of Corruption. The aggregate indicators combine the views of a large number of enterprises, citizens and expert survey respondents in industrial and developing countries. The individual data sources underlying the aggregate indicators are drawn from a variety of survey institutes, think-tanks, non-governmental and international organizations. It is important to note that these are composite indicators whose raw data variables in most cases are not readily accessible. For the RCI we have considered the aggregate indicators which are measured in units ranging from -2.5 to 2.5, with higher values corresponding to better governance outcomes. Data have been extracted from the official website: www.govindicators.org. More details on the World Bank indicators may be found in Kaufmann et al. (2009).

We also propose to include one indicator from the *Doing Business 2010* report by the World Bank (www.doingbusiness.org). The Doing Business project, launched 8 years ago, looks at domestic small and medium-size companies and measures the regulations applying to them through their life cycle. It provides a quantitative measure of regulations for starting a business, dealing with construction permits, employing workers, registering property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts and closing a business—as they apply to domestic small and medium-size enterprises. A fundamental premise of Doing Business is that economic activity requires good rules. These include rules that establish and clarify property rights and reduce the costs of resolving disputes, rules that increase the predictability of economic interactions and rules that provide contractual partners with core protections against abuse. The *Doing Business 2010* covers the period June 2008 through May 2009. Economies are ranked on their ease of doing business, from 1 – 183, with a high ranking on the ease of doing business index meaning that the regulatory environment is conducive to the operation of business. This index averages the country's percentile rankings on 10 topics, made up of a variety of indicators, giving equal weight to each topic.

Box 9 shows the set of eleven candidate indicators proposed to describe the Istitutions pillar.

The six governance indicators (from 5th to 10th) belong to the set of World Bank Worldwide Governance Indicators. They are measured in units ranging from -2.5 to 2.5, with higher values corresponding to better governance outcomes.

The last indicator, from *Doing Business 2010*, has been reversed to be positively related to the level of competitiveness of the country.

Box 9: Indicators for Institution

	Data Source	Indicator description
1.	Special Eurobarometer 325	Corruption as a major problem at the national level
2.		Corruption as a major problem at the regional level
3.	Flash Eurobarometer 236	Perceived extent to which the state budget is defrauded (customs fraud, VAT fraud, fraud with subsidies, etc.)
4.		Perceived extent of corruption or other wrongdoing in the national government institutions
5.	World Bank Worldwide Governance Indicators	Voice and accountability
6.		Political stability
7.		Government effectiveness
8.		Regulatory quality
9.		Rule of law
10.		Control of corruption
11.	Doing Business 2010	Ease of doing business

3.2 Macroeconomic stability

Why does it matter?

Macroeconomic stability measures the quality of the general economic climate. Economic stability is essential for guaranteeing trust in the markets both for consumers and producers of goods and services. Stable macroeconomic conditions lead to higher rate of long-term investments and are essential ingredients for maintaining competitiveness.

We propose a set of indicators similar to the ones chosen by WEF for the GCI, with the exception of the 'interest rate spread' that is included in the GCI but is not available for EU countries. On the basis of experts' opinion we have replaced this indicator with the government long term bond yields which measures the trust of the market in the country.

The candidate indicators for this pillar are listed in Box 10. They are all measured at the country level as the aspects captured by the pillar are intrinsically national.

Box 10: Indicators for Macroeconomic Stability		
Data source		**Indicator description**
1.	Eurostat	General government deficit (-) and surplus (+)
2.		Income, saving and net lending / net borrowing
3.		Annual average inflation rate
4.		Long term bond yields
5.		General government gross debt

3.3 Infrastructure

Why does it matter?

The quality of infrastructure is essential for the efficient functioning of an economy. Modern and efficient infrastructure endowment contributes to both economic efficiency and territorial equity as it allows for the maximization of the local economic potential and the efficient exploitation of resources (Crescenzi and Rodriguez-Pose, 2008). As pointed out by Schwab and Porter (2007), it is an important factor determining the location of economic activity and the kinds of activities and sectors that can develop in an economy. High-quality infrastructure guarantees easy access to other regions and countries, contributes to better integration of peripheral and lagging regions, and facilitates the transport for goods, people and services. This has a strong impact on competitiveness as it increases the efficiency of regional economies. The pillar describes different dimensions of infrastructural quality such as infrastructure density, connectivity and accessibility.

The list of candidate indicators, all available at the regional level, is shown in Box 11.

Box 11: Indicators for Infrastructure		
Data source		**Indicator description**
1.	Eurostat/DG TREN/EuroGeographics/National Statistical Institutes	Motorway index
2.		Railway index
3.	Eurostat/EuroGeographics/National Statistical Institutes	Number of flights accessible with 90' drive

3.4 Health

Why does it matter?

This pillar is devoted to the description of human capital in terms of health condition and well-being, with special focus on the workforce. The 2006 Community Strategic Guidelines on Cohesion (Official Journal of the European Union, 2006) underline that a healthy workforce is a key factor in increasing labor market participation and productivity and enhancing competitiveness at national and regional level. They point out to major differences in health status and access to health care across European regions. Good health conditions of the population lead to greater participation in the labor force, longer working life, higher productivity and lower healthcare and social costs. Box 12 shows possible indicators to measure some of these aspects, available from Eurostat at the NUTS 2 regional level.

Box 12: Indicators for Health		
Data source		**Indicator**
1.	Eurostat Regional Health Statistics	Hospital beds
2.	Eurostat, CARE, ITF, National Statistical Institutes, DG Regional Policy	Road fatalities
3.	Eurostat, DG Regional Policy	Healthy life expectancy
4.	Eurostat Regional Health Statistics	Infant mortality
5.	DG Regional Policy	Cancer disease death rate
6.	Eurostat, DG Regional Policy	Heart disease death rate

7.	Eurostat, DG Regional Policy	Suicide death rate

Among the candidate indicators, Hospital beds is the only one which gives an indication of an 'input' factor from the health system. The remaining indicators are related either to outcomes – infant mortality, cancer and heart disease death rates – or to the social welfare in more general terms – road fatalities and suicide rate. Our intent is, in fact, to measure some aspects of the population well-being from not only strictly health but also more social point of view.

3.5 Quality of Primary and Secondary Education

Why does it matter?

High levels of basic skills and competences increase the ability of individuals to subsequently perform well in their work and to continue to tertiary education. To capture this dimension we focus on compulsory education outcomes as an indication of effectiveness and quality of the educational system across EU Member States. To this aim, we have taken into account the performance of students in the OECD Programme for International Student Assessment (PISA) 2006 wave. PISA indicators make it possible to identify the share of pupils, 15 year old, who have a low level of basic skills in reading, math and science. Pupils who fail to reach higher levels can be considered to be inadequately prepared for the challenges of the knowledge society and for lifelong learning, thus indicating a lower potential in terms of human capital.

In order to describe educational input factors, we also consider indicators related to teacher to pupil ration, public expenditure on compulsory education and financial aid available for students. Investment in education can be considered as an essential element in guaranteeing good quality of the educational system.

Participation in early childhood education has become one of the new EU benchmarks in the field of education and training. Several studies have pointed out to the positive effects of early childhood education from an educational and social perspective as it can counter potential educational disadvantages of children, coming from unfavorable family situations (NESSE, 2009; European Commission, 2009a). We have, thus, included a potential indicator measuring this aspect.

The following box presents the set of proposed indicator describing the Quality of Primary and Secondary education.

Box 13: Indicators for Quality of Primary and Secondary Education		
Data source		**Indicator description**
1.	OECD - PISA	Low achievers in Reading of 15-year-olds
2.		Low achievers in Math of 15-year-olds
3.		Low achievers in Science of 15-year-olds
4.	Eurostat Educational Statistics	Teacher/pupil ratio
5.		Financial aid to students ISCED 1-4
6.		Public expenditure ISCED 1
7.		Public expenditure ISCED 2-4
8.		Participation in early childhood education

3.6 Higher Education/Training and Lifelong Learning

Why does it matter?

The contribution of education to productivity and economic growth has been widely researched in the last decades. Knowledge-driven economies based on innovation require well-educated human capital, capable to adapt, and education systems which successfully transmit key skills and competences. A clear picture of the economic benefits of education can be found in the most current release of the OECD publication *Education at a Glance 2009* (OECD, 2009). As also underlined by the Lisbon Council president (Hofheinz, 2009), the main findings of the OECD report are straightforward: investment in educations pays always, for the individual and for society at large. Further, a stream of research literature in the past two decades has shown that the quality of human resources is not only directly involved in knowledge generation but plays a crucial role for applying and imitatatin technologies developed somewhere else (ex. Azariadis and Drazen, 1990).

It is clear that this pillar plays a key role in describing competitiveness.

Variables traditionally used for measuring educational quality are levels of educational attainment of the population, number of years of schooling of the labour force or literacy rates (Psacharopoulous, 1984). Participation in education throughout one's life has also been deemed essential for the continuous upgrade of the skills and competences of workers in order to assist them in handling the challenges of continuously evolving technologies. In this pillar, these aspects are captured by proposing to include indicators on levels of tertiary educational attainment, participation in lifelong learning among the population as well as percentage of young people who have left the educational system at an earlier stage. Furthermore, an indicator of geographical accessibility to higher education institutions is proposed as a relevant factor, especially at the regional level. All these indicators are available at the required NUTS2 regional level. The analysis has been complemented by adding a fifth indicator to take into account the expenditure on tertiary education.

Box 14 presents the indicators proposed to describe the pillar.

Box 14: Indicators for Higher Education/Training and Lifelong Learning

Data source		Indicator
1.	Eurostat - LFS	Higher educational attainment (ISCED 5-6)
2.	Eurostat Regional Education Statistics	Lifelong learning
3.	Eurostat Structural Indicators	Early school leavers
4.	Nordregio, EuroGeographics, GISCO, EEA ETC-TE	Accessibility to universities
5.	Eurostat Educational Statistics	Total public expenditure on tertiary education (ISCED 5-6)

3.7 Labor Market Efficiency

Why does it matter?

The efficiency of the labor market gives an important indication as to the economic development or a region. Efficient and flexible labor markets contribute to efficient allocation of resources (Schwab and Porter, 2007).

We have used nine indicators to describe this pillar. Three of them are directly related to the level of employment/unemployment. Employment and unemployment rates indicate the level of activity of the regional economy while long-term unemployment can give indication as to the presence of structural problems in the economy. Furthermore, high employment rates do not necessarily correspond to high labor productivity which is one of the main factors in a region's competitiveness. High labor productivity attracts economic activity and increases competitiveness. Thus, we have included data on regional labor productivity.

An interesting indicator on job mobility has been added to the suite of candidate indicators. It is officially defined by Eurostat as *people who started to work for the current employer or as self-employed in the last two years* (as percentage of total employment). Our aim is to describe, following the most recent trends in employment policy, a labor market which promotes job creation and flexibility while maintaining quality of employment. Clearly job mobility includes temporary workers, but the intention is here to value temporary work as it may represent a way for the worker to acquire valuable experience while not having to commit himself to a single employer.

According to Schwab and Porter (2007), efficient labor markets ensure equity in the business environment between men and women. We have, thus, analyzed three indicators describing the equity aspect of the labor market – female unemployment, and differences in unemployment and employment rates between females and males in order to account for any gender bias in labor market participation.

Labor market policies (LMP) contribute to the more efficient match between labor market demand and supply. Data on LMP provides information on labor market interventions defined as "Public interventions in the labor market aimed at reaching its efficient functioning and correcting disequilibria and which can be distinguished from other general employment policy interventions in that they act selectively to favor particular groups in the labor market." The scope of LMP statistics is limited to public interventions which are explicitly targeted at groups of persons with difficulties in the labor market: the unemployed, persons employed but at risk of involuntary job loss and inactive persons who would like to enter the labor market.[8]

Box 15 reports the list of candidate indicators selected for the pillar.

Box 15: Indicators for Labour Market Efficiency		
Data source		**Indicator**
1.	Eurostat Regional Labour Market Statistics	Employment rate

[8] For more information on statistics on LMP, see http://epp.eurostat.ec.europa.eu/portal/page/portal/labour_market/labour_market_policy

2.	(LFS)	Long-term unemployment
3.		Unemployment rate
4.		Job mobility
5.	Eurostat Economic Statistics	Labour productivity
6.	Eurostat, DG Regional Policy	Difference between female and male unemployment rates
7.	Eurostat, DG Regional Policy	Difference between male and female employment rates
8.	Eurostat Regional Labour Market Statistics (LFS)	Female unemployment
9.	Eurostat Regional Labour Market Policy Statistics (LFS)	Public expenditure on Labour Market Policies

3.8 Market Size

Why does it matter?

The pillar Market Size aims at describing the size of the market available to firms which directly influences their competitiveness. In fact, larger markets allow firms to develop and benefit from economies of scale and could potentially give incentive to entrepreneurship and innovation. We capture not only the regional market, proxied by GDP, but also the potential market, which is not confined to the administrative borders of a region, by using an indicator on potential GDP within a pre-defined distance matrix (for more information, see Appendix E). Thus, we take into account the fact that the EU common market allows for easy access to neighboring regions, regardless of whether they are situated within the same or another country.

Candidate indicators describing this theme are listed in Box 16.

Box 16: Indicators for Market Size

	Data source	**Indicator**
1.	Eurostat Regional Economic Accounts	GDP
2.		Compensation of employees
3.	Eurostat, DG Regional Policy	Disposable income
4.		Potential market size in GDP

5.		Potential market size in population

3.9 Technological Readiness

Why does it matter?

The pillar Technological Readiness aims at measuring the level at which households and enterprises are using and adopting existing technologies. It is largely recognized that technological infrastructures are a fundamental ingredient for country development. The last two decades have seen a steady increase of the importance of new information and communication technologies – ICT – both in business and every-day life. ICT has profoundly changed the organizational structure of firms, facilitating the adoption of new and more efficient technologies, improving productivity and speeding-up commercial processes. Hence, the use of ICT has become an essential element of competitiveness. ICT have also changed the way people do things in their private life. In fact, the way employees within firms are able to use efficiently new technologies is to a large degree dependent upon the ways in which technologies have penetrated their everyday life. We, thus, measure this aspect of technological readiness by concentrating also on the use of ICT by households as a proxy for the level of penetration of technologies in the population.

We propose to divide the pillar into two sub-pillars which describing access and use of technology by individuals/families, on the one hand, and enterprises, on the other. The sub-pillar related to personal use ('households') is described by three indicators collected at the NUTS2 level, whilst the sub-pillar related to technological readiness of enterprises ('enterprises') is described by some indicators at the NUTS2 level and by others at the country level. However, as it will be detailed later in Section 5.9, indicators available at the regional level are affected by a high percentage of missing values.

Box 17 and Box 18 show the candidate indicators for the two sub-pillars.

Box 17: Indicators for Technological Readiness – Sub-pillar HOUSEHOLDS		
	Data source	**Indicator**
1.	Regional Information Society Statistics	Households with access to broadband
2.		Individuals who ordered goods or services over the Internet for private use
3.		Households with access to Internet

Box 18: Indicators for Technological Readiness – Sub-pillar ENTERPRISES		
Data source		**Indicator**
1.	Community Survey on ICT usage and e-Commerce	Enterprises use of computers
2.		Enterprises having access to Internet
3.		Enterprises having a website or a homepage
4.		Enterprises using Intranet
5.		Enterprises using internal networks (e.g. LAN)
6.		Persons employed by enterprises which use Extranet
7.		Persons employed by enterprises which have access to the Internet

3.10 Business Sophistication

Why does it matter?

The level of business sophistication within an economy gives a sign as to the level of its productivity and its potential for responding to competitive pressures. Specialization in sectors with high value added contributes positively to the competitiveness of regions. We have, thus, included indicators on employment and GVA specifically in the NACE sectors J (information and communication) and K (Financial and insurance activities).

Furthermore, it is widely accepted that Foreign Direct Investments (FDI) are beneficial for the economic performance of countries and regions as they contribute to enhancing the capital and technological endowment of the host country or region (e.g. Barba Navaretti and Venables, 2004). We have included an indicator of FDI intensity, proxied by the number of new foreign firms, in order to capture this aspect of competitiveness.

Geographical proximity and interconnectedness among firms and suppliers leads to different types of spillovers, productivity and efficiency, but most importantly knowledge spillovers due to the higher concentration of specialized human capital. We, hence, propose to include a measure of the state of cluster development, similar to the practice used by the GCI, which describes the state of cluster development and gives an indication of the level of regional specialization and business sophistication (Schwab and Porter, 2007). As Porter also points out (Porter, 1998), regional clusters could lead to higher competitiveness for firms that are part of them due to the increasing productivity, higher innovation rate and availability of specialized resources. A variable on the strength of regional clusters is included which not only evaluates the level to which a region has been able to specialize in a given sector(s) but especially so in knowledge and technology-intensive sectors.

We have also considered indicators describing the availability of venture capital as it can give information as to the financial sophistication of the region and the potential of access to captal.

Proposed indicators to be included in the pillar are shown in Box 19.

Box 19: Indicators for Business Sophistication

Data source		Indicator
1.	Eurostat Regional Labour Market Statistics	Employment in 'sophisticated' sectors (NACE sectors J-K)
2.	Eurostat Regional Economic Accounts	Gross Value Added (GVA) in 'sophisticated' sectors (NACE sectors J-K)
3.	ISLA-Bocconi	FDI intensity
4.	European Cluster Observatory	Aggregate indicator for strength of regional clusters (for details on the computation, see Appendix B)
5.	Eurostat, European Private Equity and Venture Capital Association (EVCA)	Venture capital (investments early stage)
6.	Eurostat, European Private Equity and Venture Capital Association (EVCA)	Venture capital (expansion-replacement)
7.	Eurostat, European Private Equity and Venture Capital Association (EVCA)	Venture capital (buy outs)

3.11 Innovation

Why does it matter?

As pointed out by Schwab and Porter (2007), innovation is especially relevant for developed economies. They need to be at the forefront of new technologies, produce cutting-edge products and processes in order to maintain their competitive advantage. This requires an environment which is conducive, as Cantwell (2006) underlines, to creating relationships between firms and the science infrastructure, producers and users of innovation and the inter-firm level and between firms and the wider institutional environment. Furthermore, he stresses that such mechanisms are strongly influenced by spatial proximity. The level of innovative capability of a region influences directly the ways in which technology is diffused within the region. Research has shown that knowledge production is highly geographically concentrated. Feldman (1993) suggests that firms producing innovations tend to locate in areas with resources and that resources accumulate due to a region's success with innovations.

We have included both input or innovative potential indicators, such as employment in science and technology, knowledge workers, core creativity class, R&D expenditure, and outcome indicators (patent applications). Our objective is to capture as much as possible both the regional potential to innovate as well its actual performance in innovative activities. Potential indicators are listed in Box 20.

Box 20: Indicators for Innovation

Data source		**Indicator**
1.	OECD REGPAT	Innovation patent applications
2.		Total patent applications
3.	Eurostat – LFS	Core Creative class employment
4.		Knowledge workers
5.	Thomson Reuters Web of Science & CWTS database (Leiden University)	Scientific publications
6.	Eurostat Regional Science and Technology Statistics	Total intramural R&D expenditure
7.		Human resources in Science and Technology (HRST)
8.		Employment in technology and knowledge-intensive sectors

9.	OECD - REGPAT	High-tech inventors
10.		ICT inventors
11.		Biotechnology inventors

3.12 Stages of development of the EU NUTS2 regions

As mentioned in Section 2.1, the GCI by WEF takes into account the development stage of a country and accordingly assigns a different weighting scheme to groups of pillars (Schwab and Porter, 2007). Given that some variability across the development stages of NUTS 2 regions of the 27 EU members is expected, a similar approach is adopted for the RCI.

The first criterion proposed by WEF is considered[9], that is the development stage of a region is defined according to its GDP level per capita at current market prices. We have taken GDP per capita measured as PPP per inhabitants and expressed as percentage of the EU average (% GDP) as a defining variable. The year of reference is 2007. We have classified EU regions in three categories – low, medium and high according to the %GDP.

Table 2: GDP thresholds for RCI computation

Stage of development	GDP per capital (PPP per inhabitant as % of EU average)
Medium	**< 75%**
Intermediate	**≥ 75% and < 100%**
High	**≥ 100%**

The threshold defining the 'low' level (GDP below 75% of EU average) has been taken as a reference as it is the criterion for identifying regions eligible for funding under the Convergence criteria of the EU Regional Policy 2007-2013 framework. The second threshold (100 % of EU average) has been a more arbitrary choice and has been examined by uncertainty analysis in Chapter 6.

[9] The second criterion is related to the extent to which countries are factor-driven, i.e. they compete based on their factor endowments, primarily unskilled labor and natural resources. The proxy used is the share of exports of primary goods in total exports. As EU economies are not factor-driven in the GCI definition, we consider this criterion not to be relevant for the definition of the stages of development at the EU regional level.

Medium stage of development is associated with regional economies primarily driven by factors such as lower skilled labor and basic infrastructures. Aspects related to good governance and quality of public health are considered basic inputs in this framework.

Intermediate stage of development is characterized by labor market efficiency, quality of higher education and market size, factors which contribute to a more sophisticated regional economies and greater potential for competitiveness.

In the high stage of development, factors related to innovation, business sophistication and technological readiness are necessary inputs for innovation-driven regional economies.

On the basis of these thresholds, EU NUTS 2 regions are classified into different development stages. Appendix F shows the relative development stage assigned to each of the EU NUTS 2 regions.

4 Statistical assessment

The project aims at measuring the level of competitiveness by providing the RCI for European regions at the NUTS2 level.

The phenomenon is a multi-faceted concept that cannot be directly measured. The underlying hypothesis of this kind of analysis is that the phenomenon to be measured may be indirectly observed by several variables (indicators), which describe different features/aspects of the latent dimension. Choosing different aspects and indicators is equivalent to choosing the 'framework' of the index. This framework may be seen as the 'measurement instrument' of the latent phenomenon.

In the case of the RCI, the framework has been constructed on the basis of literature review, general reasoning, experts' opinion and practitioners' advice, as outlined in Chapter 3.

The RCI is structured according to the framework illustrated in Figure 3-1 and comprises eleven pillars which aim at measuring the economic strength of a region and its potentialities in the short and log run. For each pillar a number of candidate indicators have been selected and then screened by a set of univariate and multivariate statistical analyses to assess the validity of the theoretical framework and the internal consistency of each pillar. The statistical analysis is useful to support the framework and identify possible pitfalls which require further refinements. As a result, the final set of indicators may be, and in general is, a subset of the initial candidates.

The present chapter is devoted to the process of data analysis from the methodological point of view and the various statistical techniques employed at different steps of the analysis. Chapter 5 provides a discussion of results separately for each pillar.

The guidelines which drove this preliminary data analysis are major references of applied statistical analysis (Zani, 2000; Helsel and Hirsch, 2002; Knoke et al., 2002; Morrison, 2005) and the OECD (2008) Handbook on composite indicators.

4.1 Distortion due to commuting patterns

The geographical level is that of the NUTS2 as defined officially by the EU. However, in a few cases some regions have been combined to correct for the bias due to commuting patterns. Commuting patterns can indeed distort some of the data points for certain NUTS-2 regions. In particular a very high share of jobs in Inner London (UKI1) is taken up by residents of Outer London (UKI2). The same is true for jobs in Brussels. Almost half the jobs in Bruxelles Capital (BE10) are taken by residents of Vlaams Brabant (BE24) or Brabant Wallon (BE31). This is why these NUTS-2 regions are integral parts of the metro-region as defined by the OECD-EU. In addition, from a competitiveness point of view, it is not operational to calculate a score for a half of a functional labour market area. The competitiveness of a region relies on the quality of the available skills. In the case of Brussels and Inner London, the skills of the residents of the surrounding NUTS-2 region(s) are also relevant. To solve this problem we chose to combine Inner and Outer London to obtain a 'new' London region (coded as UKI00 for the purpose of the report) and the three regions around Bruxelles (BE10, BE 24, and BE31) to obtain BE00 (coded for the purpose of the report). The value of all the indicators has been accordingly combined in these cases, taking into account population size.

For the RCI computation, 268 total regions are then considered (the official number of NUTS 2 regions being 271).

Appendix D shows the NUTS2 classification used for RCI and the population sizes used for computing the weighted combined value of the indicators for the merged regions.

4.2 Missing data

When analyzing real data, the problem of missing data is always present at various degrees. In the case of RCI the preliminary selection of possible indicators has been driven also by the availability of a sufficient number of observations at least for the most recent surveys. For the purpose of this study a limit rate of 10%-15% of missing data has been considered as threshold for including an indicator in the RCI computation. In this way we could limit the issue to few cases. For some indicators we still face the following two situations:

- ✓ for <u>some</u> NUTS2 regions NUTS2 values are not observed while NUTS1 values are available;

- ✓ for <u>all</u> NUTS2 regions data are available at the country level only.

In the former case we assign NUTS1 values to the corresponding NUTS2 regions, thus imposing no variation at the NUTS2 level. Whenever only the country level is available no imputation is performed and data are marked as missing as we consider that imputing country values to the NUTS2 level would not give any information as to the regional variation within a country and would give a distorted message in the construction of the RCI.

In the latter case, if within the pillar most indicators are available at the NUTS2 level and only a minority of them at the country level, we adopted an empirical imputation method as described in the following subsection.

4.2.1 Imputation method

Whenever one or more indicators, within one pillar, are observed at the country level only, an imputation method is adopted which imputes missing data by statistical estimates using available data, which has been recently employed for the methodological assessment of the Regional Innovation Scoreboard (Hollanders et al, 2009). The method is detailed in the following.

Let Y be an indicator observed only at the country level – Y^{national} – for which it is necessary to estimate values at the regional level – Y_j^{regional}, with j being the region index. Select a subset of indicators $\{X_1, X_2, \ldots X_k\}$, where both national – X^{national} - and regional values – X_j^{regional} – have been observed, which are in direct relation to Y, according to either the analyst's judgment or some quantitative analysis. For a certain country C[10], the procedure calculates, for region j and indicator X_i, the ratio:

$$r_i^j = \frac{X_i^{\text{national}}}{X_{ij}^{\text{regional}}}$$

where X_i^{national} is the value of indicator X_i at the country level and X_{ij}^{regional} is the value of X_i for region j in country C. The arithmetic mean over of r_i^j over i, the subset of indicators $\{X_1, X_2, \ldots X_k\}$, is then computed to obtain an average ratio for each region of country C:

[10] For sake of simplicity the reference to the country is omitted in the notation.

$$\bar{r}^{j} = \frac{1}{k}\sum_{i=1}^{n} r_i^{j}$$

Eventually the missing value of indicator *Y* for region *j* in country *C* is imputed by assuming that the average ratio $\bar{r}^{j}$ between region *j* and *C* is valid for *Y*, that is the missing value for region *j* of indicator *Y* is imputed as:

$$Y_j^{\text{regional}} = \frac{Y^{\text{national}}}{\bar{r}^{j}}$$

Given that all national values are available for indicator *Y*, all missing values at the regional level can be imputed.

The procedure stems from the idea to 'spread' national values of the indicator *Y* across the regions according to the average performance of that region with respect to its country. The average performance is computed as a mean ratio of country and regional values for all the indicators, observed at the regional level, which show a significant correlation with *Y*, and are thus, considered as 'reference indicators' for *Y*.

4.3 Univariate analysis

In the first part of the statistical analysis, we focus on evaluating the quality of the candidate indicators and the extent to which they are sufficient and appropriate to describe their respective pillar. To this aim, indicators are first analyzed separately by a univariate analysis to

- ✓ check for the presence of missing values and evaluate the feasibility of including the indicator;
- ✓ compute basic descriptive statistics - mean, standard deviation, coefficient of variation, percentiles, minimum and maximum values;
- ✓ check for skewness, that implies the presence of outliers, and adopt appropriate transformations;
- ✓ normalize indicators.

For each indicator in each pillar a summary table with descriptive statistics and maps with the 10% best performing (market in blue) and 10% worst performing (marked in red[11]) regions are shown. These maps are effective in visualizing the performance of a region along the various aspects, described by the single indicators, contributing to competitiveness.

Histograms are also provided for depicting large differences in shape or symmetry across indicators. They give helpful information as to the need of scale transformation for indicators which demonstrate highly skewed or asymmetric distributions. The choice of transforming the indicator is based on the value of the distribution skewness. Each indicator is, hence, checked for skewness, transformed if necessary and then normalized. Note that the term 'transformation' is a general term which includes linear and non linear transformations. In this context we understand 'transformation' as a non linear one to symmetrize indicators in order to reduce the influence of outliers, and normalization as a linear transformation to get comparability across indicators and homoscedasticity.

Data transformation

In data analysis transformations are done in order to make data more symmetric, more linear, and more constant in variance. Transformation are monotonic, to preserve order relation, and have in general the effect of either expanding or contracting the distances to extreme observations on one side of the median, making distributions more symmetric around their central location. The classical measure to detect asymmetry in a distribution of an indicator is the skewness, which is defined as the adjusted third moment divided by the cube of the standard deviation (Helsel and Hirsch, 2002):

$$\kappa = \frac{n}{(n-1)(n-2)} \sum_{i=1}^{n} \frac{\left(x_i - \bar{x}\right)^3}{s^3} \qquad \text{4-1}$$

where *n* is the number observed values for the indicator, $\bar{x}$ is the arithmetic mean and *s* is its standard deviation. A right-skewed distribution has positive κ and outliers on the right hand side of the histogram; a left-skewed distribution has negative κ and a tail on the left. According to the skewness value the analyst chooses to proceed or not with data

[11] Regions in between best and worst 10% are marked in grey. The white color has been used for regions which either have missing observations on the indicator in question or represent regions which do not belong to the

transformation. A comment is in due. Despite the fact that transformations are often employed in the setting-up of composite indicators, it is worth noting that every transformation alters the original data. It is in general advisable to ponder the choice of transformation and to employ it only if really considered not avoidable. As for RCI, given the variety of indicators and their initial distribution used in the construction of RCI pillars, we adopted an approach which addresses data diversity while at the same time limits the use of transformations as much as possible. According to this, we chose a relative high threshold for κ, that is $|\kappa| = 1$, to limit the number of transformations.

Indicators are then transformed if $|\kappa| > 1$. In these cases we used a transformation belonging to the Box-Cox family.

The Box-Cox transformations are a set of power transformations for skewed data, which include the logarithmic transformation as particular case. They depend on parameter λ and take the following form (Zani, 2000):

$$\begin{aligned} \Phi_\lambda(x) &= \frac{x^\lambda - 1}{\lambda} \qquad \text{if } \lambda \neq 0 \\ \Phi_\lambda(x) &= \log(x) \qquad \text{if } \lambda = 0 \end{aligned} \tag{4-2}$$

Box-Cox transformations are continuous, monotonously increasing, concave if $\lambda < 1$ or convex if $\lambda > 1$. Due to these properties, the Box-Cox transformations generate a contraction of higher values when $\lambda < 1$ and a stretching of the higher values when $\lambda > 1$. Figure 4-1 shows some Box-Cox transformations corresponding to different values of the parameter λ. The choice of the value of λ depends on whether the distribution has a positive or negative asymmetry; hence it depends on the value of the skewness κ. In the RCI case we set:

$\lambda = 2$ if $\kappa \leq -1$ (left or negative skewness)

$\lambda = -0.05$ if $\kappa \geq +1$ (right or positive skewness)

We then adopted $\lambda = 2$ to correct for negative skewness and $\lambda = -0.05$ to correct for negative skewness. This choice is the result of a series of experiments carried out on the RCI

EU.

data-set. This is in line with literature recommendation of avoiding the tendency to search for the 'best' transformation tailor-made on each indicator. When dealing with several similar data-sets, it is in fact suggested to find one single transformation which fits reasonably well for all, rather than using slightly different ones for each (Helsel and Hirsch, 2002). Nevertheless, for two (out of 57) RCI indicators a slight adaptation of parameter λ was necessary to decrease the skewness value below the selected threshold.

It is worth noting that, given the low value chosen to correct for negative skewness, (λ = -0.05), the transformation to correct for right skewness is very close to the logarithmic one, which corresponds to $\lambda = 0$ (see 4-2).

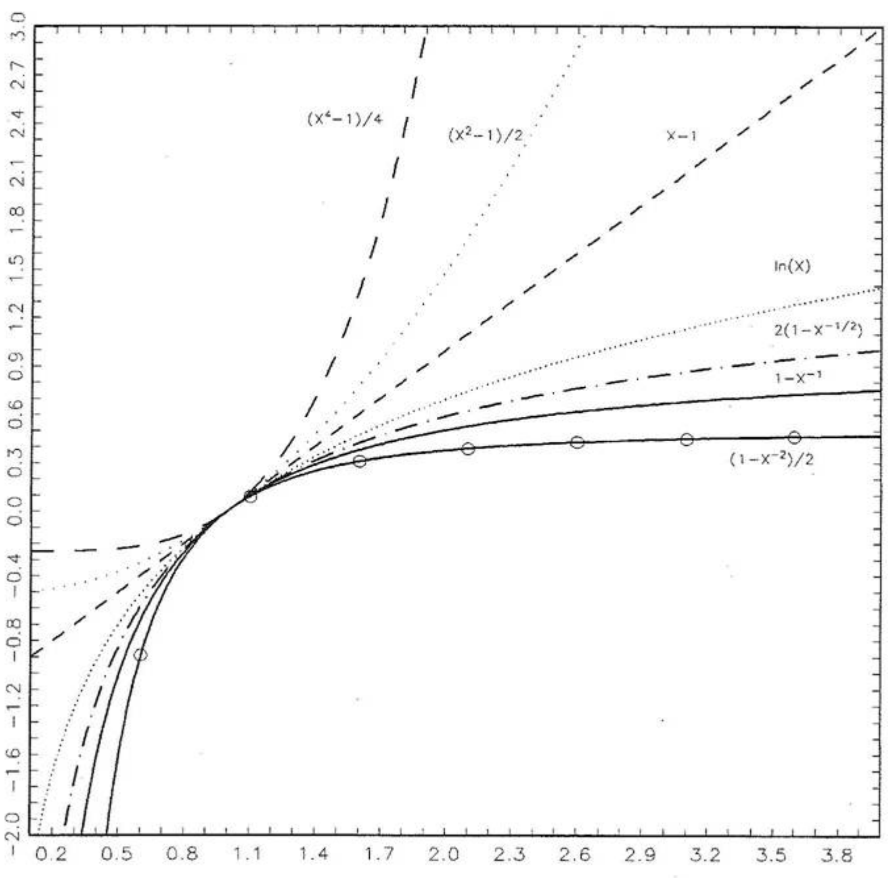


Figure 4-1: Box-Cox transformations for some values of λ of particular interest (Zani 2000)

If a negative value of λ is necessary, as is the case with highly negatively skewed distributions, the Box-Cox transformation is inappropriate if some observations are null. In these cases a logarithmic transformation corrected for zero values is adopted (Longman et al., 1995):

$$\Phi_{\lambda}(x) = \log(x+1) \tag{4-3}$$

After transformation, the indicator distribution is checked again to verify that the skewness of the transformed indicator falls below the threshold. With this regard, for highly asymmetric distributions, which are generally associated to the massive presence of null values, a robust measure of skewness is adopted instead of □, namely the quartile skew coefficient (Helsel and Hirsch, 2002):

$$\kappa_{\text{quartile}} = \frac{\left(P_{0.75} - P_{0.50}\right) - \left(P_{0.50} - P_{0.25}\right)}{\left(P_{0.75} - P_{0.25}\right)} \tag{4-4}$$

where $P_{0.\mathrm{m}}$ is the *m*-th percentile. By definition κ_{quartile} is based on the difference between distances of the upper and lower quartiles from the median divided by the interquartile range. As for κ, a right-skewed distribution has positive κ_{quartile} and a left-skewed distribution has a negative κ_{quartile}.

In all cases where these transformations have been undertaken, the histograms include both the distribution of the original indicator and the one of the transformed indicator as well as the description of the type of transformation adopted.

Normalization

Normalization is a kind of linear transformation. Normalization is necessary for any data aggregation as the indicators in a dataset have very frequently different measurement units and aggregation is meaningful only when indicators are comparable. There are a variety of normalization methods and the most frequently used in composite indicators are z-scores and min_max transformations (OECD, 2008).

For RCI weighted z-scores are adopted. As known, the z-scores transformation converts indicators to a common scale with a mean of zero and unitary standard deviation putting all indicator scores onto the same scale, one where the unit of measurement is the standard deviation (Knoke et al., 2002). In the RCI case, weighted averages and weighted standard deviation are chosen for the standardization with weights being the average population size of the region in the period 2004-2008 (see Table in Appendix D), which is the period covered by the indicators in the RCI data-set. The value of each indicator is then transformed as

$$x_{\text{std}} = \frac{x - \bar{x}_w}{\sigma_w}$$

$$\bar{x}_w = \frac{1}{P_{tot}} \sum_{i=1}^{n} x_i p_i \qquad P_{tot} = \sum_{i=1}^{n} p_i \tag{4-5}$$

$$\sigma_w = \sqrt{\frac{1}{P_{tot}} \sum_{i=1}^{n} (x_i - \bar{x}_w)^2 p_i}$$

where *n* is the total number of NUTS2 region p_i is the average population size in region *i* in the period 2004-2008.

For RCI computation, indicators are firstly transformed by a Box-Cox or logarithmic transformation, if necessary, and then they are all z-standardized.

4.4 Multivariate analysis

Multivariate analysis is carried out to verify internal data consistency within each pillar. Some general considerations are due at this point. In the setting-up of a composite each pillar is designed to describe a particular aspect of the latent phenomenon which is viewed as a 'combination' of related still different aspects. This implies that a desired feature of the composite framework is to have a high level of correlation within each pillar that would imply, in turn, that a unique single aspect is underlying each pillar. To assess, ex ante, that the selected indicators fulfill this requirement, a dimensionality reduction method is applied. To this aim Classical Principal Component Analysis (PCA) is employed separately for each pillar, as all the RCI indicators are numerical, quantitative variables. PCA is a classical multivariate exploratory technique that does not assume any statistical underlying model (Morrison, 2005).

Standard practice in PCA is to choose relevant dimensions if they (OECD, 2008):

- ✓ are associated to eigenvalues above one (Kaiser's rule);
- ✓ individually account to total variance by more than 10%;

- ✓ cumulatively contribute to total variance by more than 60%.

For each pillar an overall PCA is carried out with all the indicators included in the pillar to assess/confirm the number of relevant dimensions 'behind' the pillar itself. Prior PCA, indicators are checked for the right orientation with respect to the level of competitiveness. As a rule, we chose to have a positive orientation, that is the higher the score the higher the competitiveness level. Accordingly, some indicators have been reversed.

The main goal of PCA for RCI is to statistically detect the number of underlying dimensions within each pillar. In the ideal situation, every sub-pillar should show a single most relevant dimension accounting for a large amount of variance, evenly described by all indicators included in the sub-pillar, with all concordant[12] correlations with the main PCA component, that is the component loadings. This would also allow for completely avoiding compensability when aggregating indicators to get sub-scores at the pillar level, where 'compensability' is intended as the undesirable offsetting of low performing indicators with high performing ones. As it will be shortly discussed (Chapter 5), overall the framework chosen for RCI has been confirmed by the multivariate statistical analysis. Only few cases present anomalous indicators which may be due either to the choice of the indicators or their actual observed values. In these cases better alternatives have been looked for.

Various outcomes from PCA are reported and discussed for each of the ten pillars (Chapter 5) :

- ✓ the correlation matrix between indicators;
- ✓ the plot of eigenvalues with respect to their corresponding PCA dimension - scree plot, which visually indicates the presence of a major unique dimension, if any;
- ✓ the component matrix, which shows the correlation coefficients between indicators and the PCA dimensions to identify indicators relevance in the composition of PCA components;
- ✓ the total variance (both absolute and cumulative) explained by PCA dimensions, to determine their relevance in explaining the total indicators variance.

[12] If the sign of the correlation of the indicators with the main factors is the same, it means that the set of indicators have all the same orientation with respect to the level of competitiveness.

The PCA analysis helped to assess the validity of the underlying starting hypothesis of each pillar describing the same latent aspect of the level of competitiveness.

All the statistical analyses for RCI development are carried out using Matlab® 6.5 and PASW Statistics® 18.

The next Chapter presents the outcomes of the statistical assessment carried out pillar by pillar.

5 Pillar by pillar statistical analysis

Following the structure of the statistical assessment presented in Chapter 4, a separate discussion of each of the eleven pillars is outlined in the following sections. For each pillar, the chosen indicators are individually analyzed by univariate statistical methods and as a whole by the multivariate approach. The indicators used have a direct positive relation with competitiveness, i.e. the higher their value the higher the level of competitiveness. Whenever necessary, original indicators have been reversed. Multivariate analysis has been used to verify the existence of a single latent dimension. In few cases indicators which do not describe this common dimension, underlying the specific pillar, have been discarded (Appendix C gives information on all indicators considered and the reasons for discarding some of them). The geographical distribution of the pillar sub-score, computed as a simple average of the transformed/standardized indicators, is shown. Sub-scores are presented as min-max normalized scores (as percentage) and are divided into six classes, with high values associated with high competitiveness. Tables with corresponding sub-scores and the regions' ranks have been included at the end of each section.

5.1 Institutions

The candidate indicators identified to describe the pillar are detailed in Section 3.1. In the following we recall them, including the abbreviations used for the statistical analysis.

Indicators included, in brackets short names:

1. Corruption as a major national problem (reversed) (country_corruption)
2. Presence of corruption in regional institutions (reversed) (regional_corruption)
3. Perceived level of budget defraud (reversed) (budget_defraud)
4. Frequency of corruption and/or wrongdoing of national institutions (reversed) (corruption_frequency)
5. Voice and accountability (voice_accountability)
6. Political stability (political_stability)
7. Government effectiveness (govt_effectiveness)
8. Regulatory quality (regulatory_quality)
9. Rule of law (rule_of_law)
10. Control of corruption (corruption_control)
11. Ease of doing business (reversed) (business_ease)

UNIVARIATE ANALYSIS

Table 3 presents some basic descriptive statistics of the eleven indicators listed above. All indicators are measured at the country level and we have no missing data for all but one indicator. Malta is not included in the ranking of the Ease of Doing Business index. Most indicators do not present high coefficients of variation with the exception of some of the World Bank Governance indicators - political stability, government effectiveness, rule of law, control of corruption and ease of doing business - which indicate a somewhat more heterogeneous situation among EU Member States.

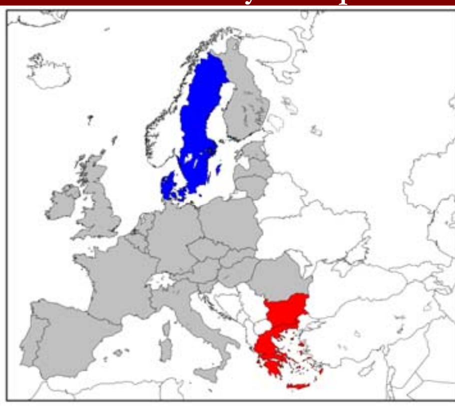
Table 3: Descriptive statistics of Institutional indicators

Name of indicator	Country level corruption perception	Regional level corruption perception	Budget defraud level	Perception of corruption frequency	Voice and accountability	Political stability	Government effectiveness	Regulatory quality	Rule of law	Control of corruption	Ease of doing business index
description of indicator	% of respondents who totally agree that corruption is a major problem in their country	% of respondents who agree that there is corruption in regional institutions in their country	% of respondants who think that the state budget is being defrauded rather frequently	% of respondents who think that corruption or other wrongdoing in the national government and institutions are rather frequent	score ranging from -2.5 to 2.5	score ranging from -2.5 to 2.5	score ranging from -2.5 to 2.5	score ranging from -2.5 to 2.5	score ranging from -2.5 to 2.5	score ranging from -2.5 to 2.5	rank out of 183
source	Special Eurobarometer 325	Special Eurobarometer 325	Flash Eurobarometer 2008	Flash Eurobarometer 2008	World Bank Governance Indicators	World Bank Governance Indicators	World Bank Governance Indicators	World Bank Governance Indicators	World Bank Governance Indicators	World Bank Governance Indicators	World Bank Doing Business Report 2010
reference year	2009	2009	2008	2008	2008	2008	2008	2008	2008	2008	June 2008-May 2009
% of missing values	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70
mean value	77.30	79.41	65.37	59.03	1.13	0.80	1.15	1.29	1.14	1.09	40.50
standard deviation (unbiased)	20.05	15.60	13.76	17.96	0.29	0.39	0.61	0.38	0.61	0.80	25.29
coefficient of variation	0.26	0.20	0.21	0.30	0.25	0.48	0.53	0.29	0.53	0.74	0.62
maximum value	98.00	96.00	90.80	83.90	1.53	1.52	2.19	1.92	1.92	2.34	109
region corresponding to maximum value	GR	GR	GR	LT	SE	LU	DK	IE	DK	FI	GR
minimum value	22.00	30.00	36.60	23.30	0.48	-0.03	-0.14	0.53	-0.12	-0.17	5
region corresponding to minimum value	DK	DK	EE	DK	RO	ES	RO	RO	BG	BG	UK

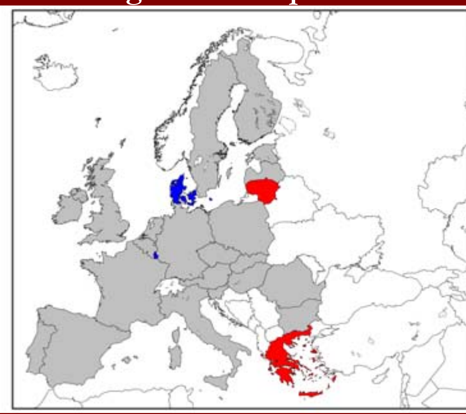
How do EU regions score in each of the indicators?

We can note that Scandinavian countries (Denmark, Sweden, Finland) are best performers in almost all indicators describing the Institutional pillar. Denmark is a top performer in five out the eleven indicators. We see Eastern European countries (Bulgaria, Romania, Estonia and Lithuania), and some of the Mediterranean countries (Greece, worst performer in four indicators, and Spain), having the lowest scores.

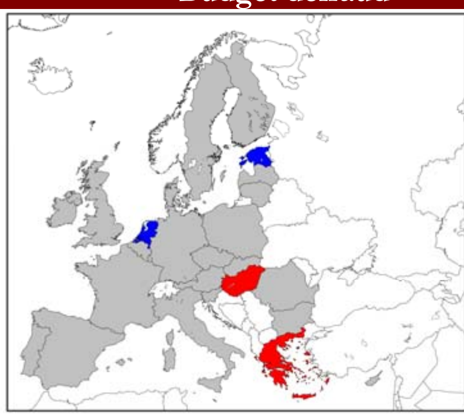
Country corruption



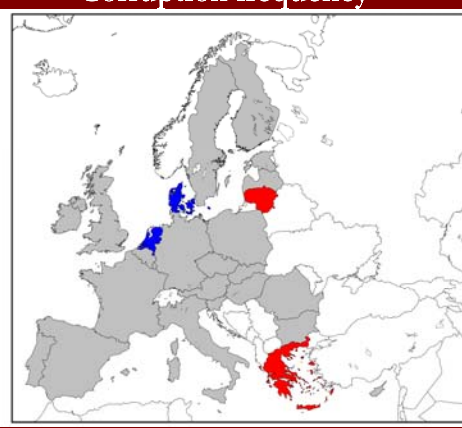
Regional corruption



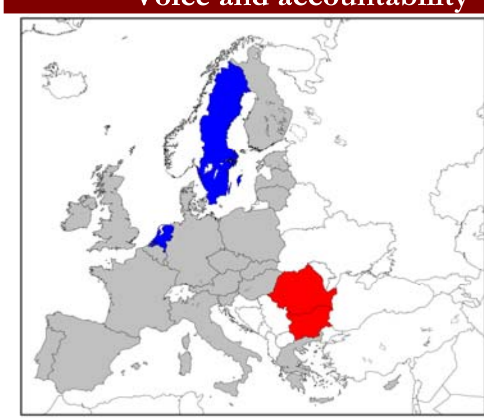
Budget defraud



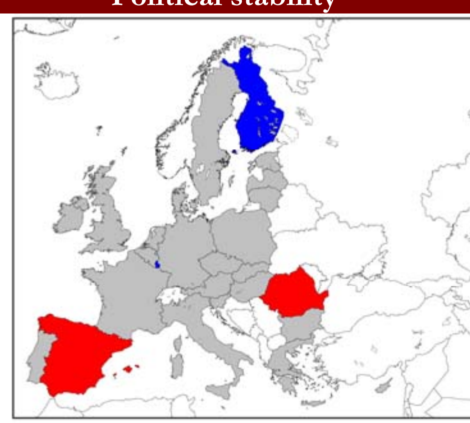
Corruption frequency



Voice and accountability



Political stability



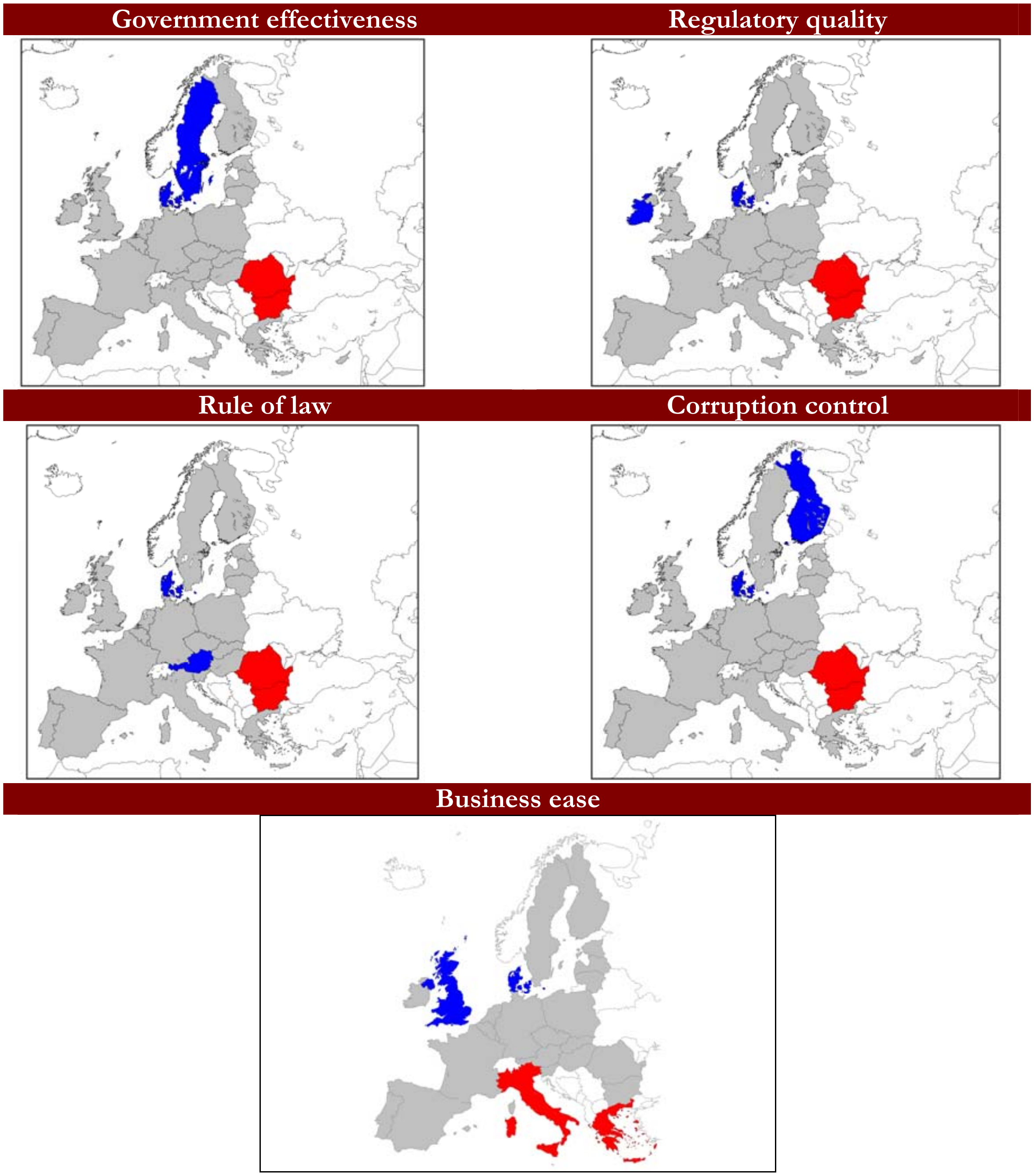
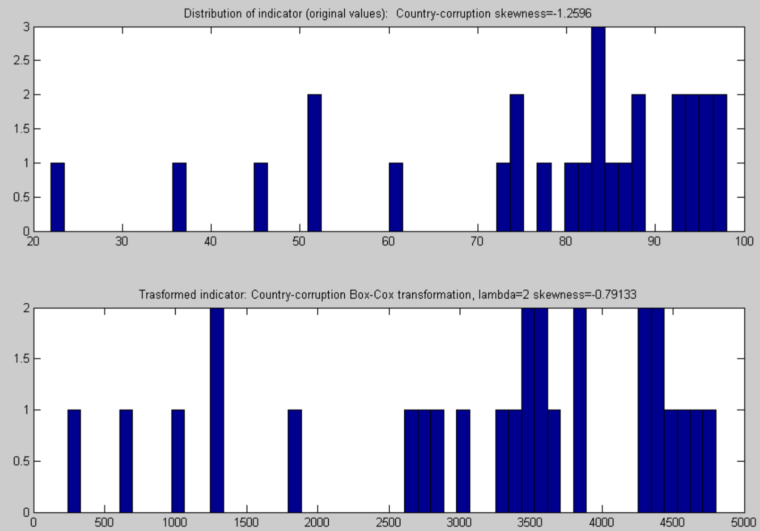


Figure 5-1: Best and worst performing regions for each indicator – Institutions

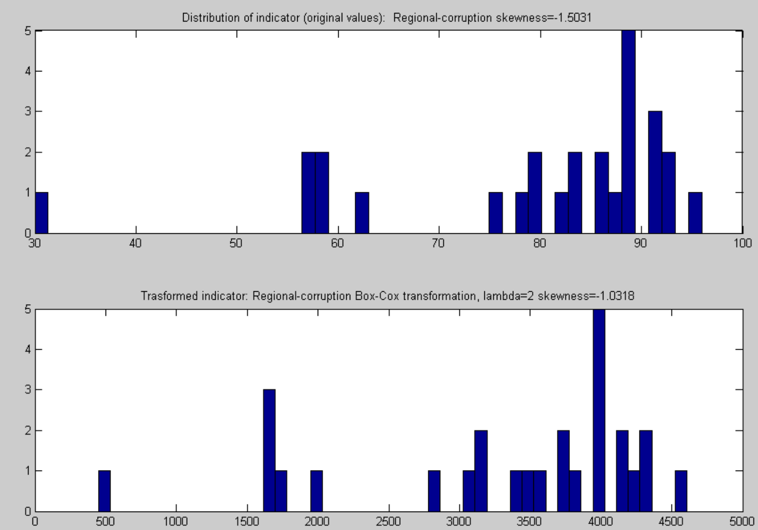
Out of all indicators, only two, national and regional corruption, have been transformed using the Box-Cox method. Histograms are shown in Table 4.

Table 4: Histograms of Institutional indicators

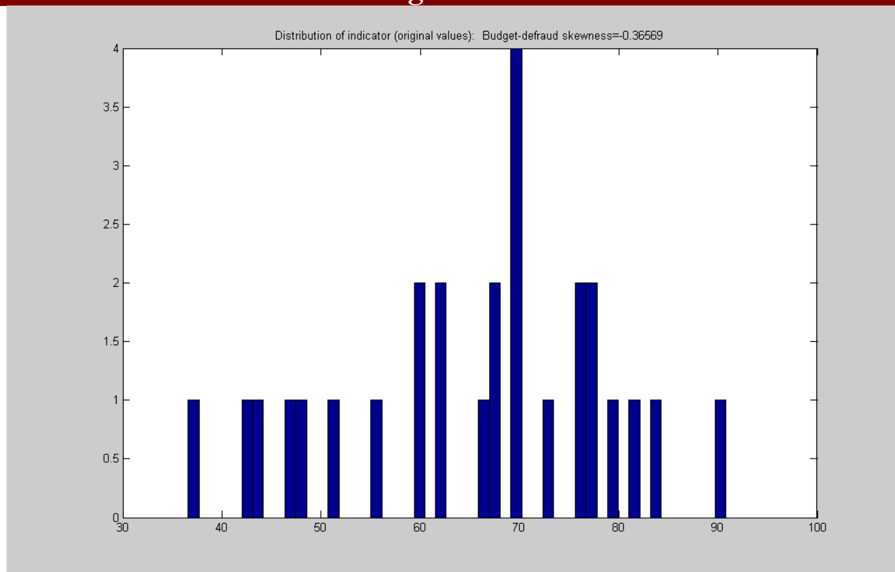
Country corruption



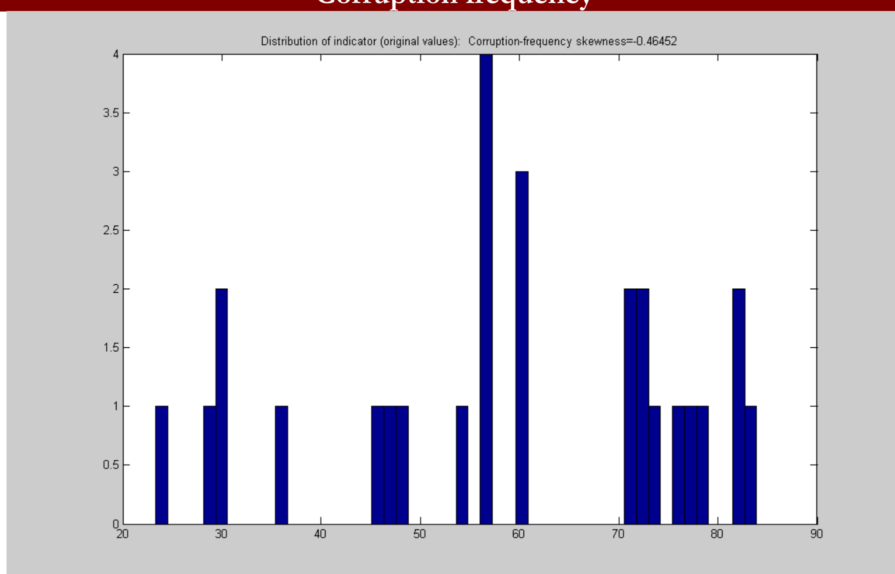
Regional corruption



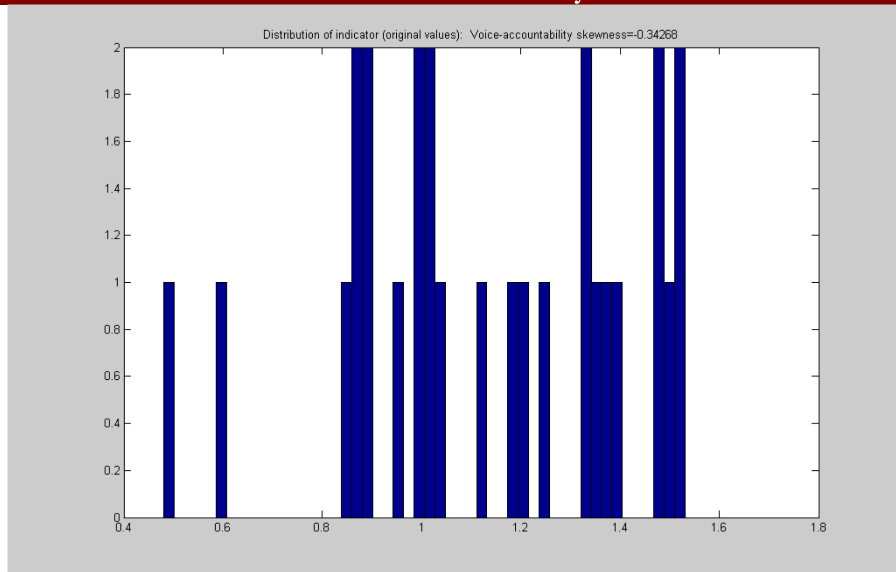
Budget defraud



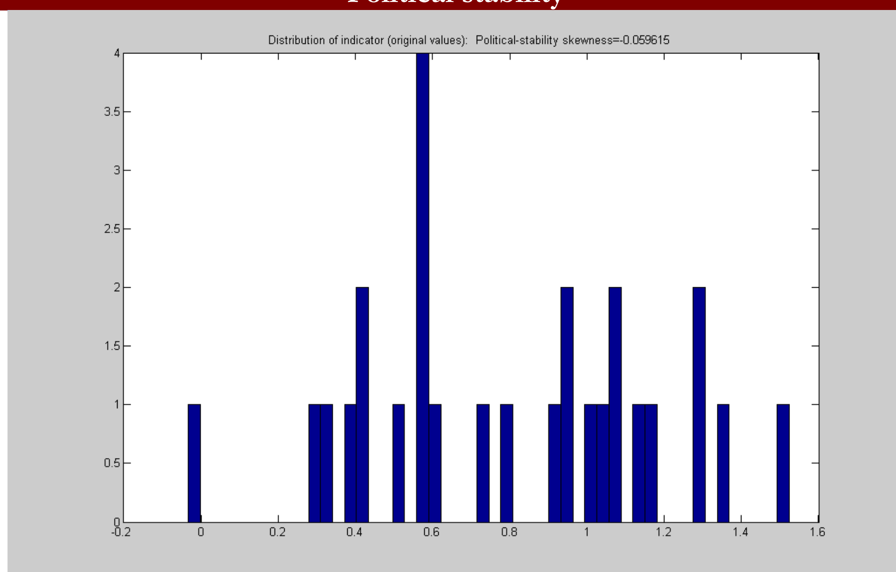
Corruption frequency



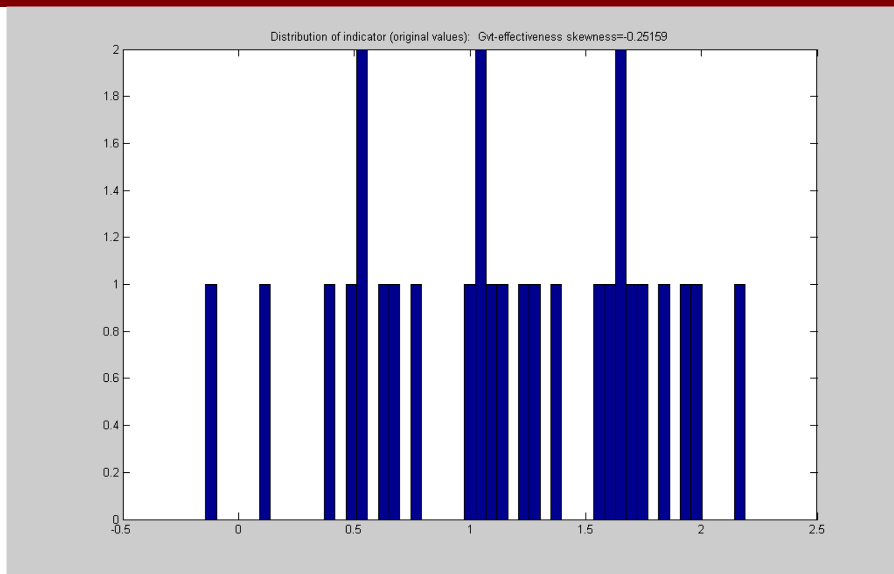
Voice accountability



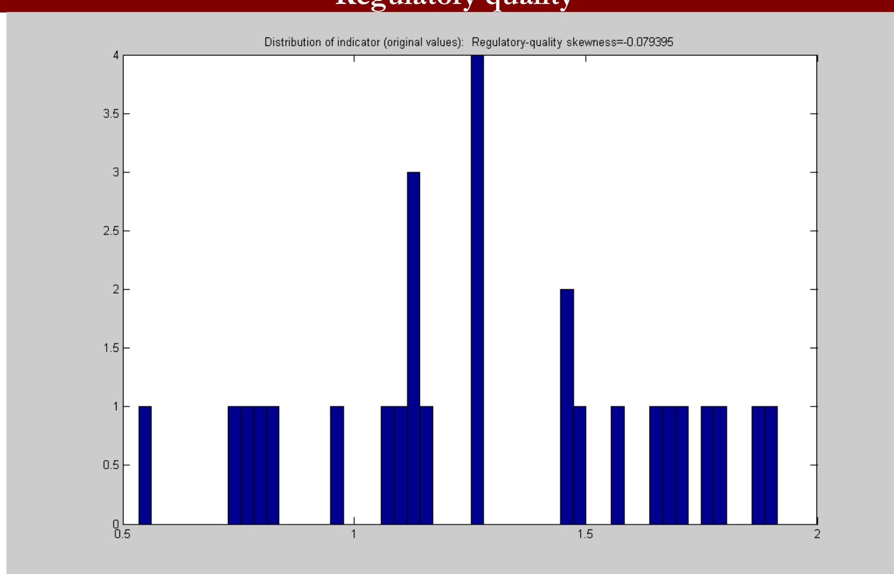
Political stability



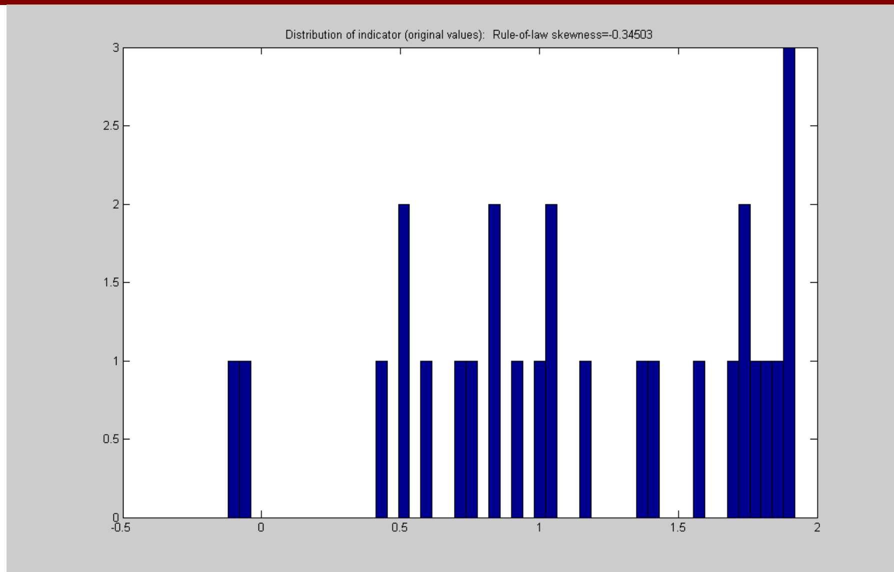
Government effectiveness



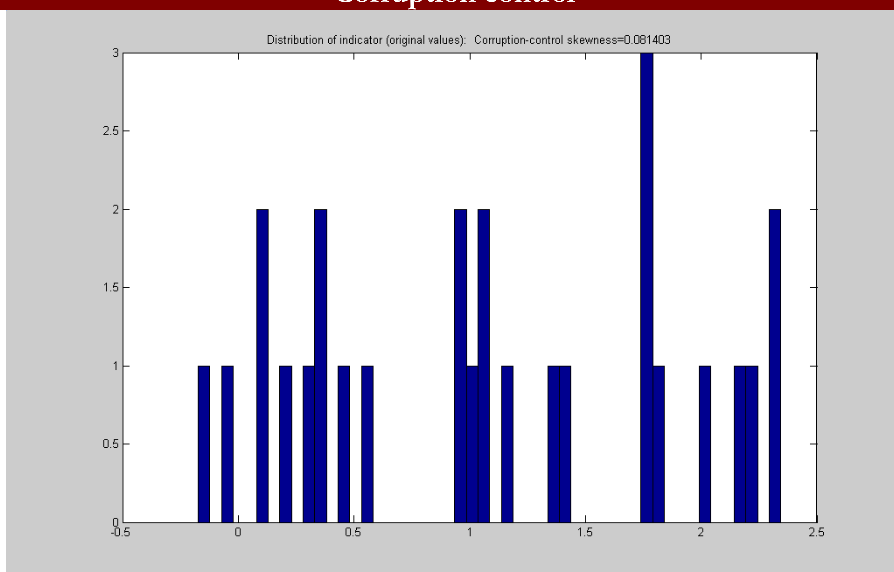
Regulatory quality



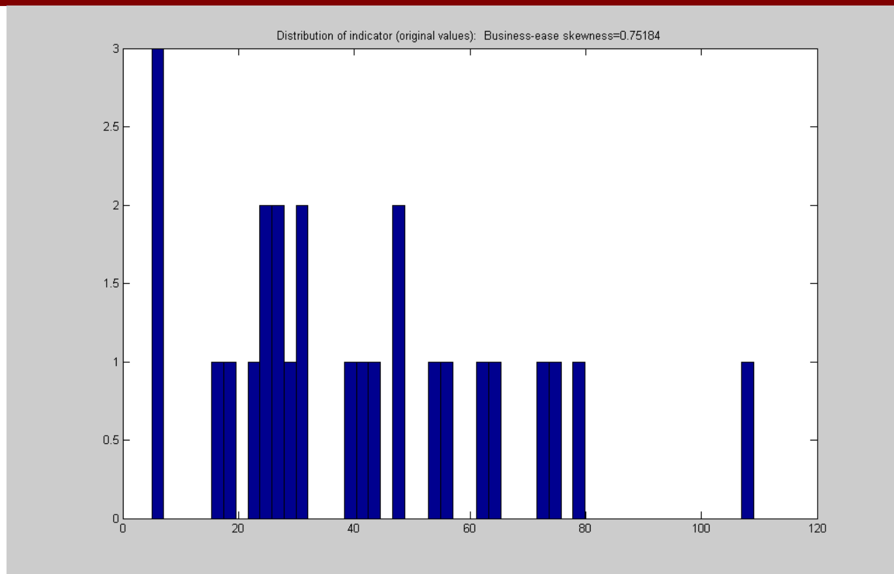
Rule of law



Corruption control



Business ease



MULTIVARIATE ANALYSIS

Despite the different sources of indicators which describe this pillar, the PCA analysis clearly depicts a single latent dimension almost uniformly represented by all the selected indicators. This can be easily seen in the scree plot (Figure 5-2) which reveals the presence of a clear unique aspect underlying the whole set of indicators included in the pillar. The correlation matrix (Table 5) accordingly shows that all the indicators are well correlated. The first PCA component alone explains more than 73% of total variation (Table 7). From Table 6 one can see that the contribution of each indicator to this component is approximately the same, with the exception of indicators budget_defraud, political_stability and business_ease which show a relatively lower correlation with the first dimension.

Overall, the multivariate analysis indicates the presence of a unique single latent dimension to which all the indicators contribute in a balanced way. This supports the simple choice of equal weights for the computation of the Institutional pillar sub-score as linear combination of transformed and standardized indicators. Figure 5-3 shows the geographical distribution of the Institutional sub-score at the country level, while Table 8 reports the Institutions pillar sub-score values. The distribution of sub-score values across countries is due in Figure 5-4.

Table 5: Correlation matrix between indicators included in the Institutions pillar

Correlation Matrix

		country_ corruption_ reversed	regional_ corruption_ reversed	budget_ defraud_ reversed	corruption_ frequency_ reversed	voice_ accountability	political_ stability	govt_ effectiveness	regulatory_ quality	rule_of_law	corruption_ control	business_ ease_ reversed
Correlation	country_corruption_ reversed	1.000	.958	.487	.757	.748	.516	.769	.722	.709	.803	.490
	regional_corruption_ reversed	.958	1.000	.586	.834	.760	.584	.809	.738	.745	.837	.510
	budget_defraud_reversed	.487	.586	1.000	.800	.536	.356	.545	.598	.505	.599	.486
	corruption_frequency_ reversed	.757	.834	.800	1.000	.799	.510	.805	.750	.777	.861	.538
	voice_accountability	.748	.760	.536	.799	1.000	.631	.950	.892	.962	.944	.507
	political_stability	.516	.584	.356	.510	.631	1.000	.624	.494	.620	.594	.327
	govt_effectiveness	.769	.809	.545	.805	.950	.624	1.000	.888	.964	.962	.606
	regulatory_quality	.722	.738	.598	.750	.892	.494	.888	1.000	.892	.878	.681
	rule_of_law	.709	.745	.505	.777	.962	.620	.964	.892	1.000	.948	.552
	corruption_control	.803	.837	.599	.861	.944	.594	.962	.878	.948	1.000	.601
	business_ease_reversed	.490	.510	.486	.538	.507	.327	.606	.681	.552	.601	1.000
Sig. (1-tailed)	country_corruption_ reversed		.000	.005	.000	.000	.003	.000	.000	.000	.000	.006
	regional_corruption_ reversed	.000		.001	.000	.000	.001	.000	.000	.000	.000	.004
	budget_defraud_reversed	.005	.001		.000	.002	.034	.002	.000	.004	.000	.006
	corruption_frequency_ reversed	.000	.000	.000		.000	.003	.000	.000	.000	.000	.002
	voice_accountability	.000	.000	.002	.000		.000	.000	.000	.000	.000	.004
	political_stability	.003	.001	.034	.003	.000		.000	.004	.000	.001	.052
	govt_effectiveness	.000	.000	.002	.000	.000	.000		.000	.000	.000	.001
	regulatory_quality	.000	.000	.000	.000	.000	.004	.000		.000	.000	.000
	rule_of_law	.000	.000	.004	.000	.000	.000	.000	.000		.000	.002
	corruption_control	.000	.000	.000	.000	.000	.001	.000	.000	.000		.001
	business_ease_reversed	.006	.004	.006	.002	.004	.052	.001	.000	.002	.001	

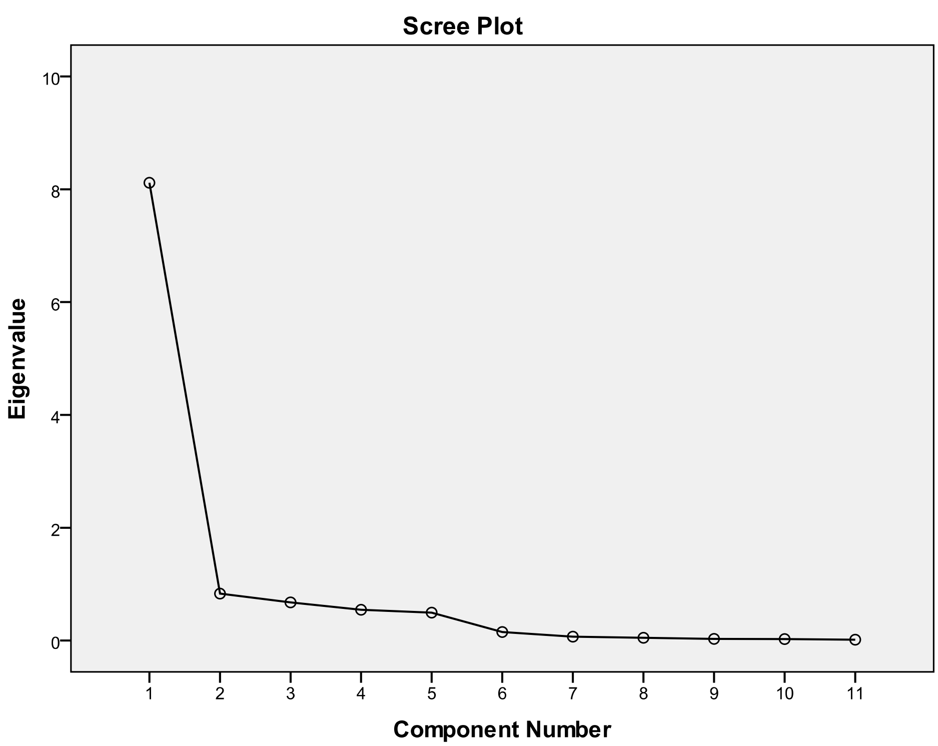


Figure 5-2: PCA analysis of the Institutions pillar - eigenvalues

Table 6: PCA analysis Institutions pillar: correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component										
	1	2	3	4	5	6	7	8	9	10	11
country_corruption_ reversed	.853	-.064	.238	-.370	.236	.077	.006	.095	.007	.025	.056
regional_corruption_ reversed	.894	-.018	.288	-.241	.207	.009	.033	-.101	.004	.001	-.074
budget_defraud_reversed	.680	.567	.303	.288	-.145	.104	.094	.027	.003	.017	.000
corruption_frequency_ reversed	.899	.228	.243	.022	-.114	-.196	-.168	-.027	.017	-.011	.022
voice_accountability	.940	-.192	-.100	.012	-.206	.025	-.043	.132	.046	-.011	-.065
political_stability	.657	-.440	.180	.506	.291	.030	-.023	-.001	-.010	-.006	.010
govt_effectiveness	.959	-.134	-.141	-.015	-.094	-.064	.116	-.049	.093	-.064	.037
regulatory_quality	.914	.060	-.252	-.038	-.092	.267	-.097	-.067	-.025	-.033	.016
rule_of_law	.934	-.191	-.184	.024	-.189	-.040	.025	-.046	-.006	.128	.011
corruption_control	.970	-.064	-.063	-.051	-.108	-.110	.068	.027	-.133	-.047	.002
business_ease_reversed	.658	.402	-.472	.074	.413	-.076	-.004	.025	.008	.011	-.012

Extraction Method: Principal Component Analysis.

a. 11 components extracted.

Table 7: PCA analysis for the Institutions pillar: explained variance

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	8.115	73.770	73.770
2	.831	7.557	81.327
3	.676	6.144	87.471
4	.544	4.950	92.421
5	.495	4.502	96.923
6	.151	1.376	98.299
7	.068	.622	98.921
8	.048	.441	99.362
9	.030	.270	99.632
10	.025	.230	99.861
11	.015	.139	100.000

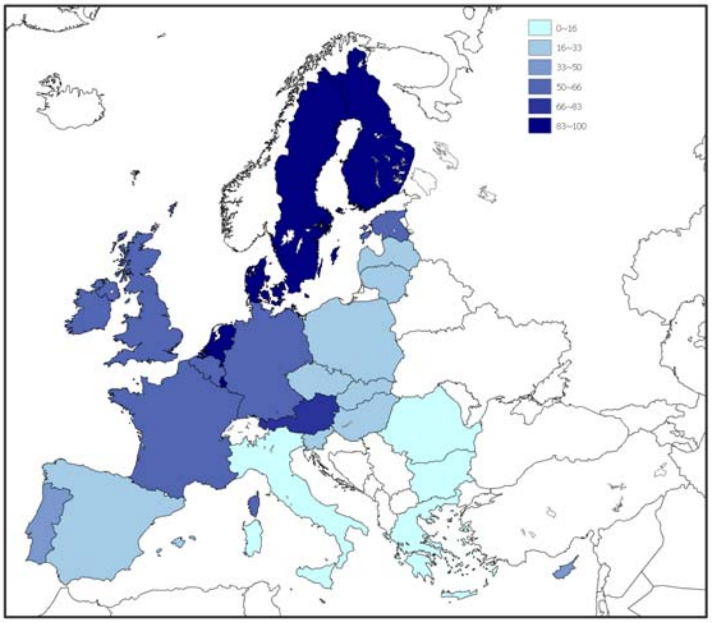


Figure 5-3: Map of Institutions sub-score at the country level (min-max normalized values)

Table 8: Institutions sub-score as arithmetic mean of transformed and standardized indicators.

country	Subscore	Min_max normalized subscore
BE	0.54	57
BG	-1.24	7
CZ	-0.61	24
DK	2.05	100
DE	0.49	56
EE	0.41	53
IE	0.86	66
GR	-1.47	0
ES	-0.33	32
FR	0.3	50
IT	-0.97	14
CY	-0.24	35
LV	-0.74	21
LT	-0.75	20
LU	1.57	86
HU	-0.75	20
MT	0.26	49
NL	1.56	86
AT	1	70
PL	-0.84	18
PT	-0.09	39
RO	-1.37	3
SI	-0.44	29
SK	-0.44	29
FI	1.67	89
SE	1.46	83
UK	0.68	61

Figure 5-4. Histogram of Institutions sub-score

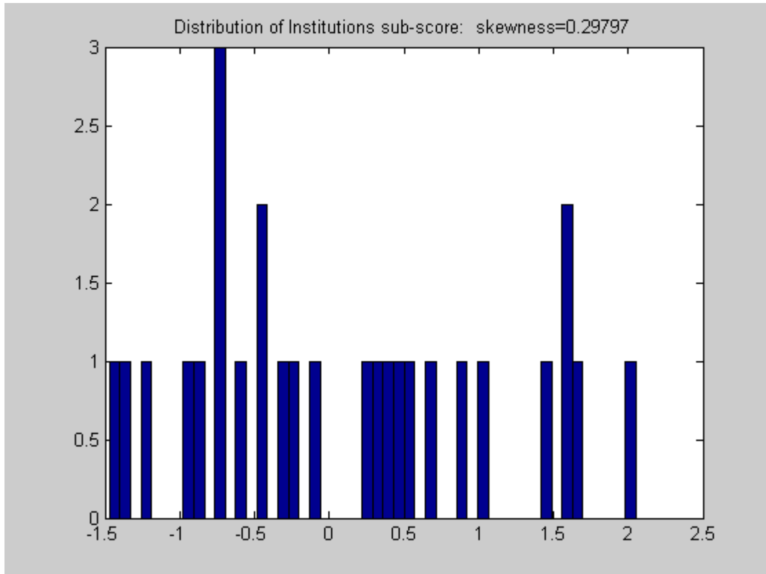


Table 9 shows the re-ordering of countries from best to worst in the quality of institutions.

Table 9: Institutions pillar sub-rank (from best to worst)

Institutions		
1	DK	Denmark
2	FI	Finland
3	LU	Luxembourg
4	NL	Netherlands
5	SE	Sweden
6	AT	Austria
7	IE	Ireland
8	UK	United Kingdom
9	BE	Belgium
10	DE	Germany
11	EE	Estonia
12	FR	France
13	MT	Malta
14	PT	Portugal
15	CY	Cyprus
16	ES	Spain
17	SI	Slovenia
18	SK	Slovakia
19	CZ	Czech republic
20	LV	Latvia
21	LT	Lithuania
22	HU	Hungary
23	PL	Poland
24	IT	Italy
25	BG	Bulgaria
26	RO	Romania
27	GR	Greece

5.2 Macroeconomic stability

The indicators identified to describe the pillar are detailed in Section 3.2. In the following we recall them including the abbreviations used for the statistical analysis.

Indicators included, in brackets short names:

1. General government deficit (-) and surplus (+) (government_surplus/deficit)
2. Income, saving and net lending / net borrowing (national_savings)
3. Annual average inflation rate (reversed) (inflation)
4. Long term bond yields (reversed) (government_bond_yields)
5. Government gross debt (reversed) (government_debt)

Due to temporal fluctuations of all the indicators, we have computed the 2006-2008 average for each of them. The most recent data (2009) has not been included as, at the time of the RCI 2010 elaborations, the figures were not yet final but mostly provisional.

As for the orientation of the indicators, the first two – government surplus/deficit and national savings – are positively related to the level of competitiveness, while the remaining ones are all negatively related to competitiveness.

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Basic descriptive statistics of selected indicators are shown in Table 10. There are no missing values for three out of the five indicators. We have 7.41% of missing values for the indicator on national_savings which is below out threshold and thus, has been included. Similarly, government_bond_yields shows low percentage of missing values equal to 3.7 %. Greatest variation among EU Member states can be observed in the indicator on government_surplus/deficit.

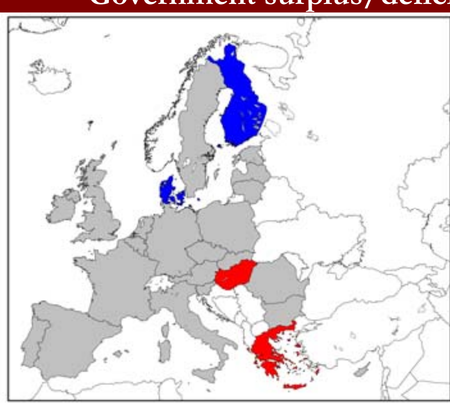
Table 10: Descriptive statistics of Macroeconomic stability indicators

Name of indicator	Government surplus/deficit	National savings	Inflation	Government bond yields	Government debt
description of indicator	% of GDP	% of GDP	Annual average rate of change in Harmonized Indices of Consumer Prices (HICPs)	EMU convergence criterion bond yields	% of GDP
source	Eurostat	Eurostat	Eurostat	Eurostat	Eurostat
reference year	average 2006-2008	average 2006-2008	average 2006-2008	average 2006-2008	average 2006-2008
% of missing values	0.00	7.41	0.00	3.70	0.00
mean value	-0.95	20.17	3.90	4.63	44.98
standard deviation (unbiased)	2.62	5.59	2.27	0.89	26.81
coefficient of variation	-2.76	0.28	0.58	0.19	0.60
maximum value	4.57	28.30	10.67	7.37	105.27
region corresponding to maximum value	FI	SE	LV	HU	IT
minimum value	-6.03	7.87	1.83	3.92	4.30
region corresponding to minimum value	HU	GR	NL	SE	EE

How do EU regions score in each of the indicators?

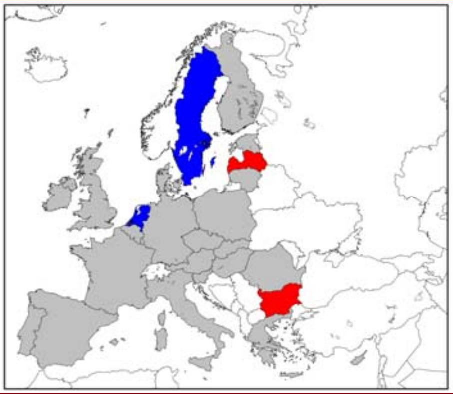
The countries with highest government deficit are Hungary and Greece while the highest surplus is present in Finland and Denmark. Highest level of national savings is observed in Sweden and the Netherlands while lowest results are present in Greece and Cyprus. Highest inflation is present in Latvia and Bulgaria while the countries with lowest inflation rate are Sweden and the Netherlands. With regards to the indicator on government bond yields, highest trust by the markets is observed for Sweden and Germany while Romania and Hungary show the lowest results. Government debt is highest in Italy and Greece and lowest in Estonia and Luxembourg.

Government surplus/deficit

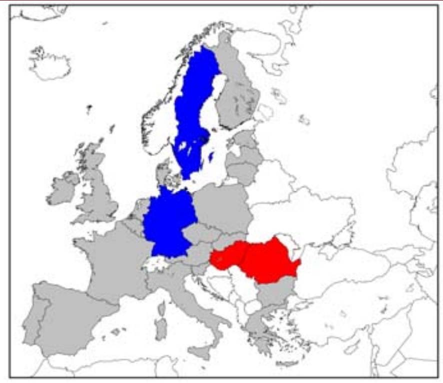


National savings

Inflation



Government bond yields



Government debt

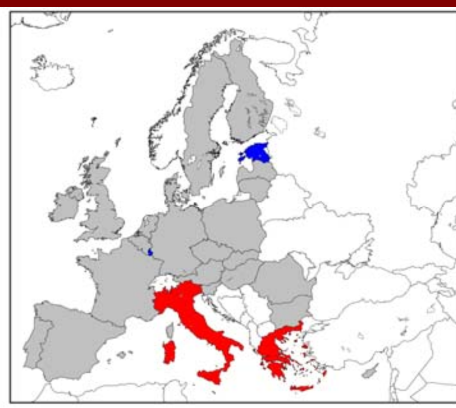
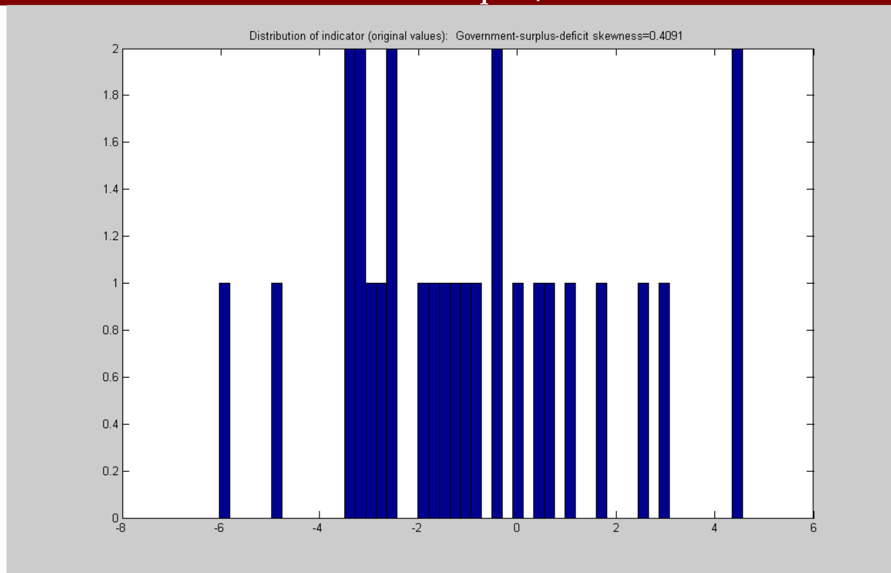


Figure 5-5: Best and worst performing regions for each indicator – Macroeconomic stability

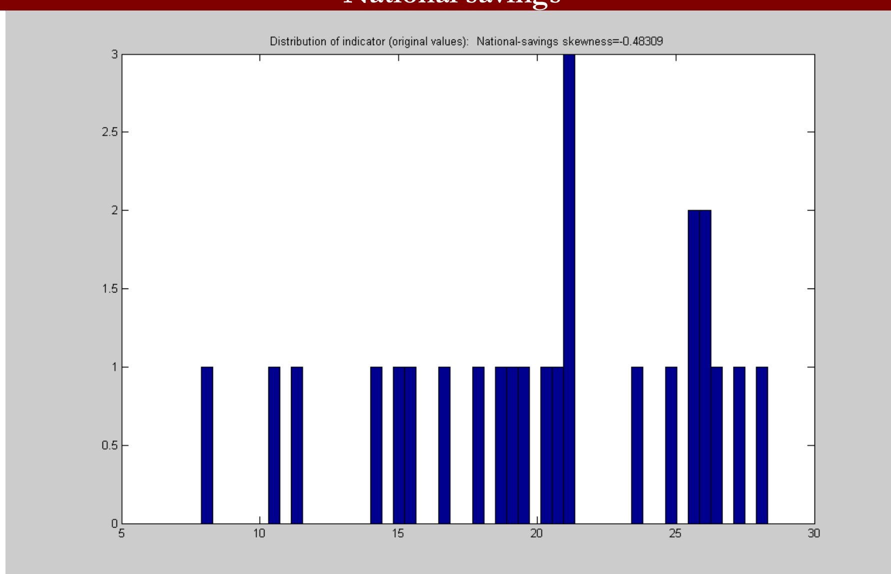
Table 11 shows the histograms of the five indicators included in the Macroeconomic stability pillar. Two indicators have been transformed due to positive skewness – Inflation has been transformed with the Box-Cox method while Government_bond_yields has been transformed logarithmically.

Table 11. Histograms of Macroeconomic stability indicators

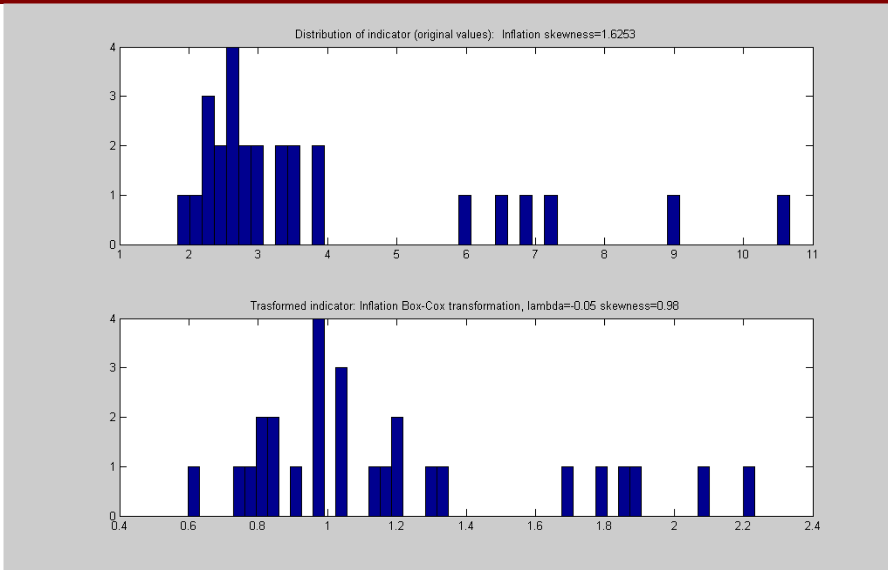
Government surplus/deficit



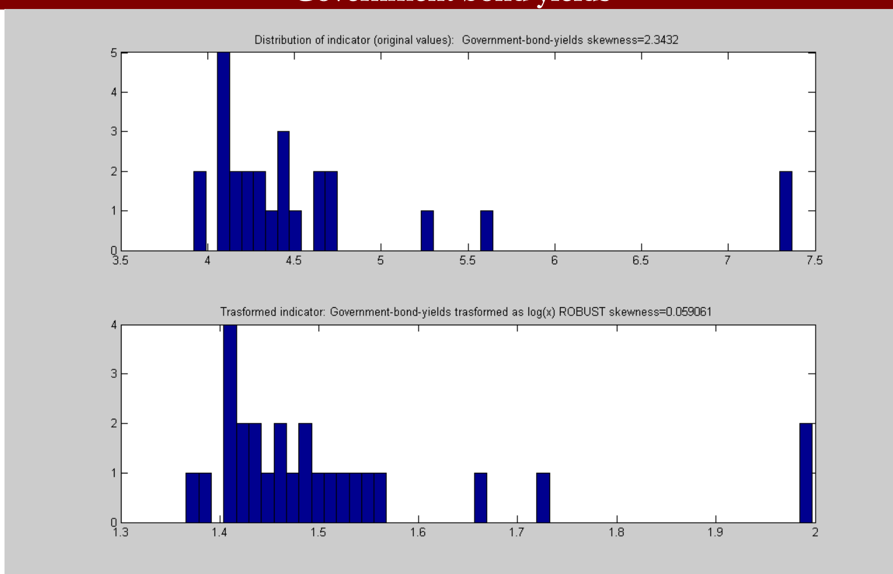
National savings



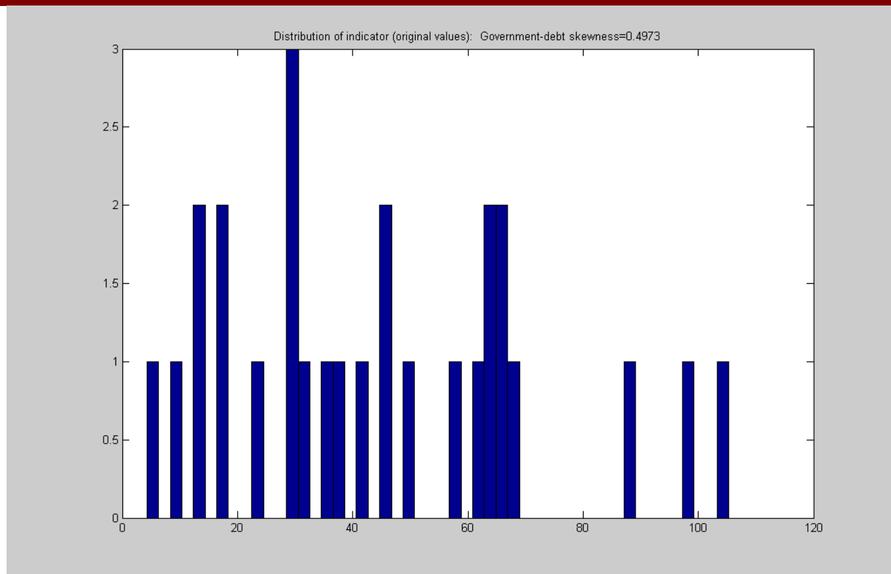
Inflation



Government bond yields



Government debt



MULTIVARIATE ANALYSIS

The correlation and PCA analysis including all the indicators shows that the indicator Government_debt is not fully consistent with the others. The correlation matrix (

Table 12) already shows that Government_debt is significantly negatively correlated with the inflation indicator (reversed), with a correlation coefficient of -0.522, while it is not correlated with National_savings and Government_bond_yields (reversed). Accordingly, the PCA scree plot (Figure 5-6) highlights the presence of two latent dimensions, the first accounting for 46% and the second for 32% of total variance (Table 13). The two dimensions have then comparable explanatory power, with the second one mostly related to Government_debt whose correlation coefficient with the second dimension is 0.94 (Table 14). This could be potentially explained by the fact that higher government debt is not necessarily related to a weak and unstable economy, especially in times of economic crisis. Moreover, there are particular countries, as Romania for instance, where the government debt is very low for political reasons (during the dictatorship the country was forced to be economically self-sufficient) but this is not positively correlated with higher competitiveness and economic stability. In fact, countries could have higher government debt, both in absolute terms and relative to GDP, but more competitive countries would have better prospects to pay it back, as partially described by the indicator Government_bond_yields. For these reasons the indicator Government_debt is more likely to have a 'bell shape' behavior with respect to the level of competitiveness, rather than a linear one as can be captured by correlation and PCA-type analyses. This does not mean that the indicator is 'bad' in absolute terms, but that it does not fit into the simple mathematical structure desired, and needed, for the composite RCI.

Table 12: Correlation matrix between all initial indicators included in the Macroeconomic Stability pillar

Correlation Matrix

		Government_ surplus_deficit	National_ savings	Inflation_ reversed	Government_ bond_yields_ reversed	Government_ debt_reversed
Correlation	Government_surplus_deficit	1.000	.496	.194	.544	.387
	National_savings	.496	1.000	.368	.322	.187
	Inflation_reversed	.194	.368	1.000	.610	-.522
	Government_bond_yields_ reversed	.544	.322	.610	1.000	-.167
	Government_debt_reversed	.387	.187	-.522	-.167	1.000
Sig. (1-tailed)	Government_surplus_deficit		.006	.167	.002	.023
	National_savings	.006		.035	.062	.186
	Inflation_reversed	.167	.035		.000	.003
	Government_bond_yields_ reversed	.002	.062	.000		.207
	Government_debt_reversed	.023	.186	.003	.207	

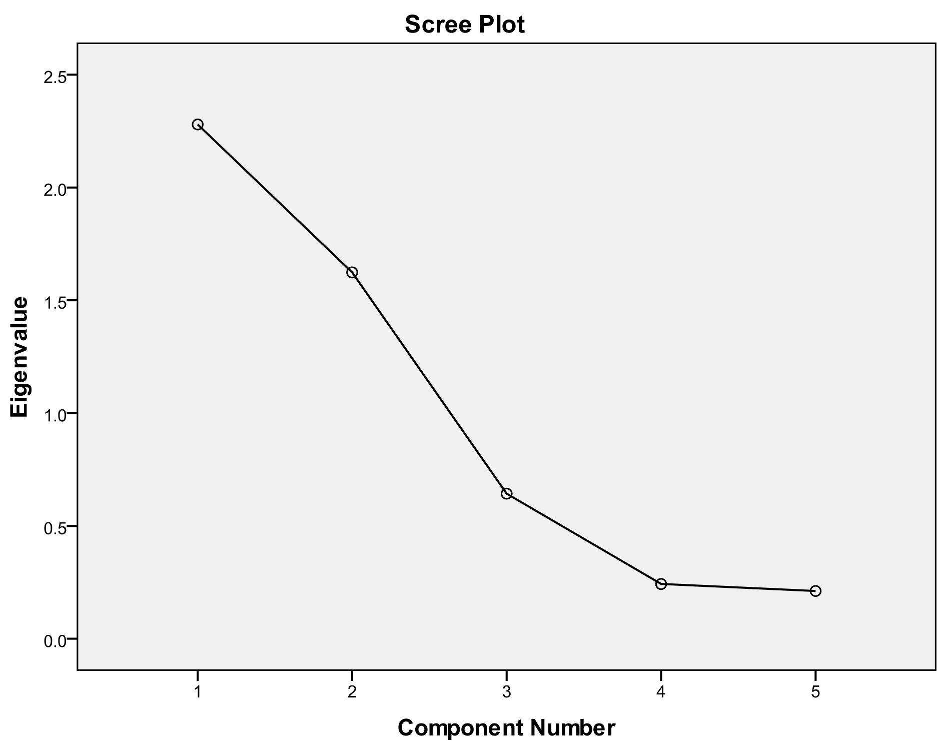


Figure 5-6: PCA analysis of all initial indicators included in the Macroeconomic Stability pillar - eigenvalues

Table 13: PCA analysis for the Macroeconomic Stability pillar, all initial indicators: explained variance

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	2.279	45.586	45.586
2	1.624	32.475	78.061
3	.643	12.861	90.922
4	.242	4.850	95.772
5	.211	4.228	100.000

Table 14: PCA analysis Macroeconomic Stability pillar, all initial indicators: correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component				
	1	2	3	4	5
Government_surplus_ deficit	.712	.556	-.260	-.335	.062
National_savings	.691	.330	.623	.022	-.158
Inflation_reversed	.752	-.551	.129	.066	.332
Government_bond_ yields_reversed	.848	-.135	-.410	.236	-.196
Government_debt_ reversed	-.101	.940	-.048	.263	.185

Extraction Method: Principal Component Analysis.

a. 5 components extracted.

For the reasons discussed above, we decided to exclude the indicator Government_debt from further analysis. We believe that dropping this indicator will not penalize the pillar excessively. Indeed the indicator on government long-term bond yields, retained in the pillar, describes the market perception of the reliability of the country and its debt. In other words, no matter how large is a country's debt, the important thing is that investors believe that the country will be able to pay it back in the long-term.

In the following the multivariate analysis with the subset of indicators is discussed. The scree plot (Figure 5-7) shows that now only one prevalent dimension underlies the set of indicators, explaining almost 57% of total variability (Table 15). Each indicator contributes at roughly the same extent to this major dimension, as can be seen from the table of component loadings (Table 16).

The pillar without the Government_debt indicator is statistically consistent.

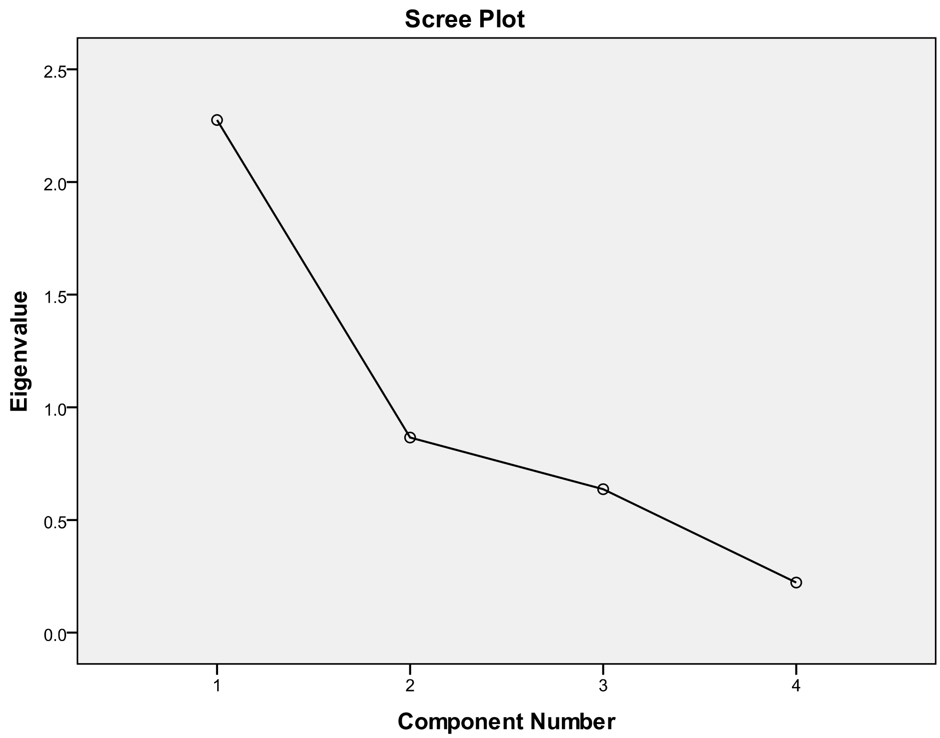


Figure 5-7: PCA analysis Macroeconomic Stability, without Government_debt

Table 15: PCA analysis Macroeconomic Stability pillar, without Government_debt: explained variance

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	2.275	56.876	56.876
2	.866	21.648	78.524
3	.637	15.914	94.438
4	.222	5.562	100.000

Table 16: PCA analysis Macroeconomic Stability pillar without Government_debt indicator:

Component Matrix[a]

	Component			
	1	2	3	4
Government_surplus_ deficit	.743	.520	-.347	.238
National_savings	.708	.389	.571	-.143
Inflation_reversed	.719	-.611	.229	.240
Government_bond_ yields_reversed	.840	-.265	-.371	-.296

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

The Macroeconomic stability sub-score is computed as a simple arithmetic mean of transformed (if necessary) and standardized values of the first four indicators listed at the beginning of this section. The geographical distribution of the sub-scores is shown in Figure 5-8 while Table 17 displays pillar sub-scores. The distribution of the sub-scores is shown in Figure 5-9.

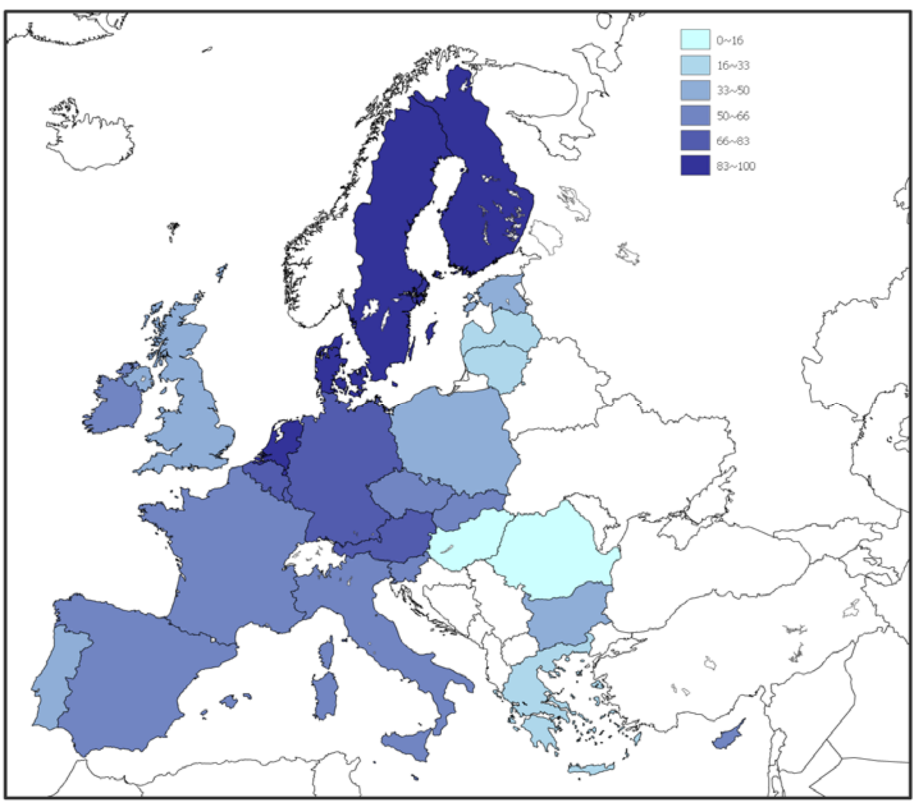


Figure 5-8: Map of Macroeconomic Stability sub-score at the country level (min-max normalized values shown in Table 17)

Table 17: Macroeconomic Stability sub-score as arithmetic mean of transformed and standardized indicators.

country	Subscore	Min_max normalized subscore
BE	0.6	75
BG	-0.83	35
CZ	0.08	60
DK	1.3	94
DE	0.83	81
EE	-0.43	46
IE	0.18	63
GR	-1.22	24
ES	0.23	65
FR	0.15	62
IT	-0.05	57
CY	-0.18	53
LV	-1.35	20
LT	-1	30
LU	0.67	77
HU	-2.08	0
MT	-0.23	52
NL	1.2	92
AT	0.75	79
PL	-0.58	42
PT	-0.55	43
RO	-1.63	13
SI	0.25	65
SK	-0.2	53
FI	1.47	99
SE	1.5	100
UK	-0.55	43

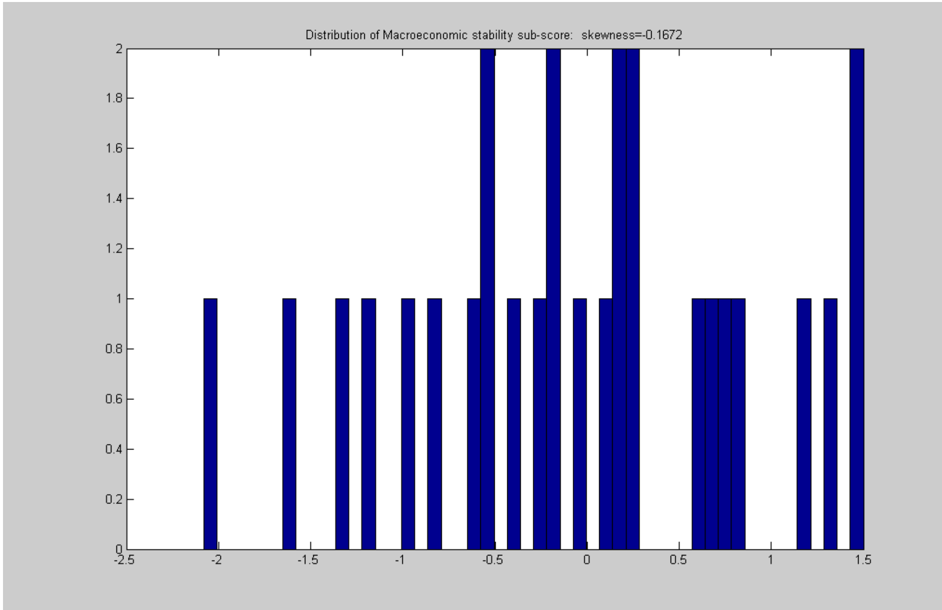


Figure 5-9. Histogram of Macroeconomic Stability sub-score

Table 18 shows the re-ordering of countries from best to worst in terms of Macroeconomic Stability.

Table 18: Macroeconomic Stability pillar sub-rank (from best to worst)

Macroeconomic stability		
1	SE	Sweden
2	FI	Finland
3	DK	Denmark
4	NL	Netherlands
5	DE	Germany
6	AT	Austria
7	LU	Luxembourg
8	BE	Belgium
9	SI	Slovenia
10	ES	Spain
11	IE	Ireland
12	FR	France
13	CZ	Czech republic
14	IT	Italy
15	CY	Cyprus
16	SK	Slovakia
17	MT	Malta
18	EE	Estonia
19	PT	Portugal
20	UK	United Kingdom
21	PL	Poland
22	BG	Bulgaria
23	LT	Lithuania
24	GR	Greece
25	LV	Latvia
26	RO	Romania
27	HU	Hungary

5.3 Infrastructure

Candidate indicators are described in Section 3.3 and are recalled bellow.

Indicators included, in brackets short names:

1. Motorway combined index (motorway_index_combined)
2. Railway combined index (railway_index_combined)
3. Number of passenger flights (number_of_passenger_flights)

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Table 19 presents the descriptive statistics for the three indicators included in the Infrastructure pillar. The motorway index refers to 2006 while the remaining two indicators refer to 2007. The coefficients of variation indicate diverse infrastructural condition within EU regions, especially so for the access to passenger flights. Two of the indicators do not have any missing data while the third one, number of passenger flights, presents only close to 2% of missing values.

Table 19: Descriptive statistics of Infrastructure indicators

Indicator	Motorway density	Railway density	Number of passenger flights
description	motorway, combined index (average pop/area), EU27=100	railway combined index (average pop/area), EU27=100	daily number of passenger flights (accessible within 90'drive)
source	Eurostat/DG TREN/EuroGeographics/National Statistical Institutes	Eurostat/DG TREN/EuroGeographics/National Statistical Institutes	Eurostat/EuroGeographics/National Statitical Institutes
reference year	2006	2007	2007
% of missing values	0.00	0.00	1.87
mean value	146.65	138.40	587.42
standard deviation (unbiased)	127.01	91.56	672.53
coefficient of variation	0.87	0.66	1.14
maximum value	846.04	727.24	3428.67
region corresponding to maximum value	PT17	DE30	UKJ1
minimum value	0.00	0.00	0.00
region corresponding to minimum value	BG32	GR21	ES63

How do EU regions score in each of the indicators?

Motorway development is underdeveloped in Eastern Europe while railway development sees Southern European regions underperforming. We can see that Mediterranean and Eastern European countries generally perform worse on the infrastructure indicators. Swedish regions score very high on the railway index. The UK region Berkshire, Buckinghamshire and Oxfordshire (UKJ1) has the highest number of daily passenger flights and generally, the southern regions of the UK have among the most developed passenger flight connections.

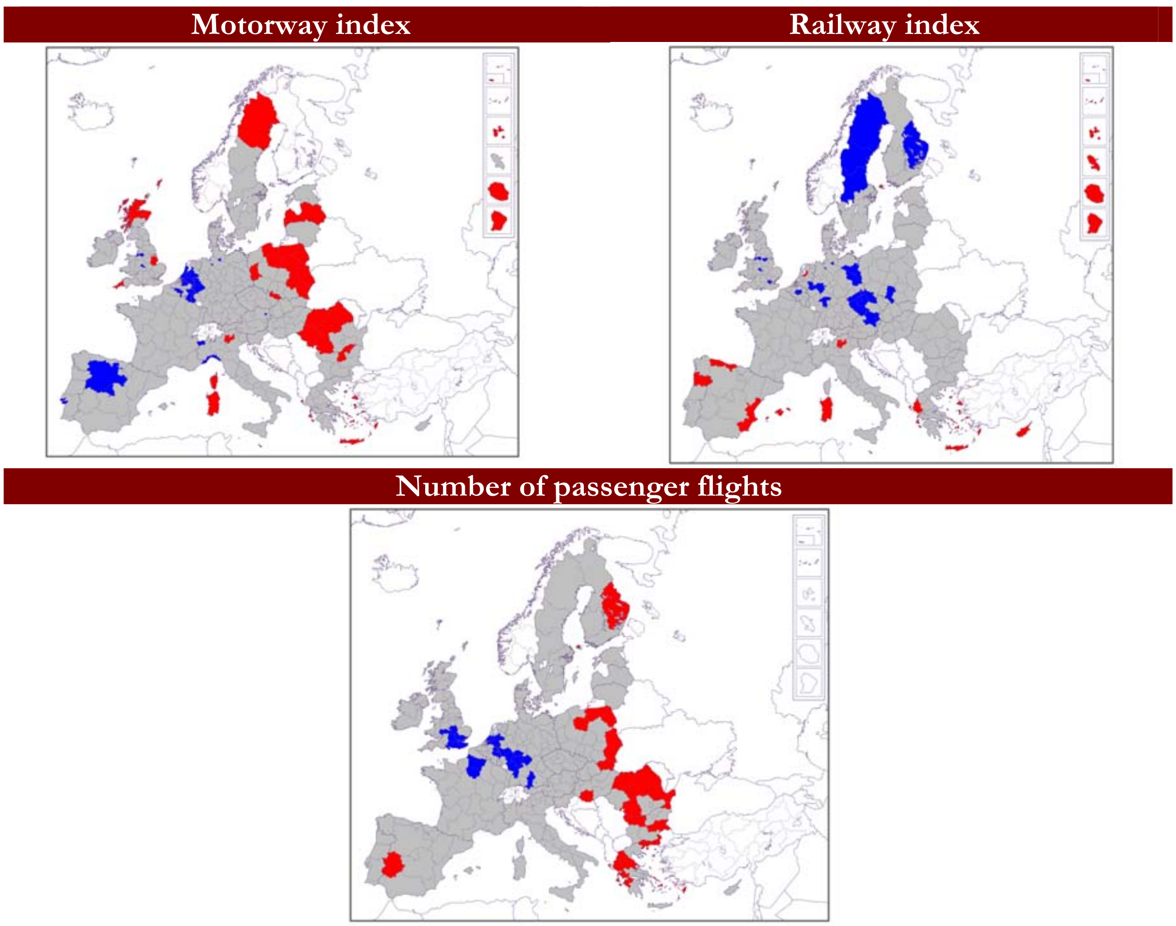


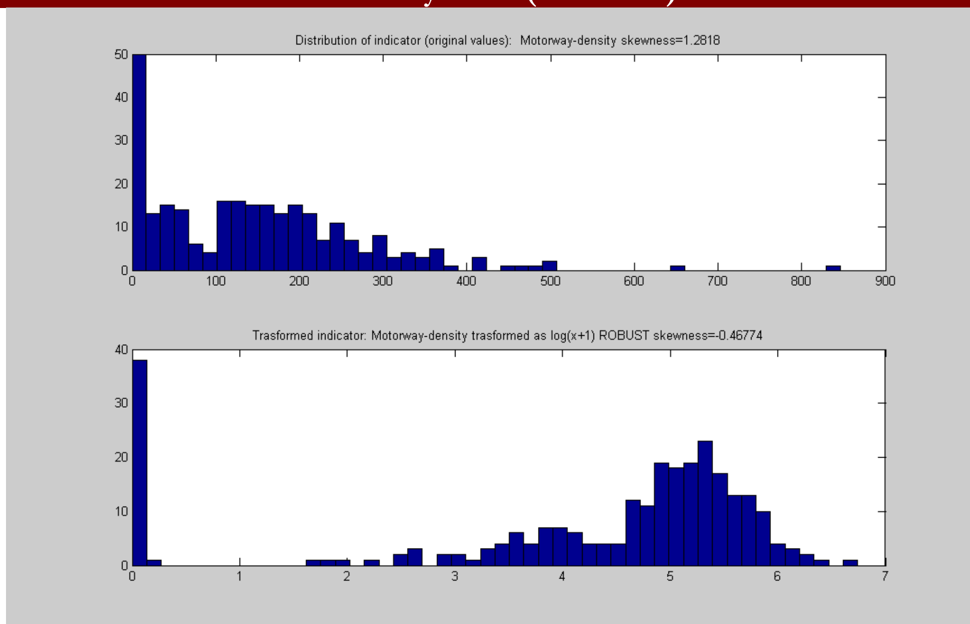
Figure 5-10: Best and worst performing regions for each indicator – Infrastructure[13]

[13] In some cases the worst performers include more than 10% of all regions in order to accommodate the fact that they all have the same value for the indicator.

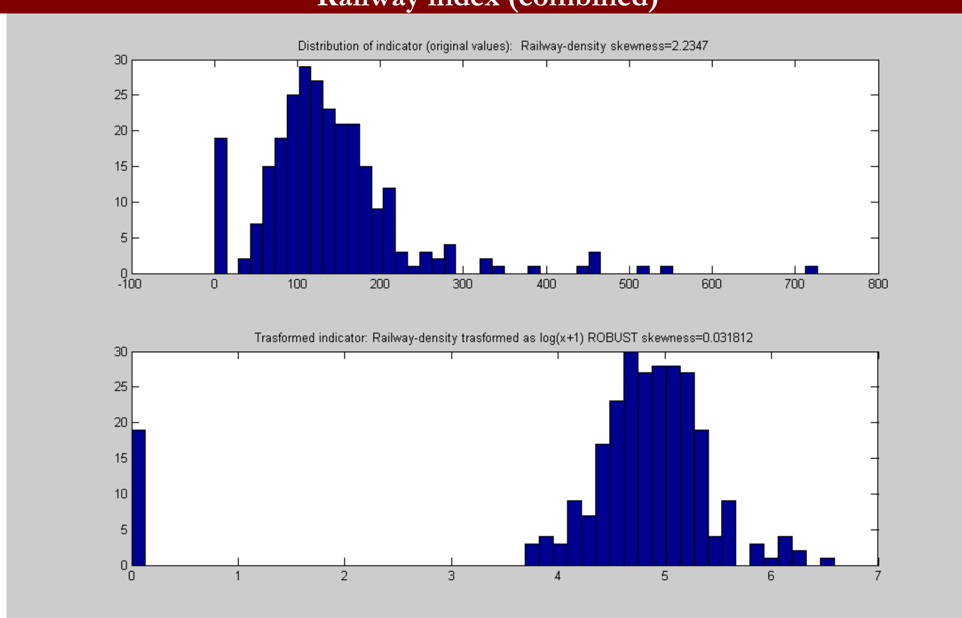
Due to the nature of the infrastructure data and the presence of zero values, all indicators have been logarithmically transformed as described in Section 4.3. Table 20 shows the histograms of both the original and transformed values.

Table 20 Histograms of Infrastructure indicators

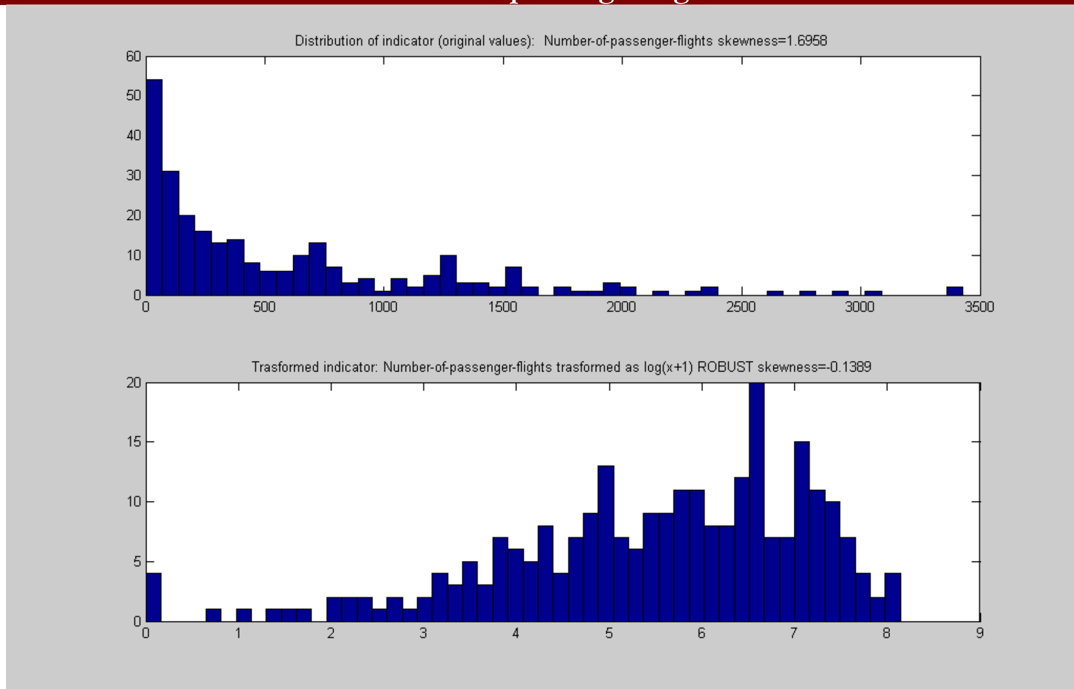
Motorway index (combined)



Railway index (combined)



Number of passenger flights



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The PCA analysis highlights the presence of one prevalent dimension almost equally described by all the indicators. The analysis of both the scree plot (Figure 5-11) and the cumulative percentage of explained variance (Table 23) suggests the presence of a second minor dimension which accounts for about 23% of the total variance. This dimension is mainly represented by the indicator 'railway_index_combined' with which it has the highest correlation, 0.713 (Table 22). In any case, it can be concluded that this pillar has a unique, underlying dimension, well captured by the selected indicators.

The geographical distribution of sub-scores across NUTS2 regions is displayed in Figure 5-12 while the histogram of the Infrastructure sub-scores is shown in Figure 5-13. Negative skewness of the sub-score distribution can be noted which is due to the relevant presence of zero values in the original indicators (not eliminated by the indicator transformation). Reordered regions from best to worst are due in Table 25.

Table 21: Correlation matrix between indicators included in the Infrastructure pillar

Correlation Matrix

		motorway_index_combined	railway_index_combined	number_of_passenger_flights
Correlation	motorway_index_combined	1.000	.442	.654
	railway_index_combined	.442	1.000	.334
	number_of_passenger_flights	.654	.334	1.000
Sig. (1-tailed)	motorway_index_combined		.000	.000
	railway_index_combined	.000		.000
	number_of_passenger_flights	.000	.000	

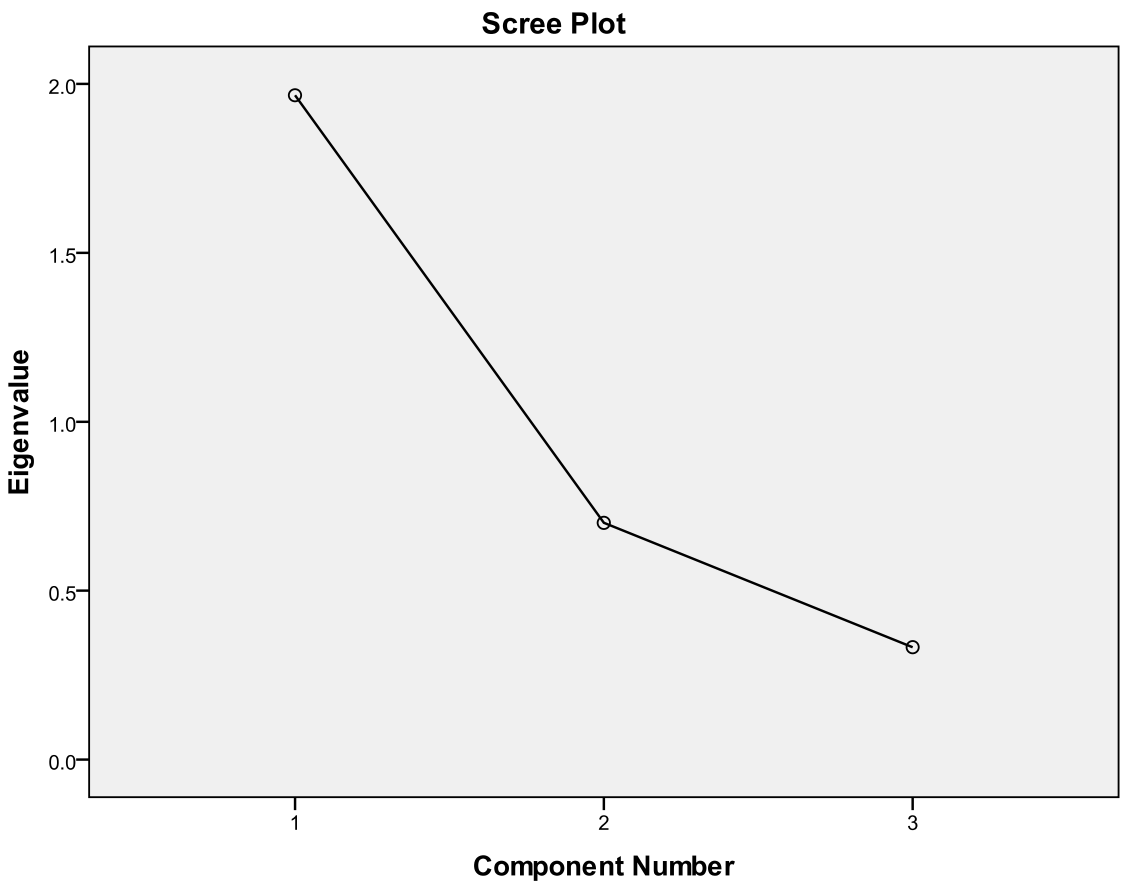


Figure 5-11: PCA analysis of the Infrastructure pillar - eigenvalues

Table 22: PCA analysis of the Infrastructure pillar: correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component		
	1	2	3
motorway_index_ combined	.885	-.181	-.430
railway_index_combined	.694	.713	.099
number_of_passenger_ flights	.838	-.399	.372

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Table 23: PCA analysis for the Infrastructure pillar: explained variance

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.966	65.549	65.549	1.966	65.549	65.549
2	.701	23.361	88.910	.701	23.361	88.910
3	.333	11.090	100.000	.333	11.090	100.000

Extraction Method: Principal Component Analysis.

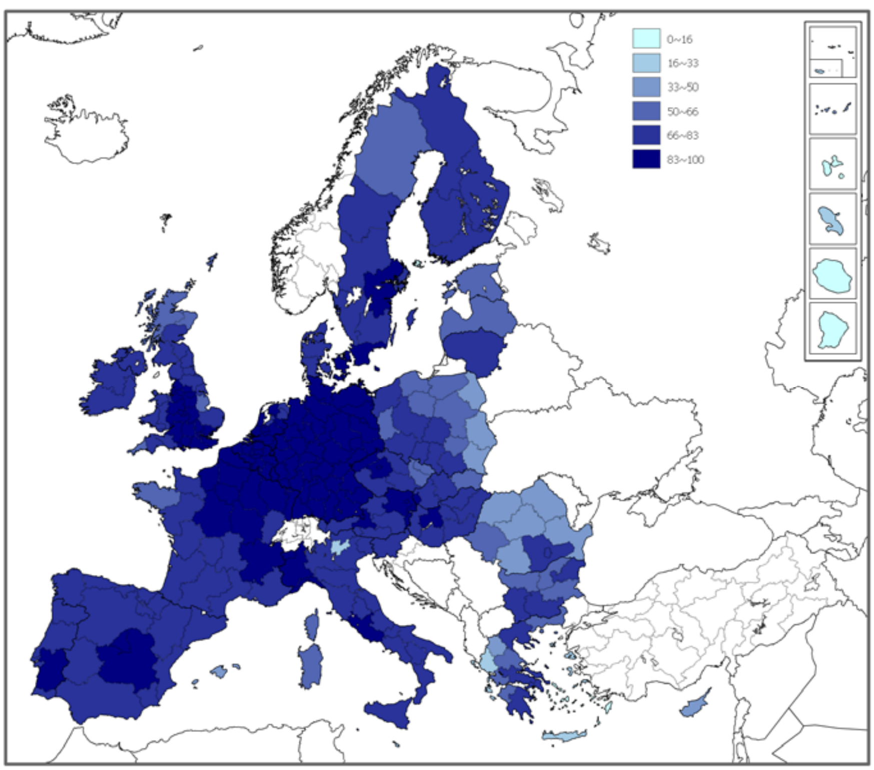


Figure 5-12: Map of Infrastructure sub-score (min-max normalized values)

Table 24: Infrastructure sub-score as arithmetic mean of transformed and standardized indicators.

region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore
BE00	0.88	95	ES30	0.52	88	AT33	0.15	82
BE21	0.73	92	ES41	0.14	81	AT34	0.08	80
BE22	0.53	89	ES42	0.37	86	PL11	-0.55	69
BE23	0.65	91	ES43	-0.57	68	PL12	-1.05	60
BE25	0.41	86	ES51	0.18	82	PL21	-0.51	70
BE32	0.67	91	ES52	-0.19	75	PL22	-0.14	76
BE33	0.67	91	ES53	-1.96	43	PL31	-1.80	46
BE34	0.54	89	ES61	-0.22	75	PL32	-1.72	47
BE35	0.46	87	ES62	-0.28	74	PL33	-1.42	53
BG31	-1.17	57	ES63	-4.14	3	PL34	-2.19	39
BG32	-1.41	53	ES64	-4.14	3	PL41	-0.57	68
BG33	-0.63	67	ES70	-1.96	43	PL42	-0.57	68
BG34	-0.79	64	FR10	0.72	92	PL43	-0.94	62
BG41	-0.56	69	FR21	0.62	90	PL51	-0.42	71
BG42	-0.67	67	FR22	0.73	92	PL52	-0.26	74
CZ01	0.67	91	FR23	0.52	88	PL61	-1.40	53
CZ02	0.44	87	FR24	0.48	88	PL62	-1.55	51
CZ03	0.23	83	FR25	-0.37	72	PL63	-1.20	57
CZ04	0.36	85	FR26	0.40	86	PT11	-0.54	69
CZ05	-0.10	77	FR30	0.54	89	PT15	-0.08	77
CZ06	0.22	83	FR41	0.27	84	PT16	-0.16	76
CZ07	-0.69	66	FR42	0.46	87	PT17	0.39	86
CZ08	-1.10	59	FR43	0.16	82	PT18	0.21	83
DK01	0.50	88	FR51	-0.14	76	PT20	-4.32	0
DK02	0.51	88	FR52	-0.70	66	PT30	-3.27	19
DK03	-0.01	79	FR53	-0.13	76	RO11	-1.64	49
DK04	-0.09	77	FR61	-0.11	77	RO12	-1.88	45
DK05	-0.31	73	FR62	-0.01	79	RO21	-1.96	43
DE11	0.49	88	FR63	-0.06	78	RO22	-1.65	49
DE12	0.76	93	FR71	0.26	84	RO31	-0.51	70
DE13	0.53	89	FR72	0.04	80	RO32	0.11	81
DE14	0.31	84	FR81	0.03	79	RO41	-2.28	37
DE21	0.53	89	FR82	0.02	79	RO42	-1.21	57
DE22	0.45	87	FR83	-1.30	55	SI01	0.02	79
DE23	0.53	89	FR91	-4.32	0	SI02	0.03	79
DE24	0.31	84	FR92	-3.30	19	SK01	0.53	89
DE25	0.61	90	FR93	-4.32	0	SK02	0.09	80
DE26	0.63	90	FR94	-4.32	0	SK03	-0.54	69
DE27	0.56	89	ITC1	0.43	87	SK04	-0.76	65
DE30	1.16	100	ITC2	0.43	87	FI13	-0.41	71
DE41	0.59	90	ITC3	0.38	86	FI18	0.00	79
DE42	0.63	90	ITC4	0.23	83	FI19	-0.40	72
DE50	1.14	100	ITD1	-0.06	78	FI1A	-0.48	70
DE60	0.96	96	ITD2	-2.96	25	FI20	-3.59	13
DE71	0.84	94	ITD3	0.16	82	SE11	0.18	82
DE72	0.67	91	ITD4	0.06	80	SE12	0.33	85
DE73	0.59	90	ITD5	0.10	81	SE21	-0.05	78
DE80	0.34	85	ITE1	0.01	79	SE22	0.35	85
DE91	0.36	85	ITE2	-0.14	76	SE23	0.04	80
DE92	0.27	84	ITE3	-0.44	71	SE31	-0.07	78
DE93	0.45	87	ITE4	0.26	84	SE32	-0.26	74
DE94	0.27	84	ITF1	-0.01	79	SE33	-0.84	64
DEA1	0.93	96	ITF2	-0.08	77	UKC1	-0.09	77
DEA2	0.82	94	ITF3	-0.08	77	UKC2	-0.60	68
DEA3	0.70	92	ITF4	-0.50	70	UKD1	0.16	82
DEA4	0.44	87	ITF5	-0.53	69	UKD2	0.70	92
DEA5	0.83	94	ITF6	-0.37	72	UKD3	0.94	96
DEB1	0.67	91	ITG1	-0.22	75	UKD4	0.43	87
DEB2	0.58	89	ITG2	-1.57	50	UKD5	0.85	94
DEB3	0.78	93	CY00	-1.96	43	UKE1	0.03	79
DEC0	0.79	93	LV00	-1.10	59	UKE2	0.05	80
DED1	0.32	85	LT00	-0.65	67	UKE3	0.78	93
DED2	0.26	84	LU00	0.38	86	UKE4	0.67	91
DED3	0.42	86	HU10	0.07	80	UKF1	0.32	85
DEE0	0.46	87	HU21	0.32	85	UKF2	0.35	85
DEF0	0.30	84	HU22	0.06	80	UKF3	-0.77	65
DEG0	0.26	84	HU23	-0.53	69	UKG1	0.49	88
EE00	-0.71	66	HU31	-0.17	76	UKG2	0.32	85
IE01	-0.31	73	HU32	-0.31	73	UKG3	0.94	96
IE02	-0.27	74	HU33	-0.19	75	UKH1	-0.06	78
GR11	-1.23	56	MT00	-3.23	20	UKH2	0.69	91
GR12	-0.64	67	NL11	-0.11	77	UKH3	0.47	87
GR13	-1.72	47	NL12	0.27	84	UKI	1.15	100
GR14	-1.23	56	NL13	0.03	79	UKJ1	0.67	91
GR21	-3.16	21	NL21	0.48	88	UKJ2	0.56	89
GR22	-3.44	16	NL22	0.68	91	UKJ3	0.48	88
GR23	-1.22	57	NL23	0.13	81	UKJ4	0.84	94
GR24	-0.24	74	NL31	0.81	94	UKK1	0.40	86
GR25	-0.44	71	NL32	0.69	91	UKK2	-0.10	77
GR30	-0.13	76	NL33	0.76	93	UKK3	-1.18	57
GR41	-3.52	15	NL34	0.35	85	UKK4	-0.49	70
GR42	-3.36	18	NL41	0.61	90	UKL1	-0.29	74
GR43	-3.15	21	NL42	0.71	92	UKL2	-0.05	78
ES11	-0.25	74	AT11	0.26	84	UKM2	-0.05	78
ES12	-0.55	69	AT12	0.60	90	UKM3	0.17	82
ES13	-0.28	74	AT13	1.04	98	UKM5	-1.25	56
ES21	-0.10	77	AT21	0.10	81	UKM6	-0.86	63
ES22	-0.22	75	AT22	0.01	79	UKN0	-0.35	72
ES23	-0.21	75	AT31	0.21	83			
ES24	-0.26	74	AT32	0.30	84			

Figure 5-13: Histogram of Infrastructure sub-score

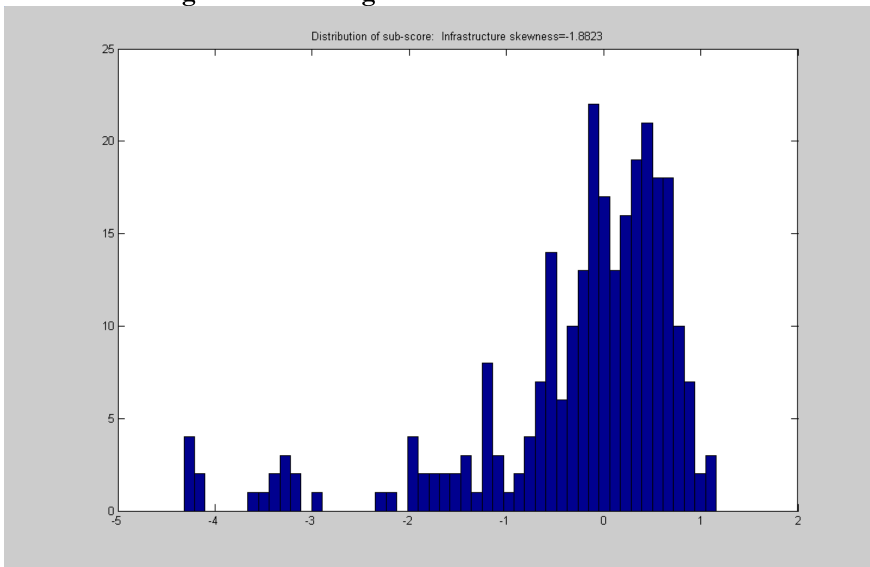


Table 25. Institutions pillar sub-rank (from best to worst)

Infrastructure											
1	DE30	46	DEB2	91	DED1	136	UKE1	181	ES13	226	LV00
2	UKI	47	DE27	92	HU21	137	FR82	182	ES62	227	BG31
3	DE50	48	UKJ2	93	UKF1	138	SI01	183	UKL1	228	UKK3
4	AT13	49	BE34	94	UKG2	139	ITE1	184	DK05	229	PL63
5	DE60	50	FR30	95	DE14	140	AT22	185	IE01	230	RO42
6	UKD3	51	BE22	96	DE24	141	FI18	186	HU32	231	GR23
7	UKG3	52	DE13	97	DEF0	142	DK03	187	UKN0	232	GR11
8	DEA1	53	DE21	98	AT32	143	FR62	188	FR25	233	GR14
9	BE00	54	DE23	99	DE92	144	ITF1	189	ITF6	234	UKM5
10	UKD5	55	SK01	100	DE94	145	SE21	190	FI19	235	FR83
11	DE71	56	ES30	101	FR41	146	UKL2	191	FI13	236	PL61
12	UKJ4	57	FR23	102	NL12	147	UKM2	192	PL51	237	BG32
13	DEA5	58	DK02	103	DED2	148	FR63	193	GR25	238	PL33
14	DEA2	59	DK01	104	DEG0	149	ITD1	194	ITE3	239	PL62
15	NL31	60	DE11	105	FR71	150	UKH1	195	FI1A	240	ITG2
16	DEC0	61	UKG1	106	ITE4	151	SE31	196	UKK4	241	RO11
17	DEB3	62	FR24	107	AT11	152	ITF2	197	ITF4	242	RO22
18	UKE3	63	NL21	108	CZ03	153	ITF3	198	PL21	243	GR13
19	DE12	64	UKJ3	109	ITC4	154	PT15	199	RO31	244	PL32
20	NL33	65	UKH3	110	CZ06	155	DK04	200	ITF5	245	PL31
21	BE21	66	BE35	111	AT31	156	UKC1	201	HU23	246	RO12
22	FR22	67	DEE0	112	PT18	157	CZ05	202	PT11	247	ES53
23	FR10	68	FR42	113	ES51	158	ES21	203	SK03	248	ES70
24	NL42	69	DE22	114	SE11	159	UKK2	204	ES12	249	CY00
25	DEA3	70	DE93	115	UKM3	160	FR61	205	PL11	250	RO21
26	UKD2	71	CZ02	116	FR43	161	NL11	206	BG41	251	PL34
27	NL32	72	DEA4	117	ITD3	162	GR30	207	ES43	252	RO41
28	UKH2	73	ITC1	118	UKD1	163	FR53	208	PL41	253	ITD2
29	NL22	74	ITC2	119	AT33	164	FR51	209	PL42	254	GR43
30	BE32	75	UKD4	120	ES41	165	ITE2	210	UKC2	255	GR21
31	BE33	76	DED3	121	NL23	166	PL22	211	BG33	256	MT00
32	CZ01	77	BE25	122	RO32	167	PT16	212	GR12	257	PT30
33	DE72	78	FR26	123	ITD5	168	HU31	213	LT00	258	FR92
34	DEB1	79	UKK1	124	AT21	169	ES52	214	BG42	259	GR42
35	UKE4	80	PT17	125	SK02	170	HU33	215	CZ07	260	GR22
36	UKJ1	81	ITC3	126	AT34	171	ES23	216	FR52	261	GR41
37	BE23	82	LU00	127	HU10	172	ES22	217	EE00	262	FI20
38	DE26	83	ES42	128	ITD4	173	ES61	218	SK04	263	ES63
39	DE42	84	CZ04	129	HU22	174	ITG1	219	UKF3	264	ES64
40	FR21	85	DE91	130	UKE2	175	GR24	220	BG34	265	FR91
41	DE25	86	NL34	131	FR72	176	ES11	221	SE33	266	FR93
42	NL41	87	SE22	132	SE23	177	ES24	222	UKM6	267	FR94
43	AT12	88	UKF2	133	FR81	178	PL52	223	PL43	268	PT20
44	DE41	89	DE80	134	NL13	179	SE32	224	PL12		
45	DE73	90	SE12	135	SI02	180	IE02	225	CZ08		

5.4 Health

Candidate indicators are described in Section 3.4 and are here recalled with their abbreviations used in the analysis.

Indicators included, in brackets short names:

1.	Hospital beds	(hospital_beds)
2.	Road fatalities (reversed)	(road_fatalities)
3.	Healthy life expectancy	(healthy_life)
4.	Infant mortality (reversed)	(infant_mortality)
5.	Cancer disease death rate	(cancer)
6.	Heart disease death rate	(heart_disease)
7.	Suicide rate	(suicide)

Imputation of missing data

For the indicator on Hospital_beds, 2007 data has been used for most regions. However, for the following countries the most recent available data has been used: for Germany, Estonia, and Sweden – 2006 data (for Germany, NUTS 1 data has been imputed at the NUTS 2 level); for Greece – 2005 data, for Portugal – 2004 data; for the Netherlands – 2002 data.

For the indicator on Road_fatalities, 2004-2006 average has been used. However, in some cases, due to lack of data, different time periods have been considered: for Greece, Spain and France: 2003-2005; for Bulgaria, Ireland, Sweden and the UK: 2002-2004; for Italy: 2001-2003.

For the indicator on Infant_mortality, as 2007 data was not available for some countries, 2006 NUTS 2 data has been used for Belgium, Germany, Ireland, Italy, Poland, and the United Kingdom.

For the indicator on Healthy_life, data for DE 41 and DE 42 has been estimated by DG Regional Policy.

For the indicators on Cancer, Hearth_disease and Suicide, an average of 2006-2008 (or most recent year) has been taken.

Univariate analysis

Table 26 presents the descriptive statistics for the seven indicators included in the Health pillar. All indicators have a very low percentage of missing values (less than 1%) with the exception of the indicator on Hospital_beds (11.19%) which is, however, still within the thresholds defined in Section 4.2 and has been included in the final computation of the sub-score.

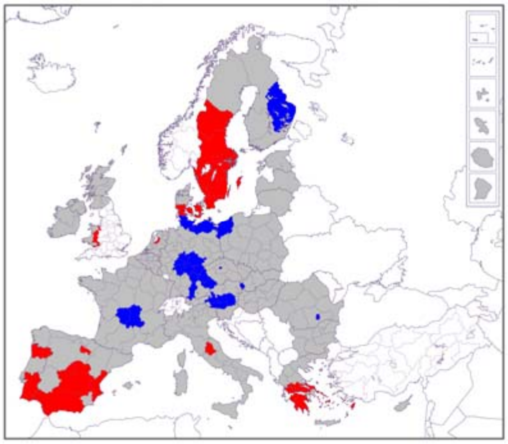
Table 26: Descriptive statistics of Health indicators

Indicator	Hospital beds	Road fatalities	Healthy life expectancy	Infant mortality	Cancer disease death rate	Heart disease	Suicide
description	rate of hospital beds per 100,000 inhabitants	number of deaths in road accidents per million inhabitants	number of years of healthy life expected	number of deaths of children under 1 year of age during the year to the number of live births in that year	standardized cancer death rate for population under 65	standardized heart diseases death rate for population under 65	standardized death rate for suicide for population under 65
source	Eurostat Regional Statistics	Eurostat, CARE, ITF, NSIs, DG Regio	Eurostat/DG Regional Policy	Eurostat Regional Statistics	DG Regio	DG Regio, Eurostat	DG Regio, Eurostat
reference year	2007	2004-2006	2007	2007	2006-08	2006-08	2006-08
% of missing values	11.19	0.75	0.37	0.75	0.37	0.37	0.37
mean value	592.26	103.35	62.24	4.03	76.38	51.57	9.95
standard deviation (unbiased)	204.97	46.47	3.41	2.43	15.93	31.70	4.89
coefficient of variation	0.35	0.45	0.05	0.60	0.21	0.61	0.49
maximum value	1216.80	304.00	69.90	14.20	143.90	189.80	28.20
region corresponding to maximum value	DE80	GR24	MT00	RO21	HU32	BG31	LT00
minimum value	165.60	17.50	52.23	0.00	38.80	17.70	2.10
region corresponding to minimum value	NL23	DE50	EE00	ITC2	NL23	NL23	GR12

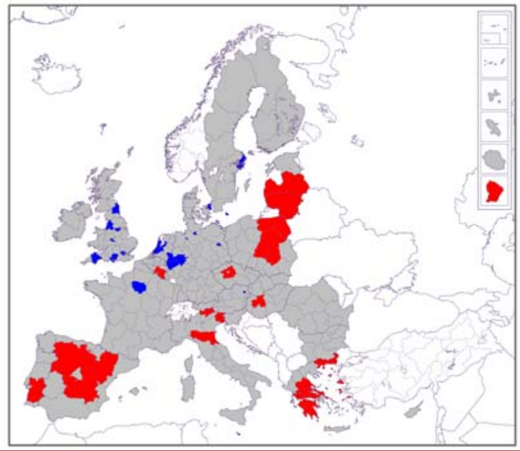
How do EU regions score in each of the indicators?

Southern European and Scandinavian regions have very low numbers of hospital beds. Road fatalities present biggest problem in Southern European regions (Spanish, Greek and Portuguese) as well as in the Baltic countries. UK regions are among the ones with the lowest number of road fatalities. Most of the Scandinavian and Greek regions have very high healthy life expectancy while regions in the Baltic States, Finland, Hungary and Slovakia are among the ones with the lowest performance. Infant mortality is highest in Eastern European regions, Bulgaria and Romania specifically, while best performers are regions in Italy, Greece, Germany and United Kingdom. Cancer rate is highest in a number of Eastern European regions (Romanian, Hungarian, Bulgarian, Baltic) while best performers are parts of Italy, Sweden and Finland. Similarly, heart diseases are most common in Eastern Europe while most rare in Spanish, Portuguese and Southern French regions. Suicide rates are very low in Southern European regions and very high in Northern European regions.

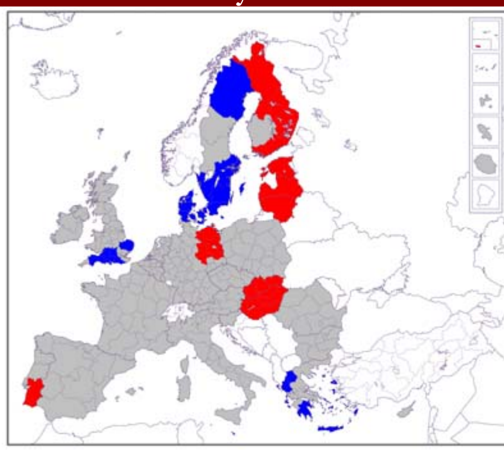
Hospital beds



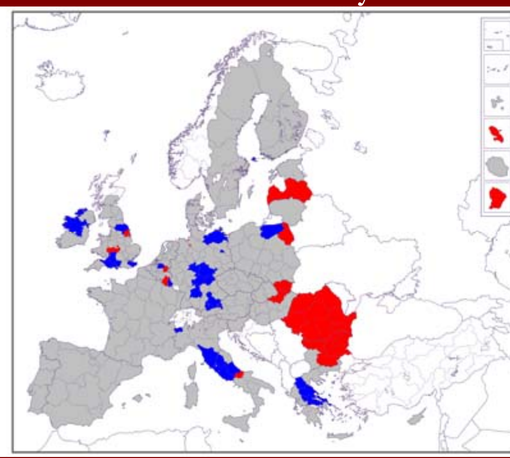
Road fatalities



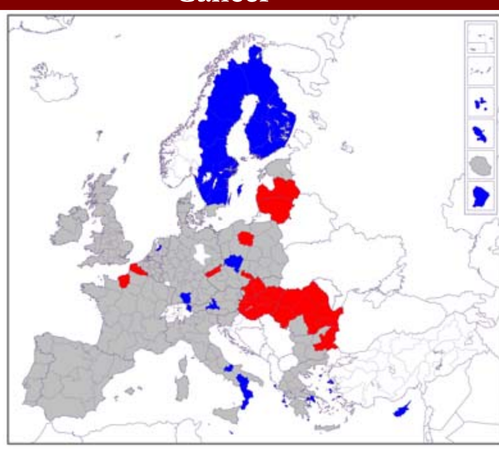
Healthy life



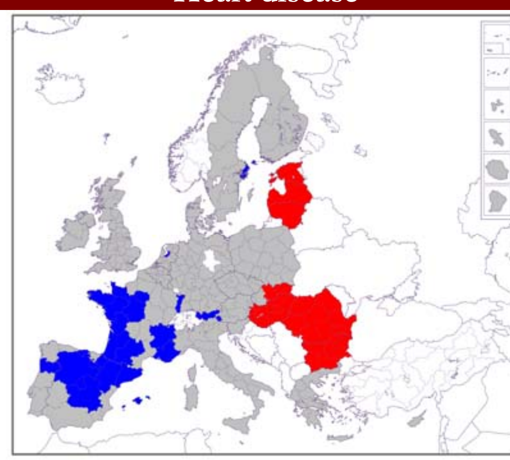
Infant mortality



Cancer



Heart disease



Suicide

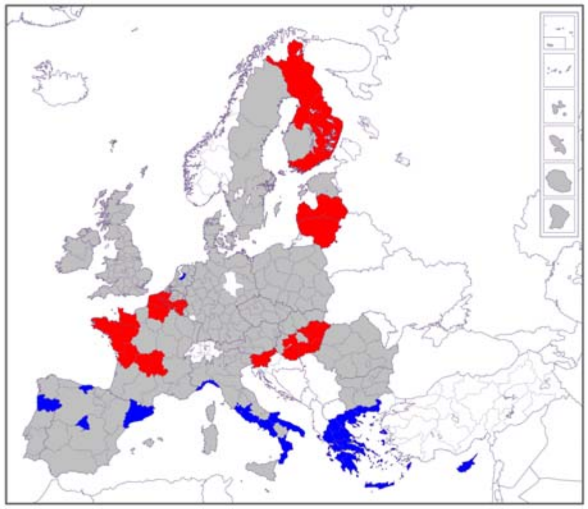
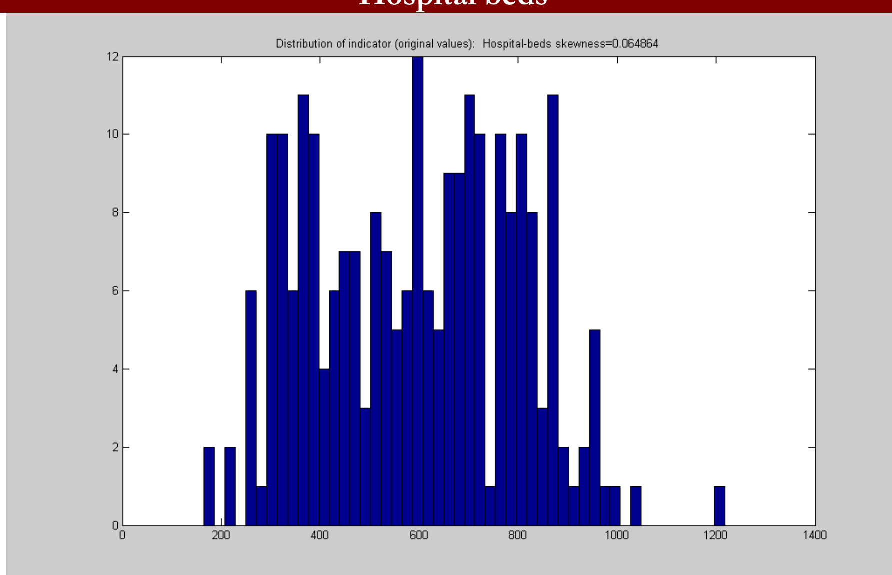


Figure 5-14: Best and worst performing regions for each indicator – Health

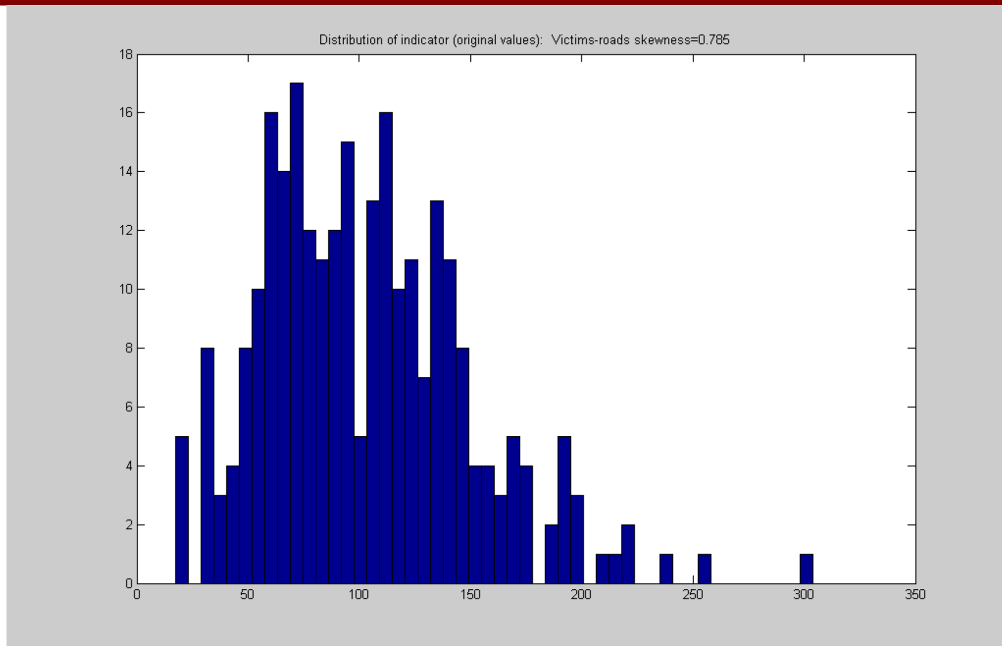
As shown in Table 27, two of the indicators (Cancer and Heart_disease) have been transformed with the Box-Cox method while Infant mortality has been transformed logarithmically due to the presence of zero values.

Table 27: Histograms of Health indicators

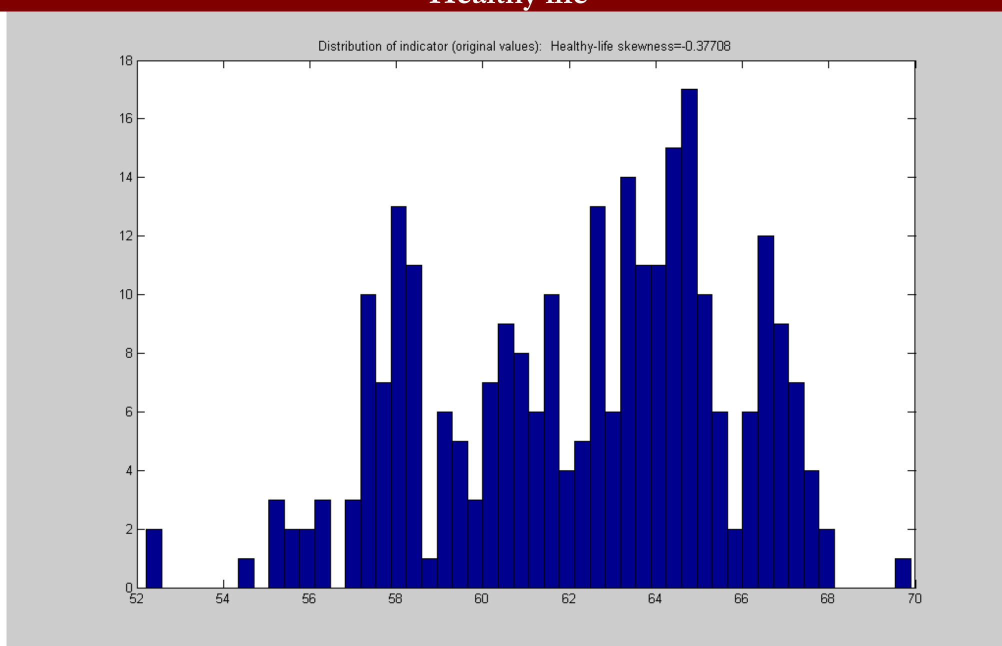
Hospital beds



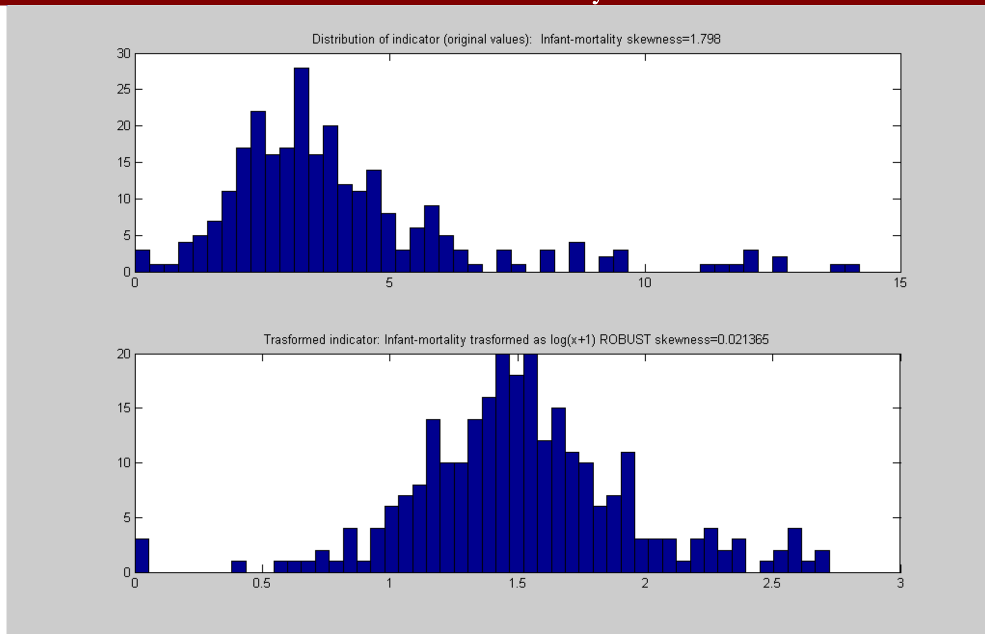
Road fatalities



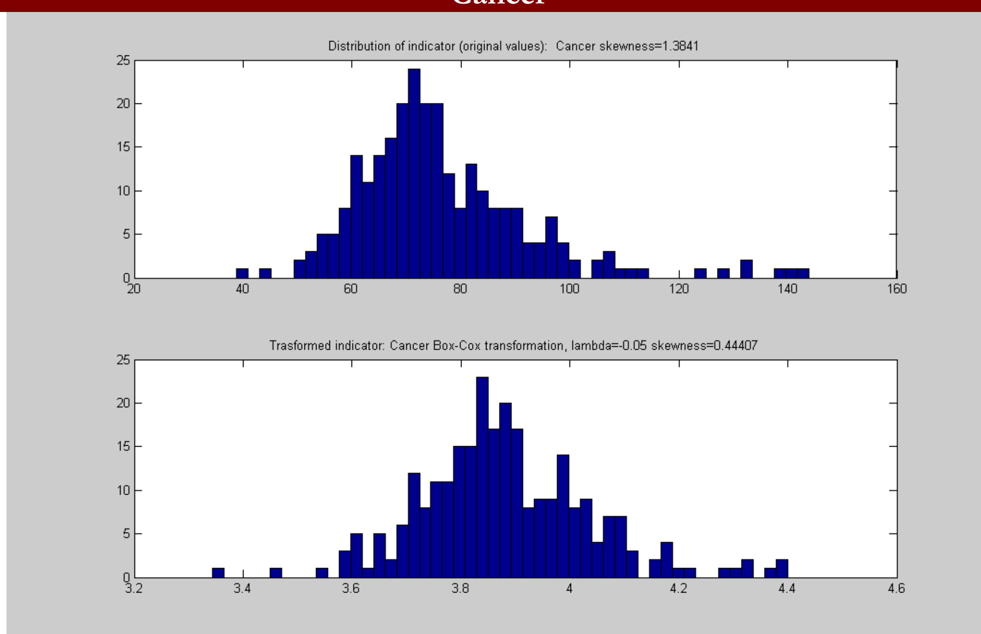
Healthy life



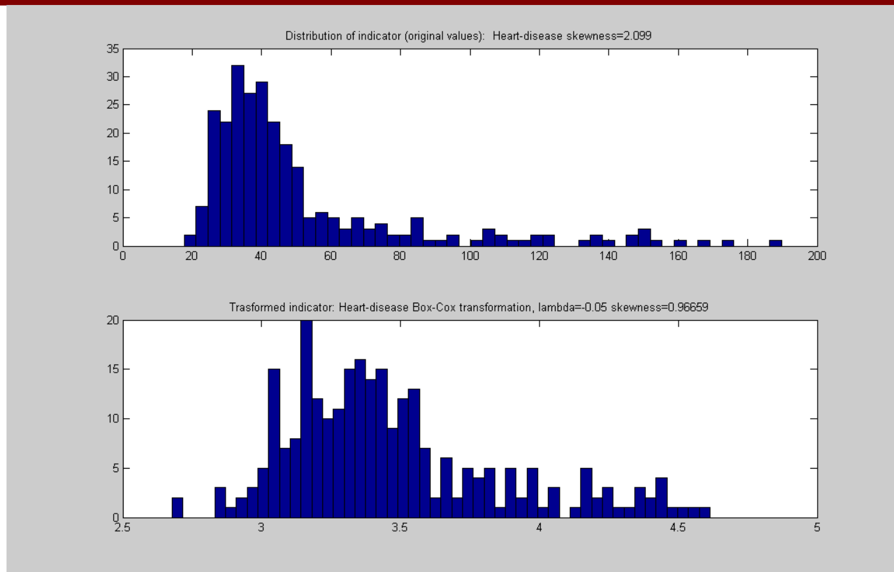
Infant mortality



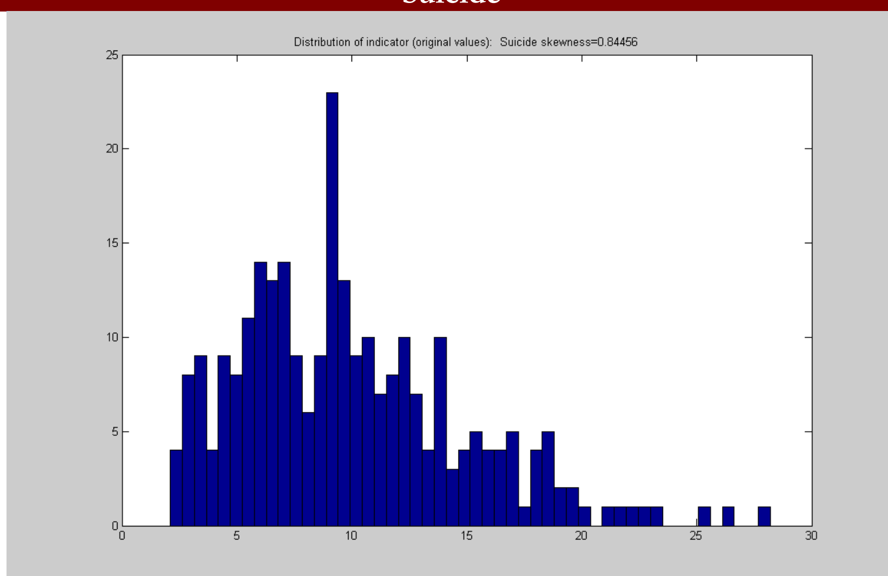
Cancer



Heart disease



Suicide



MULTIVARIATE ANALYSIS

A rather low correlation characterizes the indicators included in the pillar (Table 28). This is due to the intrinsic nature of the indicators which describe very different aspects related to the heath conditions of the population. Among the candidate indicators, Hospital_beds shows the most anomalous behaviour, being negatively correlated with almost all the other indicators. The PCA analysis is not expected to show a unique underlying dimension and indeed this may be seen from the scree plot in Figure 5-15. At least two dimensions are needed to reach about 60% of total variance (Table 30), with the second dimension mainly related to Hospital_beds and Road_fatalities (Table 29). These results suggest dropping the indicator Hospital_bed, which is also the only one which somehow describes an 'input' factor within the pillar.

Table 28: Correlation matrix between all candidate indicators of the Health pillar

Correlation Matrix

		Hospital_beds	Road_fatalities_ reversed	Healthy_life	Infant_mortalityr eversed	Cancer_ reversed	Heart_disease reversed	Suicide_ reversed
Correlation	Hospital_beds	1.000	.213	-.581	-.031	-.278	-.213	-.395
	Road_fatalities_reversed	.213	1.000	.073	.079	.164	.252	.169
	Healthy_life	-.581	.073	1.000	.194	.385	.419	.403
	Infant_mortality_reversed	-.031	.079	.194	1.000	.391	.491	.145
	Cancer_reversed	-.278	.164	.385	.391	1.000	.650	.474
	Heart_disease_reversed	-.213	.252	.419	.491	.650	1.000	.273
	Suicide_reversed	-.395	.169	.403	.145	.474	.273	1.000
Sig. (1-tailed)	Hospital_beds		.000	.000	.317	.000	.000	.000
	Road_fatalities_reversed	.000		.117	.102	.004	.000	.003
	Healthy_life	.000	.117		.001	.000	.000	.000
	Infant_mortality_reversed	.317	.102	.001		.000	.000	.009
	Cancer_reversed	.000	.004	.000	.000		.000	.000
	Heart_disease_reversed	.000	.000	.000	.000	.000		.000
	Suicide_reversed	.000	.003	.000	.009	.000	.000	

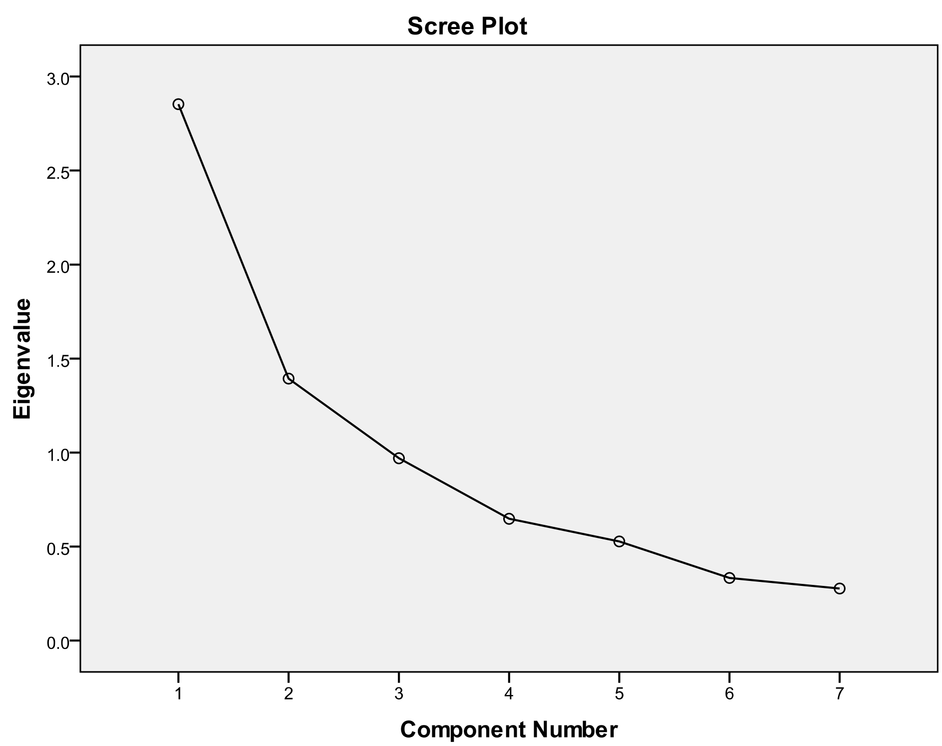


Figure 5-15: PCA analysis of the Health pillar, all candidate indicators - eigenvalues

Table 29: PCA analysis of the Health pillar, all candidate indicators: correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
Hospital_beds	-.561	.707	.015	.134	-.024	.405	.052
Road_fatalities_reversed	.223	.620	.672	-.250	.116	-.170	-.093
Healthy_life	.726	-.360	.097	-.434	.128	.354	-.062
Infant_mortality_reversed	.523	.436	-.553	.036	.468	-.067	-.075
Cancer_reversed	.806	.184	-.062	.267	-.373	.045	-.317
Heart_disease_reversed	.777	.346	-.181	-.173	-.292	-.053	.353
Suicide_reversed	.659	-.190	.406	.526	.229	.073	.174

Extraction Method: Principal Component Analysis.

a. 7 components extracted.

Table 30: PCA analysis for the Health pillar, all candidate indicators: explained variance

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	2.853	40.755	40.755
2	1.393	19.904	60.659
3	.970	13.852	74.511
4	.648	9.253	83.764
5	.527	7.528	91.292
6	.333	4.755	96.047
7	.277	3.953	100.000

The multivariate analysis without Hospital_beds is shown in Figure 5-16, Table 31 and Table 32. Results are better even if the first PCA dimension explains only 44% of total variation, slightly more than in the previous case. However, in this case all the indicators are positively related to the first major PCA dimension (Table 31) and roughly to the same extent (with the exception of Road_fatalities which has a low correlation coefficient, 0.33).

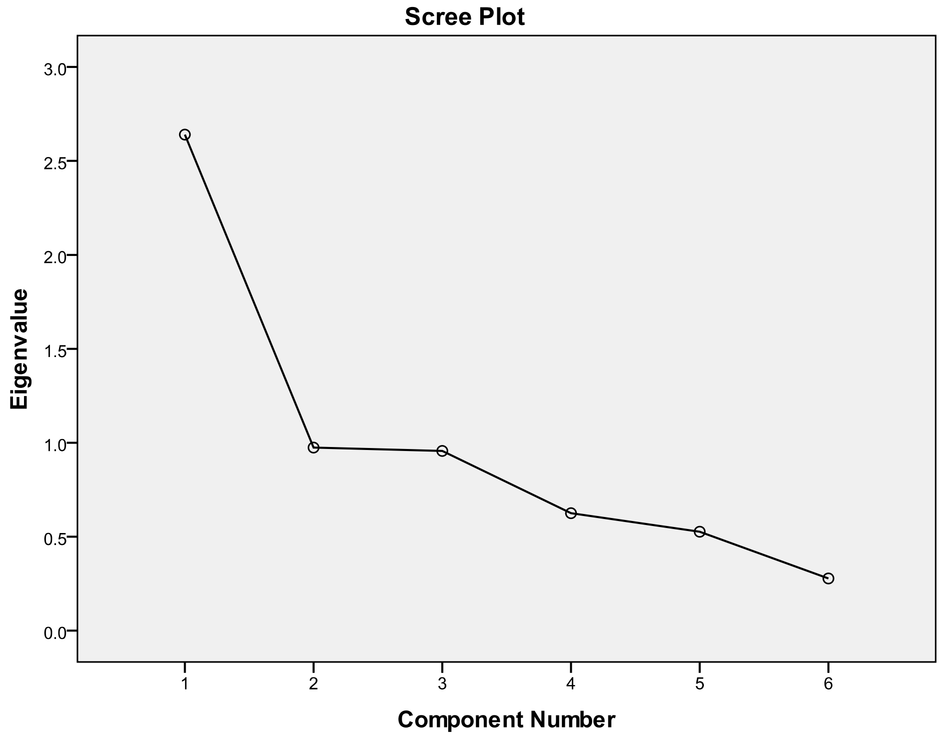


Figure 5-16: PCA analysis of the Health pillar, without Hospital_beds - eigenvalues

Table 31: PCA analysis of the Health pillar without Hospital_beds: correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component					
	1	2	3	4	5	6
Road_fatalities_reversed	.331	.239	.898	.106	.102	.072
Healthy_life	.644	.322	-.337	.574	.168	.102
Infant_mortality_reversed	.593	-.650	-.003	-.110	.458	.066
Cancer_reversed	.833	-.035	-.071	-.233	-.378	.322
Heart_disease_reversed	.826	-.270	.091	.155	-.290	-.357
Suicide_reversed	.623	.564	-.153	-.440	.226	-.163

Extraction Method: Principal Component Analysis.

a. 6 components extracted.

Table 32: PCA analysis for the Health pillar, without Hospital_beds: explained variance

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	2.640	44.003	44.003
2	.974	16.241	60.244
3	.956	15.938	76.182
4	.625	10.416	86.598
5	.526	8.773	95.371
6	.278	4.629	100.000

The final Health_sub-score has been computed as a simple arithmetic mean of the transformed and standardized indicators, excluding Hospital_beds. The geographical distribution of the sub-score across NUTS2 regions is displayed in Figure 5-17 based on values displayed in Table 33. The histogram of the Health sub-score is shown in Figure 5-18, while the ranking of regions are in Table 34.

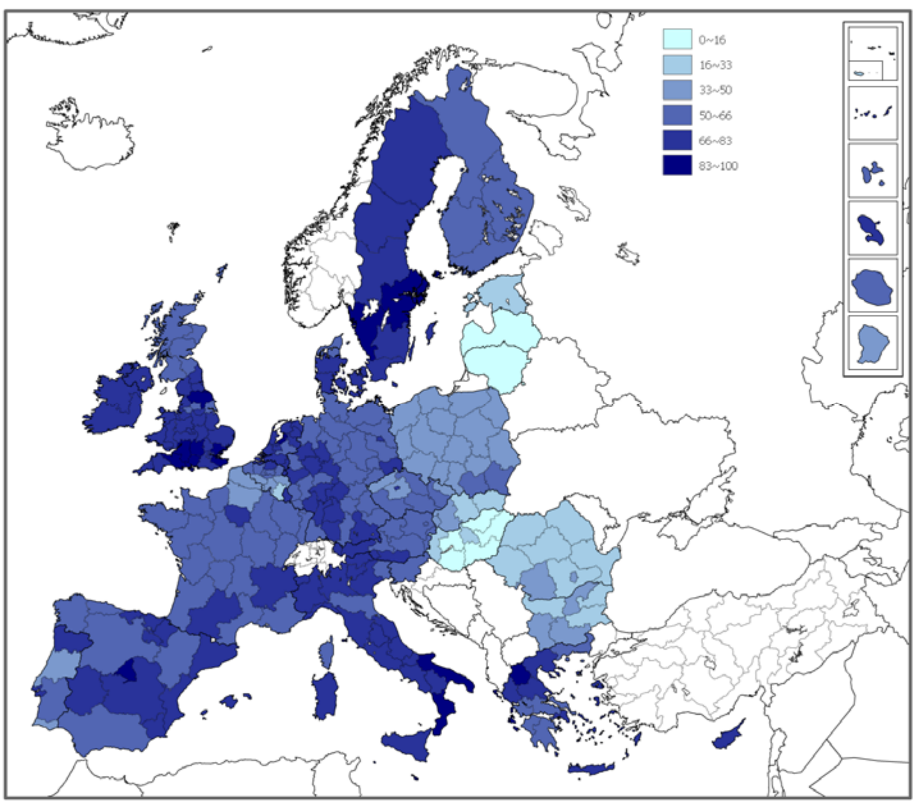


Figure 5-17: Map of Health sub-score (min-max normalized values)

Table 33: Health sub-score as arithmetic mean of transformed and standardized indicators.

region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore
BE00	-0.10	60	ES30	1.00	90	AT33	0.30	71
BE21	0.40	73	ES41	0.13	66	AT34	0.33	71
BE22	-0.30	54	ES42	0.28	70	PL11	-1.00	35
BE23	-0.32	54	ES43	0.23	69	PL12	-0.72	43
BE25	-0.18	58	ES51	0.57	78	PL21	-0.38	52
BE32	-0.95	37	ES52	0.27	70	PL22	-0.70	43
BE33	-0.57	47	ES53	0.32	71	PL31	-0.80	41
BE34	-1.58	20	ES61	0.13	66	PL32	-0.38	52
BE35	-0.82	40	ES62	0.27	70	PL33	-0.73	43
BG31	-1.15	31	ES63	0.33	71	PL34	-1.00	35
BG32	-1.02	35	ES64	0.77	83	PL41	-1.00	35
BG33	-1.18	30	ES70	0.20	68	PL42	-0.90	38
BG34	-1.45	23	FR10	0.62	79	PL43	-0.88	39
BG41	-0.80	41	FR21	-0.27	55	PL51	-0.88	39
BG42	-1.08	33	FR22	-0.53	48	PL52	-0.73	43
CZ01	0.22	68	FR23	-0.28	55	PL61	-0.77	42
CZ02	-0.62	46	FR24	-0.13	59	PL62	-0.80	41
CZ03	-0.42	51	FR25	-0.22	57	PL63	-0.60	46
CZ04	-1.02	35	FR26	-0.23	56	PT11	0.28	70
CZ05	-0.32	54	FR30	-0.53	48	PT15	-0.62	46
CZ06	-0.38	52	FR41	-0.27	55	PT16	0.15	67
CZ07	-0.45	50	FR42	0.13	66	PT17	0.08	65
CZ08	-0.50	49	FR43	-0.08	60	PT18	-0.60	46
DK01	0.57	78	FR51	-0.05	61	PT20	-0.84	40
DK02	0.23	69	FR52	-0.33	54	PT30	-1.14	32
DK03	0.28	70	FR53	-0.17	58	RO11	-1.38	25
DK04	0.17	67	FR61	0.00	63	RO12	-1.42	24
DK05	0.08	65	FR62	0.28	70	RO21	-1.22	29
DE11	0.55	77	FR63	-0.23	56	RO22	-1.28	28
DE12	0.28	70	FR71	0.40	73	RO31	-1.23	29
DE13	0.08	65	FR72	-0.28	55	RO32	-0.72	43
DE14	0.35	72	FR81	-0.17	58	RO41	-1.07	33
DE21	0.38	73	FR82	0.12	66	RO42	-1.45	23
DE22	-0.23	56	FR83	-0.15	58	SI01	-0.62	46
DE23	-0.22	57	FR91	-0.20	57	SI02	-0.33	54
DE24	0.07	64	FR92	0.17	67	SK01	-0.55	48
DE25	0.10	65	FR93	-0.70	43	SK02	-0.95	37
DE26	0.38	73	FR94	-0.42	51	SK03	-1.25	29
DE27	0.03	63	ITC1	0.32	71	SK04	-1.23	29
DE30	0.43	74	ITC2	0.53	77	FI13	-0.38	52
DE41	-0.40	52	ITC3	0.62	79	FI18	0.08	65
DE42	-0.28	55	ITC4	0.42	74	FI19	-0.10	60
DE50	-0.25	56	ITD1	0.40	73	FI1A	-0.18	58
DE60	0.07	64	ITD2	0.15	67	FI20	1.32	98
DE71	0.37	73	ITD3	0.37	73	SE11	1.15	94
DE72	-0.13	59	ITD4	-0.07	61	SE12	0.93	88
DE73	0.33	71	ITD5	0.12	66	SE21	0.72	82
DE80	-0.07	61	ITE1	0.67	81	SE22	0.73	82
DE91	0.02	63	ITE2	0.67	81	SE23	0.98	89
DE92	0.12	66	ITE3	0.62	79	SE31	0.70	82
DE93	-0.27	55	ITE4	0.55	77	SE32	0.65	80
DE94	-0.17	58	ITF1	0.67	81	SE33	0.70	82
DEA1	0.07	64	ITF2	0.23	69	UKC1	0.15	67
DEA2	0.15	67	ITF3	0.53	77	UKC2	0.50	76
DEA3	0.15	67	ITF4	0.82	85	UKD1	0.38	73
DEA4	0.17	67	ITF5	0.42	74	UKD2	0.52	77
DEA5	0.15	67	ITF6	0.87	86	UKD3	0.07	64
DEB1	-0.18	58	ITG1	0.73	82	UKD4	0.32	71
DEB2	-0.23	56	ITG2	0.43	74	UKD5	0.30	71
DEB3	0.25	69	CY00	0.65	80	UKE1	0.12	66
DEC0	-0.18	58	LV00	-2.20	3	UKE2	1.07	92
DED1	0.10	65	LT00	-2.30	0	UKE3	0.43	74
DED2	0.22	68	LU00	0.32	71	UKE4	0.12	66
DED3	0.03	63	HU10	-1.35	26	UKF1	0.40	73
DEE0	-0.47	50	HU21	-1.93	10	UKF2	0.67	81
DEF0	0.03	63	HU22	-1.55	20	UKF3	0.30	71
DEG0	0.12	66	HU23	-1.95	10	UKG1	0.20	68
EE00	-1.47	23	HU31	-2.08	6	UKG2	0.40	73
IE01	0.47	75	HU32	-2.18	3	UKG3	0.47	75
IE02	0.22	68	HU33	-2.07	6	UKH1	0.63	80
GR11	-0.23	56	MT00	0.87	86	UKH2	0.67	81
GR12	0.28	70	NL11	0.18	67	UKH3	0.85	86
GR13	0.80	84	NL12	0.33	71	UKI	0.72	82
GR14	0.43	74	NL13	0.45	75	UKJ1	0.82	85
GR21	0.57	78	NL21	0.35	72	UKJ2	0.60	79
GR22	0.80	84	NL22	0.12	66	UKJ3	1.03	90
GR23	0.13	66	NL23	1.38	100	UKJ4	0.87	86
GR24	0.05	64	NL31	0.62	79	UKK1	0.97	89
GR25	-0.05	61	NL32	0.57	78	UKK2	1.07	92
GR30	0.68	81	NL33	0.52	77	UKK3	0.70	82
GR41	0.50	76	NL34	0.60	79	UKK4	0.72	82
GR42	0.55	77	NL41	0.40	73	UKL1	0.17	67
GR43	0.48	76	NL42	0.42	74	UKL2	0.28	70
ES11	0.03	63	AT11	-0.07	61	UKM2	-0.05	61
ES12	-0.13	59	AT12	-0.28	55	UKM3	-0.28	55
ES13	0.57	78	AT13	-0.08	60	UKM5	-0.32	54
ES21	0.35	72	AT21	0.22	68	UKM6	-0.42	51
ES22	0.47	75	AT22	0.08	65	UKN0	0.20	68
ES23	0.17	67	AT31	0.02	63			
ES24	0.13	66	AT32	0.12	66			

Figure 5-18: Histogram of Health sub-score

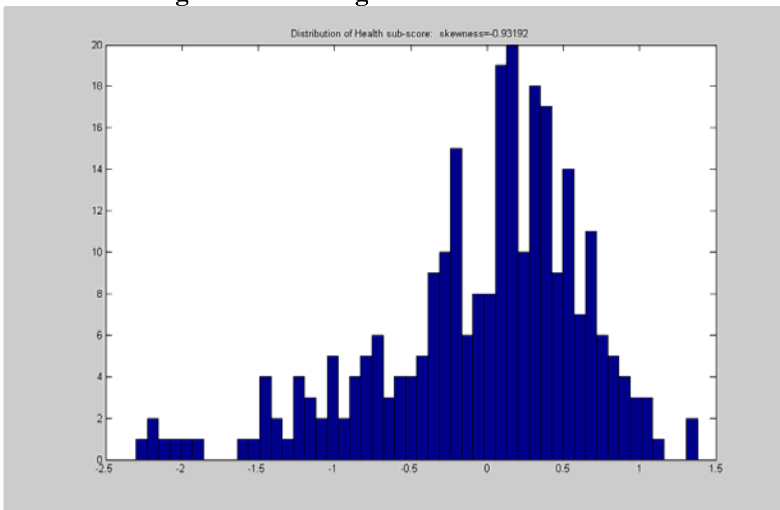


Table 34: Health pillar sub-rank (from best to worst)

Health											
1	NL23	46	ES51	91	AT33	136	AT32	181	FR25	226	PL33
2	FI20	47	NL32	92	UKD5	137	UKE1	182	DE22	227	PL52
3	SE11	48	DE11	93	UKF3	138	UKE4	183	DEB2	228	PL61
4	UKE2	49	GR42	94	DK03	139	DE25	184	GR11	229	BG41
5	UKK2	50	ITE4	95	DE12	140	DED1	185	FR26	230	PL31
6	UKJ3	51	ITC2	96	GR12	141	DK05	186	FR63	231	PL62
7	ES30	52	ITF3	97	ES42	142	DE13	187	DE50	232	BE35
8	SE23	53	NL33	98	FR62	143	AT22	188	DE93	233	PT20
9	UKK1	54	UKD2	99	PT11	144	PT17	189	FR21	234	PL43
10	SE12	55	GR41	100	UKL2	145	FI18	190	FR41	235	PL51
11	ITF6	56	UKC2	101	ES52	146	DE24	191	DE42	236	PL42
12	MT00	57	GR43	102	ES62	147	DE60	192	FR23	237	BE32
13	UKJ4	58	IE01	103	DEB3	148	DEA1	193	FR72	238	SK02
14	UKH3	59	ES22	104	DK02	149	UKD3	194	AT12	239	PL11
15	ITF4	60	UKG3	105	ES43	150	GR24	195	UKM3	240	PL34
16	UKJ1	61	NL13	106	ITF2	151	DE27	196	BE22	241	PL41
17	GR13	62	DE30	107	CZ01	152	DED3	197	BE23	242	BG32
18	GR22	63	GR14	108	DED2	153	DEF0	198	CZ05	243	CZ04
19	ES64	64	ITG2	109	IE02	154	ES11	199	UKM5	244	RO41
20	ITG1	65	UKE3	110	AT21	155	DE91	200	FR52	245	BG42
21	SE22	66	ITC4	111	ES70	156	AT31	201	SI02	246	PT30
22	SE21	67	ITF5	112	UKG1	157	FR61	202	CZ06	247	BG31
23	UKI	68	NL42	113	UKN0	158	GR25	203	PL21	248	BG33
24	UKK4	69	BE21	114	NL11	159	FR51	204	PL32	249	RO21
25	SE31	70	FR71	115	DK04	160	UKM2	205	FI13	250	RO31
26	SE33	71	ITD1	116	DEA4	161	DE80	206	DE41	251	SK04
27	UKK3	72	NL41	117	ES23	162	ITD4	207	CZ03	252	SK03
28	GR30	73	UKF1	118	FR92	163	AT11	208	FR94	253	RO22
29	ITE1	74	UKG2	119	UKL1	164	FR43	209	UKM6	254	HU10
30	ITE2	75	DE21	120	DEA2	165	AT13	210	CZ07	255	RO11
31	ITF1	76	DE26	121	DEA3	166	BE00	211	DEE0	256	RO12
32	UKF2	77	UKD1	122	DEA5	167	FI19	212	CZ08	257	BG34
33	UKH2	78	DE71	123	ITD2	168	DE72	213	FR22	258	RO42
34	CY00	79	ITD3	124	PT16	169	ES12	214	FR30	259	EE00
35	SE32	80	DE14	125	UKC1	170	FR24	215	SK01	260	HU22
36	UKH1	81	ES21	126	GR23	171	FR83	216	BE33	261	BE34
37	FR10	82	NL21	127	ES24	172	DE94	217	PL63	262	HU21
38	ITC3	83	DE73	128	ES41	173	FR53	218	PT18	263	HU23
39	ITE3	84	ES63	129	ES61	174	FR81	219	CZ02	264	HU33
40	NL31	85	NL12	130	FR42	175	BE25	220	PT15	265	HU31
41	NL34	86	AT34	131	DE92	176	DEB1	221	SI01	266	HU32
42	UKJ2	87	ES53	132	DEG0	177	DEC0	222	FR93	267	LV00
43	DK01	88	ITC1	133	FR82	178	FI1A	223	PL22	268	LT00
44	GR21	89	LU00	134	ITD5	179	FR91	224	PL12		
45	ES13	90	UKD4	135	NL22	180	DE23	225	RO32		

5.5 Quality of Primary and Secondary Education

Indicators included in the pillar are discussed in Section 3.5. In the following we recall PISA indicators, related to educational outcomes, included in the analysis with their short names:

Indicators included, in brackets short names:

1. Low achievers in reading (reversed) (PISA_reading)
2. Low achievers in math (reversed) (PISA_math)
3. Low achievers in science (reversed) (PISA_science)

All three indicators have been reversed in order to have the same polarity with respect to competitiveness (the higher the better).

As discussed in Section 3.5, the initial set of indicators originally considered for this pillar comprised more indicators, with the intention of describing also the inputs to the education system. To this aim the following indicators have been examined: student to teacher ratio, financial aid ISCED level 1 to 4, public expenditures level 1 to 4 and rates of participation in education of 4 year old pupils. All these indicators are at the country level. Although, a preliminary analysis of these indicators showed that they are very poorly related with each other. None of their correlation coefficients is statistical significant (Table 35) and, accordingly, PCA loadings have almost the same value across dimensions (Table 36). This suggests that the indicators have very little in common. They represent a mix of different aspects rather then mostly describing the quality of basic education. They were therefore dropped from the analysis.

Table 35: Correlation matrix for additional indicators originally included in the pillar of Quality of Primary and Secondary Education

Correlation Matrix

		Student to teacher ratio (reversed)	financial aid level 1_4	public expenditure level 2_4	public expenditure level 1	Early Education (reversed)
Correlation	student_teacher_ratio_reversed	1.000	-.230	-.013	.104	-.197
	financial_aid_1_4	-.230	1.000	.073	-.044	-.108
	public_expenditure_2_4	-.013	.073	1.000	-.016	.114
	public_expenditure_1	.104	-.044	-.016	1.000	-.053
	early_education_reversed	-.197	-.108	.114	-.053	1.000
Sig. (1-tailed)	student_teacher_ratio_reversed		.151	.476	.319	.184
	financial_aid_1_4	.151		.370	.421	.321
	public_expenditure_2_4	.476	.370		.470	.307
	public_expenditure_1	.319	.421	.470		.407
	early_education_reversed	.184	.321	.307	.407	

Table 36: PCA results on the set of additional indicators originally included in the pillar of Quality of Primary and Secondary Education

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	1.331	26.620	26.620
2	1.118	22.353	48.973
3	.999	19.988	68.961
4	.937	18.732	87.693
5	.615	12.307	100.000

UNIVARIATE ANALYSIS

All three indicators included in the analysis are at the country level. There is no data for Cyprus and Malta leading to 7.41 % of missing data, which is within the threshold of missing data defined in Section 4.2.

Table 37: Descriptive statistics of Quality of primary and secondary education indicators

Name of indicator	Low achievers in reading	Low achievers in math	Low achievers in science
description of indicator	% of pupils, 15 years old, with reading proficiency level 1 and low on PISA	% of pupils,15 years old, with math proficiency level 1 and low on PISA	% of pupils, 15 years old, with science proficiency level 1 and low on PISA
source	OECD Programme for International Student Assessment (PISA)	OECD Programme for International Student Assessment (PISA)	OECD Programme for International Student Assessment (PISA)
reference year	2006	2006	2006
% of missing values	7.41	7.41	7.41
mean value	22.54	22.76	19.27
standard deviation (unbiased)	10.49	10.93	8.93
coefficient of variation	0.47	0.48	0.46
maximum value	53.50	53.30	46.90
region corresponding to maximum value	RO	BG	RO
minimum value	4.80	6.00	4.10
region corresponding to minimum value	FI	FI	FI

How do EU countries score in each of the indicators?

Bulgaria and Romania are the countries with the highest percentage of low achievers in reading, math and science. Finland is the top performer in all three fields, together with Ireland (for reading), the Netherlands (for math), and Estonia (for science).

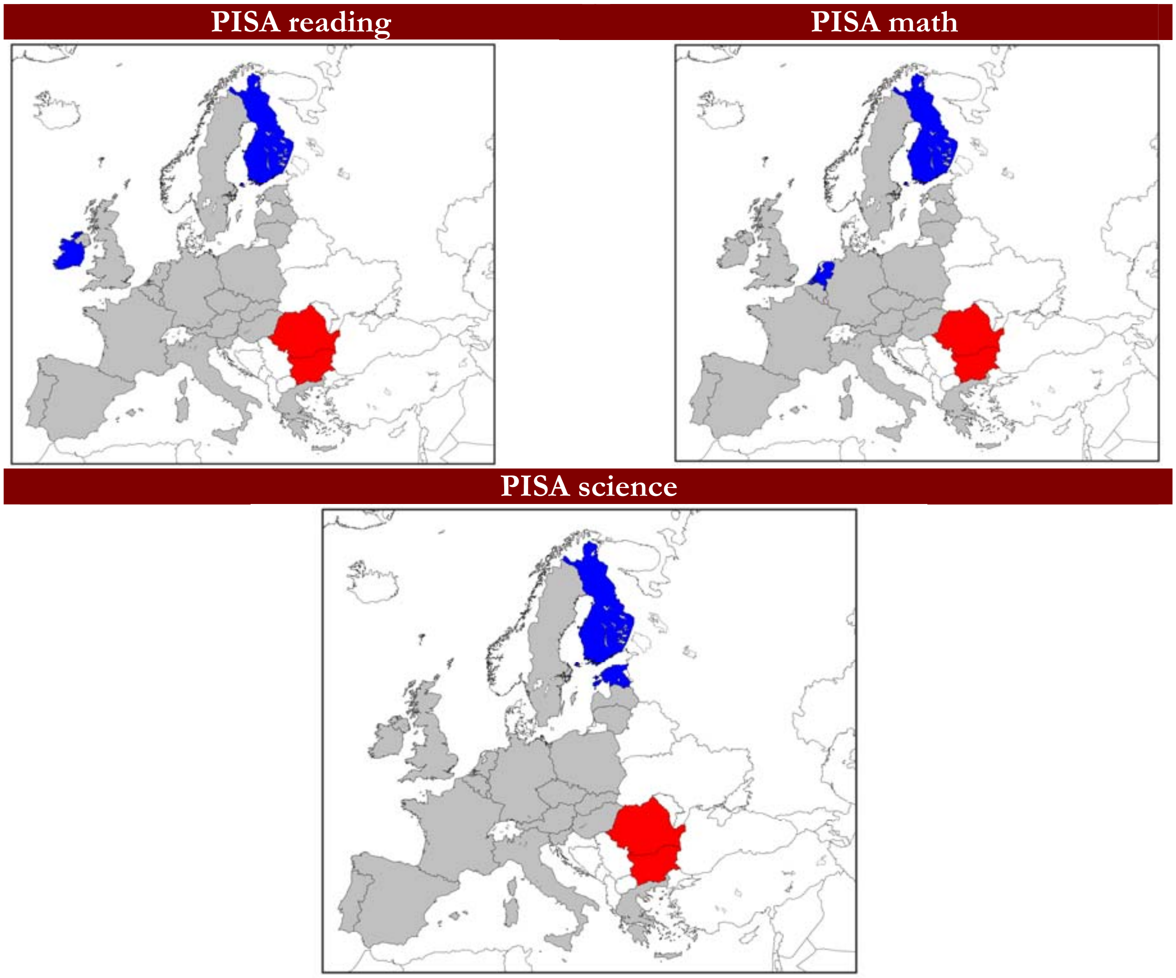
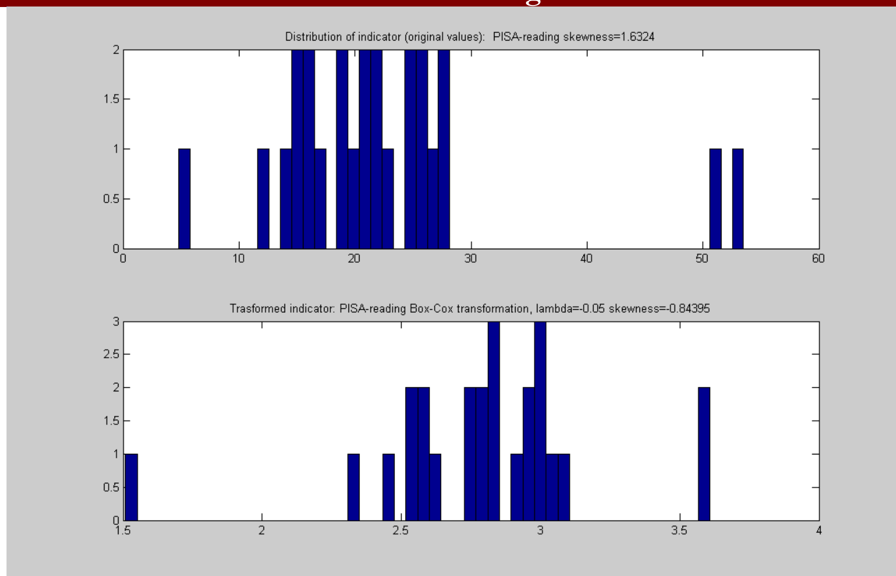


Figure 5-19. Best and worst performing countries for each indicator – Quality of primary and secondary education

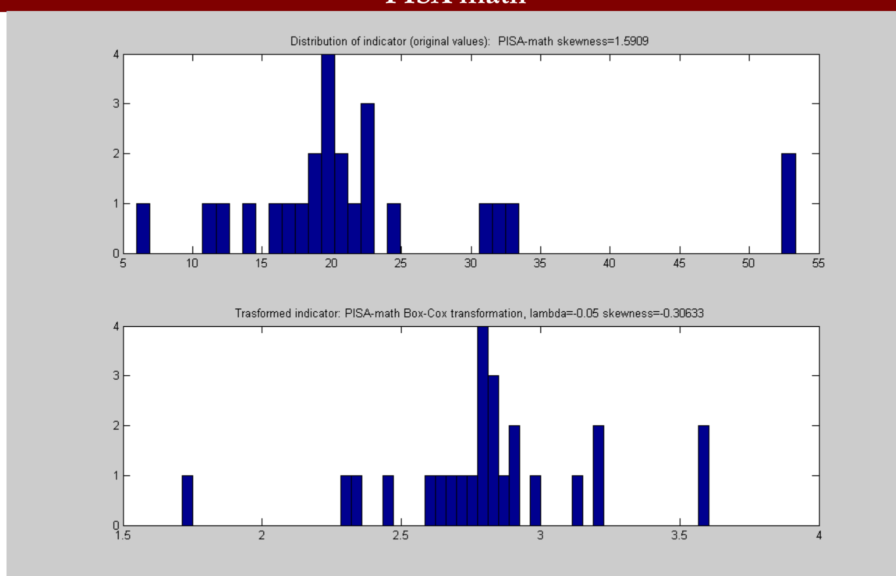
Table 38 shows the histograms of the three indicators. They all show positive skewness and have been transformed with the Box-Cox method.

Table 38 Histograms of Quality of Primary & Secondary education indicators

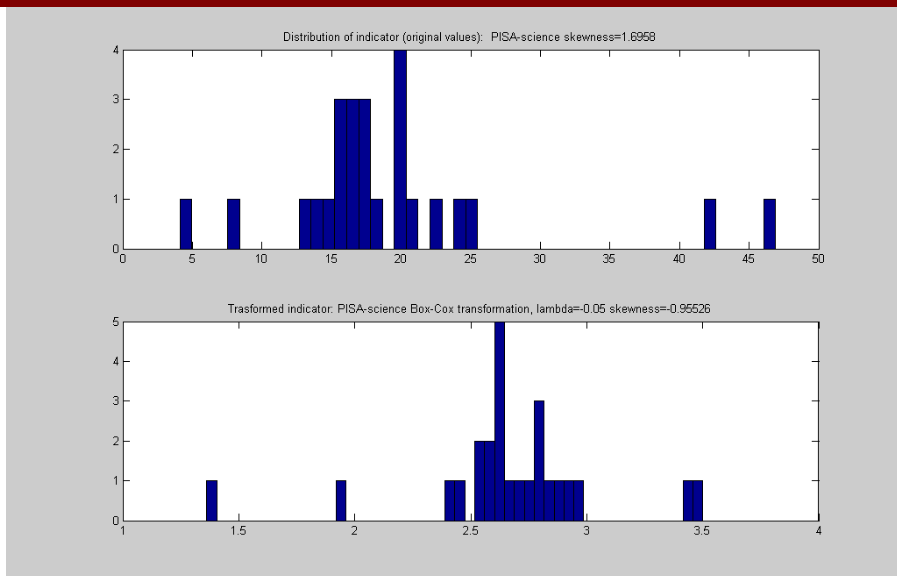
PISA reading



PISA math



PISA science



MULTIVARIATE ANALYSIS

The correlation coefficients between the three PISA indicators clearly indicate a very high level of correlation (Table 39). Accordingly, the PCA analysis highlights a single major dimension (Figure 5-20), which accounts for more than 95% of total variation (Table 41) and is equally described by all the indicators, as may be seen by the table of component loadings (Table 40). The pillar describing the level of compulsory education in EU regions is statistically consistent and well balanced, thus supporting the choice of the sub-score computation as simple average of the normalized indicators. The geographical distribution of the sub-score across EU countries is displayed in Figure 5-21 while its histogram is shown in Figure 5-22. Countries, reordered from best to worst performers in this pillar are displayed in Table 43.

Table 39: Correlation matrix between indicators included in the pillar on Quality of primary and secondary education

Correlation Matrix

		PISA_reading _reversed	PISA_math_ reversed	PISA_science _reversed
Correlation	PISA_reading_reversed	1.000	.939	.927
	PISA_math_reversed	.939	1.000	.937
	PISA_science_reversed	.927	.937	1.000
Sig. (1-tailed)	PISA_reading_reversed		.000	.000
	PISA_math_reversed	.000		.000
	PISA_science_reversed	.000	.000	

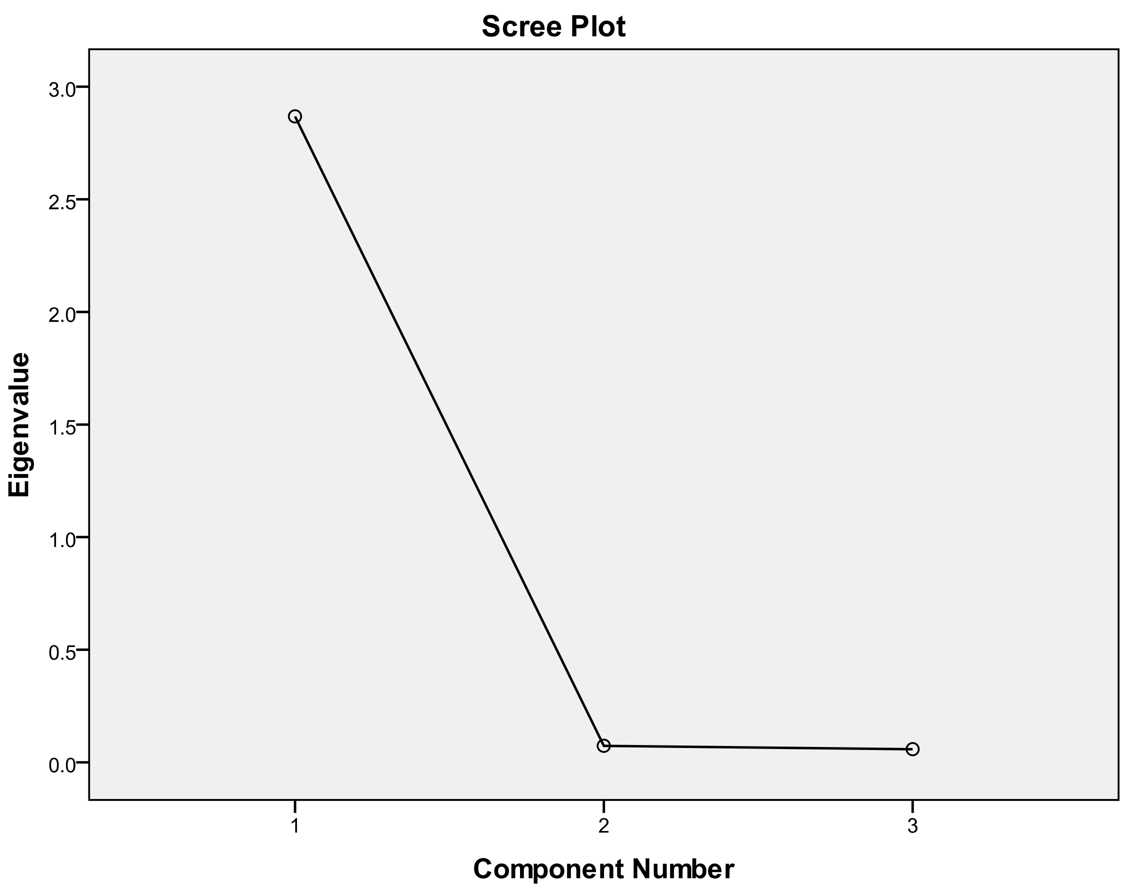


Figure 5-20: PCA analysis of the pillar on Quality of primary and secondary education- eigenvalues

Table 40: PCA analysis of the pillar on Quality of primary and secondary education: correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component		
	1	2	3
PISA_reading_reversed	.977	-.181	.113
PISA_math_reversed	.980	-.019	-.197
PISA_science_reversed	.976	.200	.084

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Table 41: PCA analysis for the pillar on Quality of primary and secondary education: explained variance

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.868	95.603	95.603	2.868	95.603	95.603
2	.073	2.447	98.050	.073	2.447	98.050
3	.059	1.950	100.000	.059	1.950	100.000

Extraction Method: Principal Component Analysis.

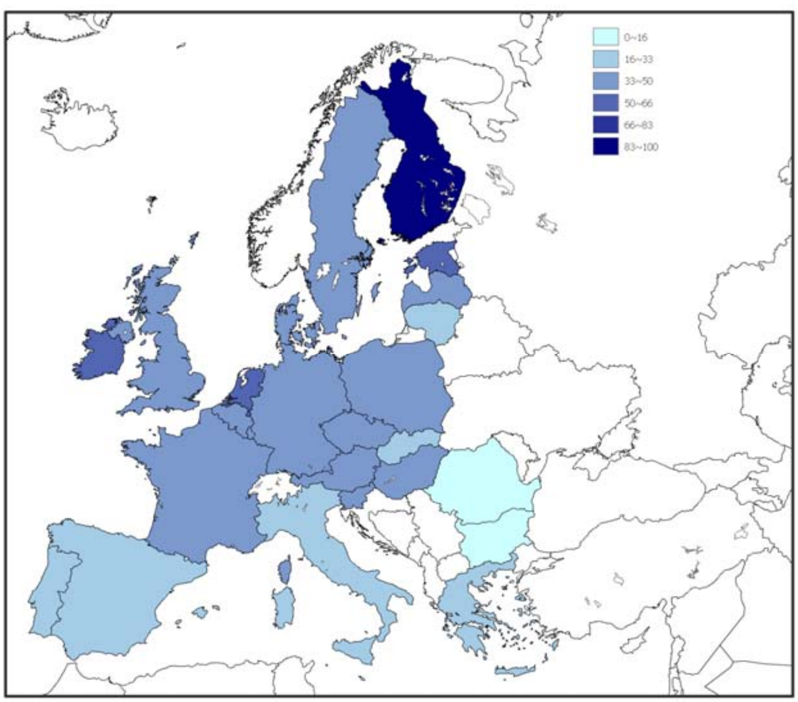


Figure 5-21: Quality of primary and secondary education pillar sub-score. (min-max normalized values)

Table 42: Quality of primary and secondary education sub-scores

country	Subscore	Min_max normalized subscore
BE	0.5	43
BG	-2.5	2
CZ	0.23	39
DK	0.87	48
DE	0.43	42
EE	2.07	65
IE	1.13	52
GR	-0.8	25
ES	-0.3	32
FR	-0.1	35
IT	-0.87	24
CY		
LV	0.23	39
LT	-0.27	33
LU	-0.23	33
HU	0.37	41
MT		
NL	1.43	56
AT	0.3	40
PL	0.53	44
PT	-0.5	29
RO	-2.63	0
SI	0.87	48
SK	-0.27	33
FI	4.63	100
SE	0.7	46
UK	0.4	42

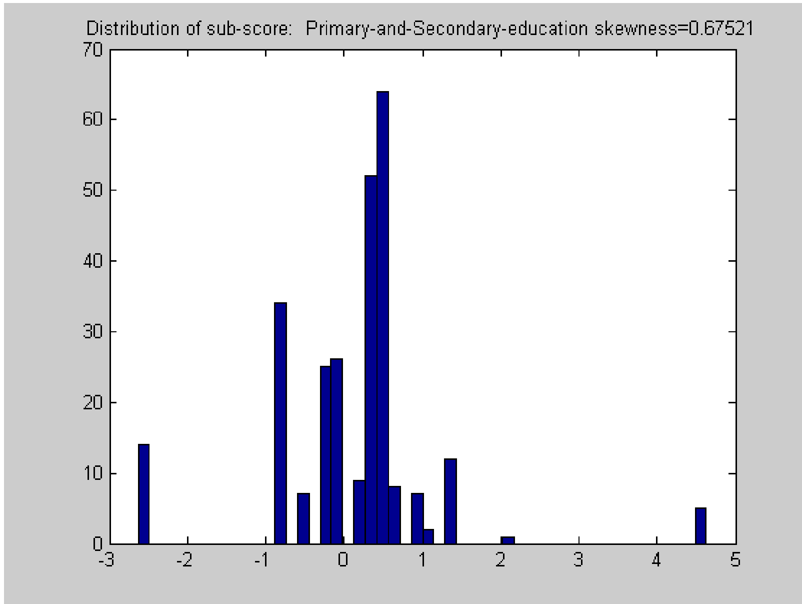


Figure 5-22: Histogram of Quality of primary and secondary education sub-scores

Table 43: Quality of primary and secondary education sub-rank (from best to worst)

Quality of primary and secondary education		
1	FI	Finland
2	EE	Estonia
3	NL	Netherlands
4	IE	Ireland
5	DK	Denmark
6	SI	Slovenia
7	SE	Sweden
8	PL	Poland
9	BE	Belgium
10	DE	Germany
11	UK	United Kingdom
12	HU	Hungary
13	AT	Austria
14	CZ	Czech republic
15	LV	Latvia
16	FR	France
17	LU	Luxembourg
18	LT	Lithuania
19	SK	Slovakia
20	ES	Spain
21	PT	Portugal
22	GR	Greece
23	IT	Italy
24	BG	Bulgaria
25	RO	Romania
--	CY	Cyprus
--	MT	Malta

5.6 Higher Education/Training and Lifelong Learning

The full description of indicators included in the pillar is due in Section 3.6. In the following we recall them together with the short names used for the statistical analysis.

Indicators included, in brackets short names:

1. Share of population 25-64 with higher educational attainment (tertiary_ed_attainment)
2. Share of population 25-64 involved in education and training (lifelong_learning)
3. Share of population with low education (reversed) (early_school_leavers)
4. Share of population at > 60 minutes from university (reversed) (accessibility)
5. Total expenditures on tertiary education as GDP percentage (tertiary_ed_expenditure)

Indicators 3. and 4. have been reversed in order to have the same polarity with respect to competitiveness.

Imputation of missing data

Total expenditure on tertiary level of education (Tertiary_ed_expenditure) is available at the country level. 2006 data has been used with the exception of Denmark, Estonia, Greece, Poland and Malta where 2005 has been used due to lack of more recent data. The number of students in tertiary education, available at the regional level from the Eurostat Education and Training database, is considered as the best proxy for imputing Tertiary_ed_expenditure at the NUTS 2 level. 2006 figures for the number of students (ISCED 5-6 level) in the 20-29 years age brackets at the NUTS 2 level have been used. For Greece and Ireland 2005 figures have been used due to lack of 2006 data. For the UK and Germany, NUTS 2 data on the number of students has been imputed to the NUTS 2 level. Similarly, for Denmark NUTS 0 level has been imputed to the NUTS 2 level.

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Table 44 presents the descriptive statistics for the five indicators included in the Higher Education/Training and Lifelong Learning pillar. The first four indicators are at the regional level, with very low percentage of missing data. The higher education attainment, accessibility to universities and lifelong learning refer to 2007 while data on early school leavers is an average of 2006 and 2007. Data on tertiary education expenditure refers to 2006. The accessibility indicator shows a high coefficient of variation, explained by the fact that there are various regions in Europe, often times due to their geographical position, which are located far (in this case, defined as more than 60' drive) from a university.

Table 44: Descriptive statistics of Higher Education/Training and Lifelong Learning indicators

Indicator	Population 25-64 with higher education	Lifelong learning	Early school leavers	Accessibility to universities	Higher education expenditure
description	Population aged 25-64 with higher educational attainment (ISCED5_6), % of total population of age group	Participation of adults aged 25-64 in education and training, % of population aged 25-64	People with at most lower secondary education and not in further education or training, % of total population aged 18-24	Population living at more than 60 minutes from the nearest university, % of total population	Total public expenditure on education as % of GDP, at tertiary level of education (ISCED 5-6)
source	Eurostat, LFS	Eurostat Regional Education Statistics	Eurostat Structural Indicators	Nordregio/EuroGeographics/ GISCO/ EEA ETC-TE	Total public expenditure on education as % of GDP, at tertiary level of education (ISCED 5-6)
reference year	2007	2007	average 2006-2007	2006	2006
% of missing values	1.49	1.49	1.49	2.24	11.11
mean value	23.04	9.74	15.76	11.76	1.21
standard deviation (unbiased)	7.95	6.62	8.67	21.39	0.39
coefficient of variation	0.35	0.68	0.55	1.82	0.32
maximum value	42.50	29.19	56.46	99.99	2.27
region corresponding to maximum value	ES21	DK01	PT20	GR13	DK
minimum value	7.26	0.29	2.82	0.00	0.73
region corresponding to minimum value	CZ04	GR41	PL21	BE00	BG

How do EU regions score in each of the indicators?

With regards to tertiary education attainment, we can see that a number of UK regions are performing very well while the northern regions of Romania show some of the lowest performance. Northern European regions perform best on the lifelong learning indicator while we can see parts of Romania, Bulgaria and Greece having the lowest percentage of the population participating in lifelong learning activities. A number of Polish regions perform very well on the indicator on early school leavers while Mediterranean regions, especially in Portugal and Spain, are lagging significantly behind. German regions demonstrate a very dense network of universities while Greek regions have the worst accessibility to universities. Denmark and Finland are the countries with highest expenditure on tertiary education as percentage of GDP while Bulgaria and Italy have the lowest. In general, we could see a rather distinct division between the performance of Northern and Southern European regions in terms of the quality of higher education and training systems.

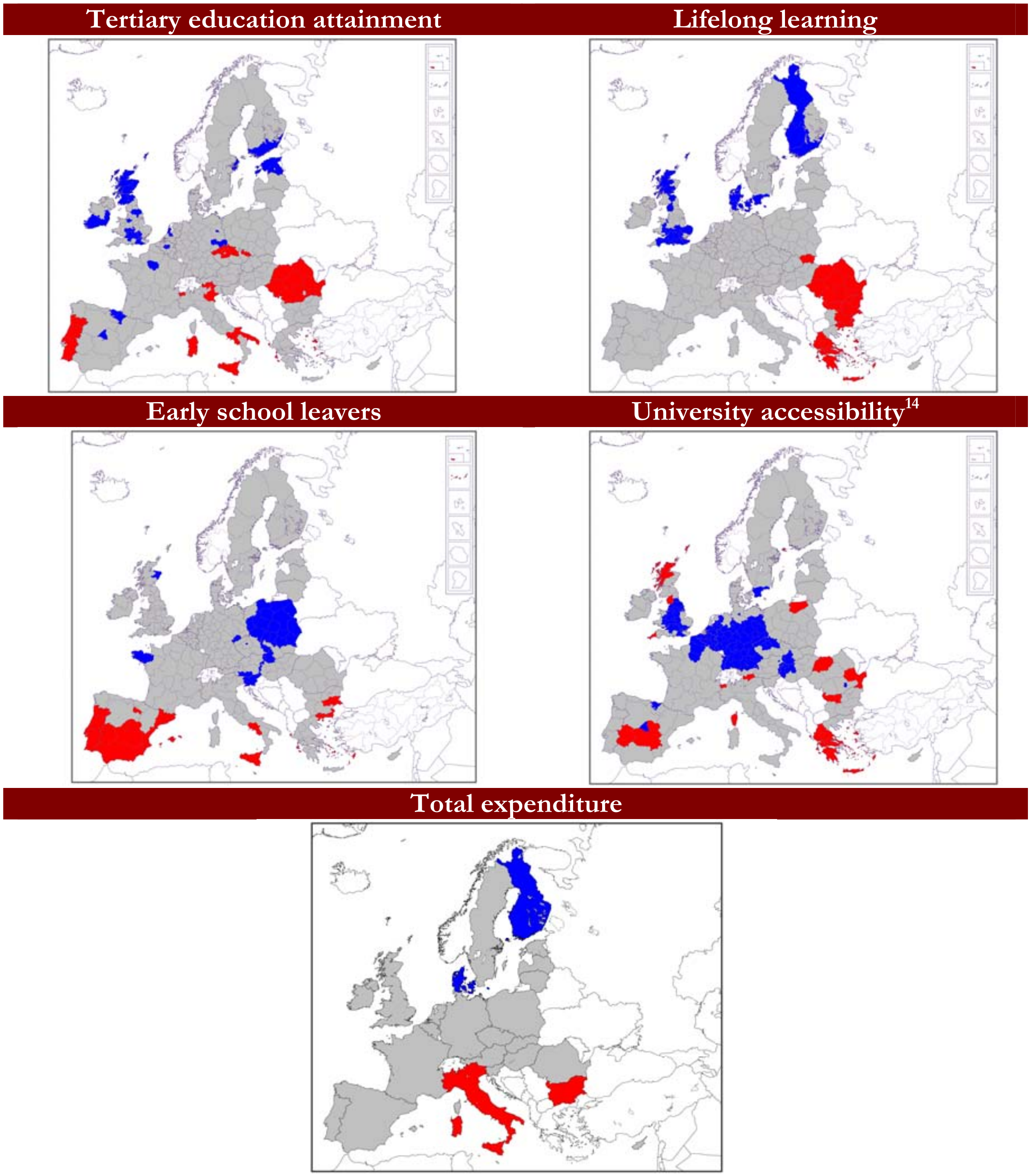


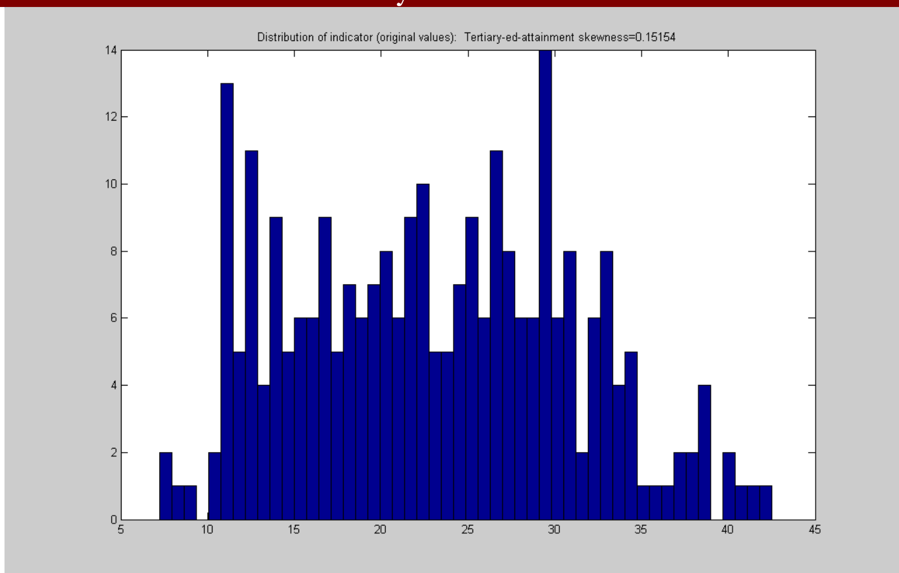
Figure 5-23. Best and worst performing regions for each indicator Higher Education/Training and Lifelong learning

[14] In the case of university accessibility indicator, the top performers include more than 10% of all regions in order to accommodate the fact that they all have the same value for the indicator.

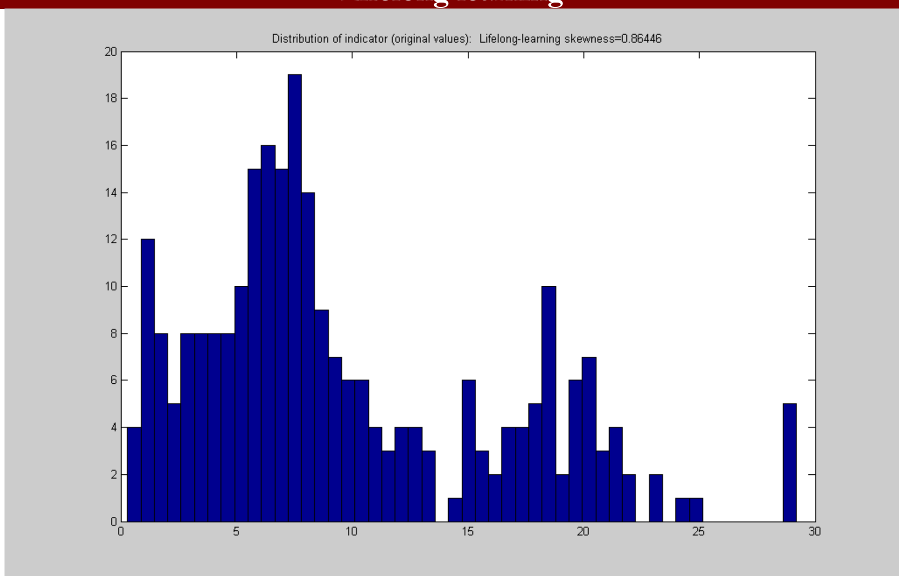
As shown in Table 45, only two of the Higher Education/Training and Lifelong Learning indicators, higher education attainment and lifelong learning, have not been transformed. Data on early school leavers and total expenditure on tertiary education demonstrates high positive skewness and has been transformed using the Box-Cox method as described in Section 4.3. Furthermore, similar to the infrastructure indicators, the data on university accessibility has a lot of zero values and has been, thus, transformed logarithmically as explained in Section 4.3. The graphs show, where relevant, both the distribution of the original data as well as the as that of the transformed indicator.

Table 45: Histograms of Higher Education/Training and Lifelong Learning indicators

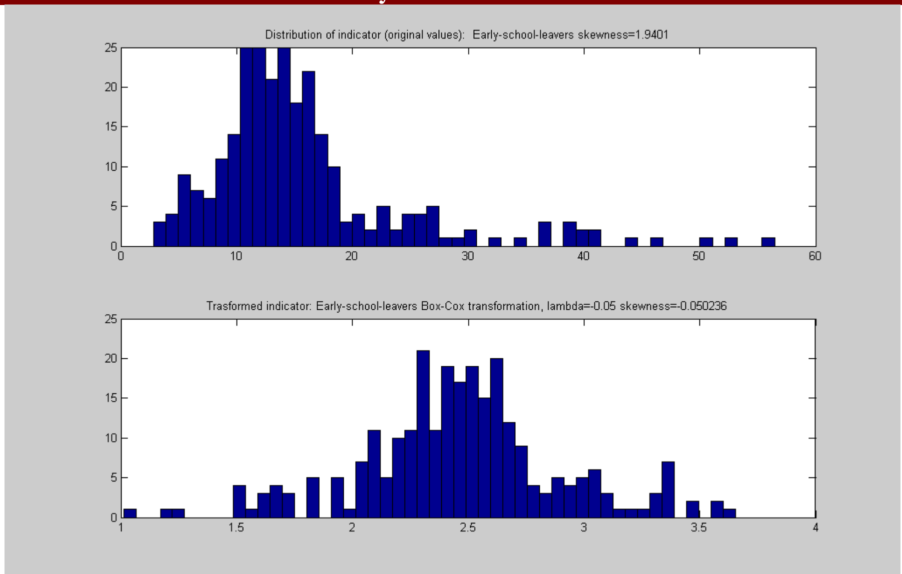
Tertiary ed attainment



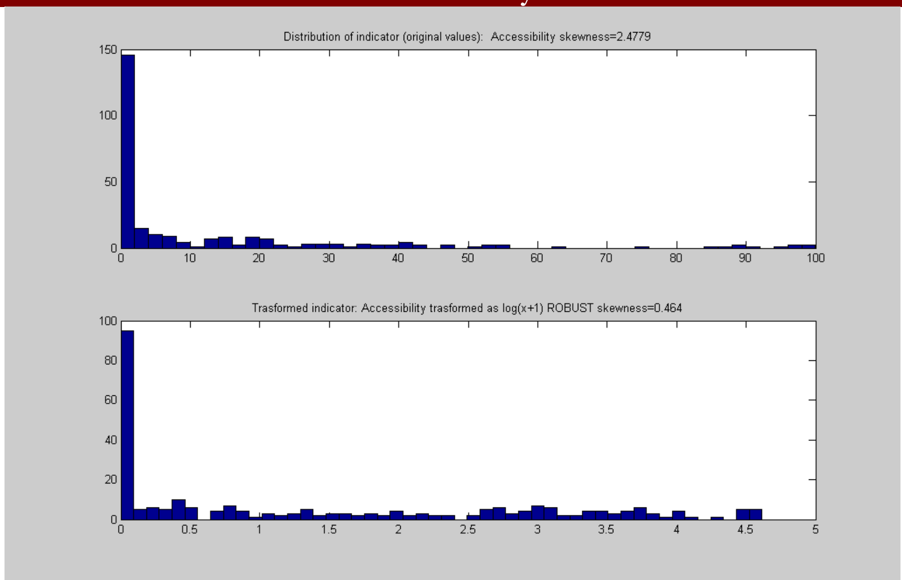
Lifelong learning



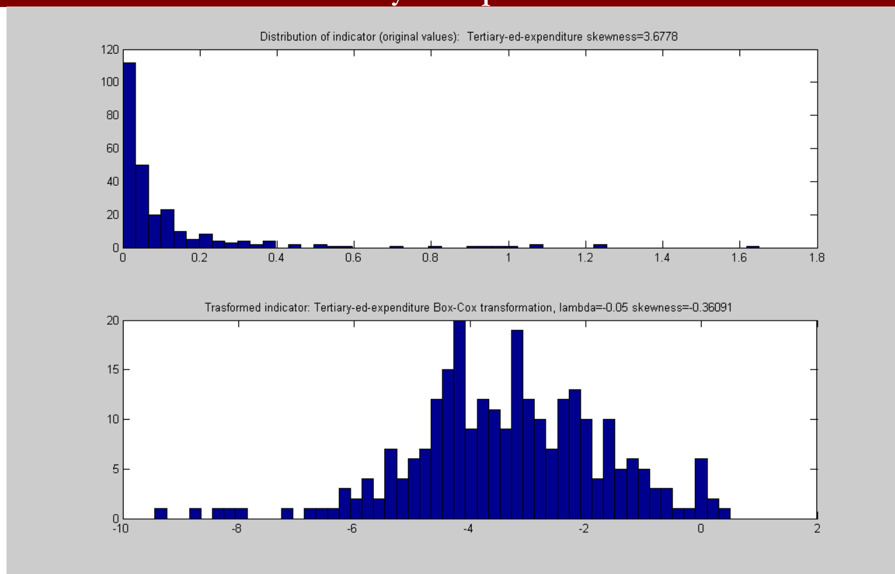
Early school leavers



Accessibility



Tertiary ed expenditure



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The PCA analysis highlights the presence of two prevalent dimensions which together explain about 62% of total variation (Table 48). The first dimension, which accounts for 40% of the variance, is described by Tertiary_ed_attainment, Lifelong_learning and Accessibility (Table 47). Early_school_leavers and Tertiary_ed_expenditure contribute to the second component, which explains 22% of total variation. From the analysis of the scree plot (Figure 5-24) it can be seen that the presence of one unique dimension cannot be fully supported in this case.

Figure 5-25 shows the map of the Higher education sub-score, computed as an arithmetic mean of the five standardized indicators (values in Table 49). In Figure 5-26 the histogram of the higher education sub-score is displayed while Table 50 shows the ranking of regions in this pillar.

Table 46: Correlation matrix between indicators included inthe Higher Education/Training and Lifelong Learning pillar

Correlation Matrix

		Tertiary_ed_ attainment	Lifelong_ learning	Early_school_ leavers_ reversed	Accessibility_ reversed	Tertiary_ed_ expenditure
Correlation	Tertiary_ed_attainment	1.000	.667	.158	.334	.187
	Lifelong_learning	.667	1.000	.121	.256	.048
	Early_school_leavers_ reversed	.158	.121	1.000	.237	.226
	Accessibility_reversed	.334	.256	.237	1.000	.049
	Tertiary_ed_expenditure	.187	.048	.226	.049	1.000
Sig. (1-tailed)	Tertiary_ed_attainment		.000	.005	.000	.001
	Lifelong_learning	.000		.025	.000	.220
	Early_school_leavers_ reversed	.005	.025		.000	.000
	Accessibility_reversed	.000	.000	.000		.219
	Tertiary_ed_expenditure	.001	.220	.000	.219	

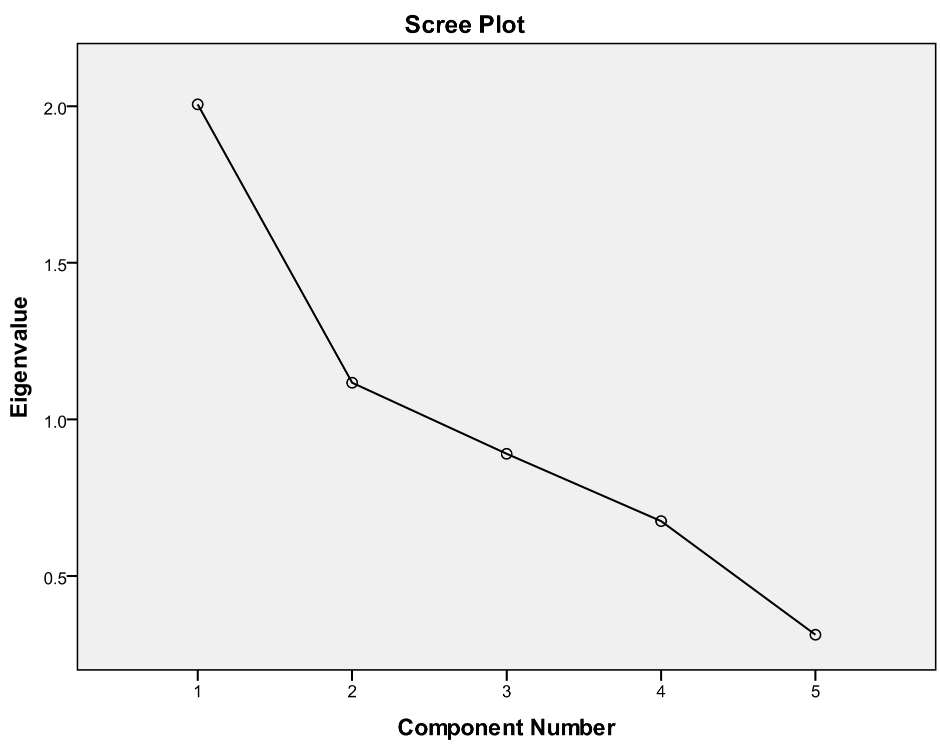

Figure 5-24: PCA analysis of the Higher Education/Training and Lifelong learning pillar – eigenvalues

Table 47: PCA analysis of the Higher Education/Training and Lifelong Learning pillar: correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component				
	1	2	3	4	5
Tertiary_ed_attainment	.851	-.244	.226	-.025	-.406
Lifelong_learning	.786	-.399	.199	-.216	.369
Early_school_leavers_reversed	.442	.643	-.365	-.507	-.021
Accessibility_reversed	.602	.020	-.605	.517	.061
Tertiary_ed_expenditure	.324	.696	.548	.321	.087

Extraction Method: Principal Component Analysis.

a. 5 components extracted.

Table 48: PCA analysis for the Higher Education/Training and Lifelong learning pillar: explained variance

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	2.006	40.118	40.118
2	1.117	22.339	62.457
3	.890	17.801	80.257
4	.675	13.500	93.758
5	.312	6.242	100.000

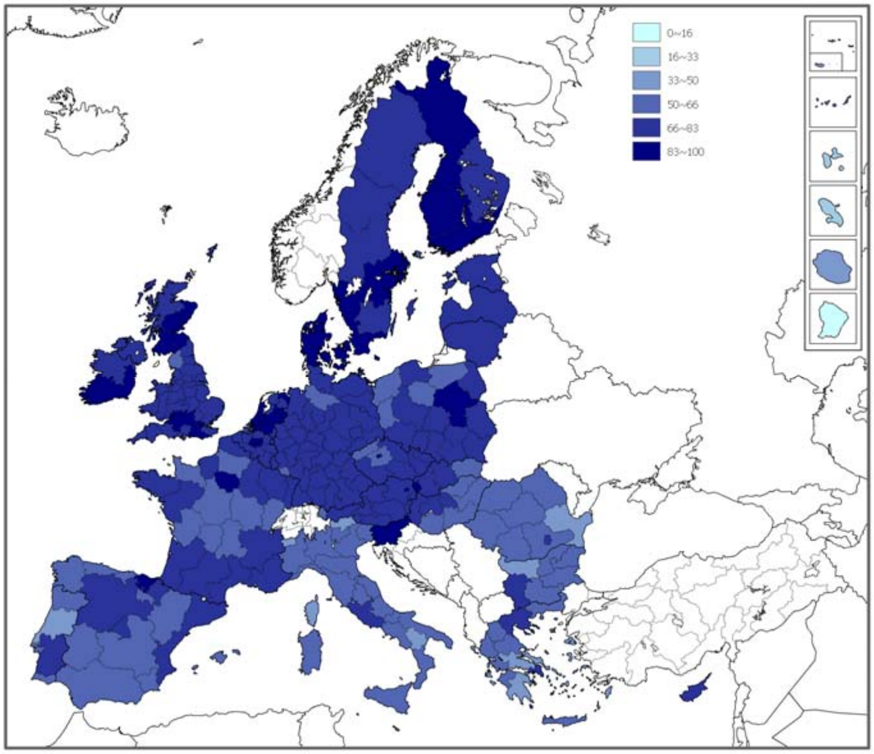

Figure 5-25: Higher Education/Training and Lifelong Learning sub-score (Min-Max normalized values)

Table 49: Higher Education/Training and Lifelong Learning sub-score as arithmetic mean of transformed and standardized indicators.

region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore
BE00	0.92	89	ES30	0.48	81	AT33	-0.04	71
BE21	0.52	82	ES41	-0.32	66	AT34	-0.60	61
BE22	0.30	78	ES42	-1.03	53	PL11	-0.07	71
BE23	0.57	83	ES43	-1.03	53	PL12	0.68	85
BE25	0.34	78	ES51	-0.07	71	PL21	0.36	79
BE32	0.00	72	ES52	-0.18	69	PL22	0.40	79
BE33	0.27	77	ES53	-1.15	51	PL31	0.05	73
BE34	-0.13	70	ES61	-0.47	64	PL32	0.03	73
BE35	0.12	74	ES62	-0.50	63	PL33	-0.07	71
BG31	-1.62	43	ES63	-1.98	36	PL34	-0.27	67
BG32	-0.79	58	ES64	-1.96	37	PL41	-0.05	71
BG33	-0.70	59	ES70	-0.79	58	PL42	-0.37	65
BG34	-1.10	52	FR10	0.85	88	PL43	-0.64	61
BG41	0.21	76	FR21	-0.17	69	PL51	0.13	75
BG42	-0.91	56	FR22	-0.38	65	PL52	-0.29	67
CZ01	0.97	90	FR23	-0.18	69	PL61	-0.36	66
CZ02	-0.41	65	FR24	-0.55	62	PL62	-0.67	60
CZ03	0.01	72	FR25	-0.41	65	PL63	-0.23	68
CZ04	-0.45	64	FR26	-0.81	57	PT11	-0.63	61
CZ05	0.05	73	FR30	0.05	73	PT15	-1.31	48
CZ06	0.04	73	FR41	0.08	74	PT16	-0.49	63
CZ07	-0.12	70	FR42	0.16	75	PT17	-0.15	69
CZ08	-0.11	70	FR43	-0.37	65	PT18	-1.09	52
DK01	1.43	98	FR51	-0.04	71	PT20	-1.94	37
DK02	0.77	86	FR52	0.59	83	PT30	-1.77	40
DK03	0.86	88	FR53	-0.54	62	RO11	-0.91	56
DK04	0.89	88	FR61	-0.29	67	RO12	-0.86	57
DK05	0.89	88	FR62	0.02	73	RO21	-1.05	53
DE11	0.22	76	FR63	-0.74	59	RO22	-1.26	49
DE12	0.19	76	FR71	0.15	75	RO31	-1.23	50
DE13	0.10	74	FR72	-0.36	66	RO32	0.28	77
DE14	0.11	74	FR81	-0.32	66	RO41	-1.13	52
DE21	0.38	79	FR82	-0.17	69	RO42	-0.87	56
DE22	-0.18	69	FR83	-1.48	45	SI01	1.13	93
DE23	-0.18	69	FR91	-2.66	24	SI02	1.03	91
DE24	-0.26	67	FR92	-2.61	25	SK01	0.96	90
DE25	-0.08	71	FR93	-3.97	0	SK02	0.29	77
DE26	-0.01	72	FR94	-1.91	37	SK03	-0.16	69
DE27	-0.14	70	ITC1	-0.71	59	SK04	-0.55	62
DE30	0.40	79	ITC2	-2.15	33	FI13	0.53	82
DE41	-0.10	70	ITC3	-0.54	62	FI18	1.53	100
DE42	0.16	75	ITC4	-0.38	65	FI19	1.10	92
DE50	-0.19	69	ITD1	-1.84	39	FI1A	0.70	85
DE60	0.09	74	ITD2	-0.67	60	FI20	-0.49	63
DE71	0.18	75	ITD3	-0.51	63	SE11	1.03	91
DE72	-0.01	72	ITD4	-0.52	63	SE12	0.78	86
DE73	-0.16	69	ITD5	-0.34	66	SE21	0.26	77
DE80	-0.05	71	ITE1	-0.45	64	SE22	1.02	91
DE91	-0.10	70	ITE2	-0.38	65	SE23	0.89	88
DE92	-0.17	69	ITE3	-0.65	60	SE31	-0.01	72
DE93	-0.44	64	ITE4	0.08	74	SE32	-0.08	71
DE94	-0.30	67	ITF1	-0.38	65	SE33	0.29	77
DEA1	-0.07	71	ITF2	-0.80	58	UKC1	0.19	76
DEA2	0.18	75	ITF3	-0.68	60	UKC2	0.35	79
DEA3	-0.04	71	ITF4	-0.91	56	UKD1	-0.43	64
DEA4	-0.20	69	ITF5	-1.26	49	UKD2	0.37	79
DEA5	-0.15	69	ITF6	-1.03	53	UKD3	0.47	81
DEB1	-0.30	67	ITG1	-1.05	53	UKD4	0.41	80
DEB2	-0.19	69	ITG2	-1.12	52	UKD5	0.31	78
DEB3	-0.09	71	CY00	0.35	79	UKE1	-0.01	72
DEC0	-0.53	63	LV00	-0.07	71	UKE2	0.45	80
DED1	0.21	76	LT00	0.19	76	UKE3	0.10	74
DED2	0.36	79	LU00	0.14	75	UKE4	0.42	80
DED3	0.30	78	HU10	0.33	78	UKF1	0.39	79
DEE0	-0.03	72	HU21	-0.25	68	UKF2	0.45	80
DEF0	-0.27	67	HU22	-0.17	69	UKF3	-0.09	71
DEG0	0.23	76	HU23	-0.45	64	UKG1	0.60	83
EE00	0.20	76	HU31	-0.37	65	UKG2	0.33	78
IE01	0.19	76	HU32	-0.37	65	UKG3	0.45	80
IE02	0.78	86	HU33	-0.35	66	UKH1	0.45	80
GR11	-0.95	55	MT00	-0.86	57	UKH2	0.58	83
GR12	-0.31	67	NL11	0.89	88	UKH3	0.22	76
GR13	-0.83	57	NL12	0.23	76	UKI	1.24	95
GR14	-0.89	56	NL13	-0.05	71	UKJ1	0.88	88
GR21	-0.83	57	NL21	0.67	84	UKJ2	1.01	91
GR22	-1.64	42	NL22	0.67	84	UKJ3	0.46	81
GR23	-0.63	61	NL23	-0.02	72	UKJ4	0.34	78
GR24	-1.36	47	NL31	1.18	94	UKK1	0.84	87
GR25	-1.37	47	NL32	0.94	89	UKK2	0.37	79
GR30	0.37	79	NL33	0.96	90	UKK3	-0.30	67
GR41	-1.43	46	NL34	0.03	73	UKK4	0.48	81
GR42	-1.57	44	NL41	0.74	86	UKL1	0.23	76
GR43	-0.91	56	NL42	0.41	80	UKL2	0.56	82
ES11	-0.42	65	AT11	-0.09	71	UKM2	1.30	96
ES12	-0.50	63	AT12	-0.14	70	UKM3	0.76	86
ES13	-0.53	63	AT13	0.73	85	UKM5	1.31	96
ES21	0.63	84	AT21	0.07	73	UKM6	0.42	80
ES22	0.19	76	AT22	0.22	76	UKN0	0.26	77
ES23	-0.53	63	AT31	0.36	79			
ES24	-0.40	65	AT32	-0.09	71			

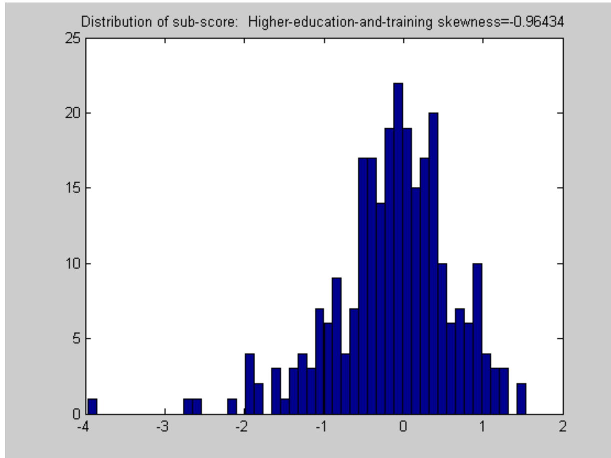

Figure 5-26: Histogram of Higher Education/Training

Table 50: Higher Education/Training and Lifelong Learning pillar sub-rank (from best to worst)

Higher education and training											
1	FI18	46	UKD3	91	IE01	136	DE25	181	FR43	226	FR26
2	DK01	47	UKJ3	92	ES22	137	SE32	182	HU31	227	GR13
3	UKM5	48	UKE2	93	LT00	138	DEB3	183	HU32	228	GR21
4	UKM2	49	UKF2	94	UKC1	139	AT11	184	PL42	229	MT00
5	UKI	50	UKG3	95	DE71	140	AT32	185	FR22	230	RO12
6	NL31	51	UKH1	96	DEA2	141	UKF3	186	ITC4	231	RO42
7	SI01	52	UKE4	97	DE42	142	DE41	187	ITE2	232	GR14
8	FI19	53	UKM6	98	FR42	143	DE91	188	ITF1	233	BG42
9	SI02	54	NL42	99	FR71	144	CZ08	189	ES24	234	GR43
10	SE11	55	UKD4	100	LU00	145	CZ07	190	CZ02	235	ITF4
11	SE22	56	DE30	101	PL51	146	BE34	191	FR25	236	RO11
12	UKJ2	57	PL22	102	BE35	147	DE27	192	ES11	237	GR11
13	CZ01	58	UKF1	103	DE14	148	AT12	193	UKD1	238	ES42
14	NL33	59	DE21	104	DE13	149	DEA5	194	DE93	239	ES43
15	SK01	60	GR30	105	UKE3	150	PT17	195	CZ04	240	ITF6
16	NL32	61	UKD2	106	DE60	151	DE73	196	ITE1	241	ITG1
17	BE00	62	UKK2	107	FR41	152	SK03	197	HU23	242	RO21
18	DK04	63	DED2	108	ITE4	153	DE92	198	ES61	243	PT18
19	DK05	64	AT31	109	AT21	154	FR21	199	PT16	244	BG34
20	NL11	65	PL21	110	CZ05	155	FR82	200	FI20	245	ITG2
21	SE23	66	CY00	111	FR30	156	HU22	201	ES12	246	RO41
22	UKJ1	67	UKC2	112	PL31	157	DE22	202	ES62	247	ES53
23	DK03	68	BE25	113	CZ06	158	DE23	203	ITD3	248	RO31
24	FR10	69	UKJ4	114	NL34	159	ES52	204	ITD4	249	ITF5
25	UKK1	70	HU10	115	PL32	160	FR23	205	DEC0	250	RO22
26	IE02	71	UKG2	116	FR62	161	DE50	206	ES13	251	PT15
27	SE12	72	UKD5	117	CZ03	162	DEB2	207	ES23	252	GR24
28	DK02	73	BE22	118	BE32	163	DEA4	208	FR53	253	GR25
29	UKM3	74	DED3	119	DE26	164	PL63	209	ITC3	254	GR41
30	NL41	75	SK02	120	DE72	165	HU21	210	FR24	255	FR83
31	AT13	76	SE33	121	SE31	166	DE24	211	SK04	256	GR42
32	FI1A	77	RO32	122	UKE1	167	DEF0	212	AT34	257	BG31
33	PL12	78	BE33	123	NL23	168	PL34	213	GR23	258	GR22
34	NL21	79	SE21	124	DEE0	169	FR61	214	PT11	259	PT30
35	NL22	80	UKN0	125	DEA3	170	PL52	215	PL43	260	ITD1
36	ES21	81	DEG0	126	FR51	171	DE94	216	ITE3	261	FR94
37	UKG1	82	NL12	127	AT33	172	DEB1	217	ITD2	262	PT20
38	FR52	83	UKL1	128	DE80	173	UKK3	218	PL62	263	ES64
39	UKH2	84	DE11	129	NL13	174	GR12	219	ITF3	264	ES63
40	BE23	85	AT22	130	PL41	175	ES41	220	BG33	265	ITC2
41	UKL2	86	UKH3	131	DEA1	176	FR81	221	ITC1	266	FR92
42	FI13	87	BG41	132	ES51	177	ITD5	222	FR63	267	FR91
43	BE21	88	DED1	133	LV00	178	HU33	223	BG32	268	FR93
44	ES30	89	EE00	134	PL11	179	FR72	224	ES70		
45	UKK4	90	DE12	135	PL33	180	PL61	225	ITF2		

5.7 Labor market efficiency

As discussed in Section 3.7, indicators included in the pillar are:

Indicators included in the pillar (in brackets short names):

1. Employment rate, not including agriculture (Empl_rate)
2. Long term unemployment (reversed) (Long_term_unempl)
3. Unemployment (reversed) (Unemployment)
4. Job Mobility (Job_mobility)
5. Labor productivity (Labor_productivity)
6. Female-male unemployment rate difference (reversed)(Gender_balance_unemp)
7. Male-female employment rate difference (reversed) (Gender_balance_empl)
8. Female unemployment (reversed) (Female_unemployment)
9. Labor Market Policy (LMP)

All indicators are available at the NUTS2 level except for LMP which is available only at the country level. For this indicator the imputation method described in Section 4.2.1 is adopted. The indicator labor productivity (Labor_productivity) has the highest correlartion, 0.66, with labor market policy (LMP) at the country level. All the other correlations are, in absolute values, lower than 0.46. The regional values of Labor_productivity are then used to impute labor market policies values at the NUTS2 level. In the following the multivariate analysis including the imputed LMP indicator is described.

The indicator on employment rate does not include employment in the agricultural sector as it is considered not a driving factor for competitiveness.

The indicator on male-female employment rate (Gender balance employment) has been transformed from the original female-male employment rate difference by multiplying the original indicators with (-1) due to data transformation needs.

It is worth noting that for the gender balance unemployment indicator, 28% of the regions show a negative value which means that female unemployment rate is lower than male. One could argue if this can be considered a positive or a negative aspect with respect to labor market efficiency. In order to avoid the possible over-awarding of regions with such values, we have decided to censor at the 0 value, i.e. all negative values of the indicator have been substituted with 0. Our main concern has been not to award regions with higher male unemployment with respect to females as this goes against the concept of gender balance. Such approach is equivalent to assigning the same score to all those regions which lay further away from the optimal gender balance labor market which should be around the null value.

Similar treatment has been applied to the gender balance employment indicator. However, as negative values were not present, no changes were necessary.

The indicators measuring unemployment, long term unemployment, gender balance employment, gender balance unemployment and female unemployment are all reversed in order to have the same polarity with respect the level of competitiveness (the higher the better).

Imputation of missing data

For the indicator on labor productivity, due to missing data, 2005 data has been used for UKN0.

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From the analysis of Table 51, we can observe very low percentage of missing values in the set of indicators describing the Labor market efficiency pillar. Six out of the nine indicators refer to data from 2008, while only job mobility and labor productivity are based on 2007 data. The indicator on Gender balance unemployment has a very high coefficient of variation (1.97) indicating a very heterogeneous situation among EU regions. Similarly, the indicators on long-term unemployment and labor productivity have somewhat higher coefficients of variation (0.97 and 0.71, respectively) even though much lower than gender balance unemployment.

Table 51: Descriptive statistics of Labor market indicators

Indicator	Employment rate (excluding agriculture)	Long-term unemployment	Unemployment	Job Mobility
description	% of population 15-64 years	% of labor force	% of active population	% of total employment (people who started to work for the current employer or as self-employed in the last 2 years)
source	Eurostat Regional Employment, LFS	Eurostat Regional Employment, LFS	Eurostat Regional Employment, LFS	Eurostat Regional Employment, LFS
reference year	2008	2008	2008	2007
% of missing values	1.49	0.00	0.00	1.49
mean value	64.04	2.80	7.01	16.35
standard deviation (unbiased)	9.65	2.70	3.74	3.94
coefficient of variation	0.15	0.97	0.53	0.24
maximum value	80.20	19.37	24.80	28.76
region corresponding to maximum value	DK01	FR91	FR94	ES61
minimum value	34.63	0.13	1.90	6.86
region corresponding to minimum value	RO21	FI20	CZ01	GR25

Indicator	Labor productivity	Gender balance uemployment	Gender balance employment	Female unemployment	Labor market policies
description	GDP/person employed in industry and services (€), Index, EU27 = 100	difference between female and male unemployment rates	difference between male and female employment rates	% of female unemployed	% of GDP spent on public expenditure on labour market policies
source	Eurostat Regional Employment, LFS	Eurostat, DG Regio	Eurostat, DG Regio	Eurostat Regional Employment, LFS	Eurostat Labor Market Policy Statistics
reference year	2007	2008	2008	2008	2007
% of missing values	0.00	1.49	0.00	0.00	3.70
mean value	93.94	1.49	13.70	7.88	1.27
standard deviation (unbiased)	25.26	2.94	6.56	4.75	0.90
coefficient of variation	0.27	1.97	0.48	0.60	0.71
maximum value	193.38	15.10	40.50	29.60	3.294
region corresponding to maximum value	NL11	ES63	GR41	FR93	BE
minimum value	28.36	-3.50	1.80	1.30	0.154
region corresponding to minimum value	BG31	DE50	FI13	UKE2	EE

How do EU regions score in each of the indicators?

As shown in Figure 5-27, we can note that Eastern European regions perform consistently bad on the indicator related to employment rate. Similarly, Southern Italian regions also have among the lowest employment rates in Europe. This pattern is confirmed by the data on long-term and short-term unemployment where together with Southern Italian regions, some parts of Spain are also among the worst performers.

The interpretation of the indicator on job mobility could be controversial as higher mobility could both mean a dynamic labor market or a very volatile and insecure one. In this representation, we have related higher job mobility to better performance but any conclusions should be taken with caution. We see the southern regions of Spain having the highest level of job mobility together with parts of Sweden while some Greek regions and parts of Romania are among the regions with lowest mobility.

Female unemployment is clearly a significant problem in Southern European regions.

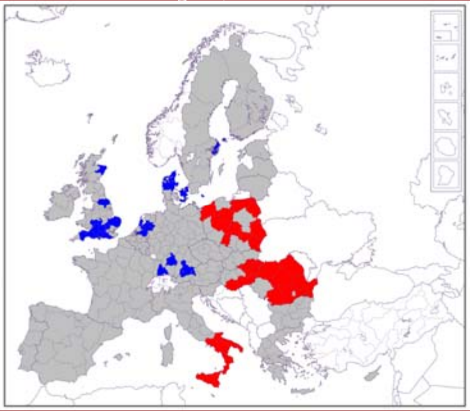
As regards labor productivity, we can see Eastern European regions are clearly showing the worst performance.

With regards to the indicator on gender balance unemployment, the highest unemployment difference among males and females can be observed in Southern European regions (parts of Spain, Portugal, Italy and Greece) while low difference, i.e. more gender balance labor market, is observed in parts of Romania and the UK as well as Ireland.

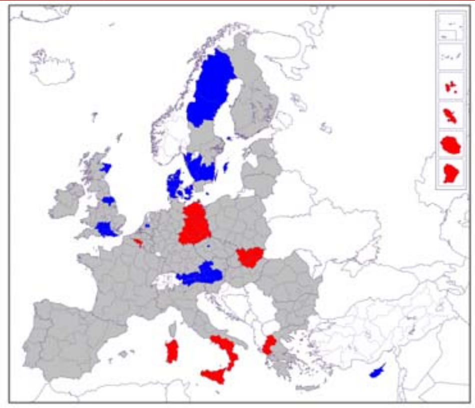
The indicator on gender balance employment shows similar results with the highest gender difference in Southern European regions and the lowest in Scandinavian regions.

Denmark and Belgium have the highest expenditure on labor market policies while Romania and Estonia the lowest.

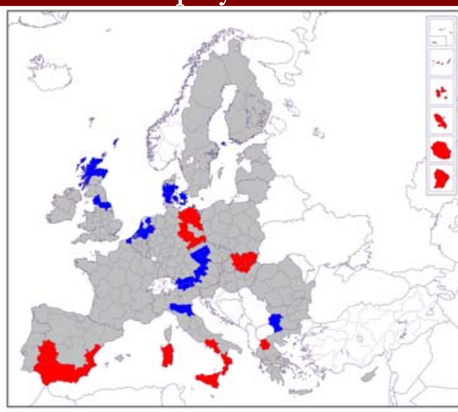
Employment rate



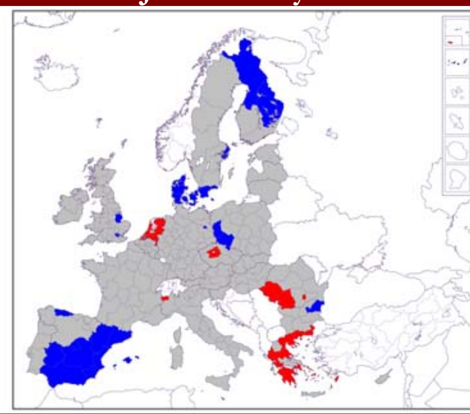
Long-term unemployment



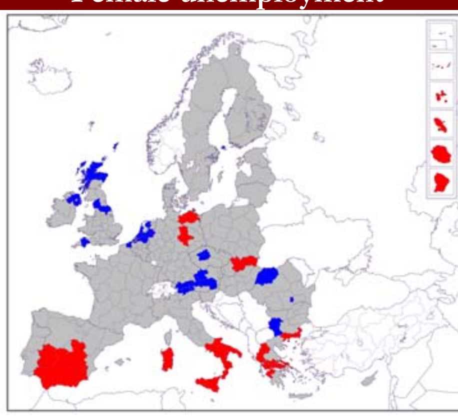
Unemployment rate



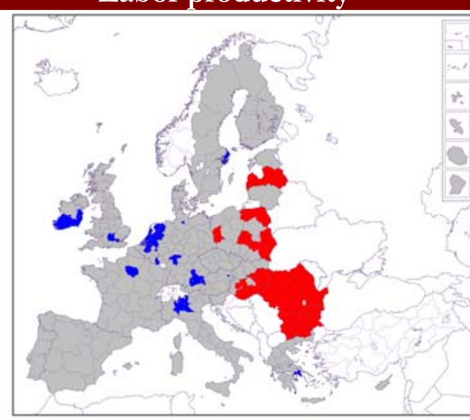
Job mobility



Female unemployment



Labor productivity



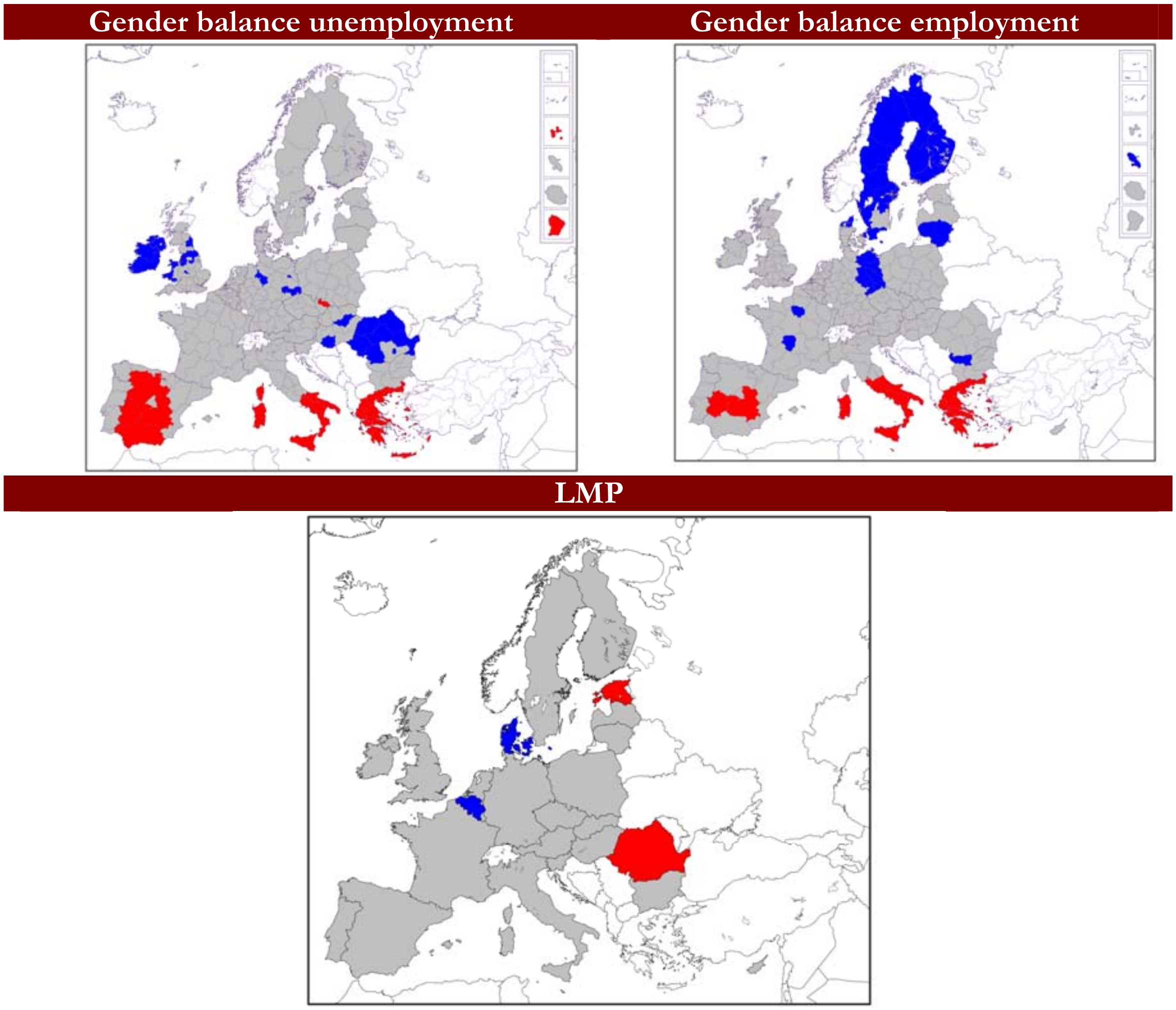
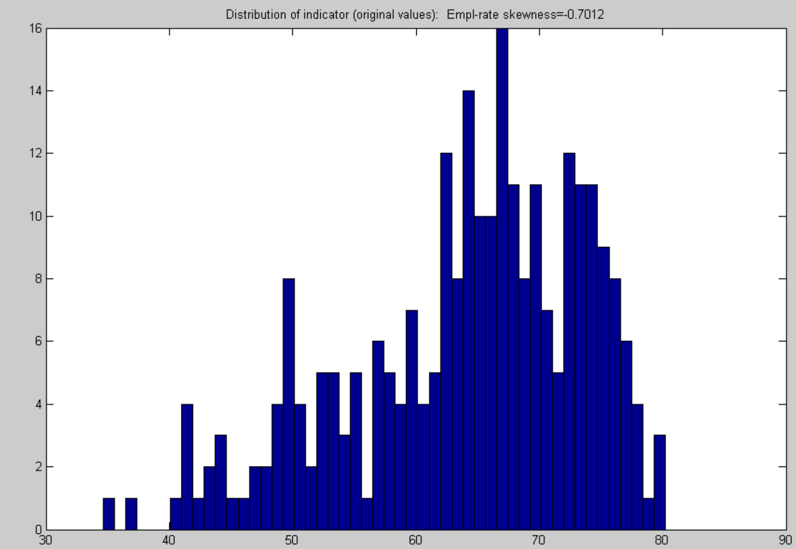


Figure 5-27. Best and worst performing regions for each indicator – Labor market

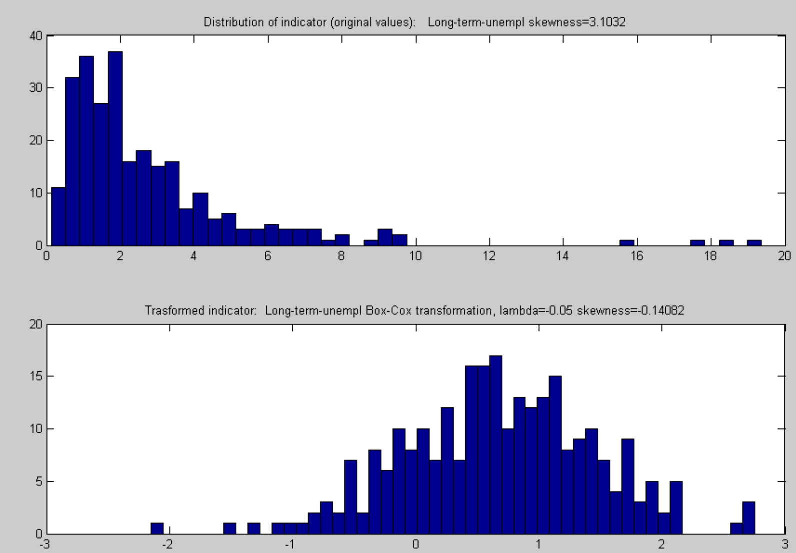
Four out of the nine indicators analyzed have been transformed with the Box-Cox method due to asymmetric distribution – long-term unemployment, unemployment rate, gender balance employment and female unemployment, as shown in Table 52. Gender balance unemployment has been transformed logarithmically due to the presence of 0 values.

Table 52: Histograms of Labor market indicators

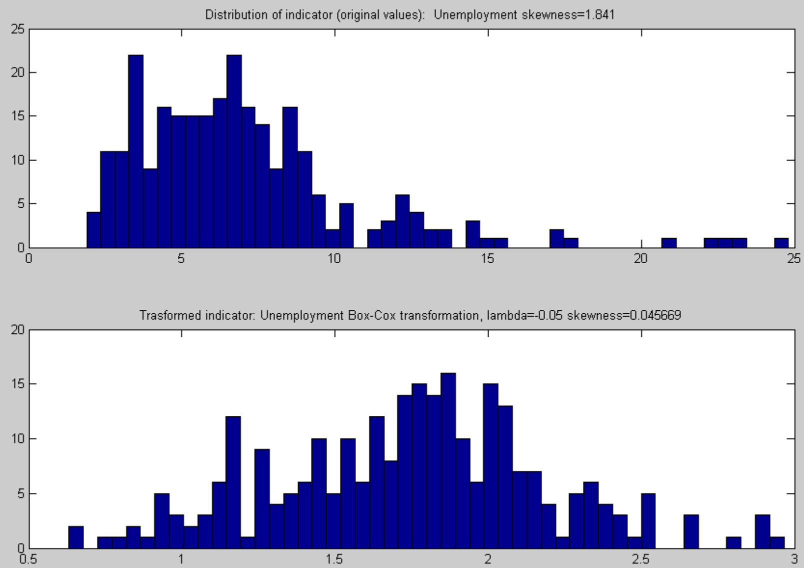
Employment rate



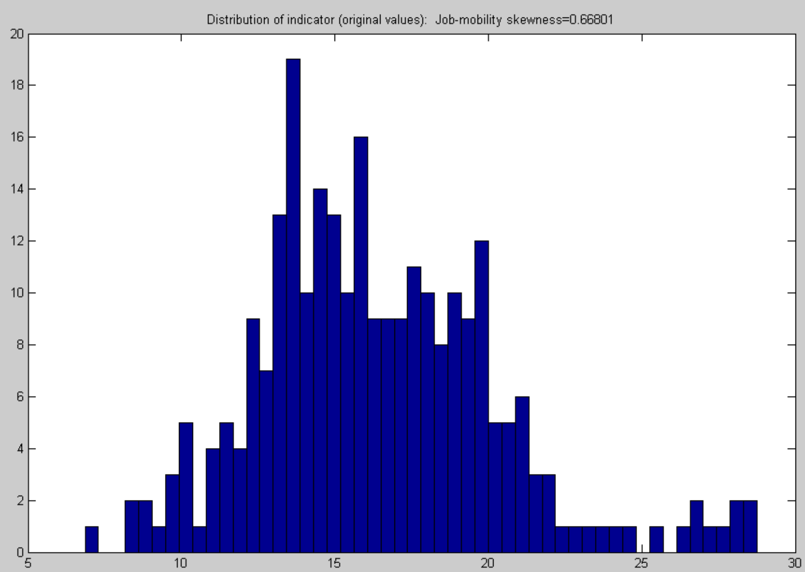
Long-term unemployment



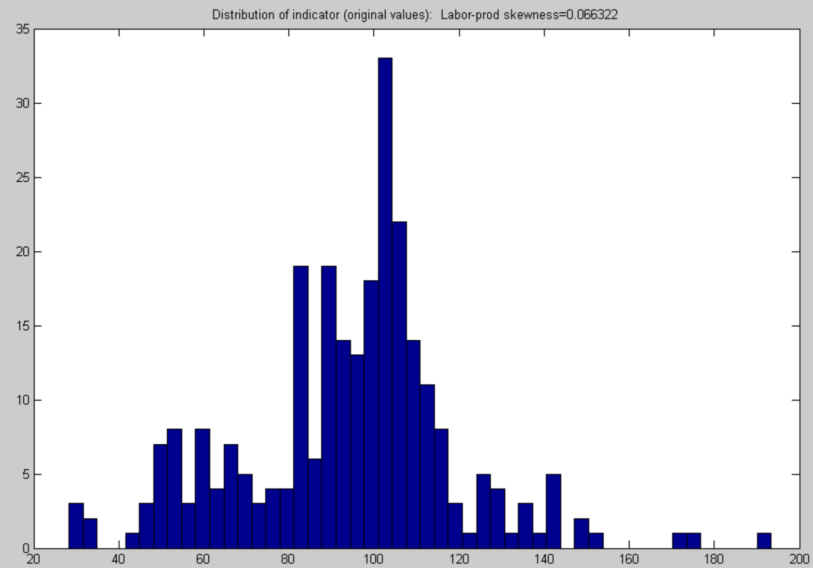
Unemployment rate



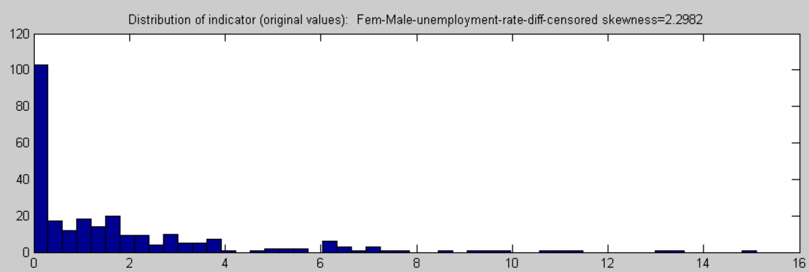
Job mobility

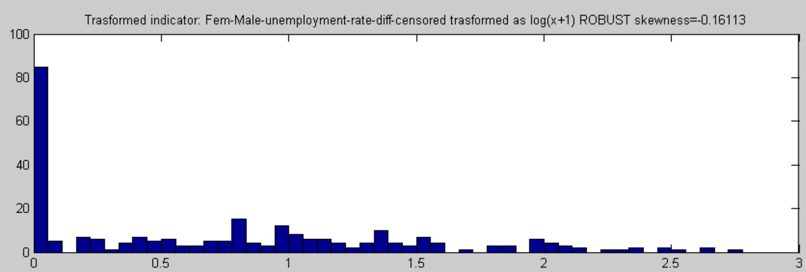


Labor productivity

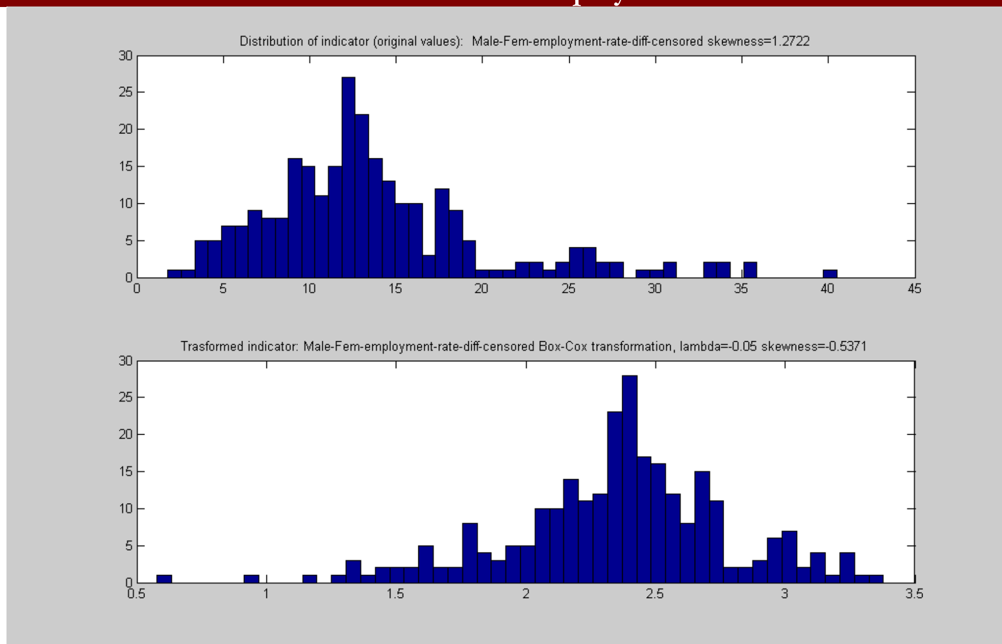


Gender balance unemployment

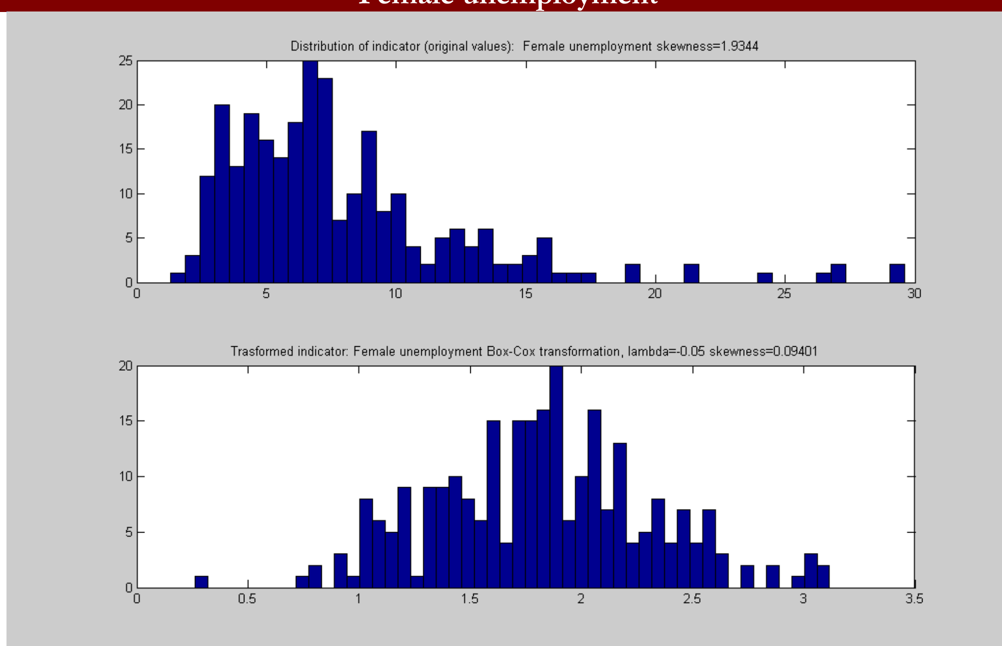




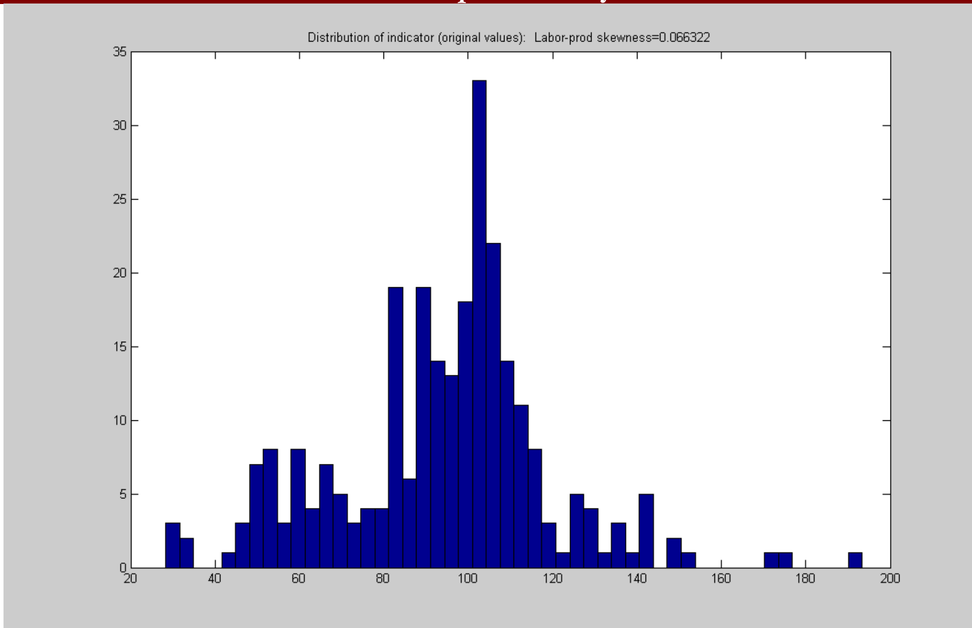
Gender balance employment



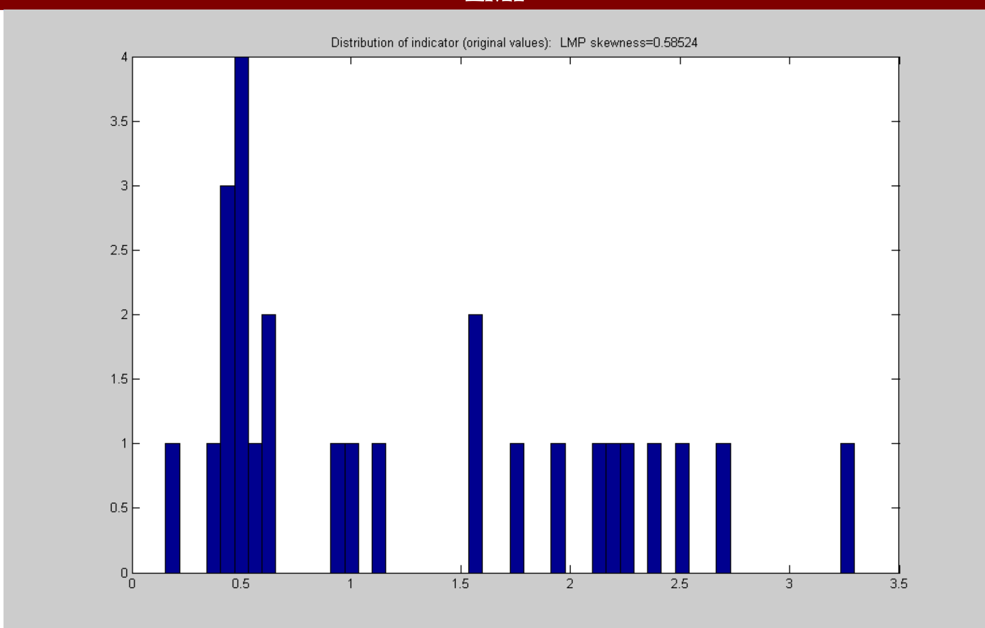
Female unemployment



Labor productivity



LMP



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From the analysis of the correlation matrix (Table 53) the indicators Job_mobility and LMP show a peculiar behavior.

Table 53: Correlation matrix between all the indicators included in the LME pillar

Correlations

		Empl_rate	Long_term_ unempl_ reversed	Unemployment _reversed	Job_mobility	labor_ productivity	Gender_ balance_ unempl_ reversed	Gender_ balance_ empl_reversed	Female_ unemployment_ reversed	LMP_imputed
Empl_rate	Pearson Correlation	1	.595**	.565**	.113*	.537**	.419**	.396**	.591**	.266**
	Sig. (1-tailed)		.000	.000	.033	.000	.000	.000	.000	.000
	N	264	264	264	264	264	262	264	264	251
Long_term_unempl_ reversed	Pearson Correlation	.595**	1	.824**	.145**	.254**	.342**	.157**	.791**	-.024
	Sig. (1-tailed)	.000		.000	.009	.000	.000	.005	.000	.354
	N	264	268	268	264	268	266	268	268	255
Unemployment_ reversed	Pearson Correlation	.565**	.824**	1	-.301**	.239**	.375**	.074	.938**	-.054
	Sig. (1-tailed)	.000	.000		.000	.000	.000	.115	.000	.197
	N	264	268	268	264	268	266	268	268	255
Job_mobility	Pearson Correlation	.113*	.145**	-.301**	1	-.132*	.116*	.280**	-.199**	.032
	Sig. (1-tailed)	.033	.009	.000		.016	.030	.000	.001	.308
	N	264	264	264	264	264	262	264	264	251
labor_productivity	Pearson Correlation	.537**	.254**	.239**	-.132*	1	.025	.020	.196**	.594**
	Sig. (1-tailed)	.000	.000	.000	.016		.340	.374	.001	.000
	N	264	268	268	264	268	266	268	268	255
Gender_balance_ unempl_reversed	Pearson Correlation	.419**	.342**	.375**	.116*	.025	1	.606**	.627**	-.214**
	Sig. (1-tailed)	.000	.000	.000	.030	.340		.000	.000	.000
	N	262	266	266	262	266	266	266	266	253
Gender_balance_ empl_reversed	Pearson Correlation	.396**	.157**	.074	.280**	.020	.606**	1	.255**	.097
	Sig. (1-tailed)	.000	.005	.115	.000	.374	.000		.000	.061
	N	264	268	268	264	268	266	268	268	255
Female_unemployment_ reversed	Pearson Correlation	.591**	.791**	.938**	-.199**	.196**	.627**	.255**	1	-.163**
	Sig. (1-tailed)	.000	.000	.000	.001	.001	.000	.000		.005
	N	264	268	268	264	268	266	268	268	255
LMP_imputed	Pearson Correlation	.266**	-.024	-.054	.032	.594**	-.214**	.097	-.163**	1
	Sig. (1-tailed)	.000	.354	.197	.308	.000	.000	.061	.005	
	N	251	255	255	251	255	253	255	255	255

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

The former is significantly negatively correlated with Unemployment (reversed), Labor productivity and Female_unemployment (reversed), while it is not correlated with LMP (Sig. 1-tailed higher than 0.01). Job_mobility is positively correlated only with four out of eight indicators included in the pillar: Empl_rate, Long_term_unemployment (reversed), Gender_balance_unemployment (reversed) and Gender_balance_employment (reversed). Indicator LMP is not correlated with Long_term_unemployment (reversed), Unemployment (reversed), Job_mobility and Gender_balance_employment (reversed), while it is significantly negatively correlated with Gender_balance_unemployment and Female unemployment (both reversed). In total, it is positively correlated only with two indicators, Empl_rate and Labor_productivity. The analysis of the correlation matrix suggests that Job_mobility and LMP are describing something else than the aspects the labor market pillar is intended to describe.

Regarding Job_mobility, the indicator is defined as the percentage share of people that in the reference year (2007 in this analysis) were working for the current employer a maximum of two years. The indicator is likely composed by two different aspects: one which actually reflects a dynamic and flexible workforce, thus being positively related to competitiveness; the other reflecting an insecure and unstable job market. It is then reasonable that it does not show a relation with unemployment or productivity measures.

As for LMP, some of the problems it shows may be due to the fact that the indicator is available at the country level only and regional values have been imputed according to the method described in Section 4.2.1.

For the reasons above, indicators Job_mobility and LMP have been excluded from the following PCA analysis.

PCA analysis (excluding Job_mobility and LMP)

The PCA analysis on the subset of indicators shows the presence of a unique prevalent dimension which explains more than 53% of total variance (Figure 5-28 and Table 55). All the indicators contribute almost equally to the first dimension, with Labor_productivity and Gender_balance_empl slightly less relevant than the others – component loadings 0.39 and 0.42 respectively (Table 54).

Overall it can be said that the pillar including Empl_rate, Long_term_unempl, Unemployment, Labor_productivity, Gender_balance_unempl, Gender_balance_empl and Female_unempl is rather balanced and statistically consistent.

The distribution of labor market efficiency sub-score across regions is shown in Figure 5-29 and its histogram is due in Figure 5-30. Reordered regions are listed in Table 57.

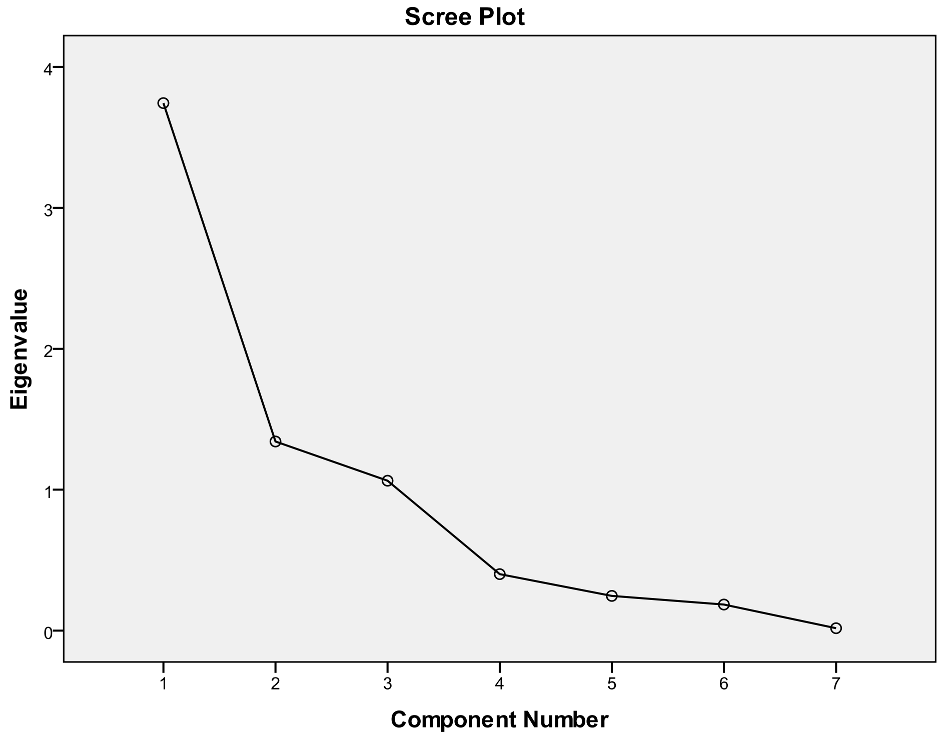


Figure 5-28: PCA analysis of the labor market efficiency pillar - eigenvalues

Table 54: PCA analysis labor market efficiency pillar:
correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
Empl_rate	.801	-.046	.424	-.198	-.372	.001	-.002
Long_term_unempl_ reversed	.846	-.265	-.205	-.250	.152	-.294	-.001
Unemployment_reversed	.872	-.304	-.308	.009	.040	.208	.084
labor_productivity	.387	-.419	.766	.226	.192	.001	.000
Gender_balance_ unempl_reversed	.656	.615	-.060	.395	-.069	-.158	.031
Gender_balance_empl_ reversed	.422	.787	.273	-.271	.203	.114	.001
Female_unemployment_ reversed	.931	-.051	-.289	.139	.021	.131	-.098

Extraction Method: Principal Component Analysis.

a. 7 components extracted.

Table 55: PCA analysis for labor market efficiency pillar: explained variance

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.744	53.481	53.481	3.744	53.481	53.481
2	1.342	19.173	72.654	1.342	19.173	72.654
3	1.064	15.196	87.850	1.064	15.196	87.850
4	.401	5.733	93.584	.401	5.733	93.584
5	.246	3.521	97.105	.246	3.521	97.105
6	.185	2.644	99.748	.185	2.644	99.748
7	.018	.252	100.000	.018	.252	100.000

Extraction Method: Principal Component Analysis.

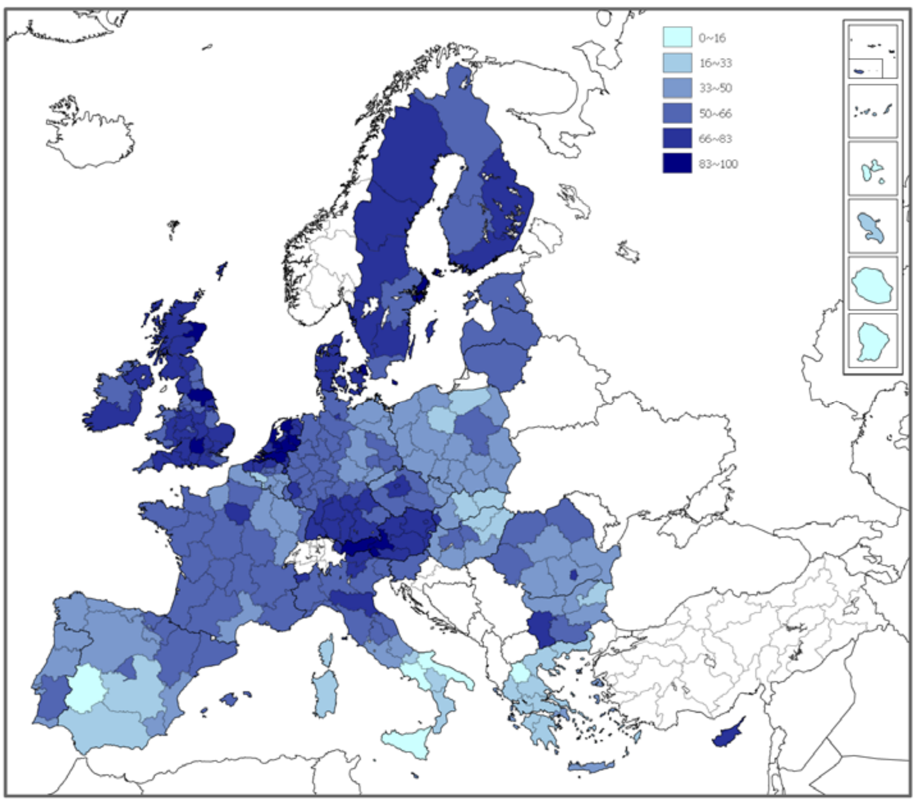


Figure 5-29: Map of Labor Market Efficiency sub-score.
Min-max normalized scores are due in Table 56.

Table 56: Labor market efficiency sub-score as arithmetic mean of transformed and standardized indicators.

region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore
BE00	-0.11	52	ES30	-0.07	53	AT33	1.24	87
BE21	0.60	70	ES41	-0.80	34	AT34	0.64	71
BE22	0.26	61	ES42	-1.03	28	PL11	-0.57	40
BE23	0.71	73	ES43	-1.56	14	PL12	0.00	55
BE25	0.83	76	ES51	0.09	57	PL21	-0.51	41
BE32	-0.91	31	ES52	-0.63	38	PL22	-0.44	43
BE33	-0.67	37	ES53	-0.13	51	PL31	-0.59	39
BE34	-0.47	43	ES61	-1.39	19	PL32	-0.73	36
BE35	-0.64	38	ES62	-0.69	37	PL33	-0.66	38
BG31	-0.29	47	ES63	-1.83	7	PL34	-0.43	44
BG32	-0.61	39	ES64	-2.04	2	PL41	-0.74	36
BG33	-1.03	28	ES70	-1.09	27	PL42	-0.74	36
BG34	-0.36	45	FR10	0.60	70	PL43	-0.53	41
BG41	0.73	73	FR21	-0.37	45	PL51	-0.79	34
BG42	-0.14	51	FR22	-0.10	52	PL52	-0.56	40
CZ01	1.09	83	FR23	-0.44	43	PL61	-0.97	30
CZ02	0.54	69	FR24	0.13	58	PL62	-0.87	32
CZ03	0.23	61	FR25	-0.17	50	PL63	-0.34	46
CZ04	-0.73	36	FR26	0.29	62	PT11	-0.74	36
CZ05	-0.16	51	FR30	-0.57	40	PT15	-0.49	42
CZ06	-0.17	50	FR41	-0.26	48	PT16	-0.30	47
CZ07	-0.30	47	FR42	0.01	55	PT17	0.07	56
CZ08	-0.84	33	FR43	-0.41	44	PT18	-0.81	34
DK01	1.34	89	FR51	0.13	58	PT20	-0.37	45
DK02	0.94	79	FR52	0.40	65	PT30	0.07	56
DK03	1.07	82	FR53	0.13	58	RO11	0.30	62
DK04	1.04	81	FR61	-0.13	51	RO12	-0.56	40
DK05	0.90	78	FR62	0.10	57	RO21	0.00	55
DE11	0.53	68	FR63	0.27	62	RO22	-0.66	38
DE12	0.47	67	FR71	0.16	59	RO31	-0.60	39
DE13	0.71	73	FR72	-0.09	52	RO32	0.67	72
DE14	0.61	70	FR81	-0.27	48	RO41	-0.41	44
DE21	1.04	81	FR82	0.00	55	RO42	-0.19	50
DE22	0.34	63	FR83	-0.87	32	SI01	-0.06	53
DE23	0.64	71	FR91	-1.68	11	SI02	0.86	77
DE24	0.14	58	FR92	-1.20	24	SK01	0.89	78
DE25	0.49	67	FR93	-2.12	0	SK02	-0.60	39
DE26	0.37	64	FR94	-1.67	12	SK03	-1.20	24
DE27	0.46	66	ITC1	-0.01	54	SK04	-1.37	19
DE30	-0.31	47	ITC2	0.51	68	FI13	0.49	67
DE41	-0.23	49	ITC3	-0.14	51	FI18	0.89	78
DE42	-0.01	54	ITC4	0.37	64	FI19	0.43	66
DE50	0.06	56	ITD1	0.94	79	FI1A	0.37	64
DE60	0.46	66	ITD2	0.47	67	FI20	1.76	100
DE71	0.40	65	ITD3	0.21	60	SE11	1.23	86
DE72	0.27	62	ITD4	-0.03	54	SE12	0.33	63
DE73	0.14	58	ITD5	0.56	69	SE21	0.84	76
DE80	-0.27	48	ITE1	-0.16	51	SE22	0.44	66
DE91	-0.17	50	ITE2	-0.16	51	SE23	0.96	79
DE92	0.14	58	ITE3	0.04	56	SE31	0.56	69
DE93	0.16	59	ITE4	-0.54	41	SE32	0.97	80
DE94	0.06	56	ITF1	-0.61	39	SE33	0.89	78
DEA1	0.11	57	ITF2	-1.13	26	UKC1	0.06	56
DEA2	0.10	57	ITF3	-1.63	13	UKC2	0.36	64
DEA3	0.17	59	ITF4	-1.54	15	UKD1	0.93	79
DEA4	-0.09	52	ITF5	-1.43	18	UKD2	0.87	77
DEA5	-0.19	50	ITF6	-1.49	16	UKD3	0.27	62
DEB1	0.03	55	ITG1	-1.64	12	UKD4	0.44	66
DEB2	0.56	69	ITG2	-1.36	20	UKD5	0.09	57
DEB3	0.36	64	CY00	0.59	70	UKE1	0.47	67
DEC0	0.10	57	LV00	0.11	57	UKE2	1.51	94
DED1	-0.47	43	LT00	0.39	65	UKE3	0.07	56
DED2	-0.06	53	LU00	0.41	65	UKE4	0.31	63
DED3	-0.14	51	HU10	0.10	57	UKF1	0.54	69
DEE0	-0.61	39	HU21	-0.19	50	UKF2	0.51	68
DEF0	0.20	60	HU22	-0.31	47	UKF3	-0.06	53
DEG0	-0.50	42	HU23	-0.67	37	UKG1	0.76	74
EE00	0.37	64	HU31	-0.96	30	UKG2	0.77	74
IE01	0.11	57	HU32	-1.00	29	UKG3	-0.04	54
IE02	0.67	72	HU33	-0.73	36	UKH1	0.77	74
GR11	-1.34	20	MT00	-0.60	39	UKH2	0.81	76
GR12	-1.20	24	NL11	1.09	83	UKH3	0.53	68
GR13	-1.56	14	NL12	1.11	83	UKI	0.56	69
GR14	-1.11	26	NL13	0.76	74	UKJ1	1.11	83
GR21	-1.46	17	NL21	1.11	83	UKJ2	1.00	80
GR22	-0.81	34	NL22	1.11	83	UKJ3	1.07	82
GR23	-1.49	16	NL23	0.89	78	UKJ4	0.41	65
GR24	-1.23	23	NL31	1.61	96	UKK1	1.09	83
GR25	-0.99	29	NL32	1.39	90	UKK2	0.87	77
GR30	-0.36	45	NL33	1.07	82	UKK3	0.24	61
GR41	-0.89	32	NL34	1.30	88	UKK4	1.06	82
GR42	-0.74	36	NL41	1.20	86	UKL1	0.41	65
GR43	-0.69	37	NL42	1.01	81	UKL2	0.67	72
ES11	-0.50	42	AT11	0.71	73	UKM2	0.80	75
ES12	-0.57	40	AT12	0.64	71	UKM3	0.60	70
ES13	-0.24	48	AT13	0.46	66	UKM5	1.40	91
ES21	-0.01	54	AT21	0.63	71	UKM6	0.95	79
ES22	-0.04	54	AT22	0.90	78	UKN0	0.61	70
ES23	-0.31	47	AT31	0.96	79			
ES24	0.00	55	AT32	1.27	87			

Figure 5-30: Histogram of Labor market efficiency sub-score

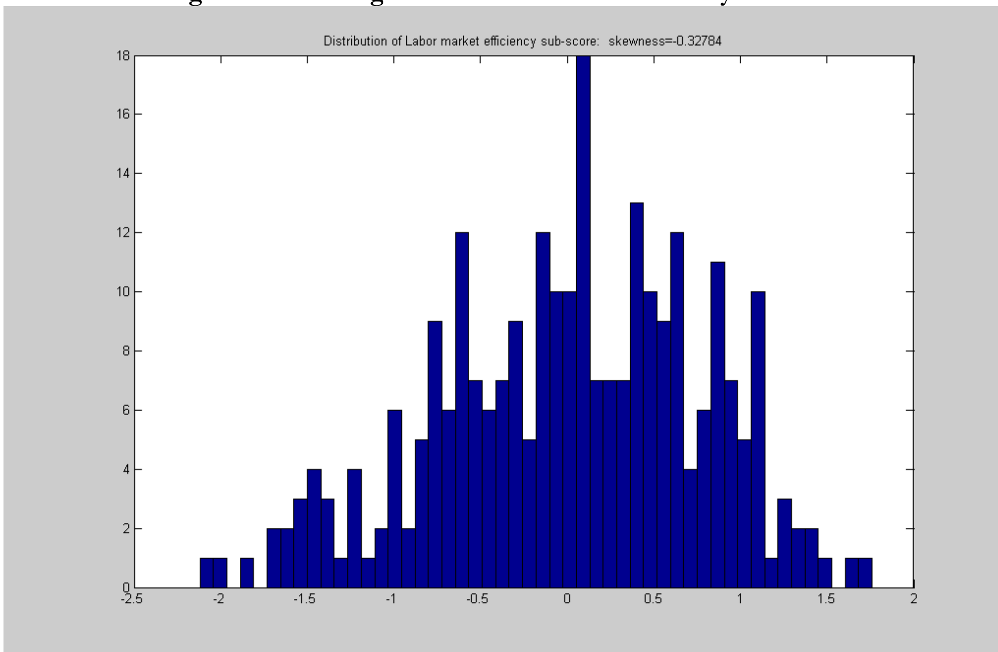


Table 57: Labor market efficiency pillar sub-rank (from best to worst)

Labor market efficiency											
1	FI20	46	UKM2	91	UKL1	136	DE71	181	ES23	226	PL42
2	NL31	47	UKG2	92	DE71	137	FR52	182	HU22	227	PT11
3	UKE2	48	UKH1	93	FR52	138	LT00	183	PL63	228	PL51
4	UKM5	49	NL13	94	LT00	139	DE26	184	BG34	229	ES41
5	NL32	50	UKG1	95	DE26	140	EE00	185	GR30	230	GR22
6	DK01	51	BG41	96	EE00	141	ITC4	186	FR21	231	PT18
7	NL34	52	BE23	97	ITC4	142	FI1A	187	PT20	232	CZ08
8	AT32	53	DE13	98	FI1A	143	DEB3	188	FR43	233	FR83
9	AT33	54	AT11	99	DEB3	144	UKC2	189	RO41	234	PL62
10	SE11	55	IE02	100	UKC2	145	DE22	190	PL34	235	GR41
11	NL41	56	RO32	101	DE22	146	SE12	191	FR23	236	BE32
12	NL12	57	UKL2	102	SE12	147	UKE4	192	PL22	237	HU31
13	NL21	58	DE23	103	UKE4	148	RO11	193	BE34	238	PL61
14	NL22	59	AT12	104	RO11	149	FR26	194	DED1	239	GR25
15	UKJ1	60	AT34	105	FR26	150	DE72	195	PT15	240	HU32
16	CZ01	61	AT21	106	DE72	151	FR63	196	DEG0	241	BG33
17	NL11	62	DE14	107	FR63	152	UKD3	197	ES11	242	ES42
18	UKK1	63	UKN0	108	UKD3	153	BE22	198	PL21	243	ES70
19	DK03	64	BE21	109	BE22	154	UKK3	199	PL43	244	GR14
20	NL33	65	FR10	110	UKK3	155	CZ03	200	ITE4	245	ITF2
21	UKJ3	66	UKM3	111	CZ03	156	ITD3	201	PL52	246	GR12
22	UKK4	67	CY00	112	ITD3	157	DEF0	202	RO12	247	FR92
23	DK04	68	DEB2	113	DEF0	158	DEA3	203	ES12	248	SK03
24	DE21	69	ITD5	114	DEA3	159	DE93	204	FR30	249	GR24
25	NL42	70	SE31	115	DE93	160	FR71	205	PL11	250	GR11
26	UKJ2	71	UKI	116	FR71	161	DE24	206	PL31	251	ITG2
27	SE32	72	CZ02	117	DE24	162	DE73	207	MT00	252	SK04
28	AT31	73	UKF1	118	DE73	163	DE92	208	RO31	253	ES61
29	SE23	74	DE11	119	DE92	164	FR24	209	SK02	254	ITF5
30	UKM6	75	UKH3	120	FR24	165	FR51	210	BG32	255	GR21
31	DK02	76	ITC2	121	FR51	166	FR53	211	DEE0	256	GR23
32	ITD1	77	UKF2	122	FR53	167	DEA1	212	ITF1	257	ITF6
33	UKD1	78	DE25	123	DEA1	168	IE01	213	ES52	258	ITF4
34	DK05	79	FI13	124	IE01	169	LV00	214	BE35	259	GR13
35	AT22	80	DE12	125	LV00	170	DEA2	215	PL33	260	ES43
36	NL23	81	ITD2	126	DEA2	171	DEC0	216	RO22	261	ITF3
37	SK01	82	UKE1	127	DEC0	172	FR62	217	BE33	262	ITG1
38	FI18	83	DE27	128	FR62	173	HU10	218	HU23	263	FR94
39	SE33	84	DE60	129	HU10	174	ES51	219	GR43	264	FR91
40	UKD2	85	AT13	130	ES51	175	UKD5	220	ES62	265	ES63
41	UKK2	86	SE22	131	UKD5	176	PT17	221	CZ04	266	ES64
42	SI02	87	UKD4	132	PT17	177	PT30	222	HU33	267	FR93
43	SE21	88	FI19	133	PT30	178	UKE3	223	PL32	268	PT20
44	BE25	89	LU00	134	UKE3	179	DE50	224	GR42		
45	UKH2	90	UKJ4	135	DE50	180	DE94	225	PL41		

5.8 Market size

Candidate indicators included in the pillar are discussed in Section 3.8 and recalled in the following.

<u>Indicators included, in brackets short names:</u>

1.	GDP index EU27=100	(GDP_index)
2.	Compensation of employees	(Compensation_employees)
3.	Disposable income	(Disposable_income)
4.	Potential GDP	(Pot_market_size_GDP)
5.	Potential population	(Pot_market_size_pop)

Disposable income is calculated as the regional net disposable income (B6NU) per head plus the difference between national net disposable income (S14_15_B6N) per head and national net adjusted disposable income (S14_15_B7N) per head multiplied by the total NUTS 2 regional population. Data for Romania is not adjusted while data for Luxembourg is estimated.

Due to the nature of the indicators on disposable income and compensation of employees, combining values for regions UKI00 and BE00, respectively in the UK and Belgium, as described in section 4.1, has been done through aggregation and not weighted average.

UNIVARIATE ANALYSIS

Table 58 reports the descriptive statistics for the market size pillar indicators. We have no missing data for the first two indicators on GDP and Compensation of employees, low percentage of missing data on both potential market size expressed in GDP and population (1.49%) and disposable income (2.24%), all within the pre-defined threshold. This allows us to include all indicators in the construction of the Market size pillar. The indicators on compensation of employees, disposable income and potential GDP in pps have high coefficient of variations indicating a very heterogeneous situation among the different EU regions.

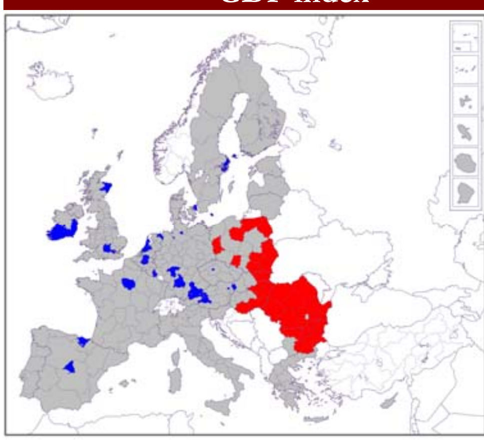
Table 58: Descriptive statistics of Market size indicators

Indicator	GDP index	Compensation of employees	Disposable income	Potential GDP in PPS	Potential POP
description	Gross Domestic Product pps index, EU27=100	Compensation of employees in millions of euros	Net adjusted disposable household income in millions of ppcs	Potential market size expressed in GDP (pps), index EU27=100	Potential market size expressed in population, index EU27=100
source	Eurostat Regional Economic Accounts	Eurostat Regional Economic Accounts	Eurostat, DG Regional Policy estimates	Eurostat, DG Regional Policy estimates	Eurostat, DG Regional Policy estimates
reference year	2007	2006	2006	2007	2000
% of missing values	0.00	0.00	2.24	1.49	1.49
mean value	95.61	21081.34	31709.70	193.20	174.78
standard deviation (unbiased)	34.14	27248.80	32598.85	216.27	156.43
coefficient of variation	0.36	1.29	1.03	1.12	0.90
maximum value	275.23	271315.00	281068.70	1467.34	895.04
region corresponding to maximum value	LU00	FR10	FR10	UKI	UKI
minimum value	25.58	560.40	455.32	2.34	3.00
region corresponding to minimum value	BG31	FI20	FI20	SE33	SE33

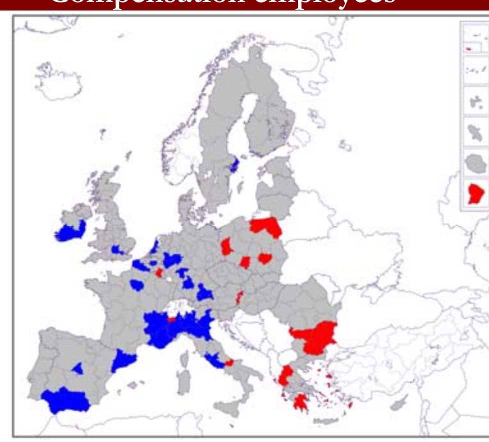
How do EU regions score in each of the indicators?

From Figure 5-31 we can see that Eastern European regions have the lowest performance in terms of the indicator on GDP index. Best performers are regions in some parts of Germany, Northern Europe and the UK. Similar situation can be noted for the indicators on compensation of employees and disposable income. With regards to the indicators on potential market size, we can see that peripheral regions have the lowest scores while regions in Belgium, the Netherlands, Germany and the UK have the highest scores.

GDP index



Compensation employees



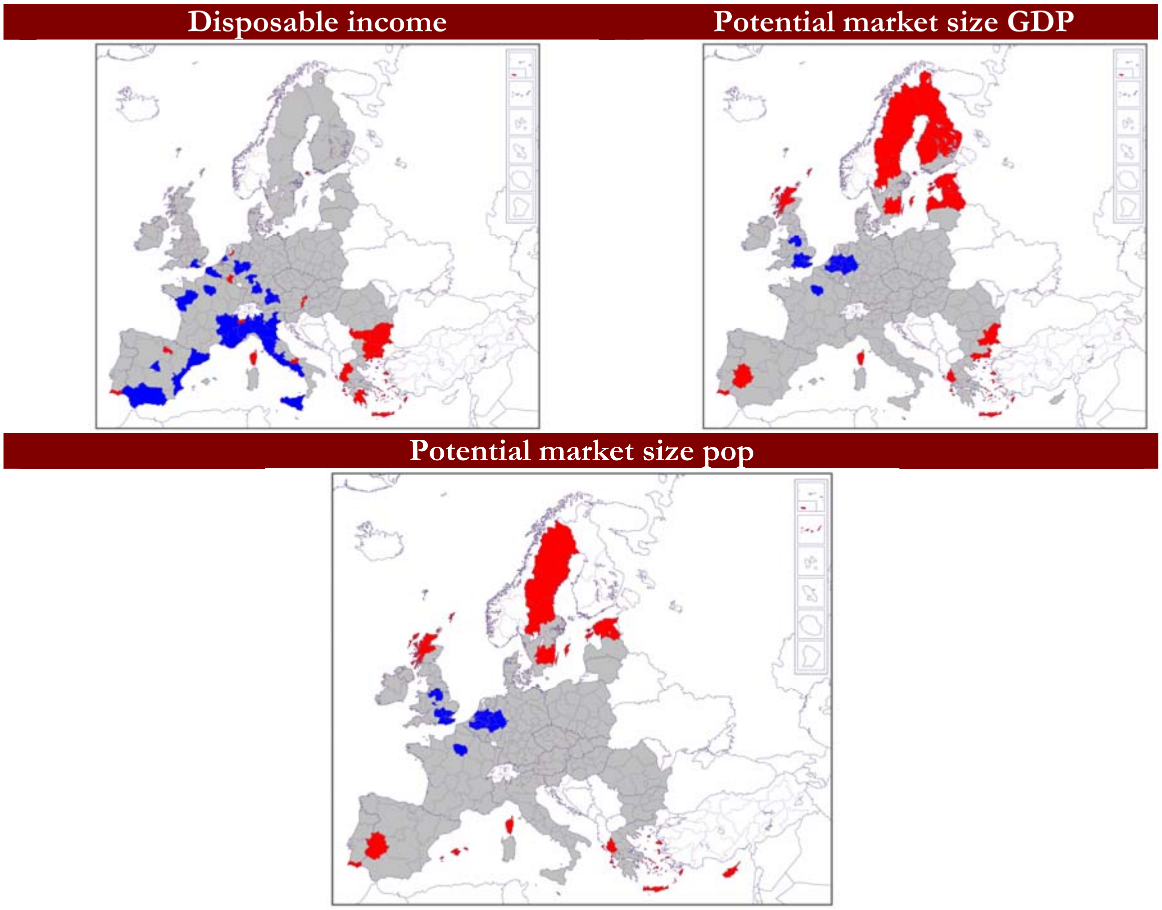
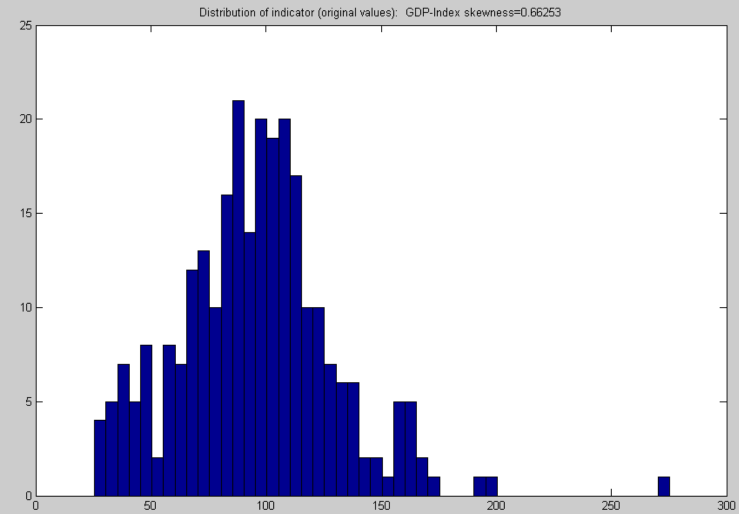


Figure 5-31: Best and worst performing regions for each indicator – Market size

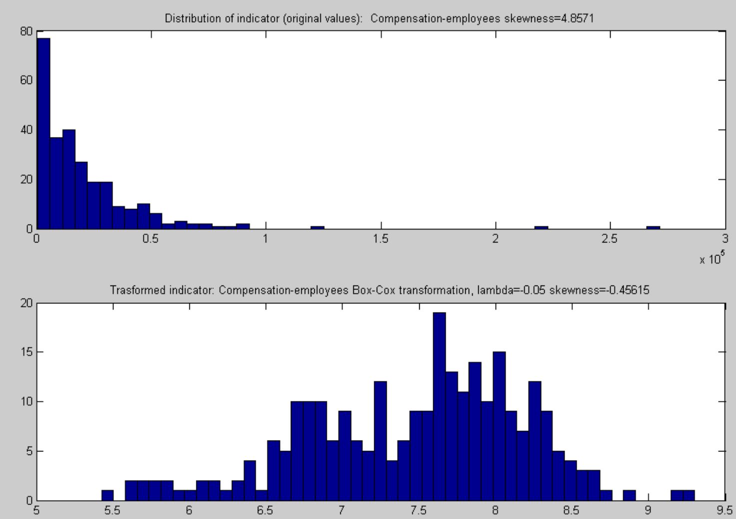
The next step in our analysis is the analysis of the distribution of the different indicators and possible transformation. Table 59 shows the initial distribution of each indicator. All four indicators have a clear positive skewness, typical of economic data (Zani, 2000). All but the GDP index have been transformed with the Box-Cox method as described in detail in Section 4.3.

Table 59: Histograms of Market size indicators

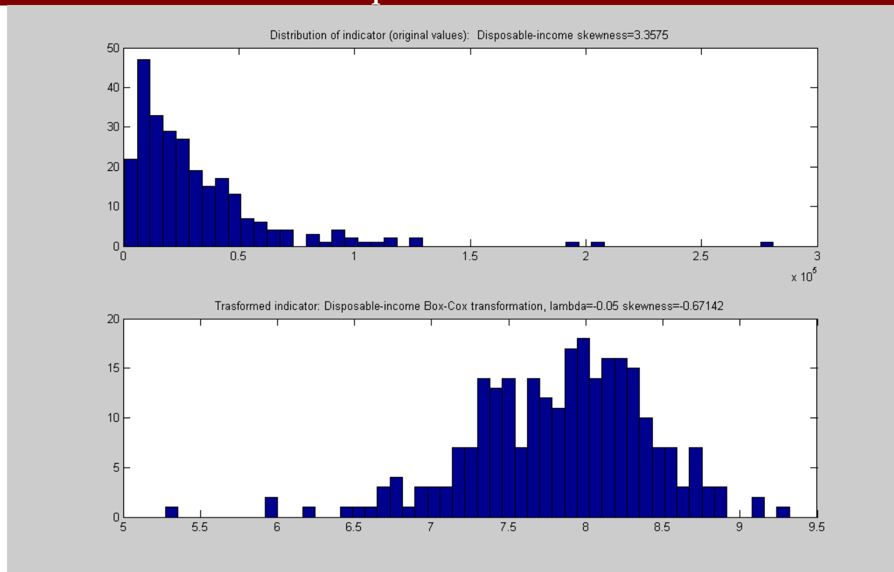
GDP index



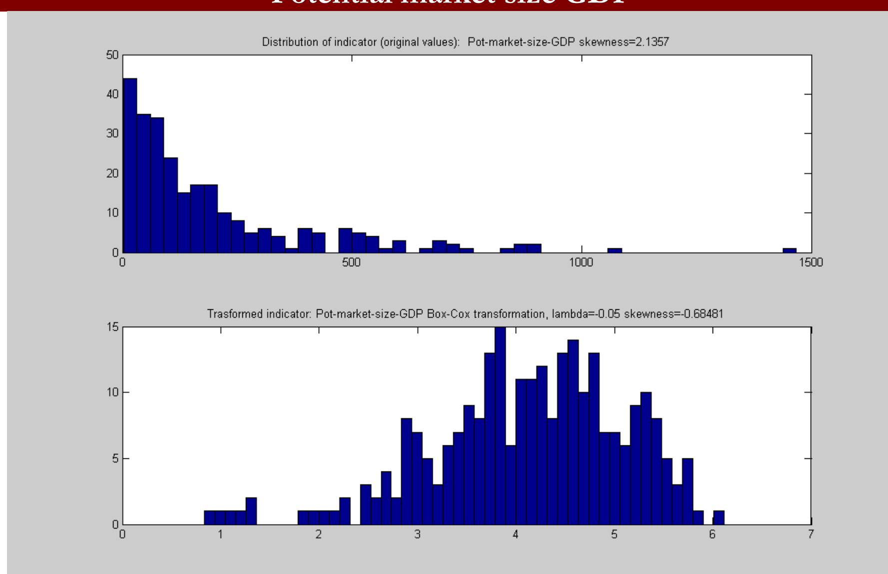
Compensation employees



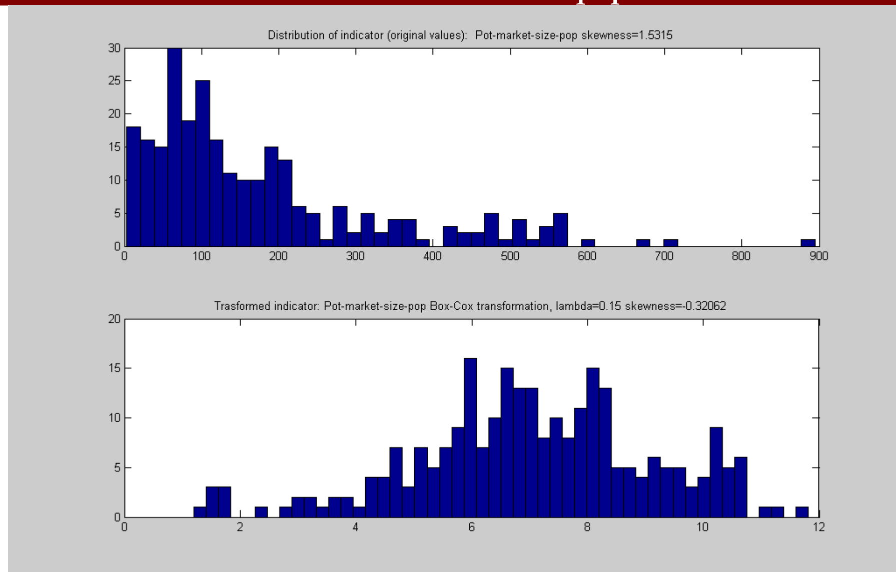
Disposable income



Potential market size GDP



Potential market size pop



Note: In the case of the Potential market size population indicator, the lambda used has been set to 0.15

MULTIVARIATE ANALYSIS

The PCA analysis highlights the presence of one prevalent dimension equally described by all the indicators. In fact, the scree plot (Figure 5-32) and the percentage of explained variance (Table 62) show that the first PCA component accounts for more than 68% of total variance, well detached from the other ones. The table of component loadings (Table 61) indicates that all the indicators contribute almost evenly to the major PCA component. Given the analysis, we can conclude that this pillar has a unique, underlying dimension well captured by all the indicators.

The geographical distribution of the market size sub-score is shown in Figure 5-33 and its histogram is displayed in Figure 5-34. The reordered list of regions is due in Table 64.

Table 60: Correlation matrix between indicators included in the Market Size pillar

Correlation Matrix

		GDP_index	Compensation_employees	Disposable_income	Pot_market_size_GDP	Pot_market_size_pop
Correlation	GDP_index	1.000	.586	.368	.461	.296
	Compensation_employees	.586	1.000	.949	.634	.531
	Disposable_income	.368	.949	1.000	.618	.561
	Pot_market_size_GDP	.461	.634	.618	1.000	.960
	Pot_market_size_pop	.296	.531	.561	.960	1.000
Sig. (1-tailed)	GDP_index		.000	.000	.000	.000
	Compensation_employees	.000		.000	.000	.000
	Disposable_income	.000	.000		.000	.000
	Pot_market_size_GDP	.000	.000	.000		.000
	Pot_market_size_pop	.000	.000	.000	.000	

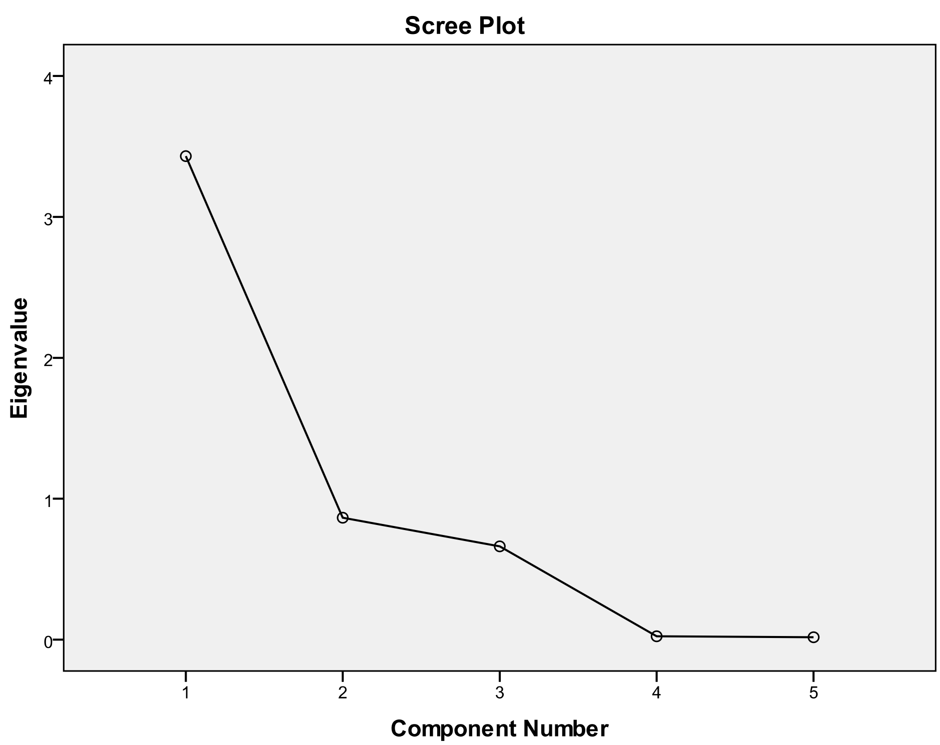


Figure 5-32: PCA analysis of the Market Size pillar - eigenvalues

Table 61: PCA analysis for the Market size pillar: correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component				
	1	2	3	4	5
GDP_index	.619	.529	.579	.032	.017
Compensation_ employees	.901	.337	-.255	-.047	-.087
Disposable_income	.864	.183	-.460	.047	.076
Pot_market_size_GDP	.898	-.381	.189	-.103	.042
Pot_market_size_pop	.826	-.542	.119	.090	-.042

Extraction Method: Principal Component Analysis.

a. 5 components extracted.

Table 62: PCA analysis for the Market size pillar: explained variance

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.431	68.623	68.623	3.431	68.623	68.623
2	.866	17.311	85.933	.866	17.311	85.933
3	.662	13.238	99.172	.662	13.238	99.172
4	.024	.483	99.654	.024	.483	99.654
5	.017	.346	100.000	.017	.346	100.000

Extraction Method: Principal Component Analysis.

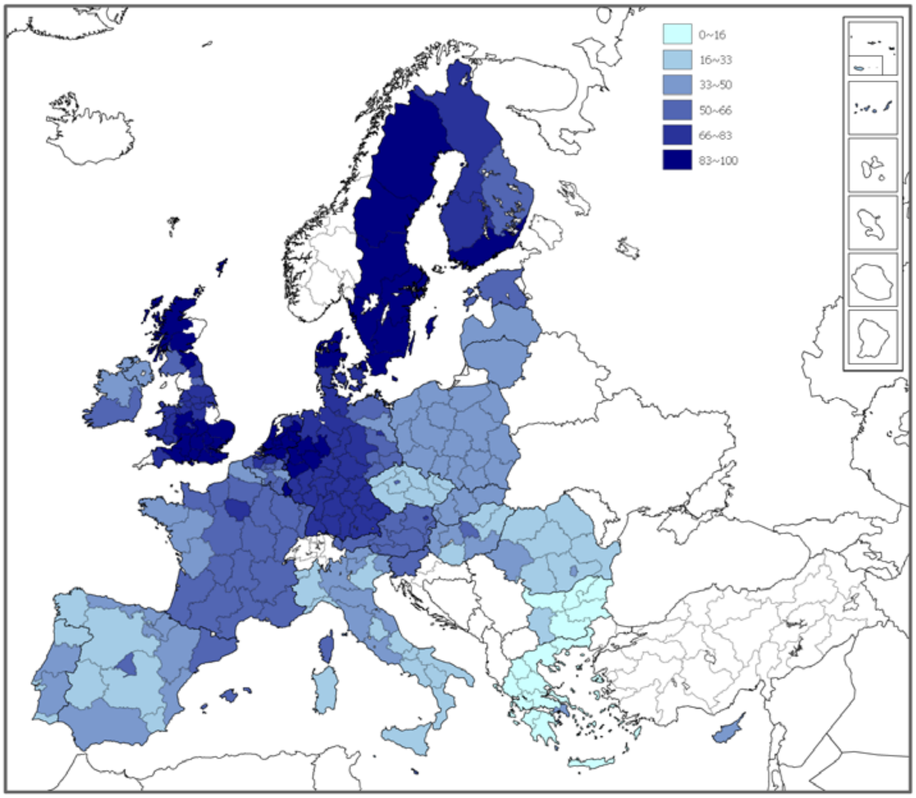


Figure 5-33: Market size sub-score
(Min-max normalized values)

Table 63: Market size sub-score as arithmetic mean of transformed and standardized indicators.

region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore
BE00	1.09	79	ES30	1.03	78	AT33	-0.38	50
BE21	0.80	74	ES41	-0.44	49	AT34	-0.64	45
BE22	0.16	61	ES42	-0.60	46	PL11	-0.72	43
BE23	0.43	66	ES43	-1.30	32	PL12	-0.06	56
BE25	0.19	61	ES51	0.57	69	PL21	-0.57	46
BE32	0.06	59	ES52	0.08	59	PL22	-0.10	56
BE33	-0.02	57	ES53	-0.83	41	PL31	-1.27	32
BE34	-1.02	37	ES61	-0.06	56	PL32	-1.21	34
BE35	-0.52	47	ES62	-0.64	45	PL33	-1.20	34
BG31	-2.16	15	ES63	-2.16	15	PL34	-1.66	25
BG32	-1.98	18	ES64	-2.89	0	PL41	-0.67	44
BG33	-2.08	16	ES70	-0.82	41	PL42	-1.26	33
BG34	-2.07	16	FR10	1.86	95	PL43	-1.36	31
BG41	-1.17	34	FR21	-0.42	49	PL51	-0.62	45
BG42	-1.90	20	FR22	0.17	61	PL52	-1.14	35
CZ01	0.24	62	FR23	0.09	59	PL61	-1.01	38
CZ02	-0.61	46	FR24	0.00	58	PL62	-1.54	27
CZ03	-0.87	40	FR25	-0.49	48	PL63	-1.01	38
CZ04	-0.74	43	FR26	-0.43	49	PT11	-0.39	50
CZ05	-0.70	44	FR30	0.40	66	PT15	-1.64	25
CZ06	-0.65	45	FR41	-0.04	57	PT16	-0.65	45
CZ07	-0.81	42	FR42	0.21	62	PT17	0.20	62
CZ08	-0.62	45	FR43	-0.46	49	PT18	-1.22	33
DK01	0.32	64	FR51	0.03	58	PT20	-2.70	4
DK02	-0.51	48	FR52	-0.14	55	PT30	-2.02	17
DK03	-0.36	50	FR53	-0.45	49	RO11	-1.36	31
DK04	-0.35	51	FR61	-0.16	54	RO12	-1.32	31
DK05	-0.88	40	FR62	-0.23	53	RO21	-1.43	29
DE11	0.99	77	FR63	-0.96	39	RO22	-1.41	30
DE12	0.84	74	FR71	0.49	67	RO31	-1.02	37
DE13	0.41	66	FR72	-0.56	47	RO32	-0.23	53
DE14	0.43	66	FR81	-0.32	51	RO41	-1.50	28
DE21	0.98	77	FR82	0.24	62	RO42	-1.46	29
DE22	-0.06	56	FR83	-1.94	19	SI01	-0.83	41
DE23	-0.07	56	FR91	-1.12	35	SI02	-0.54	47
DE24	-0.05	57	FR92	-1.10	36	SK01	-0.17	54
DE25	0.36	65	FR93	-2.04	17	SK02	-0.68	44
DE26	0.18	61	FR94	-1.09	36	SK03	-1.07	36
DE27	0.32	64	ITC1	0.55	69	SK04	-1.22	33
DE30	0.54	68	ITC2	-1.14	35	FI13	-1.70	24
DE41	-0.36	50	ITC3	-0.14	55	FI18	-0.13	55
DE42	-0.12	55	ITC4	1.21	82	FI19	-0.96	39
DE50	0.15	61	ITD1	-0.64	45	FI1A	-1.90	20
DE60	0.96	77	ITD2	-0.43	49	FI20	-2.80	2
DE71	1.11	80	ITD3	0.63	70	SE11	0.44	66
DE72	0.12	60	ITD4	-0.18	54	SE12	-0.44	49
DE73	0.05	59	ITD5	0.64	70	SE21	-1.01	38
DE80	-0.49	48	ITE1	0.27	63	SE22	-0.29	52
DE91	0.16	61	ITE2	-0.50	48	SE23	-0.31	51
DE92	0.36	65	ITE3	-0.24	53	SE31	-1.25	33
DE93	0.02	58	ITE4	0.67	71	SE32	-1.96	19
DE94	0.21	62	ITF1	-0.47	48	SE33	-1.94	19
DEA1	1.32	84	ITF2	-1.10	36	UKC1	-0.25	53
DEA2	1.08	79	ITF3	0.18	61	UKC2	-0.22	53
DEA3	0.65	71	ITF4	-0.27	52	UKD1	-0.74	43
DEA4	0.42	66	ITF5	-1.04	37	UKD2	0.52	68
DEA5	0.85	75	ITF6	-0.76	43	UKD3	0.79	73
DEB1	0.26	63	ITG1	-0.23	53	UKD4	0.29	63
DEB2	-0.43	49	ITG2	-0.92	39	UKD5	0.24	62
DEB3	0.48	67	CY00	-1.18	34	UKE1	-0.19	54
DEC0	0.06	59	LV00	-1.37	30	UKE2	-0.04	57
DED1	-0.12	55	LT00	-0.98	38	UKE3	0.33	64
DED2	-0.13	55	LU00	0.70	72	UKE4	0.64	70
DED3	-0.21	53	HU10	0.10	60	UKF1	0.61	70
DEE0	-0.04	57	HU21	-0.88	40	UKF2	0.56	69
DEF0	0.21	62	HU22	-1.03	37	UKF3	-0.36	50
DEG0	-0.03	57	HU23	-1.49	28	UKG1	0.28	63
EE00	-1.42	29	HU31	-1.16	35	UKG2	0.32	64
IE01	-0.77	42	HU32	-1.23	33	UKG3	0.69	71
IE02	0.22	62	HU33	-1.27	32	UKH1	0.34	64
GR11	-1.70	24	MT00	-1.58	26	UKH2	0.94	76
GR12	-0.75	43	NL11	-0.16	54	UKH3	0.63	70
GR13	-1.88	20	NL12	-0.40	50	UKI	2.12	100
GR14	-1.43	29	NL13	-0.42	49	UKJ1	1.16	81
GR21	-1.96	19	NL21	0.18	61	UKJ2	1.02	78
GR22	-2.47	8	NL22	0.64	70	UKJ3	0.61	70
GR23	-1.57	26	NL23	-0.26	52	UKJ4	0.51	68
GR24	-1.06	37	NL31	0.82	74	UKK1	0.63	70
GR25	-1.44	29	NL32	0.90	76	UKK2	-0.04	57
GR30	0.53	68	NL33	1.05	79	UKK3	-1.17	34
GR41	-2.86	1	NL34	-0.12	55	UKK4	-0.44	49
GR42	-2.01	18	NL41	0.93	76	UKL1	-0.37	50
GR43	-1.66	25	NL42	0.53	68	UKL2	-0.04	57
ES11	-0.39	50	AT11	-0.90	40	UKM2	0.10	60
ES12	-0.74	43	AT12	-0.03	57	UKM3	0.02	58
ES13	-0.90	40	AT13	0.64	70	UKM5	-0.70	44
ES21	0.25	63	AT21	-0.75	43	UKM6	-1.58	26
ES22	-0.53	47	AT22	-0.35	51	UKN0	-0.39	50
ES23	-1.15	35	AT31	-0.06	56			
ES24	-0.68	44	AT32	-0.48	48			

Figure 5-34: Histogram of Market size sub-score

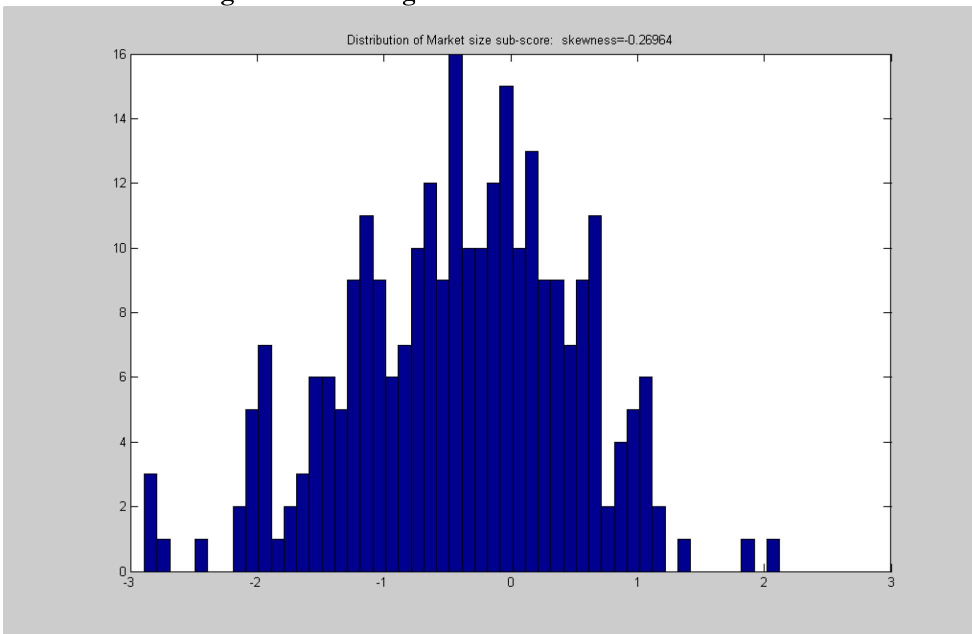


Table 64: Market size pillar sub-rank (from best to worst)

Market size											
1	UKI	46	SE11	91	FR24	136	UKL1	181	GR12	226	PL31
2	FR10	47	BE23	92	BE33	137	AT33	182	AT21	227	ES43
3	DEA1	48	DE14	93	DEG0	138	ES11	183	ITF6	228	RO12
4	ITC4	49	DEA4	94	AT12	139	PT11	184	IE01	229	PL43
5	UKJ1	50	DE13	95	DEE0	140	UKN0	185	CZ07	230	RO11
6	DE71	51	FR30	96	FR41	141	NL12	186	ES70	231	LV00
7	BE00	52	DE25	97	UKE2	142	FR21	187	ES53	232	RO22
8	DEA2	53	DE92	98	UKK2	143	NL13	188	SI01	233	EE00
9	NL33	54	UKH1	99	UKL2	144	DEB2	189	CZ03	234	GR14
10	ES30	55	UKE3	100	DE24	145	FR26	190	DK05	235	RO21
11	UKJ2	56	DK01	101	DE22	146	ITD2	191	HU21	236	GR25
12	DE11	57	DE27	102	ES61	147	ES41	192	ES13	237	RO42
13	DE21	58	UKG2	103	AT31	148	SE12	193	AT11	238	HU23
14	DE60	59	UKD4	104	PL12	149	UKK4	194	ITG2	239	RO41
15	UKH2	60	UKG1	105	DE23	150	FR53	195	FR63	240	PL62
16	NL41	61	ITE1	106	PL22	151	FR43	196	FI19	241	GR23
17	NL32	62	DEB1	107	DE42	152	ITF1	197	LT00	242	MT00
18	DEA5	63	ES21	108	DED1	153	AT32	198	PL61	243	UKM6
19	DE12	64	CZ01	109	NL34	154	DE80	199	PL63	244	PT15
20	NL31	65	FR82	110	DED2	155	FR25	200	SE21	245	GR43
21	BE21	66	UKD5	111	FI18	156	ITE2	201	BE34	246	PL34
22	UKD3	67	IE02	112	FR52	157	DK02	202	RO31	247	GR11
23	LU00	68	DE94	113	ITC3	158	BE35	203	HU22	248	FI13
24	UKG3	69	DEF0	114	FR61	159	ES22	204	ITF5	249	GR13
25	ITE4	70	FR42	115	NL11	160	SI02	205	GR24	250	BG42
26	DEA3	71	PT17	116	SK01	161	FR72	206	SK03	251	FI1A
27	ITD5	72	BE25	117	ITD4	162	PL21	207	FR94	252	FR83
28	NL22	73	DE26	118	UKE1	163	ES42	208	FR92	253	SE33
29	AT13	74	ITF3	119	DED3	164	CZ02	209	ITF2	254	GR21
30	UKE4	75	NL21	120	UKC2	165	CZ08	210	FR91	255	SE32
31	ITD3	76	FR22	121	FR62	166	PL51	211	ITC2	256	BG32
32	UKH3	77	BE22	122	ITG1	167	ES62	212	PL52	257	GR42
33	UKK1	78	DE91	123	RO32	168	ITD1	213	ES23	258	PT30
34	UKF1	79	DE50	124	ITE3	169	AT34	214	HU31	259	FR93
35	UKJ3	80	DE72	125	UKC1	170	CZ06	215	BG41	260	BG34
36	ES51	81	HU10	126	NL23	171	PT16	216	UKK3	261	BG33
37	UKF2	82	UKM2	127	ITF4	172	PL41	217	CY00	262	BG31
38	ITC1	83	FR23	128	SE22	173	ES24	218	PL33	263	ES63
39	DE30	84	ES52	129	SE23	174	SK02	219	PL32	264	GR22
40	GR30	85	BE32	130	FR81	175	CZ05	220	PT18	265	PT20
41	NL42	86	DEC0	131	DK04	176	UKM5	221	SK04	266	FI20
42	UKD2	87	DE73	132	AT22	177	PL11	222	HU32	267	GR41
43	UKJ4	88	FR51	133	DK03	178	CZ04	223	SE31	268	ES64
44	FR71	89	DE93	134	DE41	179	ES12	224	PL42		
45	DEB3	90	UKM3	135	UKF3	180	UKD1	225	HU33		

5.9 Technological readiness

As discussed in Section 3.9, the pillar has been divided into two sub-pillars, one describing Households and the other one Enterprises. In the following, the two sub-pillars are described separately.

Sub-pillar Households

Candidate indicators for the sub-pillar are shown in Box 17 (Section 3.9). Here the list of indicators is briefly recalled together with their short names.

Indicators included in the sub-pillar HOUSEHOLDS, in brackets short names:

1. Share of households with access to broadband (Households-access-broadband)
2. Share of individuals who used internet to order goods/services (Individuals-buying-internet)
3. Share of households with internet access (Households-access-internet)

All indicators are positively associated to the concept of regional competitiveness in terms of technological use.

Imputation of missing data

For the indicators on households broadband and internet access, NUTS 1 level data has been imputed at the NUTS 2 level for the following countries - Germany, Greece, France, Poland and Slovenia. Sweden NUTS 1 has been imputed for household broadband access.

For the indicator on household internet access, due to the lack of 2009 figures, 2008 data has been used for all regions in the Czech Republic and Romania, UKE2, UKG1, UKK4, UKL2, UKM6, and UKN0.

For the indicator on individuals buying over the internet, due to the lack of 2009 figures, 2008 data has been used for all region in the Czech Republic, UKE2, UKG1, UKK4, UKL2, UKM6, and UKN0.

UNIVARIATE ANALYSIS

Table 65 shows the descriptive statistics for the three indicators included in the Household pillar. All three indicators have low percentage of missing values, close to 5%.

Table 65: Descriptive statistics of Household indicators

Indicator	Households access to broadband	Individuals buying over internet	Households access to internet
description	% of total households with access to broadband	% of individuals who ordered goods or services over the internet for private use	% of total households with internet access
source	Eurostat Regional Information Society Statistics	Eurostat Regional Information Society Statistics	Eurostat Regional Information Society Statistics
reference year	2009	2009	2009
% of missing values	4.48	4.48	4.10
mean value	55.10	36.72	62.82
standard deviation (unbiased)	15.29	21.65	17.32
coefficient of variation	0.28	0.59	0.28
maximum value	83.87	79.78	95.34
region corresponding to maximum value	NL32	UKM6	NL32
minimum value	19.64	0.93	23.10
region corresponding to minimum value	GR21	RO41	RO21

How do EU regions score in each of the indicators?

We can note from Figure 5-35 that Eastern European, Greek and some Italian regions, perform worst with regards to the access to internet, as well as broadband connection, to households. This is true also for the level of utilization of the internet for purchases by individuals. Northern European regions (parts of the Netherlands, UK and Denmark) show the highest performance in all three indicators.

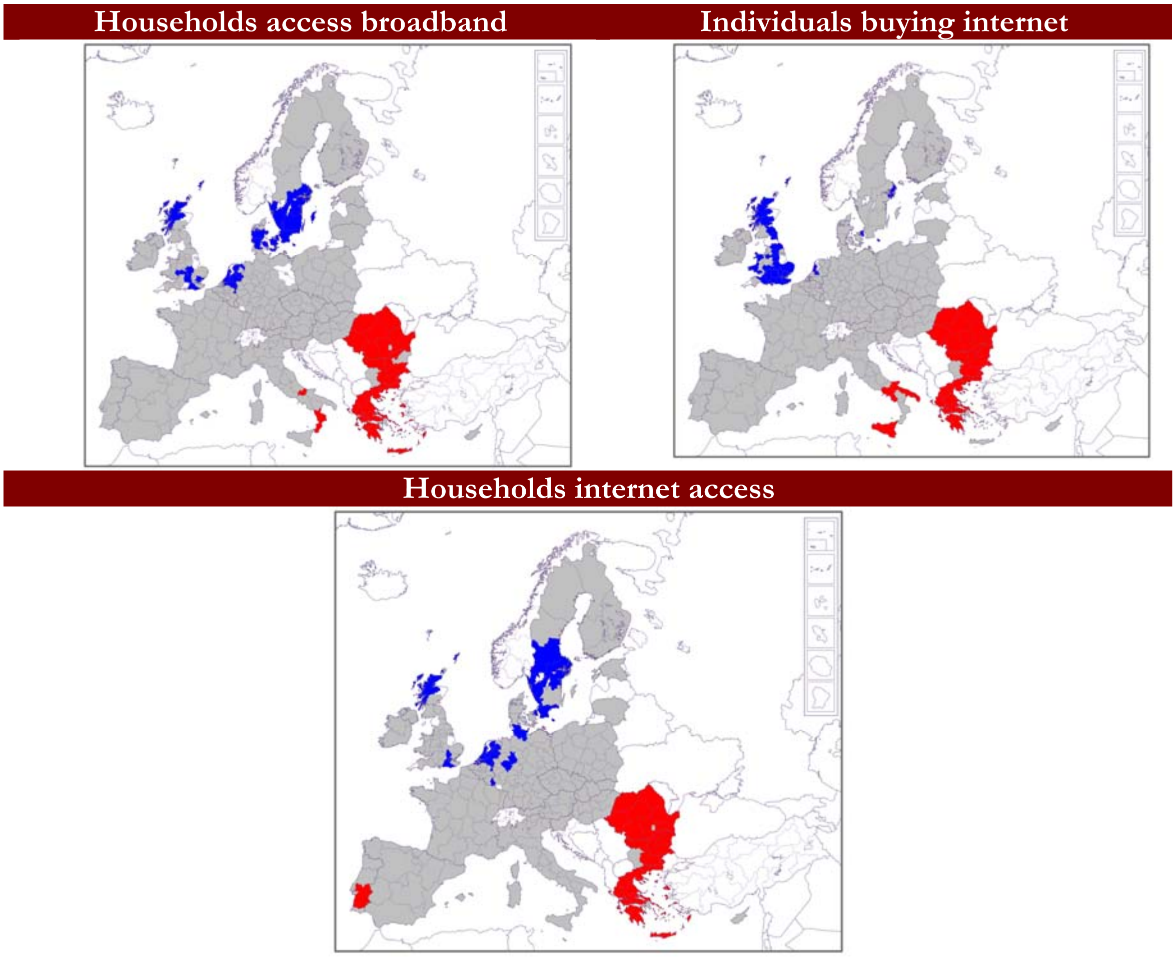
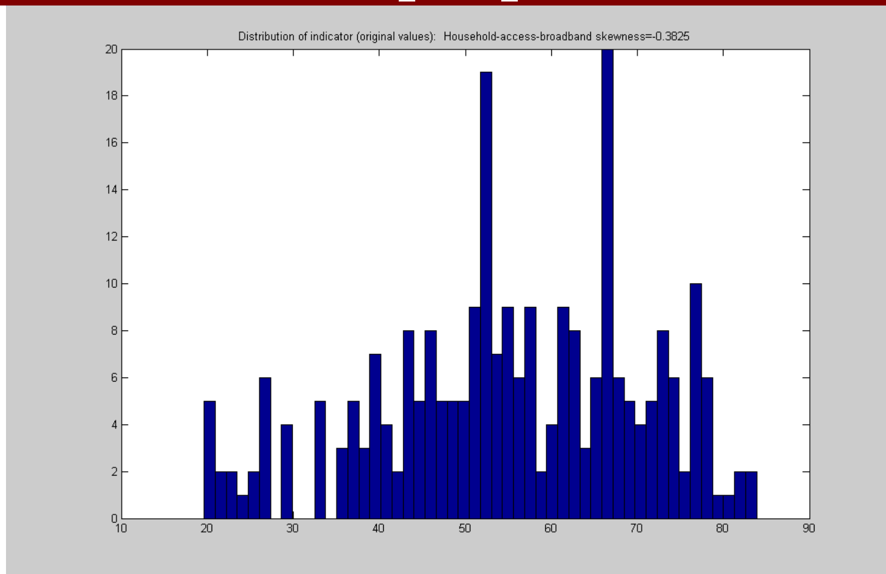


Figure 5-35: Best and worst performing regions for each indicator – Household sub-pillar

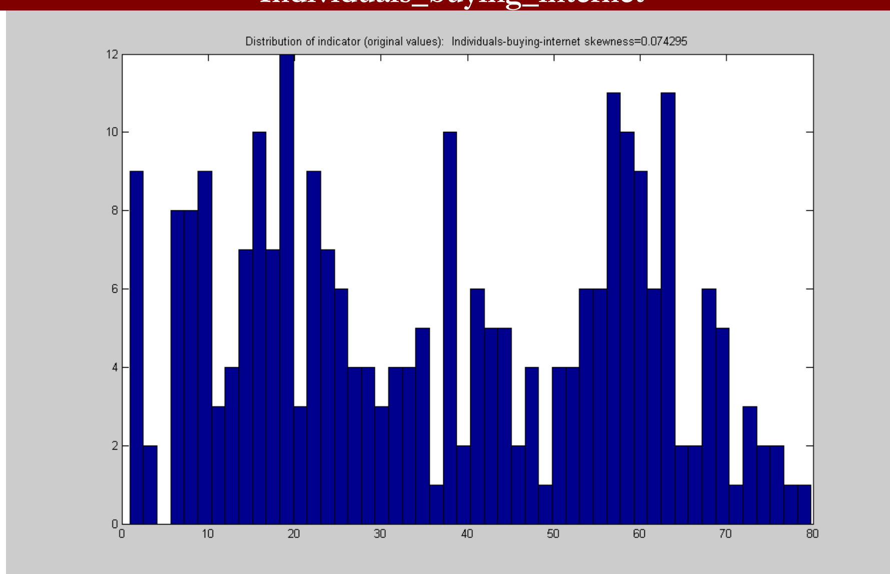
Table 66 shows the frequency distribution of all indicators. No transformation has been performed because the indicators do not present highly asymmetric distribution as shown by the value of the skewness.

Table 66: Histograms of Household indicators

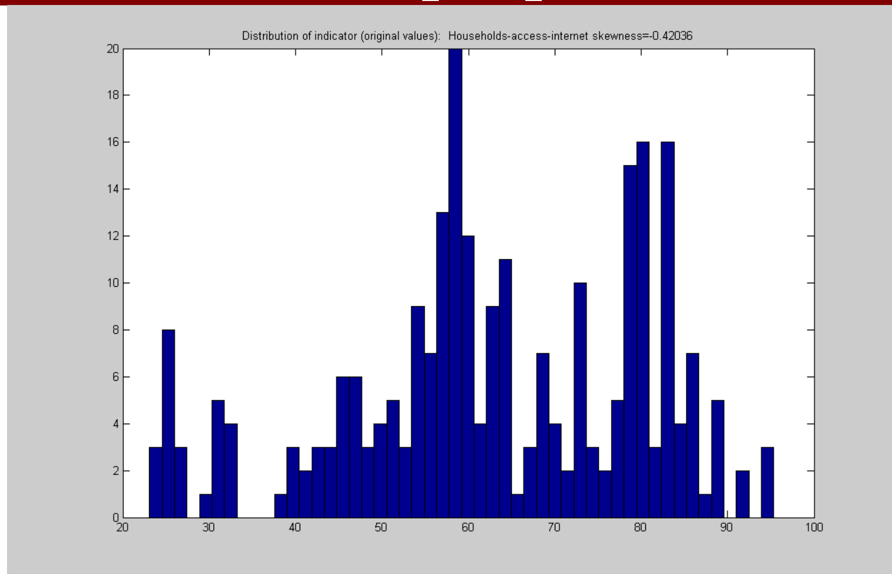
Households_access_broadband



Individuals_buying_internet



Households_access_internet



MULTIVARIATE ANALYSIS

The PCA analysis highlights the presence of one clear prevalent dimension equally described by all the three indicators (see Table 67, Table 68, Table 69 and Figure 5-36).

The sub-score is computed as simple average of the three transformed and standardized indicators (Figure 5-37); sub-score values are shown in Table 70. Note that for five regions (DE50, FR91, FR92, FR93, FR94) the sub-score is missing due to missing values on all the three indicators.

Table 67: Correlation matrix between indicators included in the Technological readiness - Households sub-pillar

Correlation Matrix

		Household_access_broadband	Individual_buying_internet	Household_access_internet
Correlation	Household_access_broadband	1.000	.808	.844
	Individual_buying_internet	.808	1.000	.899
	Household_access_internet	.844	.899	1.000
Sig. (1-tailed)	Household_access_broadband		.000	.000
	Individual_buying_internet	.000		.000
	Household_access_internet	.000	.000	

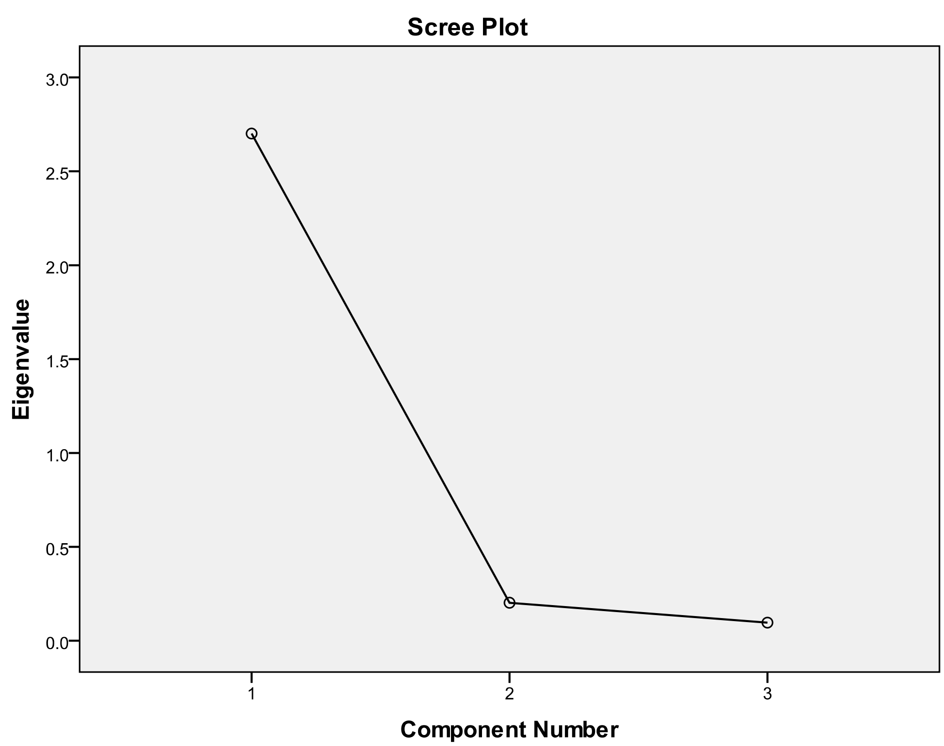


Figure 5-36: PCA analysis of the Technological readiness Households sub-pillar - eigenvalues

Table 68: PCA analysis for the Technological readiness – Households sub-pillar: correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component		
	1	2	3
Household_access_ broadband	.930	.363	.053
Individual_buying_interne t	.952	-.241	.191
Household_access_ internet	.964	-.113	-.239

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Table 69: PCA analysis for the Technological readiness Households sub-pillar: explained variance

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.701	90.036	90.036	2.701	90.036	90.036
2	.202	6.743	96.780	.202	6.743	96.780
3	.097	3.220	100.000	.097	3.220	100.000

Extraction Method: Principal Component Analysis.

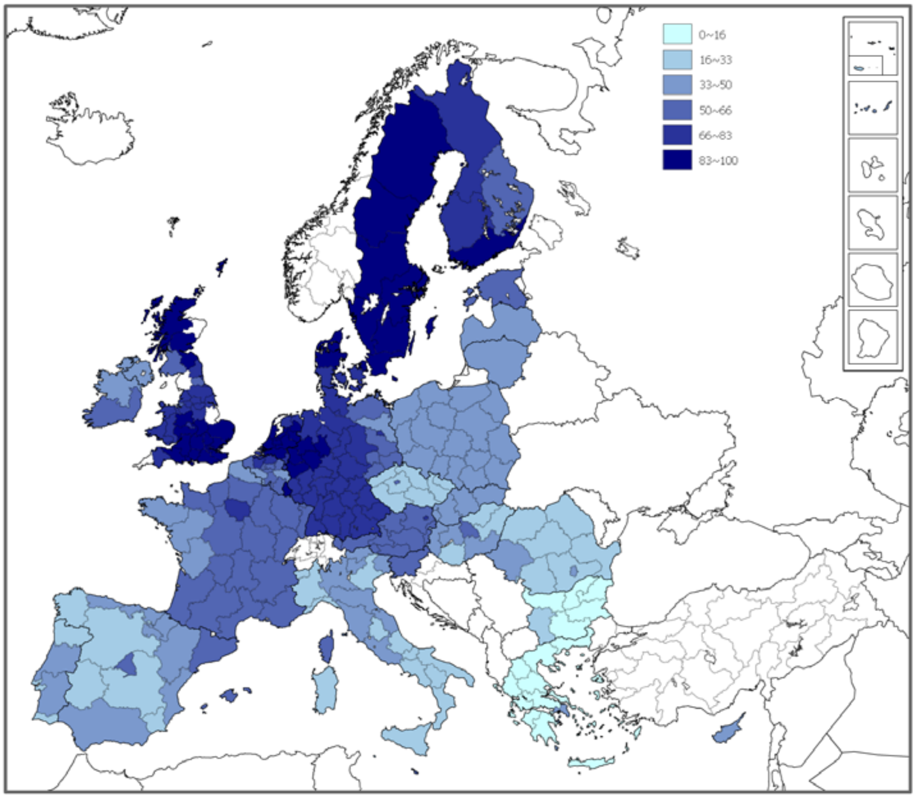


Figure 5-37: Map for sub-score of Technological readiness - Households sub-pillar (Min-max normalized values)

Table 70: Technological readiness - Households sub-score as arithmetic mean of transformed and standardized indicators.

region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore
BE00	0.38	64	ES30	0.09	57	AT33	0.22	60
BE21	0.53	68	ES41	-0.97	30	AT34	0.38	64
BE22	0.46	66	ES42	-0.92	32	PL11	-0.38	45
BE23	0.53	68	ES43	-1.16	26	PL12	-0.38	45
BE25	0.46	66	ES51	-0.01	54	PL21	-0.42	44
BE32	-0.24	49	ES52	-0.75	36	PL22	-0.42	44
BE33	-0.33	46	ES53	-0.05	53	PL31	-0.67	38
BE34	0.18	59	ES61	-0.84	34	PL32	-0.67	38
BE35	-0.09	52	ES62	-0.97	30	PL33	-0.67	38
BG31	-2.10	2	ES63	-0.84	34	PL34	-0.67	38
BG32	-2.19	0	ES64	-0.59	40	PL41	-0.23	49
BG33	-2.02	4	ES70	-0.54	41	PL42	-0.23	49
BG34	-2.08	3	FR10	0.52	67	PL43	-0.23	49
BG41	-1.37	20	FR21	-0.18	50	PL51	-0.39	45
BG42	-2.16	1	FR22	-0.18	50	PL52	-0.39	45
CZ01	-0.15	51	FR23	-0.18	50	PL61	-0.35	46
CZ02	-0.96	31	FR24	-0.18	50	PL62	-0.35	46
CZ03	-1.13	26	FR25	-0.18	50	PL63	-0.35	46
CZ04	-1.45	18	FR26	-0.18	50	PT11	-1.00	30
CZ05	-1.13	26	FR30	-0.46	43	PT15	-0.72	37
CZ06	-1.08	28	FR41	-0.10	52	PT16	-1.24	24
CZ07	-1.33	21	FR42	-0.10	52	PT17	-0.48	43
CZ08	-1.19	25	FR43	-0.10	52	PT18	-1.33	21
DK01	1.56	93	FR51	-0.31	47	PT20	-1.00	30
DK02	1.05	81	FR52	-0.31	47	PT30	-0.88	33
DK03	1.15	83	FR53	-0.31	47	RO11	-0.93	31
DK04	1.32	87	FR61	-0.17	50	RO12	-1.07	28
DK05	1.20	84	FR62	-0.17	50	RO21	-1.22	24
DE11	0.77	74	FR63	-0.17	50	RO22	-1.08	28
DE12	0.77	74	FR71	0.02	55	RO31	-1.10	27
DE13	0.77	74	FR72	0.02	55	RO32	-0.77	35
DE14	0.77	74	FR81	0.22	60	RO41	-1.33	21
DE21	0.92	77	FR82	0.22	60	RO42	-0.84	34
DE22	0.92	77	FR83	0.22	60	SI01	-0.17	50
DE23	0.92	77	FR91			SI02	-0.17	50
DE24	0.92	77	FR92			SK01	-0.45	43
DE25	0.92	77	FR93			SK02	-0.30	47
DE26	0.92	77	FR94			SK03	-0.62	39
DE27	0.92	77	ITC1	-1.02	29	SK04	-0.66	38
DE30	0.87	76	ITC2	-1.05	28	FI13	0.42	65
DE41	-0.30	47	ITC3	-1.06	28	FI18	1.22	85
DE42	0.35	63	ITC4	-0.75	36	FI19	0.76	73
DE50			ITD1	-0.75	36	FI1A	1.06	81
DE60	1.00	79	ITD2	-0.75	36	FI20		
DE71	1.03	80	ITD3	-0.91	32	SE11	1.73	98
DE72	1.03	80	ITD4	-0.77	35	SE12	1.51	92
DE73	1.03	80	ITD5	-0.79	35	SE21	1.32	87
DE80	0.31	62	ITE1	-0.77	35	SE22	1.32	87
DE91	0.89	77	ITE2	-0.90	32	SE23	1.43	90
DE92	0.89	77	ITE3	-0.74	36	SE31	1.29	87
DE93	0.89	77	ITE4	-0.71	37	SE32	1.29	87
DE94	0.89	77	ITF1	-0.97	30	SE33	1.30	87
DEA1	1.23	85	ITF2	-1.35	21	UKC1	0.32	62
DEA2	1.23	85	ITF3	-1.20	25	UKC2	1.05	81
DEA3	1.23	85	ITF4	-1.54	16	UKD1		
DEA4	1.23	85	ITF5	-1.50	17	UKD2	1.12	82
DEA5	1.23	85	ITF6	-1.54	16	UKD3	0.73	73
DEB1	0.85	76	ITG1	-1.35	21	UKD4	0.92	77
DEB2	0.85	76	ITG2	-0.99	30	UKD5	0.47	66
DEB3	0.85	76	CY00	-0.73	36	UKE1	0.77	74
DEC0	0.94	78	LV00	-0.42	44	UKE2	0.81	75
DED1	-0.12	51	LT00	-0.65	38	UKE3	0.67	71
DED2	-0.12	51	LU00	1.21	85	UKE4	0.74	73
DED3	-0.12	51	HU10	-0.15	51	UKF1	0.85	76
DEE0	0.53	68	HU21	-0.37	45	UKF2	1.16	83
DEF0	1.12	82	HU22	-0.57	40	UKF3		
DEG0	0.64	70	HU23	-0.99	30	UKG1	1.37	89
EE00	-0.16	50	HU31	-0.96	31	UKG2	1.36	88
IE01	-0.48	43	HU32	-1.08	28	UKG3	0.70	72
IE02	0.21	60	HU33	-0.77	35	UKH1	1.38	89
GR11	-1.80	10	MT00	0.16	58	UKH2	1.37	89
GR12	-1.80	10	NL11	1.06	81	UKH3	1.21	85
GR13	-1.80	10	NL12	1.10	82	UKI	1.38	89
GR14	-1.80	10	NL13	1.57	94	UKJ1	1.25	86
GR21	-2.13	1	NL21	1.35	88	UKJ2	1.62	95
GR22	-2.13	1	NL22	1.41	90	UKJ3	1.24	85
GR23	-2.13	1	NL23	1.48	91	UKJ4	1.33	88
GR24	-2.13	1	NL31	1.83	100	UKK1	1.40	89
GR25	-2.13	1	NL32	1.76	98	UKK2	1.24	85
GR30	-0.86	33	NL33	1.47	91	UKK3		
GR41	-1.74	11	NL34	1.08	81	UKK4	0.82	75
GR42	-1.74	11	NL41	1.42	90	UKL1	1.08	81
GR43	-1.74	11	NL42	1.11	82	UKL2	0.90	77
ES11	-1.12	27	AT11	0.11	57	UKM2	1.16	83
ES12	-0.51	42	AT12	0.22	60	UKM3	0.32	62
ES13	-0.32	47	AT13	0.58	69	UKM5		
ES21	-0.23	49	AT21	-0.11	52	UKM6	1.60	94
ES22	-0.30	47	AT22	-0.19	50	UKN0	-0.25	48
ES23	-0.70	37	AT31	0.31	62			
ES24	-0.53	41	AT32	0.44	65			

Sub-pillar Enterprises

Indicators included in the pillar are discussed in Section 3.9. In the following we recall them and the short names they are assigned.

Indicators included in the sub-pillar, in brackets short names:

1. Share of enterprises NOT using computers (reversed)
   (Enterprises_no_computer_use)
2. Share of enterprises NOT having access to Internet (reversed)
   (Enterprises_no_internet_access)
3. Share of enterprises having a website or a webpage
   (Enterprises_web)
4. Share of enterprises using Intranet (Enterprises_intranet)
5. Share of enterprises using an internal computer network
   (Enterprises_internal_networks)
6. Share of employees using Extranet (Employees_extranet)
7. Share of employees NOT having access to Internet (reversed)
   (Employees_no_internet_access)

The indicators Enterprises-no-computer-use, Enterprises-no-internet-access and Employees-no-internet-access have been reversed to have positive polarity with respect to competitiveness.

Imputation of missing values

For Belgium, due to lack of 2009 data, 2008 values have been used for all indicators except enterprises_intranet where 2007 has been used.

As discussed in Section 3.9, the geographical coverage is not the same for all the indicators. Some of them are available at the NUTS2 level while others at the country level only. However, indicators available at the regional level (suffer from close to 50% of missing values. For this reason the sub-pillar has been treated at the country level only.

UNIVARIATE ANALYSIS

Table 71 shows the descriptive statistics for the indicators used to describe the Enterprise sub-pillar. All indicators have no missing data. High coefficients of variation observed for the indicators on enterprise use of computers (1.04), enterprises internet access (0.90) and employees internet aces (0.91) show diverse situations across EU regions.

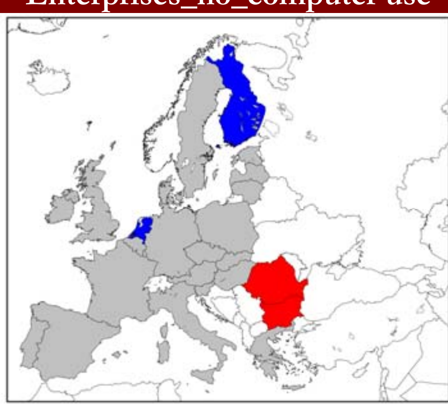
Table 71: Descriptive statistics of Enterprise indicators

Name of indicator	Enterprises use of computers	Enterprises internet access	Enterprises use of websites	Enterprises use of intranet	Enterprises use of internal networks	Employees extranet access	Employees internet access
description of indicator	% of enterprises NOT using computers	% of enterprises NOT having access to internet in the reference year	% of enterprises having a website or a homepage	% of enterprises using Intranet	use an internal computer network (e.g LAN)	% of persons employed by enterprise using Extranet	% of persons employed by enterprise NOT having access to the Internet
source	Community Survey on ICT usage and e-Commerce	Community Survey on ICT usage and e-Commerce	Community Survey on ICT usage and e-Commerce	Community Survey on ICT usage and e-Commerce	Community Survey on ICT usage and e-Commerce	Community Survey on ICT usage and e-Commerce	Community Survey on ICT usage and e-Commerce
reference year	2009	2009	2009	2009	2009	2009	2009
% of missing values	0	0	0	0	0	0	0
mean value	3.89	6.11	65.15	32.41	73.41	0.37	2.48
standard deviation (unbiased)	4.06	5.48	15.49	9.74	13.17	0.12	2.26
coefficient of variation	1.04	0.90	0.24	0.30	0.18	0.32	0.91
maximum value	19.00	27.00	88.00	54.00	97.00	0.56	12.00
region corresponding to maximum value	RO	RO	DK	SK	LU	FR	RO
minimum value	0.00	1.21	28.00	18.00	44.00	0.19	0.00
region corresponding to minimum value	NL	FI	RO	CY	RO	LV	FI

How do EU countries score in each of the indicators?

Scandinavian countries show very high penetration of ICT in their enterprises with Finland performing best in four out of the seven indicators. Sweden has the highest percentage of enterprises with a website together with Denmark, which also scores best on the indicator on enterprise internet access. Romania and Bulgaria show consistent low penetration of ICT technologies.

Enterprises_no_computer use



Enterprises_no_internet access

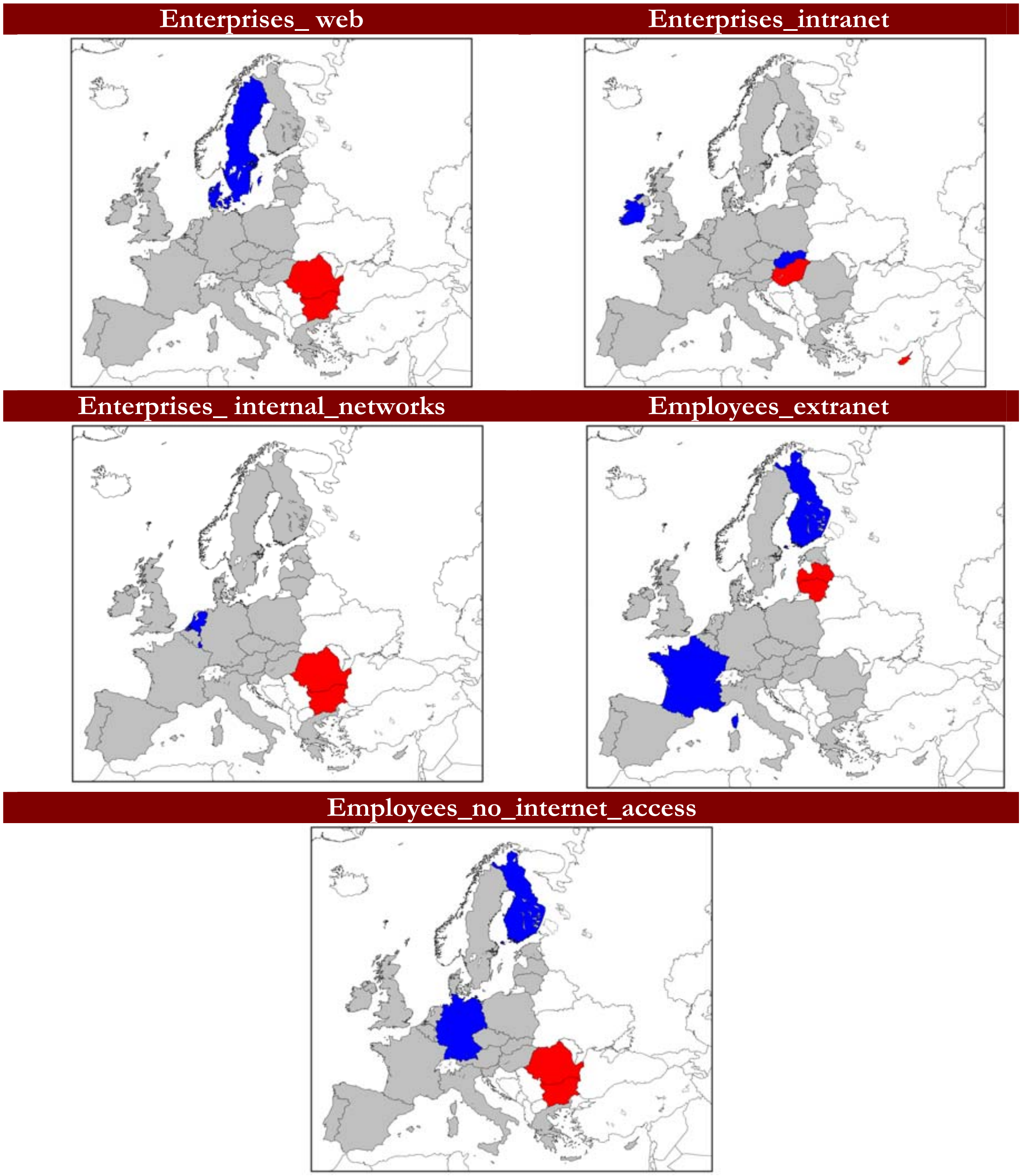
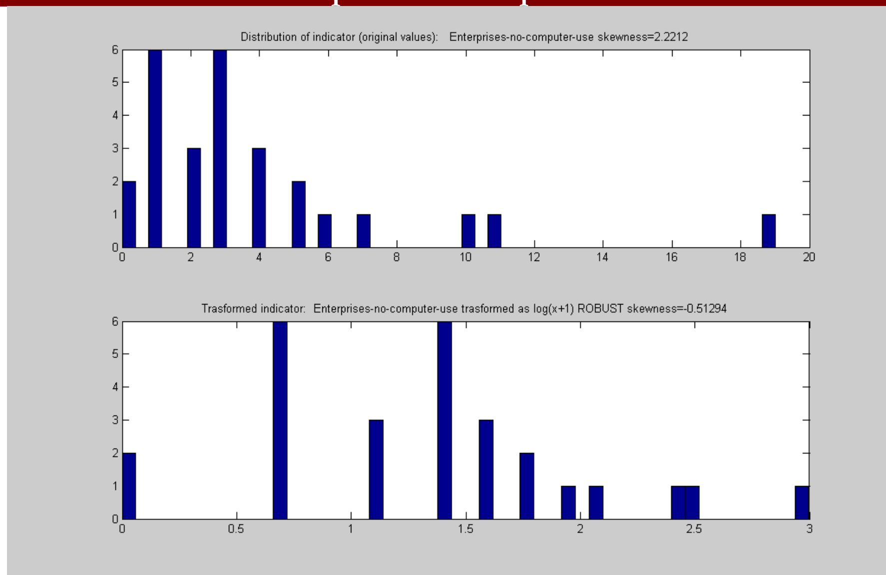


Figure 5-38. Best and worst performing regions for each indicator Enterprise sub-pillar

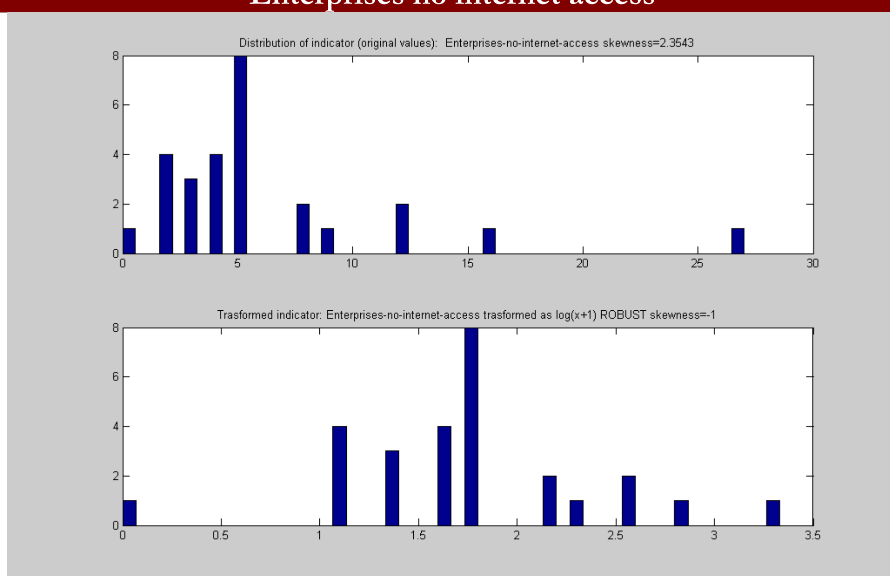
As shown in Table 72, three of the indicators have been transformed due to positive skewness. Enterprises_no_computer_use, enterprises_no_internet_access and Employees_no_internet_access have all been transformed logarithmically as described in Section 4.3, due to the presence of 0 values.

Table 72: Histograms of Enterprise indicators

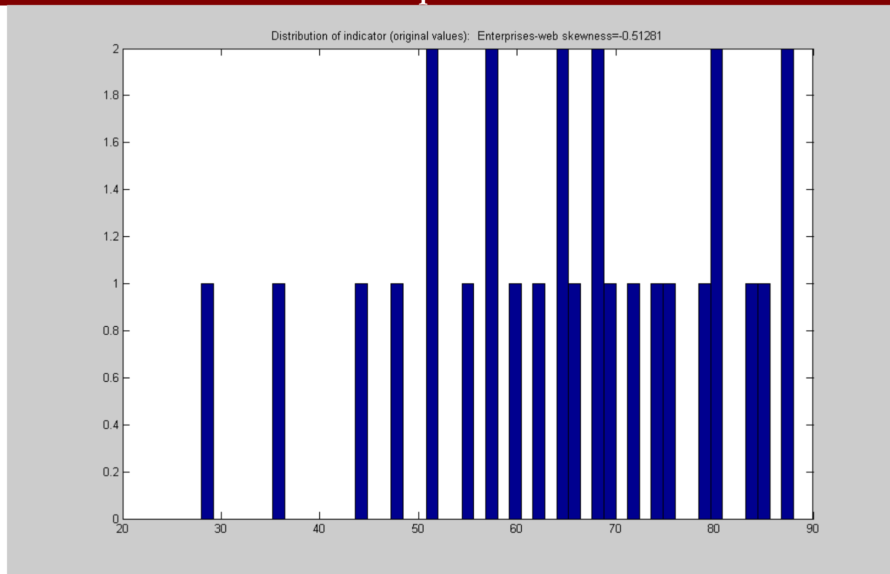
Enterprises no computer use



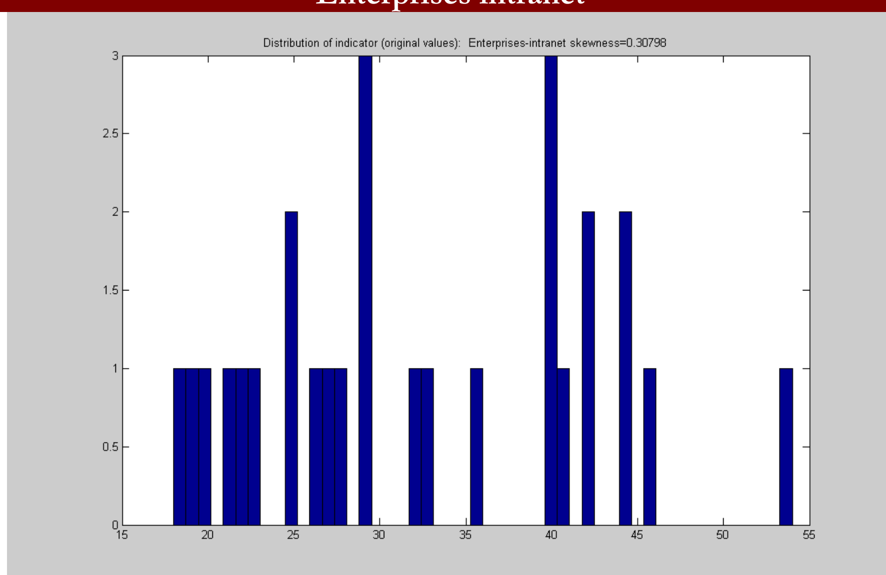
Enterprises no internet access



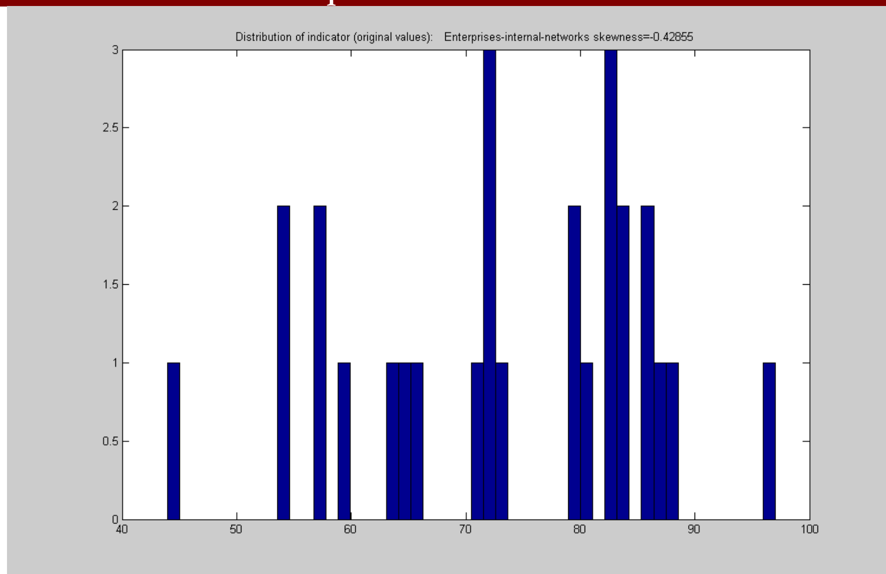
Enterprises web



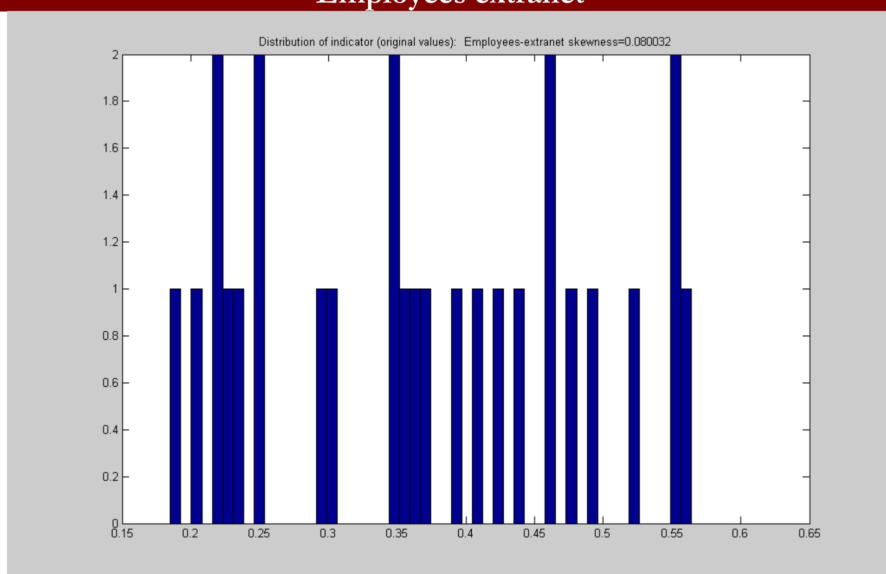
Enterprises intranet



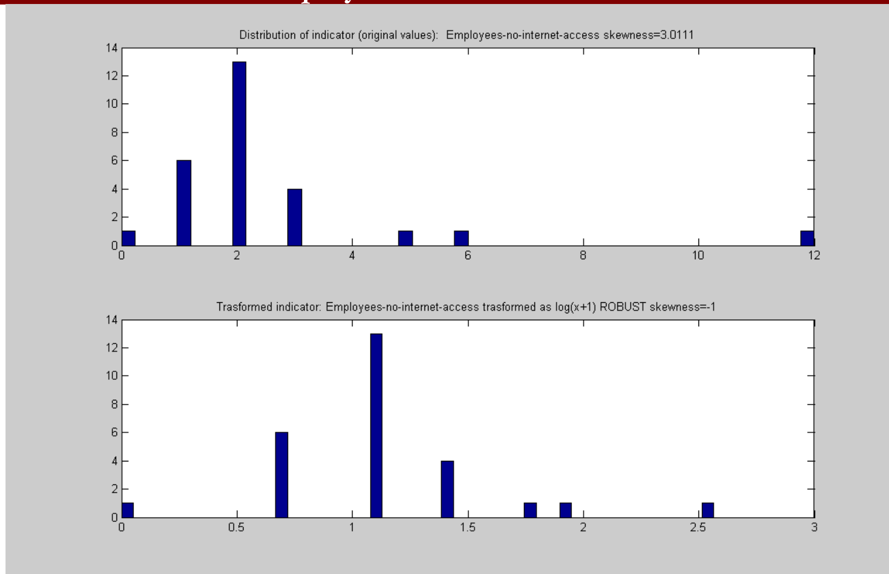
Enterprises internal networks



Employees extranet



Employees no internet access



MULTIVARIATE ANALYSIS

The PCA analysis highlights the presence of one prevalent dimension which explains more than 70% of total variance (see Figure 5-39 and Table 75) and is well described by almost all the indicators. Indicators Enterprises_intranet is the only one not showing a high correlation with the others (Table 73) and, accordingly, it has a role in defining the second PCA dimension, which explains about 12% of total variance (Table 74 and Table 75) .

On the basis of the analysis, all the indicators have been included in the computation of the final sub-score at the country level which is shown in Figure 5-40.

Table 73: Correlation matrix between indicators included in the Technological readiness Enterprises sub-pillar

Correlation Matrix

		Enterprises_no_computer_reversed	Enterprises_no_internet_reversed	Enterprises_web	Enterprises_intranet	Enterprises_internal_networks	Employees_extranet	Employees_no_internet_reversed
Correlation	Enterprises_no_computer_reversed	1.000	.911	.736	.449	.728	.689	.801
	Enterprises_no_internet_reversed	.911	1.000	.781	.466	.705	.736	.896
	Enterprises_web	.736	.781	1.000	.356	.741	.631	.673
	Enterprises_intranet	.449	.466	.356	1.000	.257	.582	.338
	Enterprises_internal_networks	.728	.705	.741	.257	1.000	.689	.647
	Employees_extranet	.689	.736	.631	.582	.689	1.000	.629
	Employees_no_internet_reversed	.801	.896	.673	.338	.647	.629	1.000
Sig. (1-tailed)	Enterprises_no_computer_reversed		.000	.000	.009	.000	.000	.000
	Enterprises_no_internet_reversed	.000		.000	.007	.000	.000	.000
	Enterprises_web	.000	.000		.034	.000	.000	.000
	Enterprises_intranet	.009	.007	.034		.098	.001	.042
	Enterprises_internal_networks	.000	.000	.000	.098		.000	.000
	Employees_extranet	.000	.000	.000	.001	.000		.000
	Employees_no_internet_reversed	.000	.000	.000	.042	.000	.000	

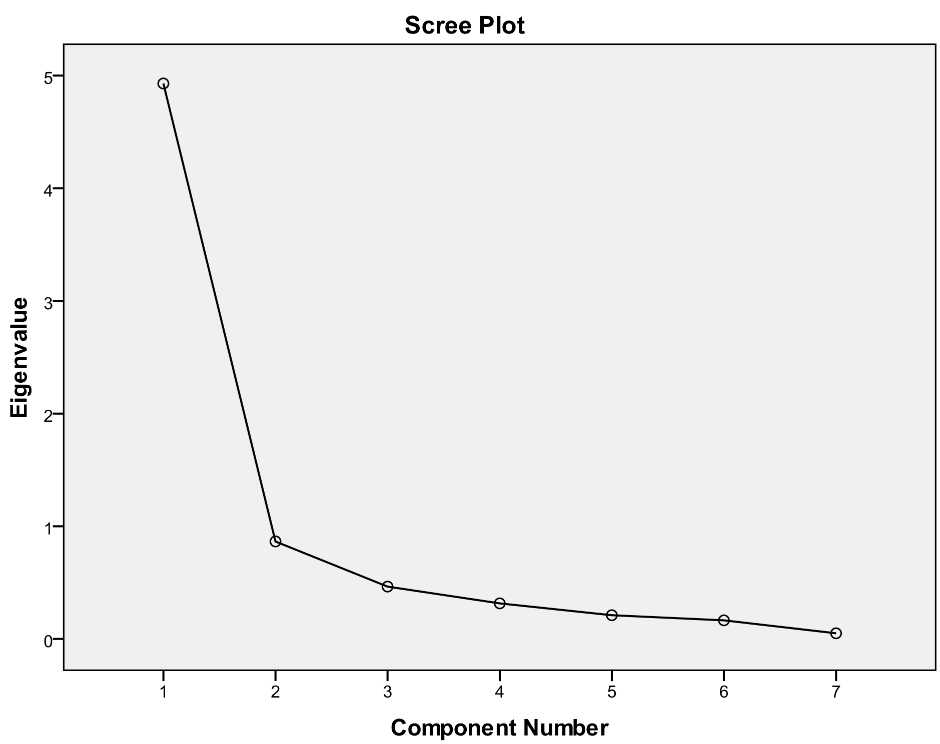


Figure 5-39: PCA analysis of the Technological readiness Enterprises sub-pillar - eigenvalues

Table 74: PCA analysis for the Technological readiness - Enterprises sub-pillar: correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
Enterprises_no_ computer_reversed	.921	-.073	-.164	.012	.232	-.241	.088
Enterprises_no_internet_ reversed	.952	-.064	-.227	-.003	-.027	-.061	-.183
Enterprises_web	.851	-.175	.175	.421	-.188	-.016	.032
Enterprises_intranet	.549	.811	-.024	.133	.100	.109	.001
Enterprises_internal_ networks	.828	-.268	.396	-.083	.227	.161	-.028
Employees_extranet	.842	.250	.259	-.313	-.223	-.116	.025
Employees_no_internet_ reversed	.869	-.179	-.362	-.124	-.097	.226	.078

Extraction Method: Principal Component Analysis.

a. 7 components extracted.

Table 75: PCA analysis the Technological readiness – Enterprises sub-pillar: explained variance

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	4.930	70.429	70.429
2	.865	12.360	82.788
3	.465	6.638	89.426
4	.315	4.507	93.933
5	.211	3.008	96.940
6	.164	2.348	99.288
7	.050	.712	100.000

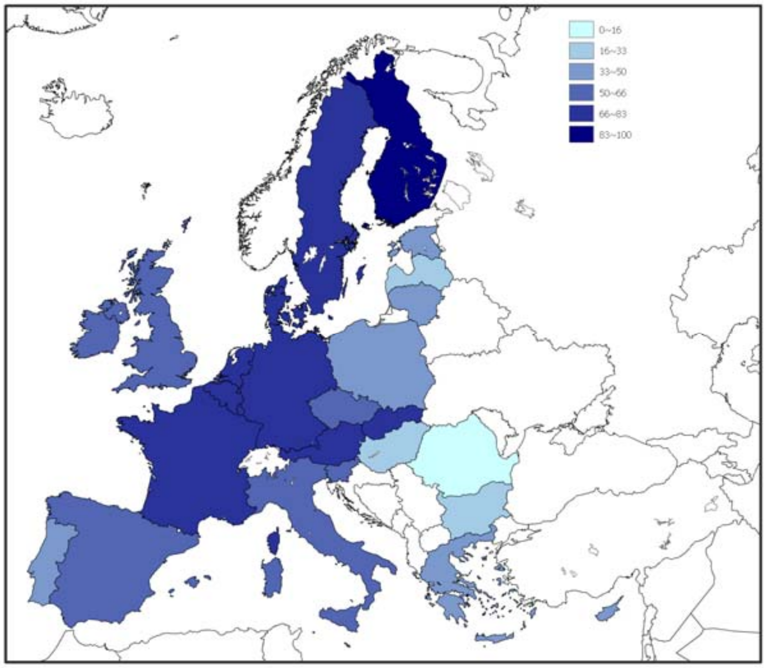


Figure 5-40: Technological readiness – Enterprises sub-scores (Min-max normalized values)

Table 76: Enterprises sub-score as arithmetic mean of transformed and standardized indicators.

country	Subscore	Min_max normalized subscore
BE	0.67	74
BG	-1.47	23
CZ	-0.29	51
DK	0.73	76
DE	0.86	79
EE	-0.51	46
IE	-0.04	57
GR	-0.51	46
ES	0.03	59
FR	0.59	72
IT	-0.36	50
CY	-0.67	42
LV	-1.16	31
LT	-0.54	45
LU	0.81	77
HU	-1.40	25
MT	-0.04	57
NL	0.66	74
AT	0.60	73
PL	-1.00	35
PT	-0.60	44
RO	-2.46	0
SI	0.13	61
SK	0.91	80
FI	1.76	100
SE	0.66	74
UK	0.06	60

The overall sub-score of Technological readiness is computed as simple arithmetic mean of the two sub-pillar scores. Since for the enterprise sub-pillar the sub-scores are available at the country level only, these values have been equally assigned to all the regions in that country. Sub-scores of the Technological readiness pillar are shown in Table 77 , while Figure 5-41 displays the sub-score histogram. The list of regions reordered form best to worst according to the overall technological readiness sub-score is due in Table 78.

Table 77: Overall technological readiness sub-score

region	subscore	Min_max normalized score	region	subscore	Min_max normalized score	region	subscore	Min_max normalized score
BE00	0.74	74	ES30	-0.04	54	AT33	0.56	69
BE21	0.72	74	ES41	-0.55	40	AT34	0.56	69
BE22	0.81	76	ES42	-0.56	40	PL11	-0.56	40
BE23	0.80	76	ES43	-0.55	40	PL12	-0.56	40
BE25	0.57	70	ES51	-0.13	51	PL21	-0.56	40
BE32	0.33	63	ES52	-0.41	44	PL22	-0.56	40
BE33	0.47	67	ES53	-0.18	50	PL31	-0.70	36
BE34	0.52	68	ES61	-0.51	41	PL32	-0.70	36
BE35	0.52	68	ES62	-0.55	40	PL33	-0.70	36
BG31	-1.94	3	ES63	-0.41	44	PL34	-0.70	36
BG32	-1.79	7	ES64	-0.36	45	PL41	-0.51	41
BG33	-1.72	9	ES70	-0.35	45	PL42	-0.51	41
BG34	-1.75	8	FR10	0.66	72	PL43	-0.51	41
BG41	-1.32	20	FR21	0.35	64	PL51	-0.54	40
BG42	-1.77	8	FR22	0.35	64	PL52	-0.54	40
CZ01	0.10	57	FR23	0.35	64	PL61	-0.58	39
CZ02	-0.27	47	FR24	0.35	64	PL62	-0.58	39
CZ03	-0.36	45	FR25	0.35	64	PL63	-0.58	39
CZ04	-0.50	41	FR26	0.35	64	PT11	-0.80	33
CZ05	-0.38	45	FR30	0.37	64	PT15	-0.69	36
CZ06	-0.35	45	FR41	0.26	62	PT16	-0.91	31
CZ07	-0.47	42	FR42	0.26	62	PT17	-0.50	42
CZ08	-0.39	44	FR43	0.26	62	PT18	-0.88	31
DK01	1.71	100	FR51	0.40	65	PT20	-0.81	33
DK02	1.32	90	FR52	0.40	65	PT30	-0.76	34
DK03	1.28	89	FR53	0.40	65	RO11	-1.96	3
DK04	1.51	95	FR61	0.23	61	RO12	-1.99	2
DK05	1.09	84	FR62	0.23	61	RO21	-2.06	0
DE11	0.58	70	FR63	0.23	61	RO22	-1.90	4
DE12	0.58	70	FR71	0.33	63	RO31	-2.02	1
DE13	0.58	70	FR72	0.33	63	RO32	-1.59	12
DE14	0.58	70	FR81	0.46	67	RO41	-2.00	2
DE21	0.67	72	FR82	0.46	67	RO42	-1.97	3
DE22	0.67	72	FR83	0.46	67	SI01	0.00	55
DE23	0.67	72	FR91	0.51	68	SI02	0.00	55
DE24	0.67	72	FR92	0.51	68	SK01	0.31	63
DE25	0.67	72	FR93	0.51	68	SK02	0.27	62
DE26	0.67	72	FR94	0.51	68	SK03	0.22	60
DE27	0.67	72	ITC1	-0.65	38	SK04	0.21	60
DE30	0.64	72	ITC2	-0.62	38	FI13	1.21	87
DE41	0.36	64	ITC3	-0.66	37	FI18	1.39	91
DE42	0.36	64	ITC4	-0.45	43	FI19	1.39	92
DE50	0.31	63	ITD1	-0.45	43	FI1A	1.29	89
DE60	0.56	69	ITD2	-0.50	42	FI20	1.17	86
DE71	0.61	71	ITD3	-0.57	40	SE11	1.13	85
DE72	0.61	71	ITD4	-0.51	41	SE12	1.13	85
DE73	0.61	71	ITD5	-0.45	43	SE21	1.18	86
DE80	0.27	62	ITE1	-0.60	39	SE22	1.18	86
DE91	0.60	71	ITE2	-0.57	40	SE23	1.18	86
DE92	0.60	71	ITE3	-0.61	38	SE31	0.97	80
DE93	0.60	71	ITE4	-0.46	43	SE32	0.97	80
DE94	0.60	71	ITF1	-0.69	36	SE33	0.97	80
DEA1	0.67	72	ITF2	-0.75	35	UKC1	0.24	61
DEA2	0.67	72	ITF3	-0.75	35	UKC2	0.16	59
DEA3	0.67	72	ITF4	-0.83	33	UKD1	-0.32	46
DEA4	0.67	72	ITF5	-0.75	35	UKD2	0.46	67
DEA5	0.67	72	ITF6	-0.86	32	UKD3	0.18	59
DEB1	0.64	71	ITG1	-0.86	32	UKD4	0.11	58
DEB2	0.64	71	ITG2	-0.63	38	UKD5	0.23	61
DEB3	0.64	71	CY00	-0.80	34	UKE1	0.02	55
DEC0	0.63	71	LV00	-0.75	35	UKE2	0.54	69
DED1	0.23	61	LT00	-0.60	39	UKE3	0.42	66
DED2	0.23	61	LU00	1.10	84	UKE4	0.35	64
DED3	0.23	61	HU10	-0.79	34	UKF1	0.44	66
DEE0	0.26	61	HU21	-0.92	30	UKF2	0.60	70
DEF0	0.53	69	HU22	-1.02	28	UKF3	0.55	69
DEG0	0.42	66	HU23	-1.17	24	UKG1	0.80	76
EE00	-0.09	52	HU31	-1.16	24	UKG2	0.20	60
IE01	0.23	61	HU32	-1.19	23	UKG3	0.31	63
IE02	0.23	61	HU33	-1.09	26	UKH1	0.63	71
GR11	-1.21	23	MT00	0.09	57	UKH2	0.56	69
GR12	-1.21	23	NL11	1.55	96	UKH3	0.59	70
GR13	-1.21	23	NL12	1.42	92	UKI	0.56	69
GR14	-1.21	23	NL13	1.21	87	UKJ1	0.81	76
GR21	-1.29	20	NL21	1.54	95	UKJ2	0.76	75
GR22	-1.29	20	NL22	1.49	94	UKJ3	0.54	69
GR23	-1.29	20	NL23	1.43	92	UKJ4	0.60	70
GR24	-1.29	20	NL31	1.59	97	UKK1	0.63	71
GR25	-1.29	20	NL32	1.61	97	UKK2	0.51	68
GR30	-0.75	35	NL33	1.51	95	UKK3	0.58	70
GR41	-1.18	23	NL34	1.34	90	UKK4	0.54	69
GR42	-1.18	23	NL41	1.37	91	UKL1	0.38	65
GR43	-1.18	23	NL42	1.34	90	UKL2	0.44	66
ES11	-0.61	38	AT11	0.55	69	UKM2	0.37	64
ES12	-0.29	47	AT12	0.50	68	UKM3	0.26	61
ES13	-0.25	48	AT13	0.75	75	UKM5	0.02	55
ES21	-0.25	48	AT21	0.39	65	UKM6	0.91	79
ES22	-0.27	48	AT22	0.51	68	UKN0	0.04	56
ES23	-0.32	46	AT31	0.55	69			
ES24	-0.30	47	AT32	0.56	69			

Figure 5-41: Histogram of Technological readiness sub-score

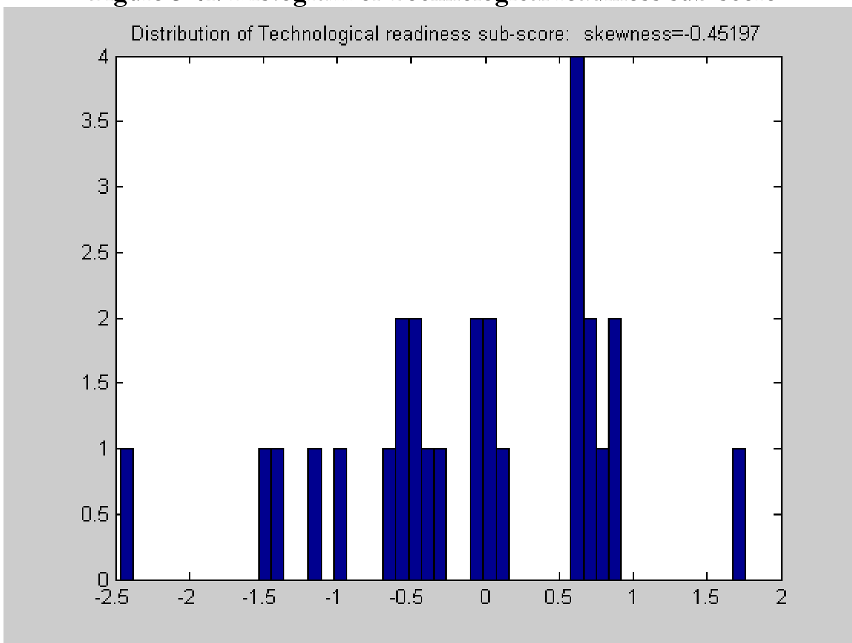


Table 78: Technological readiness pillar sub-rank (from best to worst)

Technological readiness		
1	FI	Finland
2	SK	Slovakia
3	DE	Germany
4	LU	Luxembourg
5	DK	Denmark
6	BE	Belgium
7	NL	Netherlands
8	SE	Sweden
9	AT	Austria
10	FR	France
11	SI	Slovenia
12	UK	United Kingdom
13	ES	Spain
14	IE	Ireland
15	MT	Malta
16	CZ	Czech republic
17	IT	Italy
18	EE	Estonia
19	GR	Greece
20	LT	Lithuania
21	PT	Portugal
22	CY	Cyprus
23	PL	Poland
24	LV	Latvia
25	HU	Hungary
26	BG	Bulgaria
27	RO	Romania

5.10 Business sophistication

All the indicators included in the pillar are available at the regional NUTS2 level (Section 3.10). In the following, they are recalled with their short names used in the statistical analysis.

Indicators included in the pillar, in brackets short names:

1.	Share of employment in 'sophisticated' sectors	(Employment_JK)
2.	Share of GVA in 'sophisticated' sectors	(GVA_JK)
3.	New foreign firms per (mill.) inhabitants	(FDI_intensity)
4.	Strength of regional clusters	(Regional_clusters)

As discussed in Section 3.10, three indicators on venture capital have been considered but have resulted having more than 35 % of missing values and have been thus, discarded from the analysis.

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As can be seen from Table 79, the indicators included in the pillar have a very low percentage of missing values (0.37% for Employment JK, 0% for GVA, 0.75% for new foreign firms, and 4.1 % for strength of regional clusters). Thus, all indicators have been included in the analysis.

The coefficient of variation is quite high for the indicator on new foreign firms (2.84) suggesting very diverse situations among EU regions.

Table 79: Descriptive statistics of Business sophistication indicators

Indicator	Employment, JK sector	GVA, JK sector	FDI intensity	Stength of regional clusters
description	employment in the "Financial intermediation, real estate, renting and business activities" sector (J_K) as % of total employment	GVA in the "Financial intermediation, real estate, renting and business activities" sector (J_K) as % of total GVA	Number of new foreign firms per million inhabitants	for description of the derivation of the indicator, see Appendix B
source	Eurostat Regional Statistics	Eurostat Regional Statistics	ISLA - Bocconi	European Cluster Observatory
reference year	2007	2007	2005-2007	2006
% of missing values	0.37	0.00	0.75	4.10
mean value	12.38	23.36	173.43	14.39
standard deviation (unbiased)	5.41	6.59	493.33	8.50
coefficient of variation	0.44	0.28	2.84	0.59
maximum value	29.05	48.63	6813.10	52.00
region corresponding to maximum value	NL31	LU00	RO32	ITC4
minimum value	2.53	9.59	0.00	2.00
region corresponding to minimum value	BG31	CZ04	GR22	ITF6

How do EU regions score in each of the indicators?

As we can see from Figure 5-42, employment in 'sophisticated sectors' is lowest in Eastern European regions and parts of Greece and Portugal. Similar situation is seen for the indicator on GVA with some UK and Central European regions also among the worst performers. The indicator on new foreign firms shows high FDI intensity in a number of Romanian and UK regions which are among the best performers. Worst performance in terms of FDI can be seen in Southern European regions, Italy and Greece, in particular. The indicator on the strength of regional clusters shows a very diverse situation across regions. Northern Italian regions show very strong regional clusters activity, being among the best performers together with parts of Southern Germany, Belgium, Denmark, and Spain.

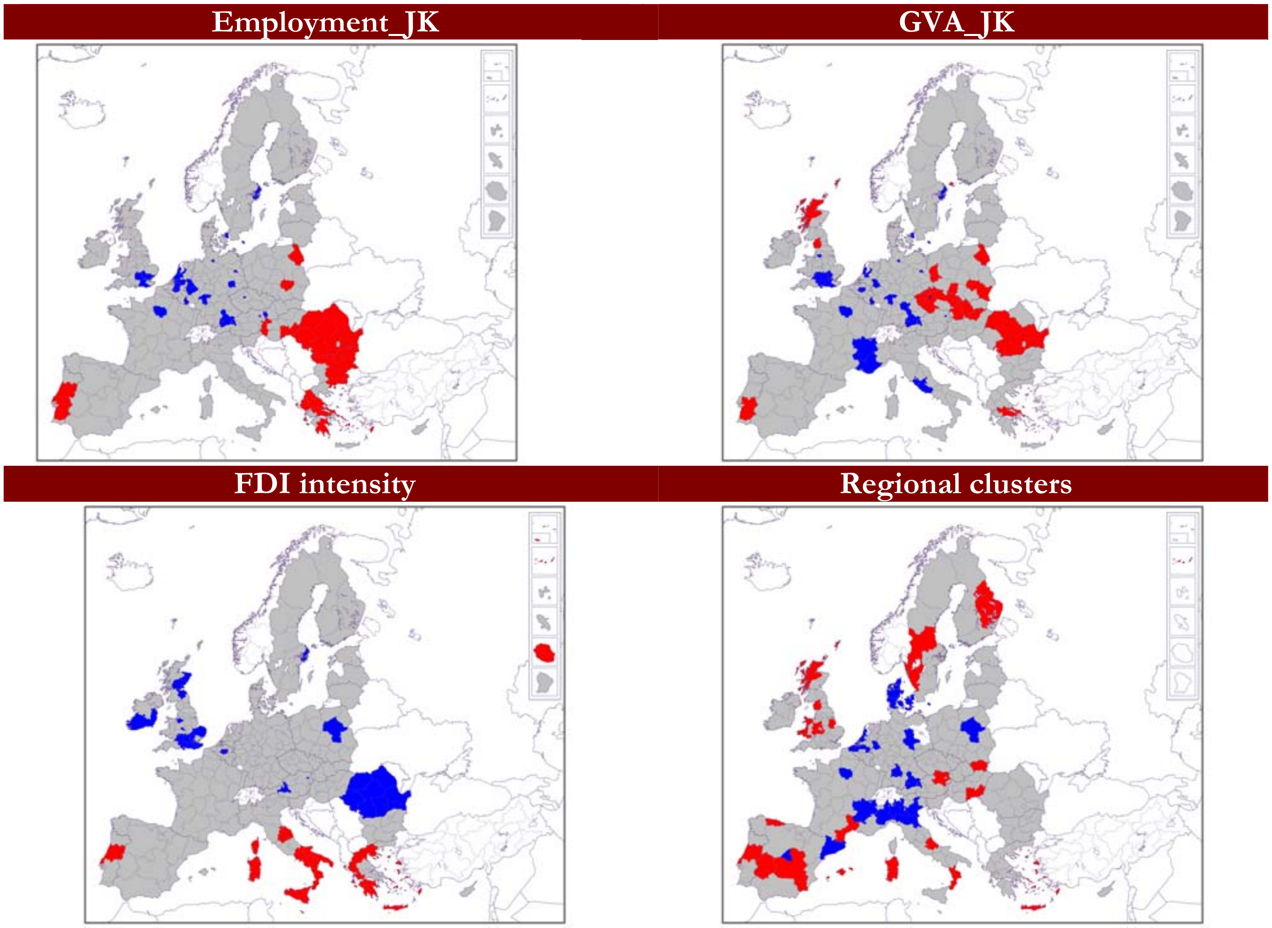
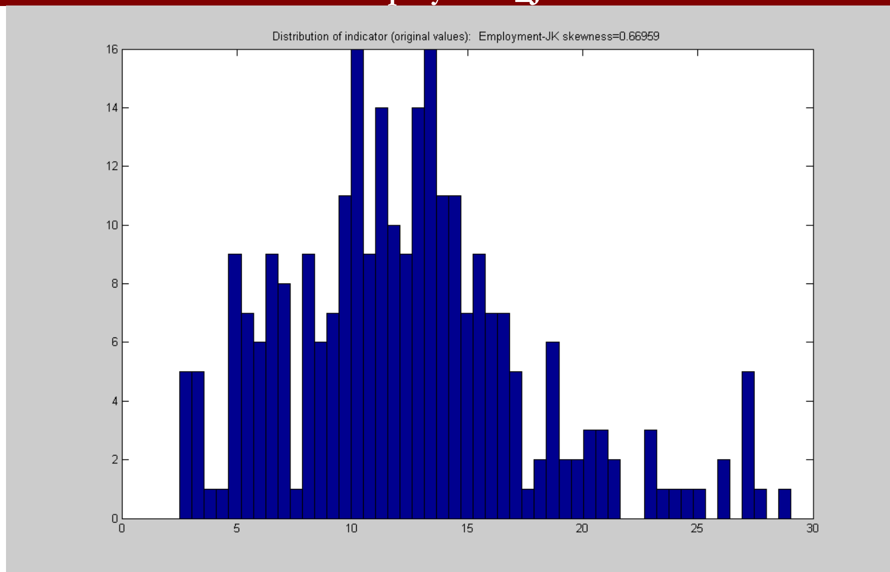


Figure 5-42: Best and worst performing regions for each indicator – Business sophistication

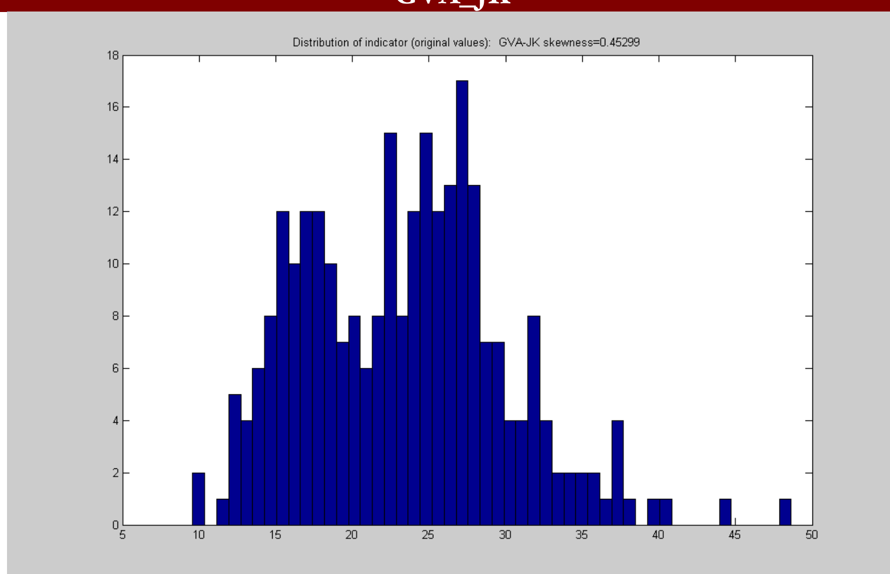
Table 80 shows the histograms of the four indicators. Two indicators have been transformed due to positive skewness. The indicator on new foreign firms has been transformed logarithmically due to the presence of zero values while the indicator on regional clusters has been transformed with the Box-Cox method.

Table 80: Histograms of Business sophistication indicators

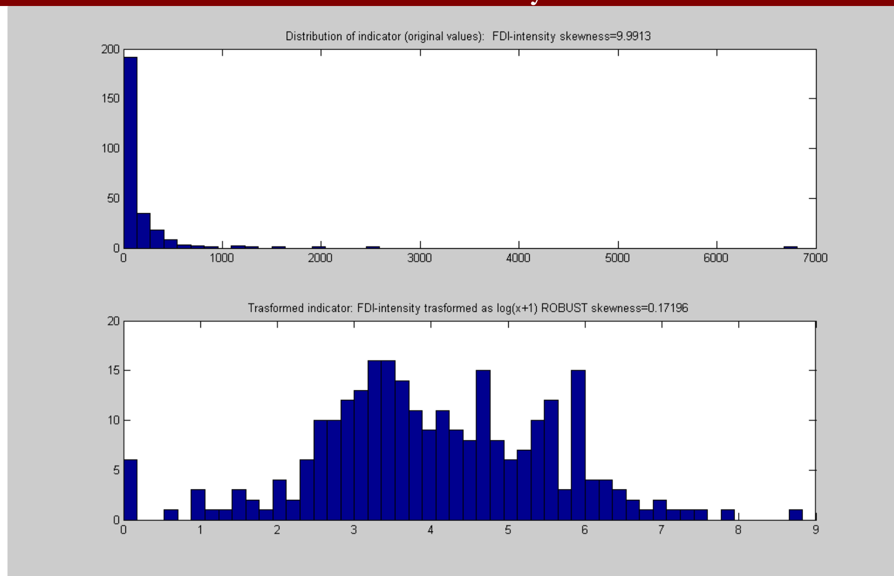
Employment_JK



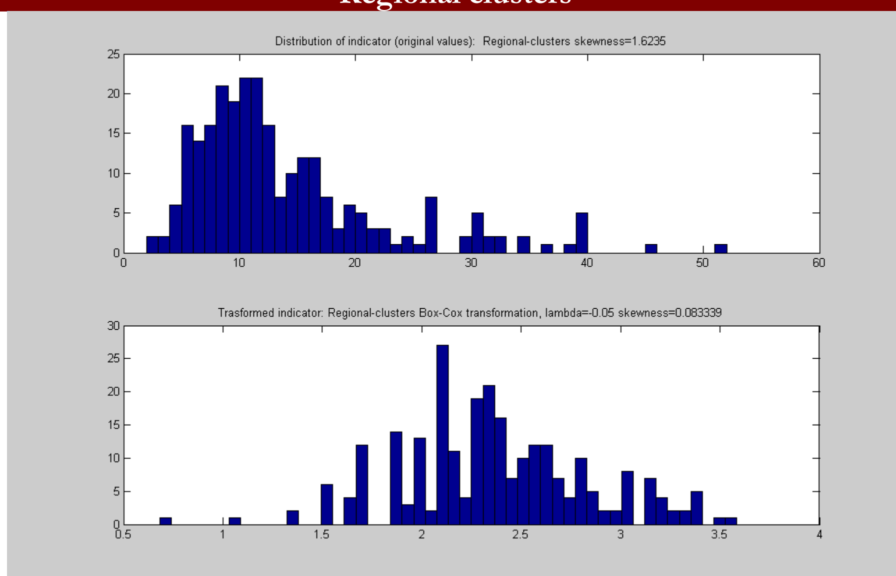
GVA_JK



FDI intensity



Regional clusters



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The correlation matrix (Table 81) shows a discrete correlation pattern between indicators with the highest correlation between Employment and GVA in J-K sectors. The PCA analysis highlights the presence of a first prevalent dimension (Figure 5-43) that accounts for about 56% of total variation (Table 83). As expected from the correlation coefficients, the first two indicators mostly contribute to the first dimension with component loadings of about 0.9, with the loadings of the remaining indicators below 0.59 (Table 82). The second dimension, which explains about 20% of variance (Table 83), is mainly due to the indicator

FDI_intensity which has a correlation of 0.70 with this second component (Table 82). Overall, PCA outcomes support the hypothesis of a single major dimension underlying the pillar. Figure 5-44 shows the geographical distribution of the business sophistication sub-score computed as arithmetic mean of all four indicators. The histogram of the sub-score is displayed in Figure 5-45 while reordered regions are listed in Table 85.

Table 81: Correlation matrix between indicators included in the Business sophistication pillar

Correlation Matrix

		Employment_JK	GVA_JK	FDI_intensity	Regional_clusters
Correlation	Employment_JK	1.000	.834	.346	.393
	GVA_JK	.834	1.000	.277	.291
	FDI_intensity	.346	.277	1.000	.226
	Regional_clusters	.393	.291	.226	1.000
Sig. (1-tailed)	Employment_JK		.000	.000	.000
	GVA_JK	.000		.000	.000
	FDI_intensity	.000	.000		.000
	Regional_clusters	.000	.000	.000	

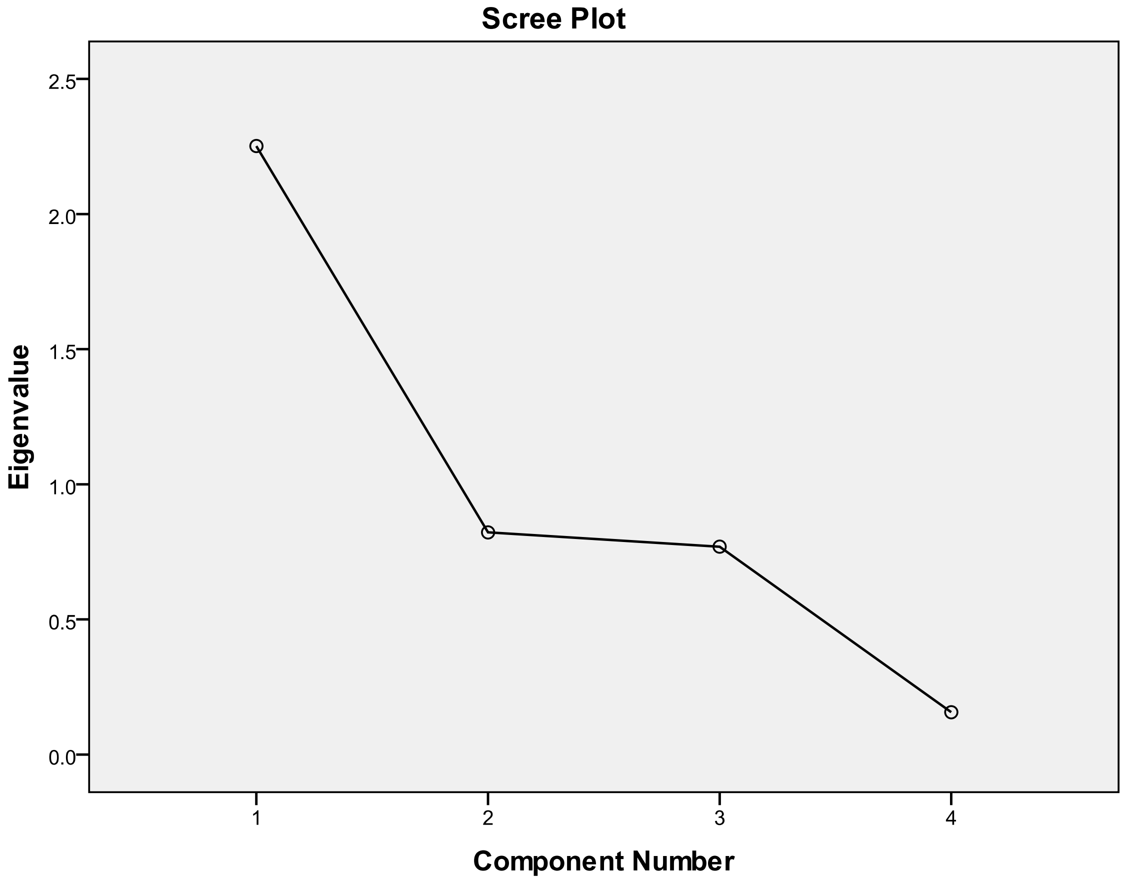


Figure 5-43: PCA analysis for the Business sophistication pillar - eigenvalues

Table 82: PCA analysis for the Business sophistication pillar: correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component			
	1	2	3	4
Employment_JK	.917	-.265	-.067	-.290
GVA_JK	.870	-.390	-.140	.267
FDI_intensity	.553	.699	-.453	.021
Regional_clusters	.590	.333	.735	.037

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Table 83: PCA analysis for the Business sophistication pillar: explained variance

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	2.252	56.295	56.295
2	.822	20.553	76.848
3	.769	19.232	96.080
4	.157	3.920	100.000

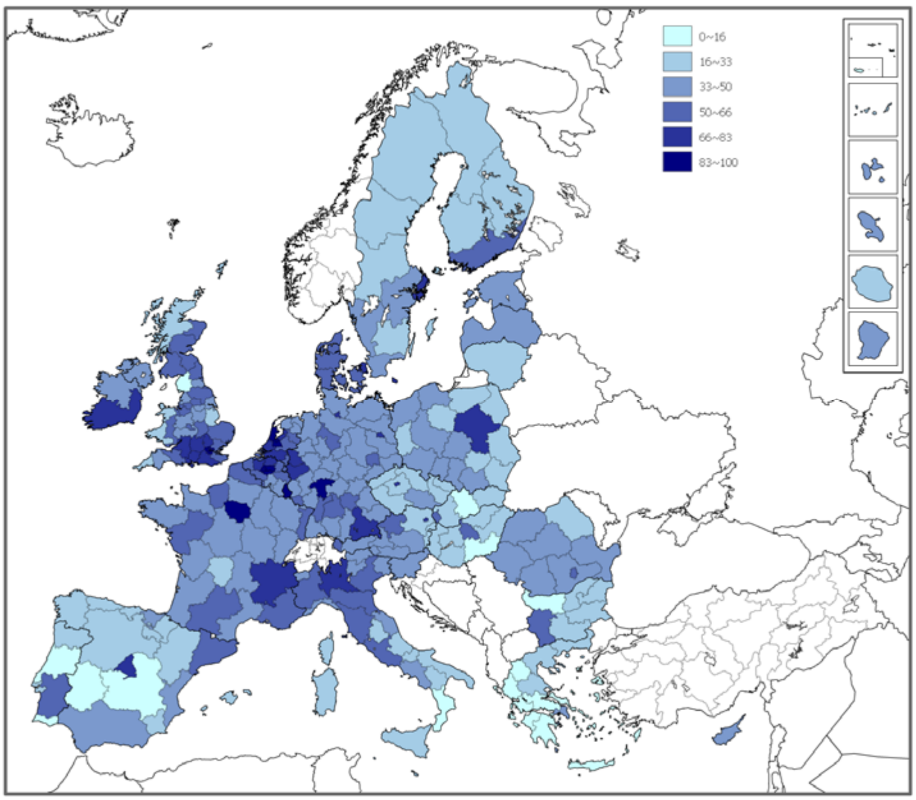


Figure 5-44: Business sophistication sub-score.
Values of the min-max normalized sub-scores are shown in Table 84

Table 84: Business sophistication sub-score as arithmetic mean of transformed and standardized indicators.

region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore
BE00	1.37	86	ES30	0.78	70	AT33	-0.24	43
BE21	0.98	76	ES41	-0.76	29	AT34	0.03	50
BE22	0.58	65	ES42	-1.42	11	PL11	-0.43	38
BE23	0.64	67	ES43	-1.52	8	PL12	0.75	70
BE25	0.50	63	ES51	0.44	61	PL21	-0.35	40
BE32	0.02	50	ES52	-0.22	43	PL22	-0.36	40
BE33	0.08	51	ES53	-0.81	27	PL31	-0.85	26
BE34	-0.22	43	ES61	-0.42	38	PL32	-0.87	26
BE35	-0.13	46	ES62	-1.05	21	PL33	-1.07	20
BG31	-1.34	13	ES63	-1.44	11	PL34	-0.97	23
BG32	-1.06	21	ES64	-1.60	6	PL41	-0.40	39
BG33	-1.08	20	ES70	-1.06	21	PL42	-0.52	35
BG34	-1.24	16	FR10	1.88	100	PL43	-0.81	27
BG41	0.31	58	FR21	-0.45	37	PL51	-0.25	43
BG42	-1.02	22	FR22	-0.11	46	PL52	-0.59	33
CZ01	0.87	73	FR23	0.05	51	PL61	-0.71	30
CZ02	-0.86	26	FR24	-0.13	46	PL62	-0.78	28
CZ03	-0.68	31	FR25	-0.38	39	PL63	-0.37	39
CZ04	-0.86	26	FR26	-0.38	39	PT11	-0.66	32
CZ05	-0.73	30	FR30	0.26	56	PT15	-1.35	13
CZ06	-0.49	36	FR41	-0.09	47	PT16	-0.96	23
CZ07	-0.91	25	FR42	0.15	53	PT17	0.25	56
CZ08	-1.13	19	FR43	-0.06	48	PT18	-1.32	14
DK01	1.22	82	FR51	0.02	50	PT20	-1.83	0
DK02	0.10	52	FR52	-0.37	39	PT30	-1.34	13
DK03	0.09	52	FR53	-0.27	42	RO11	-0.49	36
DK04	0.14	53	FR61	-0.13	46	RO12	-0.19	44
DK05	0.01	50	FR62	0.06	51	RO21	-0.74	29
DE11	0.41	60	FR63	-0.63	32	RO22	-0.58	34
DE12	0.47	62	FR71	0.77	70	RO31	-0.37	39
DE13	-0.21	44	FR72	-0.33	40	RO32	0.51	63
DE14	-0.08	47	FR81	-0.25	43	RO41	-0.56	34
DE21	1.04	77	FR82	0.27	57	RO42	-0.14	46
DE22	-0.38	39	FR83	-0.84	27	SI01	-0.77	29
DE23	-0.03	49	FR91	-0.34	40	SI02	-0.13	46
DE24	-0.17	45	FR92	-0.43	38	SK01	0.53	64
DE25	0.40	60	FR93	-0.41	38	SK02	-0.86	26
DE26	-0.03	49	FR94	-0.62	33	SK03	-1.27	15
DE27	-0.05	48	ITC1	0.44	61	SK04	-1.22	16
DE30	0.77	70	ITC2	-0.54	35	FI13	-1.17	18
DE41	-0.33	40	ITC3	-0.30	41	FI18	0.25	56
DE42	-0.11	46	ITC4	0.87	73	FI19	-0.75	29
DE50	0.28	57	ITD1	-0.56	34	FI1A	-0.92	25
DE60	1.15	80	ITD2	-0.47	37	FI20	-0.72	30
DE71	1.42	88	ITD3	0.21	55	SE11	1.20	82
DE72	-0.16	45	ITD4	-0.15	45	SE12	-0.21	44
DE73	-0.15	45	ITD5	0.34	58	SE21	-0.68	31
DE80	-0.37	39	ITE1	0.11	52	SE22	-0.33	40
DE91	-0.10	47	ITE2	-0.62	33	SE23	-0.21	44
DE92	0.14	53	ITE3	-0.46	37	SE31	-0.84	27
DE93	-0.52	35	ITE4	0.45	61	SE32	-0.82	27
DE94	-0.29	42	ITF1	-0.98	23	SE33	-1.12	19
DEA1	0.81	71	ITF2	-0.93	24	UKC1	-0.47	37
DEA2	0.75	70	ITF3	-0.48	36	UKC2	0.02	50
DEA3	-0.06	48	ITF4	-0.96	23	UKD1	-1.28	15
DEA4	-0.08	47	ITF5	-0.98	23	UKD2	0.53	64
DEA5	-0.05	48	ITF6	-1.57	7	UKD3	0.56	64
DEB1	-0.27	42	ITG1	-1.02	22	UKD4	-0.22	43
DEB2	-0.43	38	ITG2	-1.09	20	UKD5	0.08	51
DEB3	-0.09	47	CY00	-0.47	37	UKE1	-0.60	33
DEC0	0.02	50	LV00	-0.38	39	UKE2	0.06	51
DED1	-0.16	45	LT00	-0.87	26	UKE3	-0.02	49
DED2	-0.13	46	LU00	1.36	86	UKE4	0.42	61
DED3	0.04	50	HU10	0.47	62	UKF1	-0.06	48
DEE0	-0.05	48	HU21	-0.69	31	UKF2	0.18	54
DEF0	-0.11	46	HU22	-0.62	33	UKF3	-0.72	30
DEG0	-0.27	42	HU23	-0.82	27	UKG1	-0.09	47
EE00	-0.22	43	HU31	-1.03	22	UKG2	-0.34	40
IE01	-0.18	44	HU32	-1.07	20	UKG3	0.48	62
IE02	0.94	75	HU33	-1.30	14	UKH1	0.37	59
GR11	-0.93	24	MT00	-1.00	22	UKH2	0.73	69
GR12	-1.08	20	NL11	-0.28	42	UKH3	0.41	60
GR13	-1.29	15	NL12	-0.20	44	UKI	1.69	95
GR14	-1.11	19	NL13	-0.15	45	UKJ1	1.20	82
GR21	-1.28	15	NL21	0.14	53	UKJ2	1.10	79
GR22	-1.53	8	NL22	0.42	61	UKJ3	0.73	69
GR23	-1.31	14	NL23	0.90	74	UKJ4	0.21	55
GR24	-1.35	13	NL31	1.55	91	UKK1	0.82	71
GR25	-1.60	6	NL32	1.43	88	UKK2	0.23	56
GR30	-0.35	40	NL33	0.92	74	UKK3	-0.72	30
GR41	-1.50	9	NL34	0.11	52	UKK4	-0.34	40
GR42	-1.50	9	NL41	0.69	68	UKL1	-0.91	25
GR43	-1.56	7	NL42	0.45	61	UKL2	0.14	53
ES11	-0.85	26	AT11	-0.64	32	UKM2	0.51	63
ES12	-0.92	25	AT12	-0.87	26	UKM3	0.11	52
ES13	-0.91	25	AT13	0.99	76	UKM5	0.15	53
ES21	-0.46	37	AT21	-0.27	42	UKM6	-1.12	19
ES22	-0.86	26	AT22	-0.16	45	UKN0	-0.04	48
ES23	-0.96	23	AT31	0.08	51			
ES24	-0.80	28	AT32	-0.08	47			

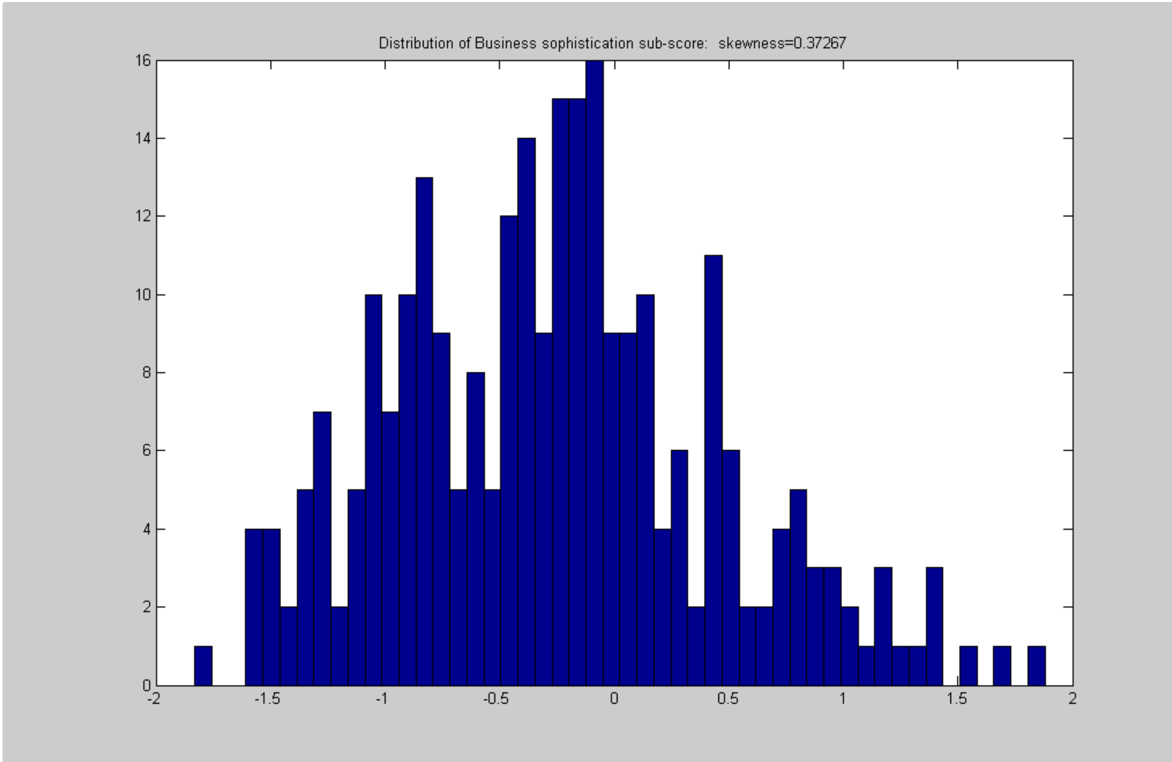


Figure 5-45: Histogram of Business sophistication sub-score

Table 85: Business sophistication pillar sub-rank (from best to worst)

Business sophistication											
1	FR10	46	NL22	91	DE27	136	AT21	181	ITE2	226	ITF1
2	UKI	47	UKE4	92	DEA5	137	NL11	182	HU22	227	ITF5
3	NL31	48	DE11	93	DEE0	138	DE94	183	FR63	228	MT00
4	NL32	49	UKH3	94	DEA3	139	ITC3	184	AT11	229	BG42
5	DE71	50	DE25	95	FR43	140	DE41	185	PT11	230	ITG1
6	BE00	51	UKH1	96	UKF1	141	FR72	186	CZ03	231	HU31
7	LU00	52	ITD5	97	DE14	142	SE22	187	SE21	232	ES62
8	DK01	53	BG41	98	DEA4	143	FR91	188	HU21	233	BG32
9	SE11	54	DE50	99	AT32	144	UKG2	189	PL61	234	ES70
10	UKJ1	55	FR82	100	DEB3	145	UKK4	190	FI20	235	HU32
11	DE60	56	FR30	101	FR41	146	GR30	191	UKF3	236	PL33
12	UKJ2	57	PT17	102	UKG1	147	PL21	192	UKK3	237	BG33
13	DE21	58	FI18	103	DE91	148	PL22	193	CZ05	238	GR12
14	AT13	59	UKK2	104	DE42	149	DE80	194	RO21	239	ITG2
15	BE21	60	ITD3	105	DEF0	150	FR52	195	FI19	240	GR14
16	IE02	61	UKJ4	106	FR22	151	PL63	196	ES41	241	SE33
17	NL33	62	UKF2	107	BE35	152	RO31	197	SI01	242	UKM6
18	NL23	63	FR42	108	DED2	153	DE22	198	PL62	243	CZ08
19	CZ01	64	UKM5	109	FR24	154	FR25	199	ES24	244	FI13
20	ITC4	65	DK04	110	FR61	155	FR26	200	ES53	245	SK04
21	UKK1	66	DE92	111	SI02	156	LV00	201	PL43	246	BG34
22	DEA1	67	NL21	112	RO42	157	PL41	202	HU23	247	SK03
23	ES30	68	UKL2	113	DE73	158	FR93	203	SE32	248	GR21
24	DE30	69	ITE1	114	ITD4	159	ES61	204	FR83	249	UKD1
25	FR71	70	NL34	115	NL13	160	DEB2	205	SE31	250	GR13
26	DEA2	71	UKM3	116	DE72	161	FR92	206	ES11	251	HU33
27	PL12	72	DK02	117	DED1	162	PL11	207	PL31	252	GR23
28	UKH2	73	DK03	118	AT22	163	FR21	208	CZ02	253	PT18
29	UKJ3	74	BE33	119	DE24	164	ES21	209	CZ04	254	BG31
30	NL41	75	AT31	120	IE01	165	ITE3	210	ES22	255	PT30
31	BE23	76	UKD5	121	RO12	166	ITD2	211	SK02	256	GR24
32	BE22	77	FR62	122	NL12	167	CY00	212	LT00	257	PT15
33	UKD3	78	UKE2	123	DE13	168	UKC1	213	AT12	258	ES42
34	SK01	79	FR23	124	SE12	169	ITF3	214	PL32	259	ES63
35	UKD2	80	DED3	125	SE23	170	CZ06	215	CZ07	260	GR41
36	RO32	81	AT34	126	BE34	171	RO11	216	ES13	261	GR42
37	UKM2	82	BE32	127	EE00	172	DE93	217	UKL1	262	ES43
38	BE25	83	DEC0	128	ES52	173	PL42	218	ES12	263	GR22
39	UKG3	84	FR51	129	UKD4	174	ITC2	219	FI1A	264	GR43
40	DE12	85	UKC2	130	AT33	175	ITD1	220	GR11	265	ITF6
41	HU10	86	DK05	131	FR81	176	RO41	221	ITF2	266	GR25
42	ITE4	87	UKE3	132	PL51	177	RO22	222	ES23	267	ES64
43	NL42	88	DE23	133	DEB1	178	PL52	223	ITF4	268	PT20
44	ES51	89	DE26	134	DEG0	179	UKE1	224	PT16		
45	ITC1	90	UKN0	135	FR53	180	FR94	225	PL34		

5.11 Innovation

Candidate indicators are discussed in Section3.11. In the following we recall them together with the short names used in the analysis.

Indicators included, in brackets short names:

1. Innovation patent applications per mill. Inhabitants (Inno_patent_appl)
2. Total patent applications per mill. Inhabitants (Total_patent_appl)
3. Core Creative class employment (share of population) (Core_creative_class)
4. Knowledge workers (share of total employment) (Knowledge_workers)
5. Scientific publications per mill. Inhabitants (Scientific_publications)
6. Intramural R&D expenditure (share of GDP) (GERD)
7. Human resources in Science & Technology (share of labor force[15]) (HRST)
8. Employment in Tech.& knowledge-intensive sectors (share of total employment) (High_tech_emp)
9. High-tech EPO applications per mill. Inhabitants (High_tech_inventors)
10. ICT EPO applications per mill. Inhabitants (ICT_inventors)
11. Biotechnology EPO applications per mill. Inhabitants (Biotech_inventors)

Imputation of missing data

All indicators have the same positive orientation with respect to the level of competitiveness.

For the indicator on Core creative class, NUTS 0 data has been imputed to the NUTS 2 level for Denmark.

For the indicator on Scientific publications, NUTS 0 data has been imputed to the NUTS 2 for Denmark and Slovenia, while NUTS 1 (UKI) data has been imputed to the NUTS 2 level (UKI 1 and 2).

[15] Labor force, or active population, is the sum of employed and unemployed people, a synonymous is economically active population.

For the indicator on GERD, NUTS 1 data has been imputed to the NUTS 2 level for Belgium. Due to lack of more recent data, 2004 data has been used for France, 2005 - for Italy, and 2003 – for the Netherlands.

For the indicator on high-tech employment, due to lack of more recent data, 2007 data has been used for Bulgaria, Poland, Slovenia, Sweden, DE22, DE80, DEC0, DED1, and DED3, 2004 - for DE50 andGR13, and 2006 - for GR14.

UNIVARIATE ANALYSIS

Table 86 reports the descriptive statistics for the innovation pillar indicators. Most indicators have a very low percentage of missing data (below 3 %). The only two exceptions are the indicators on knowledge workers (8.21%) and on employment in knowledge and technology intensive sectors (4.48%), but both are below the threshold of missing data defined in Section 4.2. Thus, all indicators have been included in the analysis. All indicators related to patents have a high coefficient of variation, a sign of the very diverse innovation output activities across EU regions.

Table 86: Descriptive statistics of Innovation indicators

Indicator	Innovation patent applications	Total patent applications	Core creative class employment	Knowledge workers	Scientific publications	Total intramural R&D expenditure
description	number of applications per million inhabitants	number of applications per million inhabitants	% of population aged 15-64	knowledge workers as % out of total employment	publications per million inhabitants	total R&D expenditure as % of GDP
source	OECD REGPAT	OECD REGPAT	Eurostat, LFS	Eurostat, LFS	Thomson Reuters Web of Science & CWTS database (Leiden University)	Eurostat, Regional Science and Technology Statistics
reference year	average 2005-2006	average 2005-2006	average 2006-2007	2006	average 2005-2006	2007
% of missing values	0.00	0.00	1.49	8.21	0.00	0.00
mean value	25.70	90.43	7.15	36.28	882.74	1.40
standard deviation (unbiased)	42.85	114.05	2.33	7.38	816.18	1.17
coefficient of variation	1.67	1.26	0.33	0.20	0.92	0.84
maximum value	419.26	673.11	14.96	60.69	4206.01	6.77
region corresponding to maximum value	NL41	NL41	SE11	CZ01	NL11	DE91
minimum value	0.00	0.00	2.49	16.85	0.70	0.08
region corresponding to minimum value	BG32	GR22	PT20	RO21	RO22	BG32

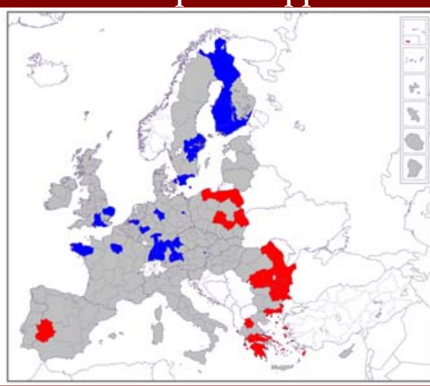
Indicator	Human Resources in Science and Technology	Employment in technology and knowledge-intensive sectors	High-tech-inventors	ICT inventors	EPO Biotechnology Patent applications authors
description	as of % labor force	as of % total employment	authors of High Technology EPO patent applications, number of inventors per million inhabitants	authors of ICT EPO patent applications, number of inventors per million inhabitants	authors of Biotechnology EPO patent applications, number of inventors per million inhabitants
source	Eurostat, Regional Science and Technology Statistics	Eurostat, Regional Science and Technology Statistics	OECD REGPAT	OECD REGPAT	OECD REGPAT
reference year	2008	2008	average 2005-2006	average 2005-2006	average 2005-2006
% of missing values	1.49	4.48	0.00	0.00	0.00
mean value	35.85	4.03	15.85	22.79	3.14
standard deviation (unbiased)	8.26	1.80	27.92	40.68	5.25
coefficient of variation	0.23	0.45	1.76	1.78	1.68
maximum value	59.80	11.33	246.49	414.79	55.01
region corresponding to maximum value	CZ01	UKJ1	NL41	NL41	DK01
minimum value	12.80	0.95	0.00	0.00	0.00
region corresponding to minimum value	PT20	RO41	BG32	BG32	BG31

How do EU regions score in each of the indicators?

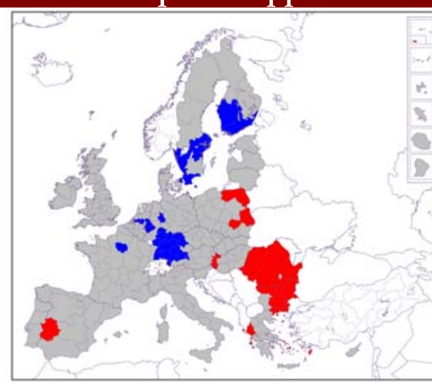
We can see from Figure 5-46 that Scandinavian regions have very high scores on all innovation indicators. Eastern European regions (Bulgarian and Romanian, in particular) have the worst performance. Some Southern European regions in Greece, Portugal, Spain and Italy show low performance as well.

The blue banana, the banana-shaped metropolitan axis, running from London through Benelux and the Rhine area to the Northern part of Italy, often identified as the area with greatest development potential in Europe in terms of innovation, still seems to be an accurate representation of innovation patterns across EU regions.

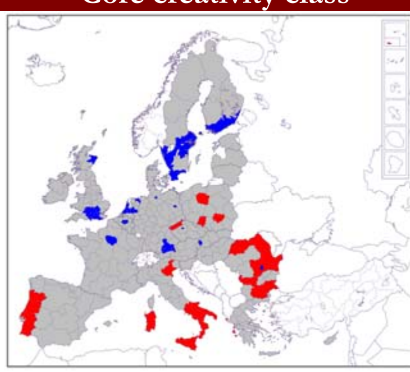
Innovation patent applications



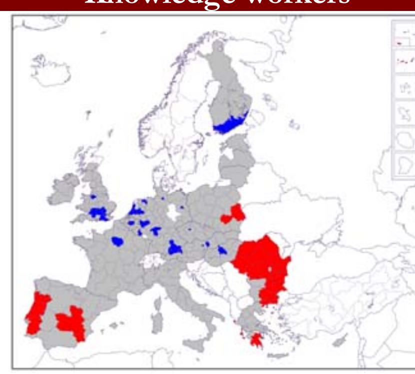
Total patent application



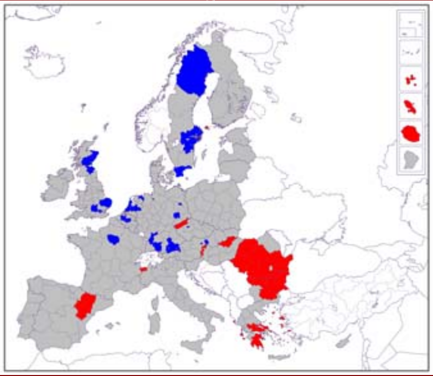
Core creativity class



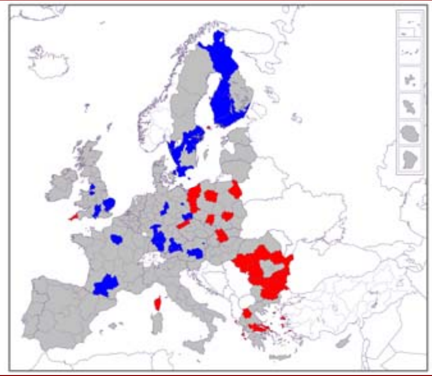
Knowledge workers



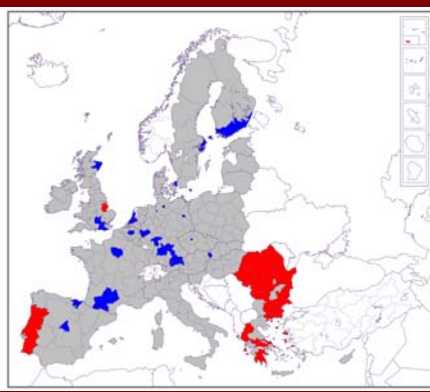
Scientific publications



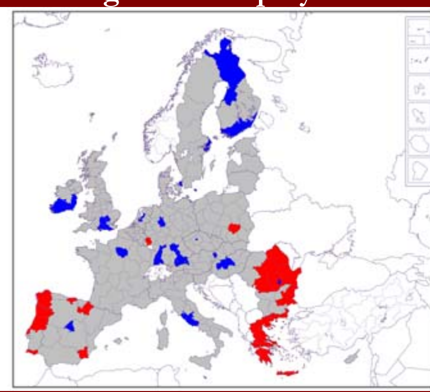
GERD



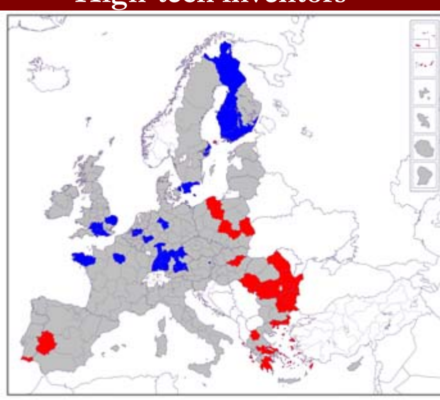
HRST



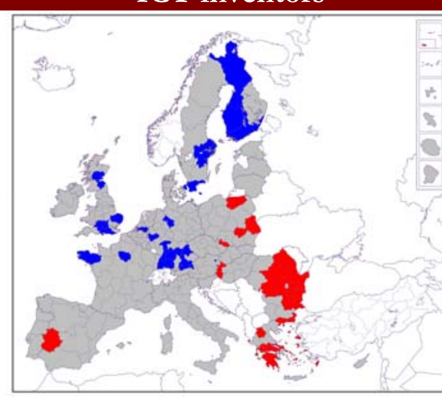
High-tech employment



High-tech inventors



ICT inventors



Biotech inventors[16]

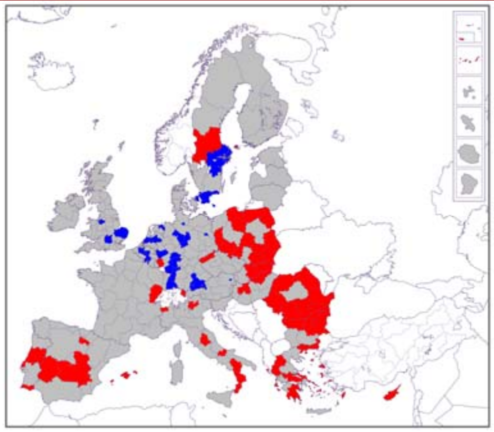


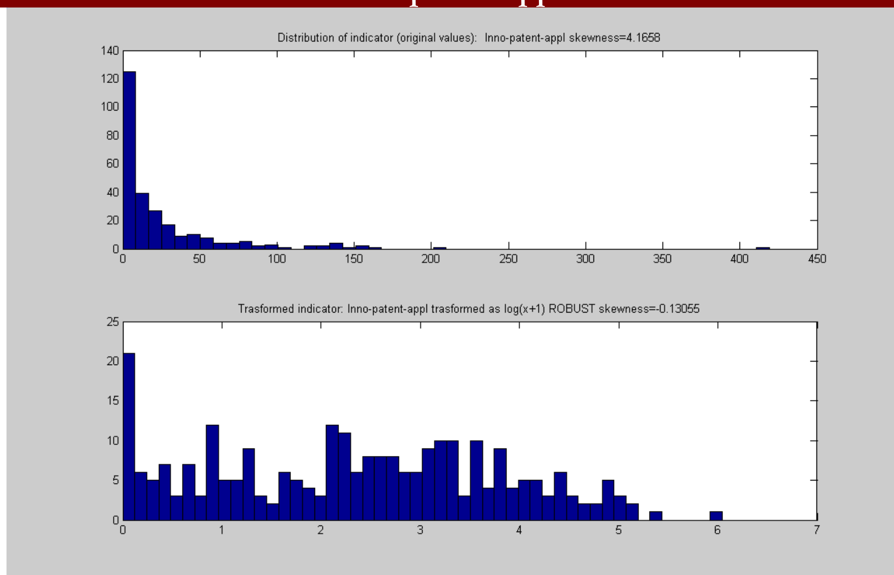
Figure 5-46: Best and worst performing regions for each indicator – Innovation

The next step in our analysis is the analysis of the distribution of the different indicators and their transformation. Table 87 shows the initial distribution of each indicator and the method used for its transformation. The approach adopted has been described in detail in Section 4.3. All indicators which have been transformed show a clear positive skewness. Due to the presence of zero values, all indicators on patents have been transformed logarithmically. The indicators on scientific publications and intramural R&D expenditure have been transformed with the Box-Cox method.

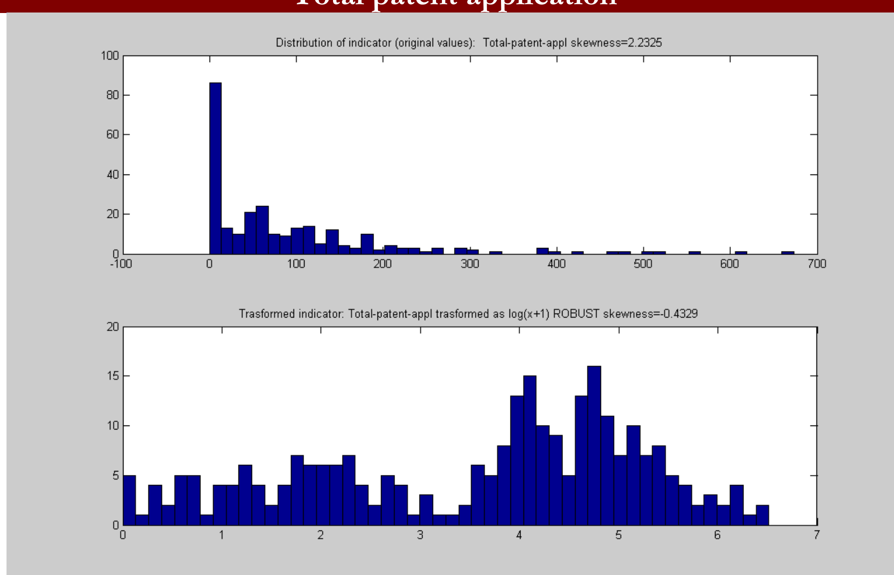
[16] In the case of Biotech patents, the worst performing regions are more than 10% because more regions have the same value for the indicator.

Table 87: Histograms of Innovation indicators

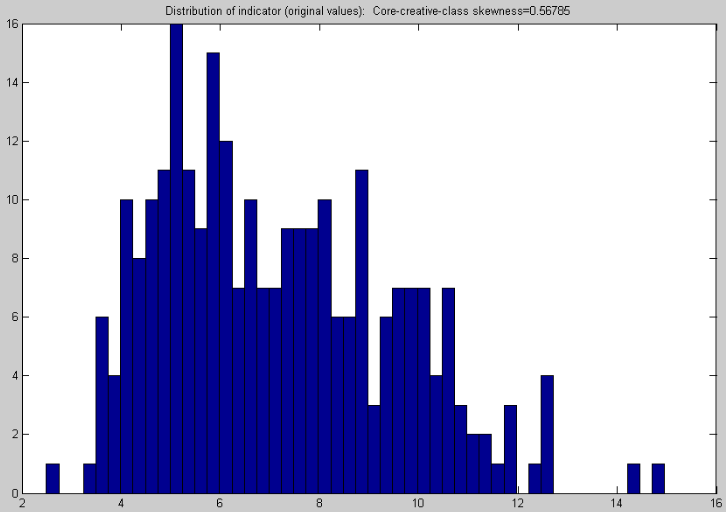
Innovation patent application



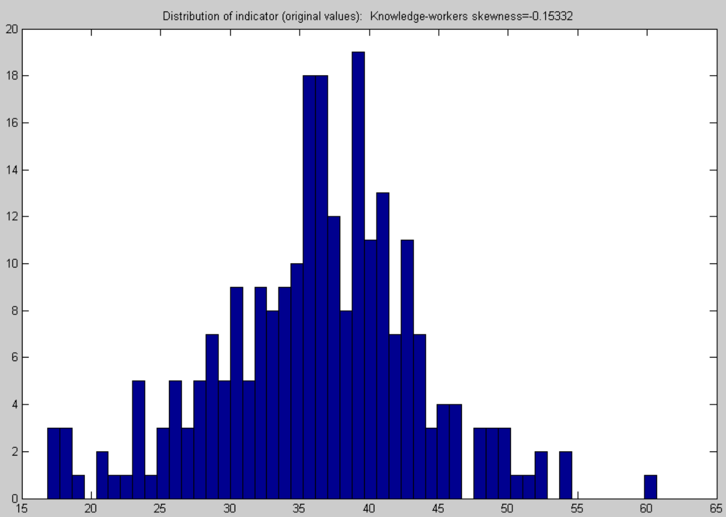
Total patent application



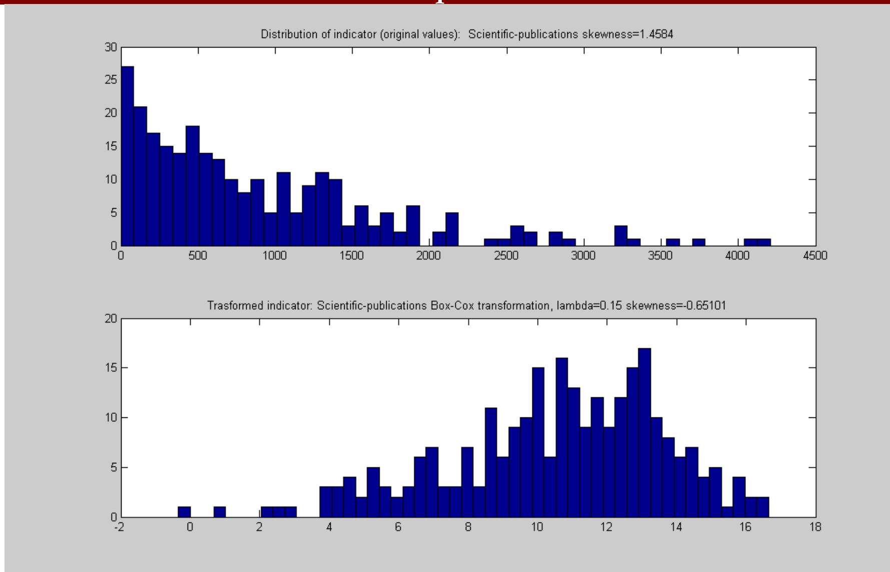
Core creative class



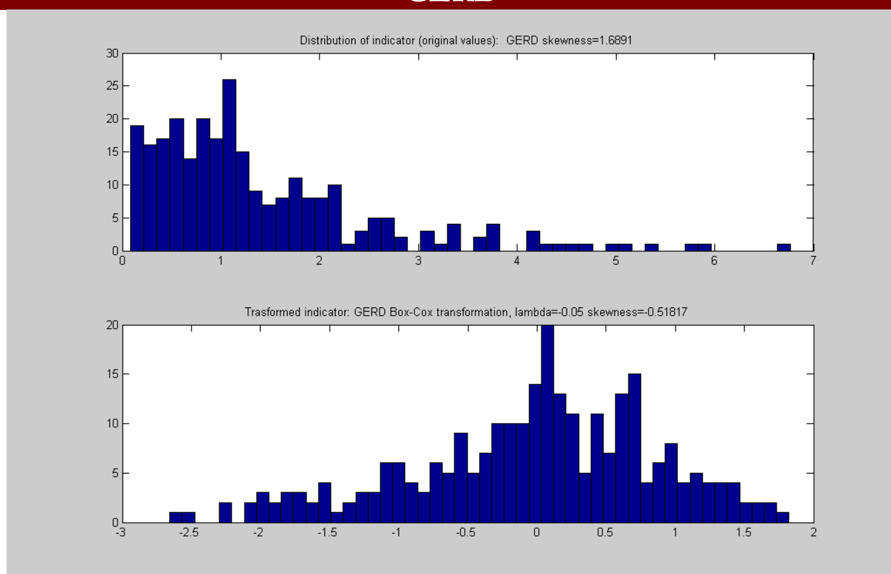
Knowledge workers



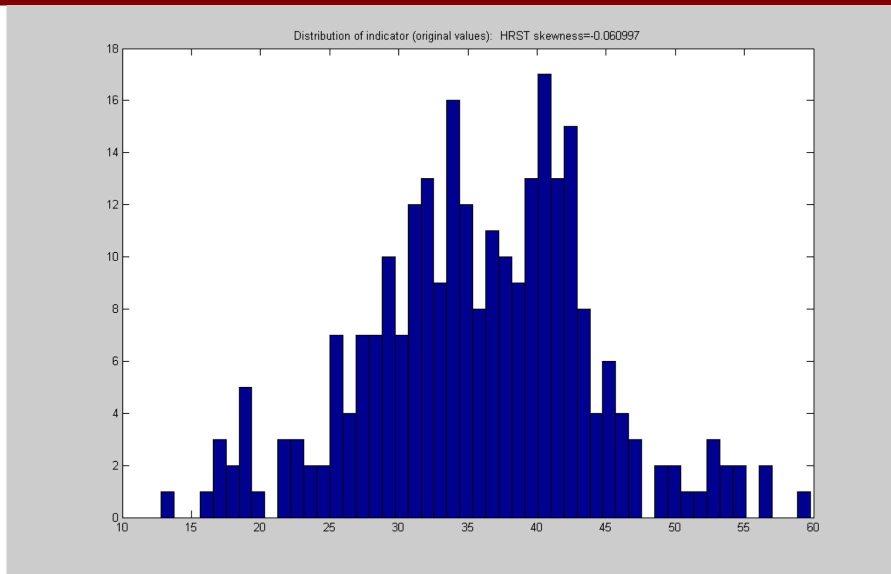
Scientific publications



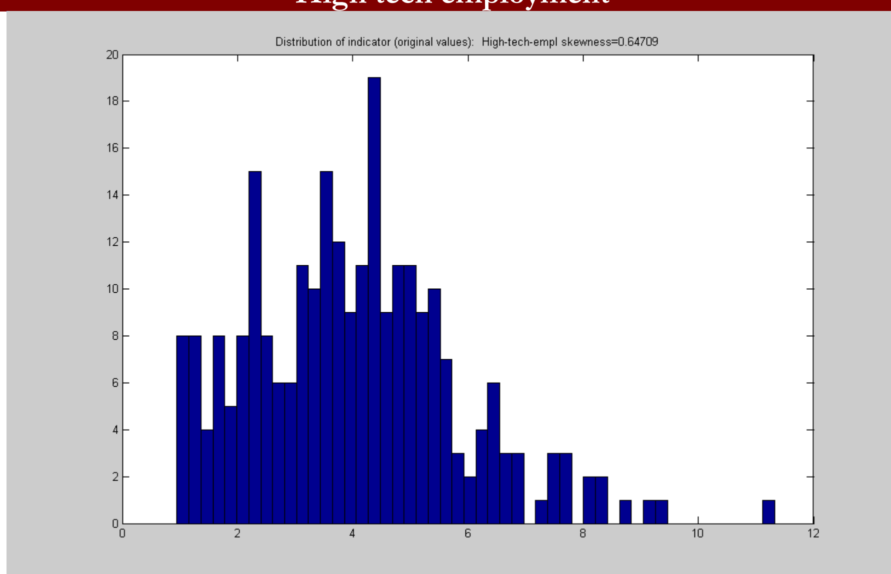
GERD



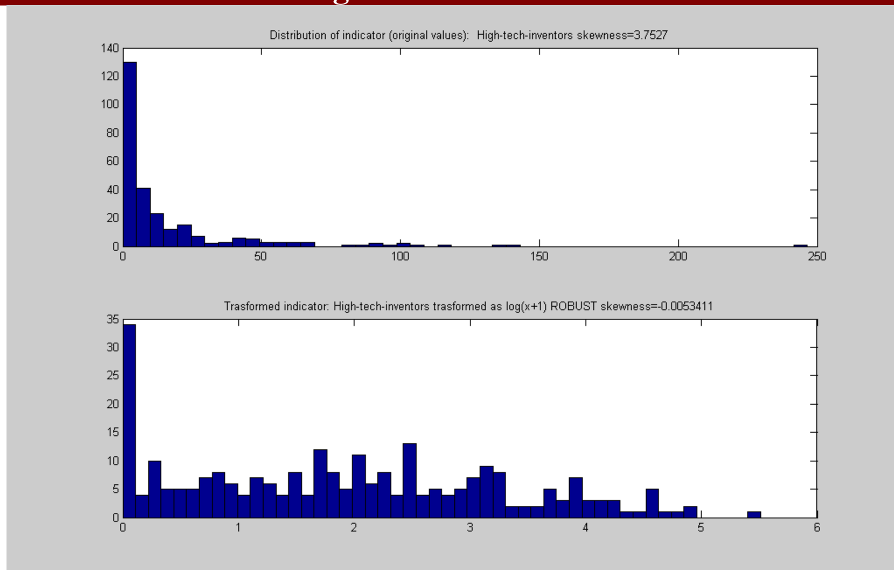
HRST



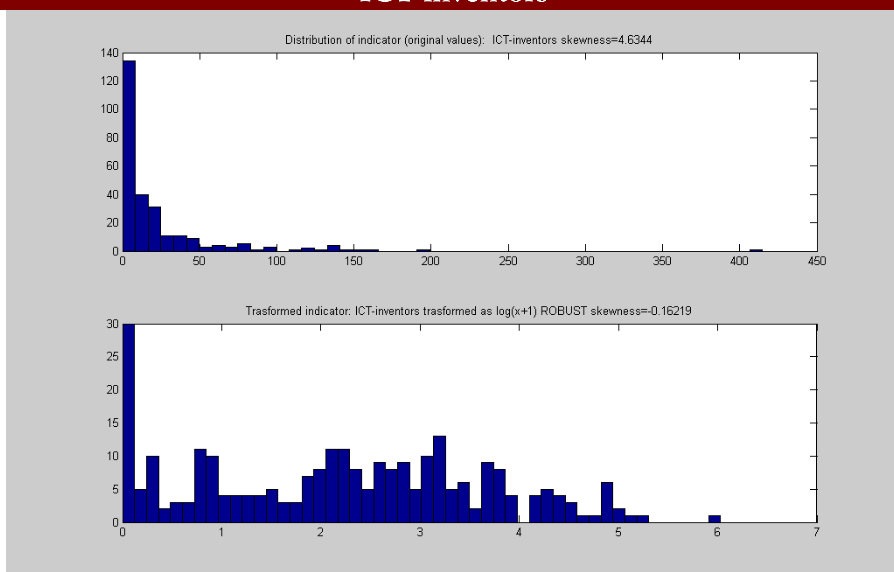
High tech employment



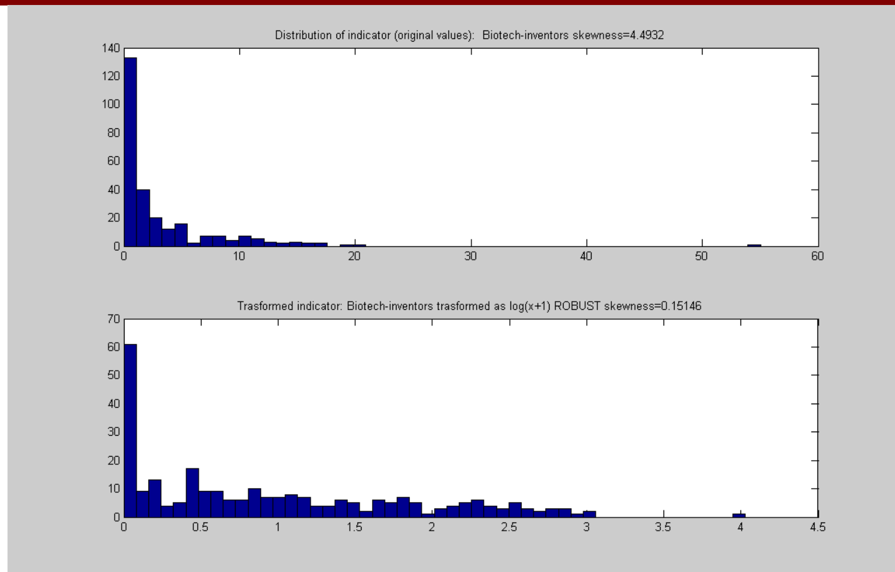
High tech inventors



ICT inventors



Biotech inventors



Note: In the case of the Scientific Publications indicator, the lambda used has been set to 0.15

MULTIVARIATE ANALYSIS

Despite the high number of indicators which describe this pillar and their different sources, the PCA analysis depicts a pillar with a clear single latent dimension, well represented by all the selected indicators (see Figure 5-47 and Table 89). Table 90 shows that the first PCA component alone explains more than 73% of total variation and from the component loadings (Table 89) one can see that the contribution of each indicator to this component is approximately the same. The analysis fully supports the starting hypothesis of a unique underlying dimension and, consequently, the simple choice of equal weights for the computation of the Innovation sub-score, which is displayed in Figure 5-48. The histogram of the Innovation sub-score is shown in Figure 5-49 while Table 92 lists the reordered regions (from best to worst).

Table 88: Correlation matrix between indicators included in the Innovation pillar

Correlation Matrix

		Inno_patent_appl	Total_patent_appl	Core_creative_class	Knowledge_workers	Scientific_publications	Gerd	HRST	High_tech_empl	High_tech_inventors	ICT_inventors	Biotech_inventors
Correlation	Inno_patent_appl	1.000	.936	.654	.719	.609	.763	.725	.640	.979	.994	.805
	Total_patent_appl	.936	1.000	.591	.690	.590	.756	.705	.541	.883	.933	.727
	Core_creative_class	.654	.591	1.000	.765	.606	.604	.797	.614	.646	.645	.657
	Knowledge_workers	.719	.690	.765	1.000	.581	.613	.838	.685	.713	.709	.657
	Scientific_publications	.609	.590	.606	.581	1.000	.667	.624	.485	.600	.593	.656
	Gerd	.763	.756	.604	.613	.667	1.000	.682	.594	.751	.749	.689
	HRST	.725	.705	.797	.838	.624	.682	1.000	.650	.699	.714	.672
	High_tech_empl	.640	.541	.614	.685	.485	.594	.650	1.000	.653	.635	.585
	High_tech_inventors	.979	.883	.646	.713	.600	.751	.699	.653	1.000	.973	.817
	ICT_inventors	.994	.933	.645	.709	.593	.749	.714	.635	.973	1.000	.773
	Biotech_inventors	.805	.727	.657	.657	.656	.689	.672	.585	.817	.773	1.000
Sig. (1-tailed)	Inno_patent_appl		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	Total_patent_appl	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000
	Core_creative_class	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000
	Knowledge_workers	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
	Scientific_publications	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000
	Gerd	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000
	HRST	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000
	High_tech_empl	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000
	High_tech_inventors	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000
	ICT_inventors	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000
	Biotech_inventors	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	

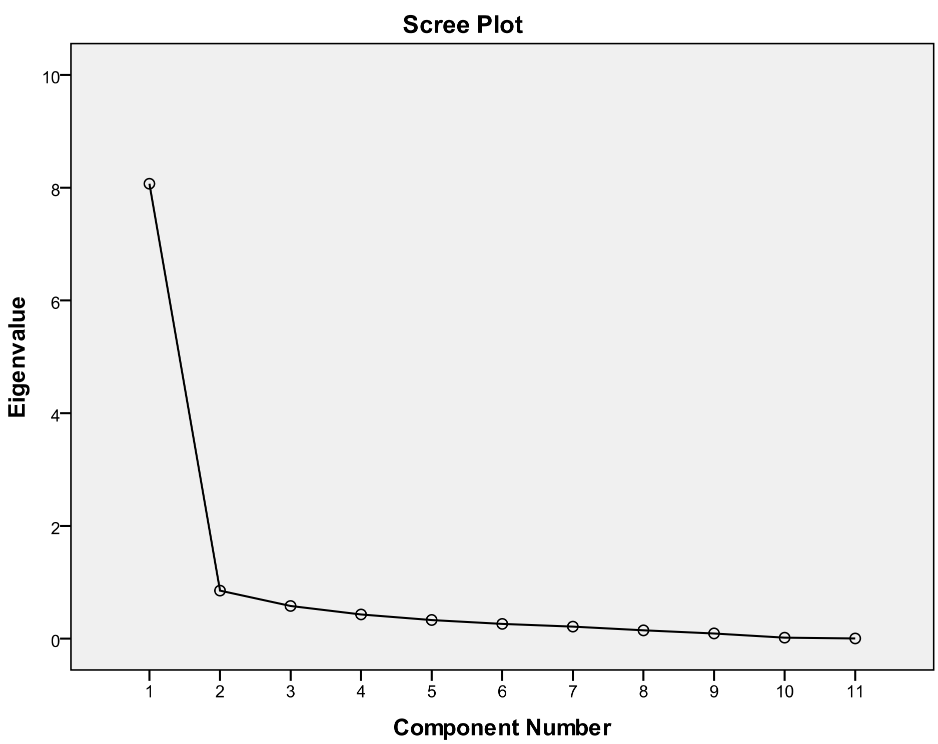


Figure 5-47: PCA analysis of the Innovation pillar - eigenvalues

**Table 89: PCA analysis Innovation pillar:
correlation coefficients between indicators and PCA components**

Component Matrix[a]

	Component										
	1	2	3	4	5	6	7	8	9	10	11
Inno_patent_appl	.946	-.288	-.089	-.037	.023	.039	.064	-.016	-.041	-.044	-.049
Total_patent_appl	.896	-.316	-.030	-.126	-.136	.081	.005	-.025	.230	.038	.003
Core_creative_class	.800	.420	-.010	-.212	.094	-.210	.284	.053	.041	.004	.000
Knowledge_workers	.845	.325	-.181	-.154	-.049	.174	-.186	.238	-.016	-.008	.000
Scientific_publications	.737	.170	.588	.099	.039	.253	.078	-.012	-.011	.000	.000
Gerd	.837	-.078	.228	.195	-.336	-.278	-.069	.093	-.030	-.006	.000
HRST	.859	.325	-.054	-.188	-.149	-.008	-.136	-.272	-.059	.004	.001
High_tech_empl	.746	.277	-.310	.508	.036	.057	.048	-.049	.054	.003	.000
High_tech_inventors	.934	-.274	-.096	.009	.087	.018	.054	.026	-.154	.089	.006
ICT_inventors	.935	-.299	-.111	-.041	.001	.060	.097	-.018	-.048	-.071	.039
Biotech_inventors	.856	-.076	.140	.027	.394	-.176	-.226	-.015	.053	-.009	.003

Extraction Method: Principal Component Analysis.
a. 11 components extracted.

Table 90: PCA analysis for Innovation pillar: explained variance

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	8.072	73.378	73.378
2	.852	7.746	81.124
3	.580	5.270	86.394
4	.430	3.908	90.302
5	.331	3.007	93.310
6	.262	2.383	95.693
7	.214	1.947	97.640
8	.147	1.332	98.972
9	.093	.841	99.814
10	.017	.150	99.964
11	.004	.036	100.000

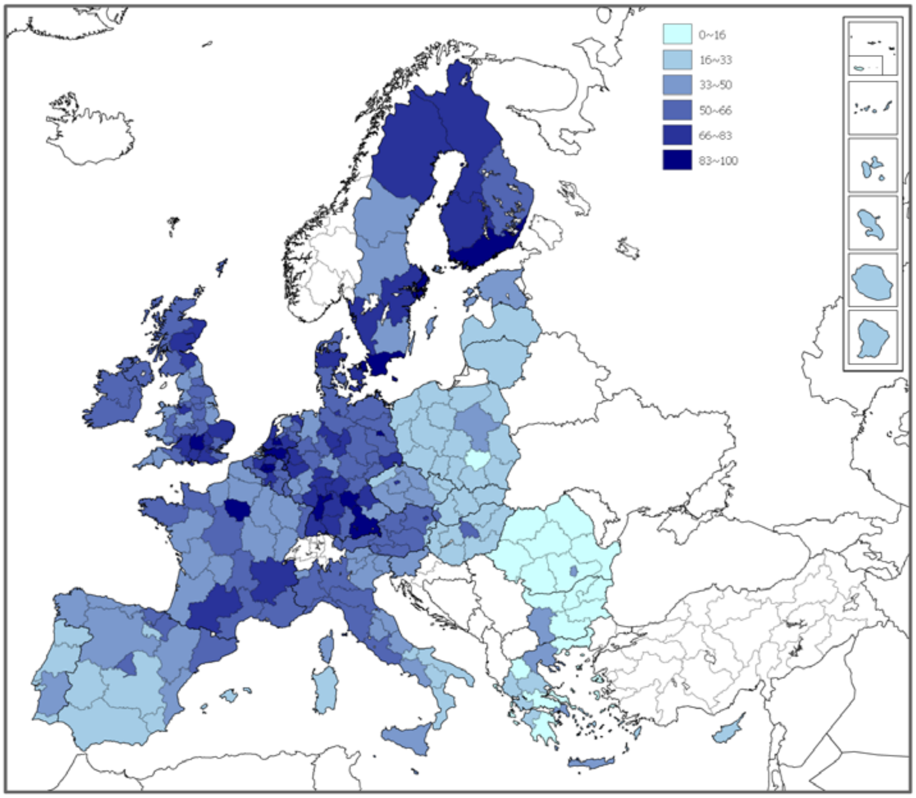


Figure 5-48: Map of Innovation sub-score.
Min-max normalized values are shown in Table 91

Table 91: Innovation sub-score as arithmetic mean of transformed and standardized indicators.

region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore	region	Subscore	Min_max normalized subscore
BE00	1.28	84	ES30	0.58	66	AT33	0.26	58
BE21	0.72	69	ES41	-0.58	36	AT34	-0.01	51
BE22	0.11	54	ES42	-1.03	25	PL11	-1.07	24
BE23	0.93	75	ES43	-1.13	22	PL12	-0.27	44
BE25	0.22	57	ES51	-0.02	51	PL21	-0.82	30
BE32	-0.01	51	ES52	-0.56	37	PL22	-0.98	26
BE33	0.48	63	ES53	-0.94	27	PL31	-1.26	19
BE34	-0.01	51	ES61	-0.84	30	PL32	-1.12	22
BE35	0.70	69	ES62	-0.96	27	PL33	-1.66	9
BG31	-1.61	10	ES63	-1.69	8	PL34	-1.30	18
BG32	-1.66	9	ES64	-1.46	14	PL41	-1.12	22
BG33	-1.62	10	ES70	-1.12	22	PL42	-0.97	26
BG34	-1.73	7	FR10	1.54	90	PL43	-0.97	26
BG41	-0.38	41	FR21	-0.62	35	PL51	-0.84	30
BG42	-1.57	11	FR22	-0.34	42	PL52	-1.29	18
CZ01	0.95	75	FR23	-0.33	43	PL61	-1.35	17
CZ02	-0.46	39	FR24	0.08	53	PL62	-1.36	16
CZ03	-0.64	35	FR25	0.10	54	PL63	-0.89	28
CZ04	-1.09	23	FR26	-0.29	44	PT11	-1.16	21
CZ05	-0.62	35	FR30	-0.24	45	PT15	-1.33	17
CZ06	-0.45	40	FR41	-0.32	43	PT16	-1.11	23
CZ07	-0.85	29	FR42	0.39	61	PT17	-0.14	47
CZ08	-0.80	31	FR43	-0.13	48	PT18	-1.12	22
DK01	1.67	94	FR51	-0.08	49	PT20	-1.75	6
DK02	0.67	68	FR52	0.40	61	PT30	-1.66	9
DK03	0.28	58	FR53	-0.41	41	RO11	-1.59	10
DK04	0.62	67	FR61	-0.06	49	RO12	-1.72	7
DK05	0.45	63	FR62	0.88	73	RO21	-1.67	8
DE11	1.11	79	FR63	-0.43	40	RO22	-2.00	0
DE12	1.43	88	FR71	0.79	71	RO31	-1.81	5
DE13	1.14	80	FR72	0.26	58	RO32	-0.16	47
DE14	0.99	76	FR81	0.22	57	RO41	-1.86	4
DE21	1.77	96	FR82	0.53	65	RO42	-1.49	13
DE22	-0.06	49	FR83	-0.59	36	SI01	-0.51	38
DE23	0.74	70	FR91	-1.13	22	SI02	0.23	57
DE24	0.50	64	FR92	-1.12	22	SK01	0.47	63
DE25	1.28	84	FR93	-0.83	30	SK02	-1.08	23
DE26	0.63	67	FR94	-1.28	18	SK03	-1.25	19
DE27	0.20	56	ITC1	0.15	55	SK04	-1.11	23
DE30	1.38	86	ITC2	-0.49	39	FI13	0.36	60
DE41	0.09	53	ITC3	0.18	56	FI18	1.61	92
DE42	0.52	64	ITC4	0.29	58	FI19	0.91	74
DE50	0.62	67	ITD1	-0.48	39	FI1A	1.05	78
DE60	1.16	81	ITD2	-0.17	47	FI20	-0.37	42
DE71	1.21	82	ITD3	-0.25	45	SE11	1.92	100
DE72	0.80	71	ITD4	-0.06	49	SE12	1.19	81
DE73	-0.10	48	ITD5	0.07	53	SE21	-0.11	48
DE80	0.04	52	ITE1	-0.03	50	SE22	1.42	87
DE91	0.86	73	ITE2	-0.47	39	SE23	1.03	77
DE92	0.89	74	ITE3	-0.51	38	SE31	-0.20	46
DE93	0.01	51	ITE4	0.23	57	SE32	-0.24	45
DE94	-0.31	43	ITF1	-0.37	42	SE33	0.82	72
DEA1	0.63	67	ITF2	-0.90	28	UKC1	-0.02	51
DEA2	1.12	80	ITF3	-0.54	37	UKC2	-0.07	49
DEA3	0.20	56	ITF4	-0.77	31	UKD1	-0.53	38
DEA4	0.53	65	ITF5	-0.74	32	UKD2	0.75	70
DEA5	0.13	54	ITF6	-0.91	28	UKD3	0.18	56
DEB1	-0.07	49	ITG1	-0.49	39	UKD4	-0.18	46
DEB2	-0.09	49	ITG2	-0.73	32	UKD5	0.01	51
DEB3	0.97	76	CY00	-0.76	32	UKE1	-0.57	36
DEC0	0.26	58	LV00	-0.80	31	UKE2	0.44	62
DED1	-0.02	51	LT00	-0.74	32	UKE3	0.08	53
DED2	0.73	70	LU00	0.46	63	UKE4	0.03	52
DED3	0.44	62	HU10	0.35	60	UKF1	0.27	58
DEE0	-0.03	50	HU21	-0.90	28	UKF2	0.40	61
DEF0	0.34	60	HU22	-1.10	23	UKF3	-0.67	34
DEG0	0.42	62	HU23	-0.78	31	UKG1	0.44	62
EE00	-0.22	45	HU31	-1.18	21	UKG2	-0.21	46
IE01	-0.01	51	HU32	-0.91	28	UKG3	-0.02	51
IE02	0.46	63	HU33	-0.76	32	UKH1	1.17	81
GR11	-1.41	15	MT00	-0.46	39	UKH2	1.03	77
GR12	-0.71	33	NL11	0.91	74	UKH3	0.55	65
GR13	-1.40	15	NL12	-0.24	45	UKI	0.92	74
GR14	-1.07	24	NL13	0.14	55	UKJ1	1.63	93
GR21	-0.88	29	NL21	0.40	61	UKJ2	1.04	78
GR22	-1.80	5	NL22	0.87	73	UKJ3	1.02	77
GR23	-1.01	25	NL23	0.37	60	UKJ4	0.18	56
GR24	-1.62	10	NL31	1.47	89	UKK1	1.01	77
GR25	-1.57	11	NL32	0.96	76	UKK2	0.06	53
GR30	-0.21	46	NL33	0.93	75	UKK3	-0.52	38
GR41	-1.17	21	NL34	-0.09	49	UKK4	-0.09	49
GR42	-1.55	11	NL41	1.34	85	UKL1	-0.30	43
GR43	-0.64	35	NL42	0.81	72	UKL2	0.42	62
ES11	-0.66	34	AT11	-0.72	33	UKM2	0.69	69
ES12	-0.58	36	AT12	0.01	51	UKM3	0.14	55
ES13	-0.63	35	AT13	1.17	81	UKM5	0.72	69
ES21	0.23	57	AT21	-0.01	51	UKM6	0.12	54
ES22	0.13	54	AT22	0.38	61	UKN0	-0.03	50
ES23	-0.81	30	AT31	0.02	52			
ES24	-0.50	38	AT32	0.16	55			

Figure 5-49: Histogram of Innovation sub-score

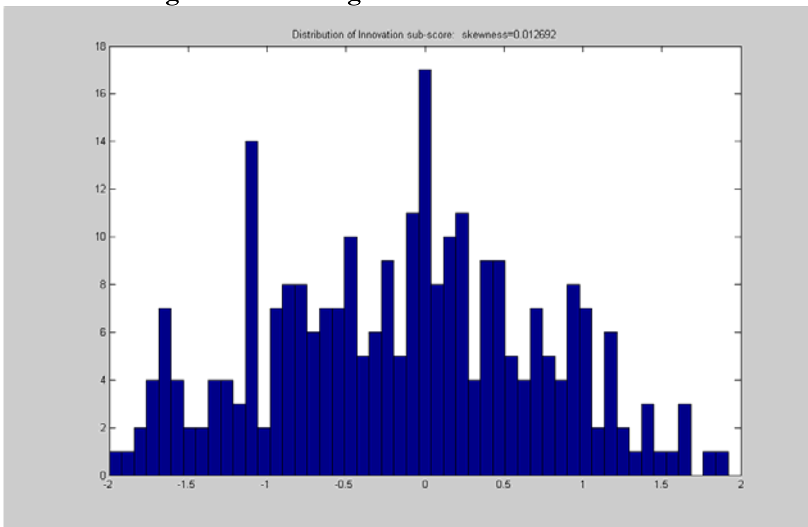


Table 92: Innovation pillar sub-rank (from best to worst)

Innovation											
1	SE11	46	DE23	91	BE25	136	DEB2	181	ES12	226	PT16
2	DE21	47	DED2	92	FR81	137	NL34	182	ES41	227	SK04
3	DK01	48	BE21	93	DE27	138	UKK4	183	FR83	228	ES70
4	UKJ1	49	UKM5	94	DEA3	139	DE73	184	CZ05	229	FR92
5	FI18	50	BE35	95	ITC3	140	SE21	185	FR21	230	PL32
6	FR10	51	UKM2	96	UKD3	141	FR43	186	ES13	231	PL41
7	NL31	52	DK02	97	UKJ4	142	PT17	187	CZ03	232	PT18
8	DE12	53	DE26	98	AT32	143	RO32	188	GR43	233	ES43
9	SE22	54	DEA1	99	ITC1	144	ITD2	189	ES11	234	FR91
10	DE30	55	DK04	100	NL13	145	UKD4	190	UKF3	235	PT11
11	NL41	56	DE50	101	UKM3	146	SE31	191	GR12	236	GR41
12	BE00	57	ES30	102	DEA5	147	GR30	192	AT11	237	HU31
13	DE25	58	UKH3	103	ES22	148	UKG2	193	ITG2	238	SK03
14	DE71	59	DEA4	104	UKM6	149	EE00	194	ITF5	239	PL31
15	SE12	60	FR82	105	BE22	150	FR30	195	LT00	240	FR94
16	AT13	61	DE42	106	FR25	151	NL12	196	CY00	241	PL52
17	UKH1	62	DE24	107	DE41	152	SE32	197	HU33	242	PL34
18	DE60	63	BE33	108	FR24	153	ITD3	198	ITF4	243	PT15
19	DE13	64	SK01	109	UKE3	154	PL12	199	HU23	244	PL61
20	DEA2	65	IE02	110	ITD5	155	FR26	200	CZ08	245	PL62
21	DE11	66	LU00	111	UKK2	156	UKL1	201	LV00	246	GR13
22	FI1A	67	DK05	112	DE80	157	DE94	202	ES23	247	GR11
23	UKJ2	68	DED3	113	UKE4	158	FR41	203	PL21	248	ES64
24	SE23	69	UKE2	114	AT31	159	FR23	204	FR93	249	RO42
25	UKH2	70	UKG1	115	DE93	160	FR22	205	ES61	250	GR42
26	UKJ3	71	DEG0	116	AT12	161	ITF1	206	PL51	251	BG42
27	UKK1	72	UKL2	117	UKD5	162	FI20	207	CZ07	252	GR25
28	DE14	73	FR52	118	BE32	163	BG41	208	GR21	253	RO11
29	DEB3	74	NL21	119	BE34	164	FR53	209	PL63	254	BG31
30	NL32	75	UKF2	120	IE01	165	FR63	210	ITF2	255	BG33
31	CZ01	76	FR42	121	AT21	166	CZ06	211	HU21	256	GR24
32	BE23	77	AT22	122	AT34	167	CZ02	212	ITF6	257	BG32
33	NL33	78	NL23	123	DED1	168	MT00	213	HU32	258	PL33
34	UKI	79	FI13	124	ES51	169	ITE2	214	ES53	259	PT30
35	NL11	80	HU10	125	UKC1	170	ITD1	215	ES62	260	RO21
36	FI19	81	DEF0	126	UKG3	171	ITC2	216	PL42	261	ES63
37	DE92	82	ITC4	127	DEE0	172	ITG1	217	PL43	262	RO12
38	FR62	83	DK03	128	ITE1	173	ES24	218	PL22	263	BG34
39	NL22	84	UKF1	129	UKN0	174	ITE3	219	GR23	264	PT20
40	DE91	85	DEC0	130	DE22	175	SI01	220	ES42	265	GR22
41	SE33	86	FR72	131	FR61	176	UKK3	221	GR14	266	RO31
42	NL42	87	AT33	132	ITD4	177	UKD1	222	PL11	267	RO41
43	DE72	88	ES21	133	DEB1	178	ITF3	223	SK02	268	RO22
44	FR71	89	ITE4	134	UKC2	179	ES52	224	CZ04		
45	UKD2	90	SI02	135	FR51	180	UKE1	225	HU22		

6 The Regional Competitiveness Index

The final setting up of the RCI is based upon the sub-score values computed for the eleven different pillars presented in Chapter 5.

For the final aggregation we followed the approach that World Economic Forum adopts for the Global Competitiveness Index (Schwab and Porter, 2007; Schwab, 2009), as discussed in Section 2.1. Given the high level of heterogeneity of European regions, especially after the 2004 and 2007 enlargements, our aim is to weight different regions according to their level of development. It is, in fact, clear that different pillars affect different regions differently: the competitiveness of a region close to London or Ile de France is driven by factors which are intrinsically different than those which can drive the competitiveness of Eastern European regions. As regions move along the path of development, their socio-economic conditions change and other determinants become more important for the regional level of competitiveness. For this reason, the best way to improve competitiveness of more developed regions is not the same as the best way to make less developed regions catch up.

WEF classifies the countries into three major groups of 'basic', 'efficiency' and 'innovation' driven economies, and two 'transition' groups with feature intermediate stages between the three major groups. The WEF classification is based upon two criteria: the level of GDP per capita at market exchange rates and the extent to which countries are driven by factor endowments (mostly unskilled labor and natural resources). Being not directly measured, the second criterion is approximated by the share of export of mineral goods in total exports. This last criterion is clearly not applicable to the RCI case.

In order to get a first impression on where EU regions are placed in terms of their stage of development as defined by WEF, we have used as a reference the WEF GCI 2010 thresholds for classifying EU regions on the basis of their stage of development. Given that the thresholds are defined in US dollars, we have used the purchasing-power-parity (PPP) conversion method in order to obtain equivalents in euros. The PPP method provides a more accurate comparison than the exchange rate conversion as it is the rate at which the currency of one country needs to be converted into that of a second country to ensure that a given amount of the first country's currency will purchase the same volume of goods and services in the second country. We use the OECD PPP for GDP data, taking as a reference year 2007. With the premise of all the limitations of such a conversion methodology, the results still give an indication as to how EU regions are placed across the stages of development defined by the WEF GCI. The majority of EU regions (89.5%) fall under the innovation-driven stage of development, as defined by WEF, while 10% belongs to the transition stage between efficiency and innovation driven economies. Only one region out of 268 is placed in the efficiency-driven group. This suggests that the classification method used by WEF is not discriminating enough among European regions. The WEF approach has been consequently modified to better describe the European situation.

In the RCI case, regional economies are divided into 'medium', 'transition' and 'high' stage of development. The development stage of the regions is computed on the basis of the regional GDP at current market prices (year 2007) measured as PPP per inhabitants and expressed as percentage of the EU average – GDP%. The table showing the singles stage of development for each EU region is shown in Appendix F. EU regions are then classified into three groups of medium, transition or high stage according to a GDP% respectively lower than 75%, between 75% and 100% and above 100%, (Table 93).

Table 93: Thresholds (% GDP) for the definition of stages of development

Stage of development	% of GDP (PPP/inhabitants)
Medium	< 75 (t_1=75)
Transition	≥ 75 and < 100
High	≥ 100 (t_2=100)

The threshold which defines the level 'medium' (t_1=75% of EU average) is the value defined by the EU Commission - Regional Policy 2007-2013 - to identify regions eligible for the 'Convergence' objective. This threshold is highly relevant as it affects EU policy funding. The second threshold, t_2= 100%, is instead more arbitrary and has been examined by an uncertainty analysis, as discussed in Section 6.2 below.

Different regions are weighted differently according to their level of development. Three groups of pillars are identified, mostly coinciding with the WEF groups (the only exception is for the Technological readiness pillar which is assigned to the intermediate group by WEF and it is here assigned to the third group). The first group of pillars includes Institutions, Macroeconomic Stability Infrastructure, Health, and Quality of Primary and Secondary Education (see Figure 6-1). These are considered as factors which are strictly necessary for the basic functioning of any economy. They, in fact, cover aspects such as unskilled or low skilled labor force, infrastructures, quality of governance and public health. The simple average of these pillars gives the first competitiveness sub-index (sub_index 1, Figure 6-1). The second group of pillars includes Higher Education/Training and Lifelong Learning, Labor Market Efficiency and Market Size. They describe an economy which is more sophisticated, with a higher potential skilled labor force and a structured labor market. These pillars are used for the computation of the second sub_index as the average of the three pillar sub-scores (sub_index 2, Figure 6-1). The last group of pillars comprises all the high tech and innovation related pillars: Technological Readiness, Business Sophistication and Innovation. A region with high scores in these sectors is expected to have the most competitive economy. The third sub_index is computed as simple average of the sub-scores of the third group of pillars (sub_index 3, Figure 6-1).

Given the pillar classification, EU regions are assigned different weights according to their development stage. The set of weights assigned for the RCI computation stems from the WEF approach with some modifications to accommodate for the fact that EU regions do not show the same level of heterogeneity, in terms of stages of development, as the countries covered by WEF. EU regions show on average a medium-high level of development, with only 25% of the regions (68 out of 268) in the medium stage of development according to the WEF criteria (Table 94). We have, thus, tried to avoid an excessive penalization of the sub_index related to the innovative aspect of competitiveness by using a slightly different weighting scheme. In any case, the choice of the weighting scheme has been examined by a full robustness analysis, as detailed in Section 6.2 of this chapter.

The regions classified into the ‘medium’ stage are assigned the weights that WEF assigns to the efficiency-driven economy (corresponding to the WEF intermediate group), while the weights of the ‘high’ stage are those which WEF uses for the innovative-driven economy.

The weights of the 'intermediate' stage of development have been chosen as the middle point between the weights of the first and third stages. Figure 6-1 displays a sketch of the pillar-groups and development stage weights.

For each region, the stage of development is assessed and the three sub_indices corresponding to the three groups of pillars are computed as simple average of the pillar sub-scores. For the computation of the overall RCI index, each sub_index is then weighted differently to reflect its relevance in defining the final index on the basis of the region's development stage. For medium economies the set of weights is: w_{M1}=0.4 for sub_index 1, w_{M2}=0.5 for sub_index 2 and w_{M3}=0.1 for sub_index 3. This reflects a situation where, given that the economy is mostly driven by basic and intermediate socio-economic factors, the first and second groups of pillars are assigned almost all the weight (90%), while the innovation-related group is assigned the lowest weight (10%). For intermediate economies, the set of weights is: w_{I1}=0.3 for sub_index 1, w_{I2}=0.5 for sub_index 2 and w_{I3}=0.2 for sub_index 3. With respect to the medium-stage, the role of the third group of pillars is given more relevance. For high-stage economies weights are defined as: w_{H1}=0.2 for sub_index 1, w_{H2}=0.5 for sub_index 2 and w_{H3}=0.3 for sub_index 3. In this type of economies basic factors have the lowest relevance while the innovative group of pillars is assigned a relatively high importance.

It can be seen that for all development stages the highest weight is assigned to the second pillar group. The importance of the first group of pillar decreases going from medium to high stage of development, while the last pillar group is correspondingly gaining importance.

It is worth noting that, in general, theoretical weights assigned to the components of a composite do not necessarily reflect their effective weight in the final composite. In fact, when combining multiple indicators into a single linear index, the weights of the linear combination determine the tradeoff between indicators rather than their effective relevance in the final score (Patil and Taillie, 2004). Their actual weight depends on the observed data, the sub-score distributions and the number of indicators included in each pillar group, if any. In the RCI case theoretical weights are expected to be close to the effective weights as sub-score distributions have similar variances (Chapter 5) and the three groups of pillars include roughly the same number of indicators.

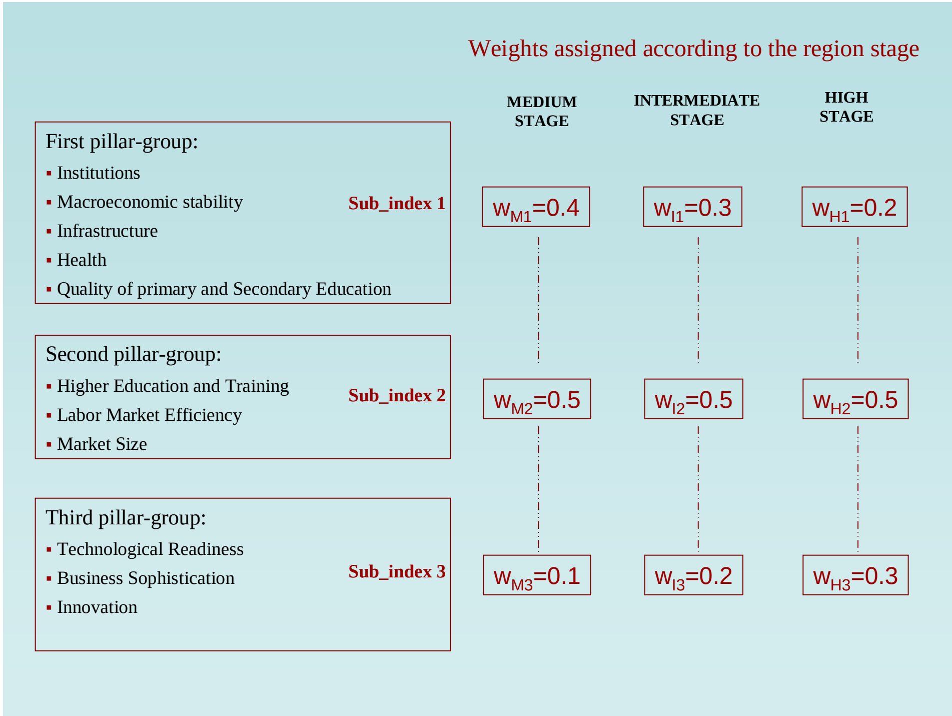


Figure 6-1: The 11 pillars of RCI classified into three groups and weighting scheme for each development stage

6.1 RCI regional scores

Table 94 shows GDP%, development stage and value of the three sub_indices for all the 268 NUTS2 EU regions.

Table 94: RCI sub_indices

Region ID	GDP%	STAGE	sub_index 1	sub_index 2	sub_index 3	Region ID	GDP%	STAGE	sub_index 1	sub_index 2	sub_index 3	Region ID	GDP%	STAGE	sub_index 1	sub_index 2	sub_index 3
BE00	154.56	HIGH	0.472	0.633	1.058	ES30	136.80	HIGH	0.224	0.480	0.473	AT33	128.20	HIGH	0.500	0.273	0.143
BE21	135.70	HIGH	0.542	0.640	0.767	ES41	101.40	HIGH	-0.026	-0.520	-0.603	AT34	128.10	HIGH	0.492	-0.200	0.170
BE22	96.20	INTERMEDIATE	0.362	0.240	0.418	ES42	81.50	INTERMEDIATE	0.050	-0.887	-0.965	PL11	50.00	MEDIUM	-0.488	-0.453	-0.730
BE23	104.60	HIGH	0.382	0.570	0.723	ES43	72.40	MEDIUM	-0.148	-1.297	-1.072	PL12	87.10	INTERMEDIATE	-0.532	0.207	-0.070
BE25	110.10	HIGH	0.362	0.453	0.428	ES51	123.30	HIGH	0.070	0.197	0.143	PL21	46.70	MEDIUM	-0.356	-0.240	-0.627
BE32	75.30	INTERMEDIATE	0.260	-0.283	0.075	ES52	95.30	INTERMEDIATE	-0.064	-0.243	-0.380	PL22	57.80	MEDIUM	-0.346	-0.047	-0.683
BE33	85.30	INTERMEDIATE	0.336	-0.140	0.243	ES53	113.80	HIGH	-0.408	-0.703	-0.587	PL31	36.90	MEDIUM	-0.698	-0.603	-0.982
BE34	78.10	INTERMEDIATE	0.108	-0.540	0.065	ES61	81.20	INTERMEDIATE	-0.098	-0.640	-0.555	PL32	36.70	MEDIUM	-0.598	-0.637	-0.942
BE35	79.70	INTERMEDIATE	0.244	-0.347	0.287	ES62	86.90	INTERMEDIATE	-0.082	-0.610	-0.827	PL33	41.90	MEDIUM	-0.608	-0.643	-1.188
BG31	25.60	MEDIUM	-1.378	-1.357	-1.578	ES63	97.30	INTERMEDIATE	-0.842	-1.990	-1.178	PL34	40.40	MEDIUM	-0.816	-0.787	-1.035
BG32	26.70	MEDIUM	-1.400	-1.127	-1.517	ES64	94.50	INTERMEDIATE	-0.754	-2.297	-1.113	PL41	56.90	MEDIUM	-0.492	-0.487	-0.712
BG33	32.40	MEDIUM	-1.276	-1.270	-1.482	ES70	92.80	INTERMEDIATE	-0.432	-0.900	-0.812	PL42	48.90	MEDIUM	-0.472	-0.790	-0.702
BG34	30.70	MEDIUM	-1.362	-1.177	-1.582	FR10	168.70	HIGH	0.338	1.103	1.325	PL43	48.20	MEDIUM	-0.542	-0.843	-0.798
BG41	62.00	MEDIUM	-1.186	-0.077	-0.497	FR21	99.70	INTERMEDIATE	0.140	-0.320	-0.288	PL51	59.20	MEDIUM	-0.438	-0.427	-0.595
BG42	27.20	MEDIUM	-1.264	-0.983	-1.468	FR22	85.70	INTERMEDIATE	0.110	-0.103	-0.082	PL52	45.20	MEDIUM	-0.376	-0.663	-0.858
CZ01	171.80	HIGH	0.118	0.767	0.533	FR23	98.40	INTERMEDIATE	0.118	-0.177	-0.025	PL61	47.30	MEDIUM	-0.612	-0.780	-0.912
CZ02	75.20	INTERMEDIATE	-0.096	-0.160	-0.648	FR24	95.30	INTERMEDIATE	0.140	-0.140	0.052	PL62	40.50	MEDIUM	-0.648	-1.027	-0.938
CZ03	71.10	MEDIUM	-0.098	-0.210	-0.677	FR25	88.30	INTERMEDIATE	-0.048	-0.357	-0.025	PL63	53.60	MEDIUM	-0.538	-0.527	-0.645
CZ04	61.70	MEDIUM	-0.192	-0.640	-0.940	FR26	94.50	INTERMEDIATE	0.104	-0.317	-0.155	PT11	60.30	MEDIUM	-0.280	-0.587	-0.873
CZ05	65.90	MEDIUM	-0.144	-0.270	-0.687	FR30	88.20	INTERMEDIATE	0.072	-0.040	0.028	PT15	79.60	INTERMEDIATE	-0.368	-1.147	-1.113
CZ06	71.70	MEDIUM	-0.092	-0.260	-0.542	FR41	88.70	INTERMEDIATE	0.070	-0.073	-0.055	PT16	64.40	MEDIUM	-0.230	-0.480	-0.997
CZ07	62.30	MEDIUM	-0.288	-0.410	-0.857	FR42	102.20	HIGH	0.188	0.127	0.262	PT17	104.70	HIGH	-0.134	0.040	-0.143
CZ08	67.50	MEDIUM	-0.380	-0.523	-0.890	FR43	90.10	INTERMEDIATE	0.086	-0.413	0.018	PT18	71.90	MEDIUM	-0.306	-1.040	-1.135
DK01	150.30	HIGH	1.058	1.030	1.345	FR51	97.70	INTERMEDIATE	0.032	0.040	0.027	PT20	67.60	MEDIUM	-1.260	-1.670	-1.460
DK02	91.40	INTERMEDIATE	0.992	0.400	0.553	FR52	94.70	INTERMEDIATE	-0.136	0.283	0.057	PT30	96.30	INTERMEDIATE	-1.110	-1.240	-1.247
DK03	113.30	HIGH	0.898	0.523	0.437	FR53	90.40	INTERMEDIATE	0.010	-0.287	-0.180	RO11	40.20	MEDIUM	-1.730	-0.657	-1.258
DK04	115.40	HIGH	0.860	0.527	0.595	FR61	98.20	INTERMEDIATE	0.048	-0.193	0.007	RO12	42.20	MEDIUM	-1.786	-0.913	-1.225
DK05	110.00	HIGH	0.798	0.303	0.475	FR62	97.30	INTERMEDIATE	0.124	-0.037	0.383	RO21	26.60	MEDIUM	-1.762	-0.827	-1.417
DE11	141.40	HIGH	0.558	0.580	0.778	FR63	87.70	INTERMEDIATE	0.012	-0.477	-0.283	RO22	33.80	MEDIUM	-1.712	-1.110	-1.450
DE12	132.20	HIGH	0.558	0.500	0.905	FR71	109.50	HIGH	0.202	0.267	0.622	RO31	34.20	MEDIUM	-1.474	-0.950	-1.320
DE13	114.20	HIGH	0.472	0.407	0.582	FR72	91.40	INTERMEDIATE	0.022	-0.337	0.078	RO32	92.20	INTERMEDIATE	-1.248	0.240	-0.422
DE14	125.30	HIGH	0.482	0.383	0.575	FR81	85.60	INTERMEDIATE	0.042	-0.303	0.125	RO41	32.70	MEDIUM	-1.796	-1.013	-1.438
DE21	164.70	HIGH	0.532	0.800	1.233	FR82	102.20	HIGH	0.098	0.023	0.402	RO42	48.20	MEDIUM	-1.658	-0.840	-1.093
DE22	115.80	HIGH	0.394	0.033	0.150	FR83	84.50	INTERMEDIATE	-0.220	-1.430	-0.342	SI01	73.10	MEDIUM	0.016	0.080	-0.433
DE23	122.10	HIGH	0.412	0.130	0.533	FR91	76.40	INTERMEDIATE	-0.834	-1.820	-0.293	SI02	106.70	HIGH	0.076	0.450	0.027
DE24	113.10	HIGH	0.426	-0.057	0.407	FR92	75.10	INTERMEDIATE	-0.556	-1.637	-0.320	SK01	160.30	HIGH	-0.186	0.560	0.410
DE25	132.50	HIGH	0.492	0.257	0.857	FR93	48.70	MEDIUM	-0.934	-2.710	-0.217	SK02	66.10	MEDIUM	-0.354	-0.330	-0.545
DE26	117.50	HIGH	0.552	0.180	0.497	FR94	62.50	MEDIUM	-0.878	-1.557	-0.437	SK03	53.30	MEDIUM	-0.540	-0.810	-0.792
DE27	120.90	HIGH	0.468	0.213	0.347	ITC1	113.60	HIGH	-0.228	-0.057	-0.033	SK04	46.00	MEDIUM	-0.580	-1.047	-0.735
DE30	97.80	INTERMEDIATE	0.668	0.210	1.005	ITC2	118.60	HIGH	-0.186	-0.927	-0.578	FI13	88.80	INTERMEDIATE	1.396	-0.227	0.093
DE41	76.10	INTERMEDIATE	0.388	-0.230	0.013	ITC3	106.80	HIGH	-0.178	-0.273	-0.277	FI18	135.60	HIGH	1.570	0.763	1.117
DE42	87.30	INTERMEDIATE	0.420	0.010	0.338	ITC4	134.80	HIGH	-0.248	0.400	0.202	FI19	104.90	HIGH	1.454	0.190	0.473
DE50	158.60	HIGH	0.528	0.007	0.587	ITD1	134.50	HIGH	-0.310	-0.513	-0.532	FI1A	102.30	HIGH	1.422	-0.277	0.513
DE60	192.00	HIGH	0.556	0.503	1.080	ITD2	122.00	HIGH	-0.940	-0.210	-0.398	FI20	143.20	HIGH	1.100	-0.510	0.223
DE71	156.10	HIGH	0.592	0.563	1.192	ITD3	121.60	HIGH	-0.272	0.110	-0.225	SE11	164.60	HIGH	0.998	0.900	1.438
DE72	107.50	HIGH	0.458	0.127	0.528	ITD4	116.60	HIGH	-0.380	-0.243	-0.258	SE12	106.20	HIGH	0.984	0.223	0.688
DE73	115.20	HIGH	0.534	0.010	0.232	ITD5	128.00	HIGH	-0.334	0.287	-0.055	SE21	110.00	HIGH	0.866	0.030	0.067
DE80	81.10	INTERMEDIATE	0.404	-0.270	0.085	ITE1	112.80	HIGH	-0.242	-0.113	-0.162	SE22	110.10	HIGH	0.948	0.390	0.693
DE91	111.40	HIGH	0.426	-0.037	0.545	ITE2	96.90	INTERMEDIATE	-0.272	-0.347	-0.573	SE23	119.10	HIGH	0.936	0.513	0.622
DE92	110.80	HIGH	0.428	0.110	0.635	ITE3	105.50	HIGH	-0.342	-0.283	-0.507	SE31	108.10	HIGH	0.858	-0.233	-0.022
DE93	83.70	INTERMEDIATE	0.386	-0.087	0.122	ITE4	122.30	HIGH	-0.216	0.070	0.048	SE32	108.30	HIGH	0.810	-0.357	-0.028
DE94	101.00	HIGH	0.370	-0.010	0.092	ITF1	85.30	INTERMEDIATE	-0.246	-0.487	-0.672	SE33	115.10	HIGH	0.704	-0.253	0.227
DEA1	127.60	HIGH	0.550	0.453	0.828	ITF2	77.90	INTERMEDIATE	-0.348	-1.010	-0.895	UKC1	81.50	INTERMEDIATE	0.118	0.000	-0.100
DEA2	118.00	HIGH	0.544	0.453	0.972	ITF3	65.90	MEDIUM	-0.288	-0.710	-0.600	UKC2	97.80	INTERMEDIATE	0.086	0.163	0.168
DEA3	98.30	INTERMEDIATE	0.520	0.260	0.395	ITF4	66.80	MEDIUM	-0.314	-0.907	-0.893	UKD1	89.70	INTERMEDIATE	0.214	-0.080	-0.583
DEA4	109.40	HIGH	0.472	0.043	0.498	ITF5	75.00	INTERMEDIATE	-0.400	-1.243	-0.883	UKD2	123.70	HIGH	0.350	0.587	0.623
DEA5	106.30	HIGH	0.546	0.170	0.375	ITF6	65.80	MEDIUM	-0.278	-1.093	-1.143	UKD3	105.30	HIGH	0.308	0.510	0.378
DEB1	97.50	INTERMEDIATE	0.448	-0.003	0.172	ITG1	66.00	MEDIUM	-0.276	-0.973	-0.788	UKD4	89.90	INTERMEDIATE	0.256	0.380	0.030
DEB2	94.20	INTERMEDIATE	0.420	-0.020	0.112	ITG2	78.40	INTERMEDIATE	-0.606	-1.133	-0.832	UKD5	83.20	INTERMEDIATE	0.336	0.213	0.118
DEB3	106.30	HIGH	0.556	0.250	0.578	CY00	93.60	INTERMEDIATE	-0.433	-0.080	-0.643	UKE1	90.50	INTERMEDIATE	0.136	0.090	-0.252
DEC0	114.50	HIGH	0.472	-0.123	0.393	LV00	55.70	MEDIUM	-1.032	-0.443	-0.657	UKE2	101.20	HIGH	0.330	0.640	0.312
DED1	82.60	INTERMEDIATE	0.434	-0.127	0.063	LT00	59.30	MEDIUM	-0.994	-0.133	-0.735	UKE3	90.20	INTERMEDIATE	0.348	0.167	0.142
DED2	87.70	INTERMEDIATE	0.446	0.057	0.323	LU00	275.20	HIGH	0.542	0.417	0.943	UKE4	103.50	HIGH	0.264	0.457	0.283
DED3	88.60	INTERMEDIATE	0.440	-0.017	0.283	HU10	102.90	HIGH	-0.748	0.177	0.015	UKF1	100.60	HIGH	0.250	0.513	0.222
DEE0	83.60	INTERMEDIATE	0.348	-0.227	0.205	HU21	58.20	MEDIUM	-0.814	-0.440	-0.825	UKF2	114.40	HIGH	0.310	0.507	0.397
DEF0	99.50	INTERMEDIATE	0.416	0.047	0.407	HU22	61.50	MEDIUM	-0.790	-0.503	-0.902	UKF3	83.30	INTERMEDIATE	0.012	-0.170	-0.443
DEG0	83.00	INTERMEDIATE	0.426	-0.100	0.300	HU23	42.70	MEDIUM	-0.988	-0.870	-0.932	UKG1	100.60	HIGH	0.244	0.547	0.355
EE00	68.80	MEDIUM	-0.026	-0.283	-0.258	HU31	40.10	MEDIUM	-0.942	-0.830	-1.130	UKG2	89.00	INTERMEDIATE	0.250	0.473	0.053
IE01	99.20	INTERMEDIATE	0.466	-0.157	-0.150	HU32	39.40	MEDIUM	-0.990	-0.867	-1.073	UKG3	105.30	HIGH	0.388	0.367	0.280
IE02	166.10	HIGH	0.424	0.557	0.495	HU33	41.80	MEDIUM	-0.944	-0.783	-1.048	UKH1	110.40	HIGH	0.220	0.520	0.753
GR11	62.10	MEDIUM	-0.990	-1.330	-1.165	MT00	76.40	INTERMEDIATE	-0.583	-1.013	-0.467	UKH2	127.00	HIGH	0.378	0.777	0.825
GR12	72.50	MEDIUM	-0.770	-0.753	-0.982	NL11	164.90	HIGH	0.852	0.607	0.497	UKH3	98.00	INTERMEDIATE	0.370	0.460	0.532
GR13	75.80	INTERMEDIATE	-0.882	-1.423	-1.282	NL12	107.50	HIGH	0.958	0.313	0.147	UKI	225.56	HIGH	0.480	1.307	1.110
GR14	68.20	MEDIUM	-0.858	-1.143	-1.112	NL13	103.60	HIGH	0.934	0.097	0.368	UKJ1	156.10	HIGH	0.404	1.050	1.162
GR21	68.30	MEDIUM	-1.216	-1.417	-1.160	NL21	114.70	HIGH	1.004	0.653	0.515	UKJ2	122.40	HIGH	0.338	1.010	0.993
GR22	74.00	MEDIUM	-1.226	-1.640	-1.550	NL22	113.50	HIGH	0.998	0.807	0.775	UKJ3	116.90	HIGH	0.408	0.713	0.800
GR23	59.80	MEDIUM	-0.916	-1.230	-1.213	NL23	107.30	HIGH	1.140	0.203	0.780	UKJ4	93.40	INTERMEDIATE	0.448	0.420	0.362
GR24	83.90	INTERMEDIATE	-0.736	-1.217	-1.430	NL31	155.40	HIGH	1.124	1.203	1.422	UKK1	128.30	HIGH	0.380	0.853	0.853
GR25	75.70	INTERMEDIATE	-0.796	-1.267	-1.497	NL32	150.10	HIGH	1.090	1.077	1.200	UKK2	97.30	INTERMEDIATE	0.300	0.400	0.313
GR30	128.10	HIGH	-0.588	0.180	-0.415	NL33	136.60	HIGH	1.094	1.027	0.972	UKK3	75.20	INTERMEDIATE	0.010	-0.410	-0.393
GR41	66.60	MEDIUM	-1.302	-1.727	-1.265	NL34	121.60	HIGH	1.028	0.403	0.297	UKK4	88.60	INTERMEDIATE	0.152	0.367	0.003
GR42	96.20	INTERMEDIATE	-1.260	-1.440	-1.392	NL41	134.40	HIGH	1.040	0.957	1.023	UKL1	73.40	MEDIUM	0.082	0.090	-0.213
GR43	83.70	INTERMEDIATE	-1.232	-1.087	-1.108	NL42	119.40	HIGH	1.064	0.650	0.715	UKL2	110.30	HIGH	0.152	0.397	0.347
ES11	88.80	INTERMEDIATE	-0.124	-0.437	-0.685	AT11	81.30	INTERMEDIATE	0.448	-0.093	-0.335	UKM2	119.90	HIGH	0.086	0.733	0.603
ES12	96.90	INTERMEDIATE	-0.216	-0.603	-0.580	AT12	100.10	HIGH	0.474	0.157	-0.150	UKM3	103.60	HIGH	0.084	0.460	0.147
ES13	105.40	HIGH	-0.022	-0.557	-0.562	AT13	163.10	HIGH	0.602	0.610	0.917	UKM5	152.90	HIGH	-0.208	0.670	0.310
ES21	136.80	HIGH	-0.030	0.290	-0.110	AT21	104.60	HIGH	0.474	-0.017	-0.012	UKM6	87.20	INTERMEDIATE	-0.150	-0.070	-0.057
ES22	132.20	HIGH	-0.030	-0.127	-0.288	AT22	106.10	HIGH	0.428	0.257	0.142	UKN0	92.80	INTERMEDIATE	0.076	0.160	-0.055
ES23	112.00	HIGH	-0.088	-0.663	-0.702	AT31	119.90	HIGH	0.456	0.420	0.185						
ES24	114.40	HIGH	-0.106	-0.360	-0.517	AT32	139.50	HIGH	0.494	0.233	0.200						

Figure 6-2, Figure 6-3 and Figure 6-4 below show the regional maps of the three RCI sub-indices. We can see an increasing heterogeneity in the performance of regions across the three pillar groups with more regions having similar scores in the Basic pillar group, as expected, with the exception of some of the newest EU Member States. Performance in the Innovation pillar group shows highest diversity across regions, suggesting the different levels of sophistication of regional economies.

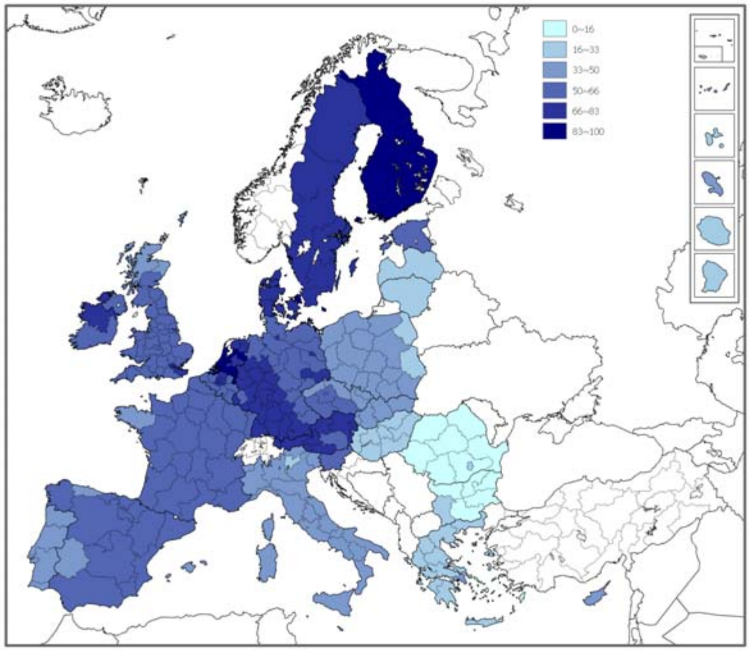


Figure 6-2. Basic RCI sub-index

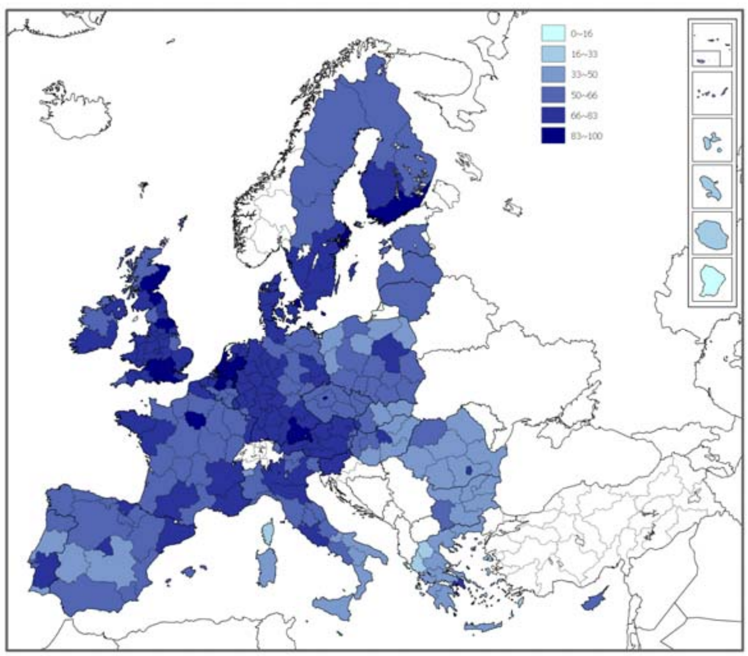


Figure 6-3. Efficiency RCI sub-index

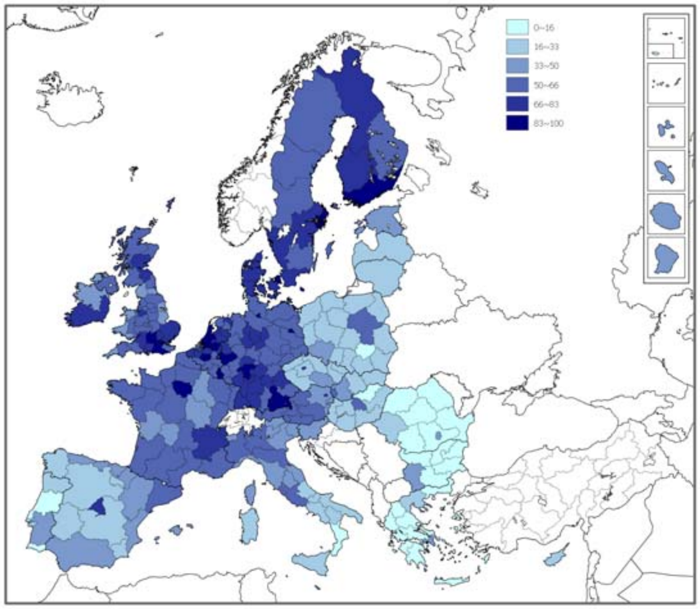


Figure 6-4. Innovation RCI sub-index

For each country, the coefficient of variation (CV = standard deviation/arithmetic mean) of the three sub_indices has been computed across the regions to identify the level of heterogeneity of the regions with respect to the partial RCI scores. In Figure 6-5 the absolute value of CV for the three sub_indices is displayed for each country (countries with only one region are not displayed). The graph is not displaying the CV value of the second sub-index (intermediate economy) for Finland since its value is over 40, almost four times the highest value. This is due to the fact that three out of five Finland regions, Itä-Suomi, Pohjois-Suomi and Åland, score very low (negative) values on the second sub-index; while the remaining two regions, Etelä-Suomi and Länsi-Suomi score higher values (positive ones). The case of CV of sub-index 3 of France is instead due to overseas regions (Guadeloupe, Martinique, Guyane, Reunion; FR91-FR94) which score extreme low values for innovative pillars.

Apart from these two cases, the coefficient of variation follows the same pattern across countries for all the three sub_indices, meaning that heterogeneity, or dually homogeneity, of one country does not depend on the particular group of pillars.

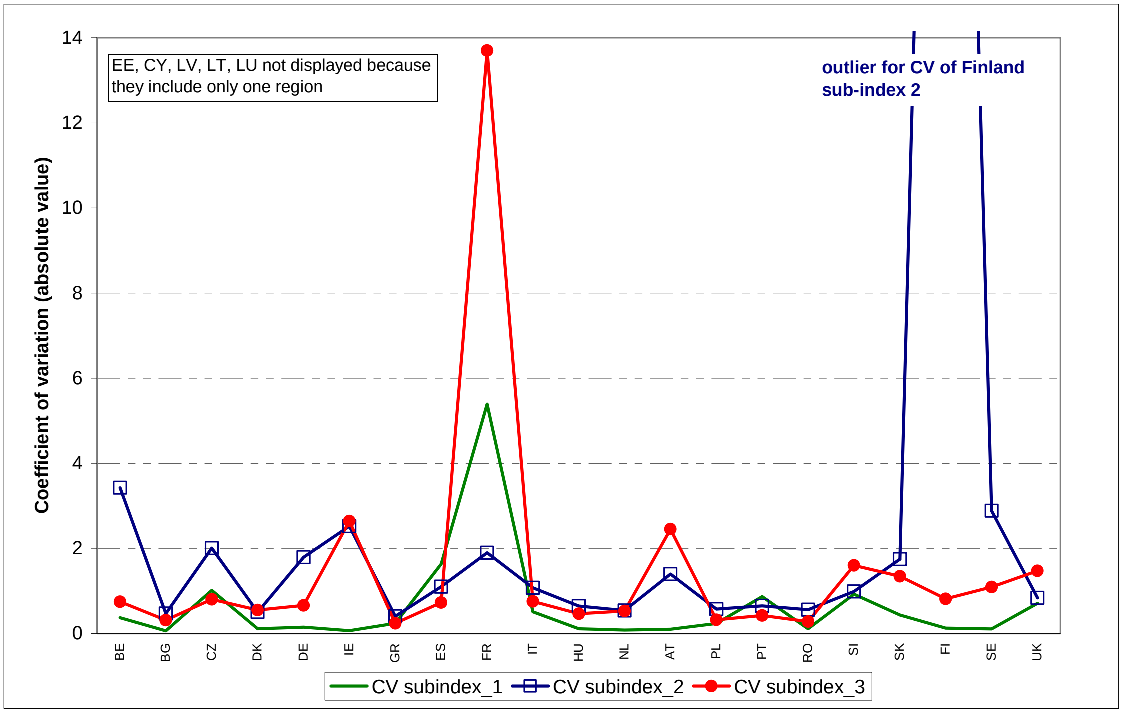


Figure 6-5: Absolute value of CV of the three sub_indices within each country (countries with only one region are not displayed)

Further, a parametric and non-parametric analysis of variance is used to test whether the classification of the regions into the three development stages is well reflected by the three sub_indices. To this aim an ANOVA (Knoke et al., 2002) is applied to test the difference in the means of the sub_indices using the development stage as classification variable. Table 95 shows basic descriptive statistics of the three sub_indices for each development stage. It can be seen that, as expected, mean values of all the sub_indices increase as the development stage increases. ANOVA results show that average values of the sub_indices depend on the region's development stage (ANOVA test is statistically significant for all the three sub_indices, see Table 96). Further, a non-parametric ANOVA, the Kruskall-Wallis test (Hollander and Wolfe, 1973), has been applied to the same data (Table 97). Results of the nonparametric test also support the discriminating power of the three sub_indices with respect to the development stage.

Table 95: Descriptive statistics of the sub_indices for each development stage

		N	Mean	Std. Deviation
sub_index 1	MEDIUM	66	-.76321	.505118
	INTERMEDIATE	85	-.00748	.485122
	HIGH	117	.40897	.464911
	Total	268	-.01178	.668743
sub_index 2	MEDIUM	66	-.80305	.483567
	INTERMEDIATE	85	-.34909	.599923
	HIGH	117	.30174	.429088
	Total	268	-.17675	.675937
sub_index 3	MEDIUM	66	-.94856	.341325
	INTERMEDIATE	85	-.21920	.522323
	HIGH	117	.40380	.484713
	Total	268	-.12684	.713641

Table 96: Analysis of variance of the three sub_indices on the basis of the development stage

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
sub_index 1	Between Groups	57.981	2	28.991	125.071	.000
	Within Groups	61.426	265	.232		
	Total	119.407	267			
sub_index 2	Between Groups	55.201	2	27.600	109.510	.000
	Within Groups	66.789	265	.252		
	Total	121.990	267			
sub_index 3	Between Groups	78.235	2	39.118	179.521	.000
	Within Groups	57.743	265	.218		
	Total	135.979	267			

Table 97: Non parametric ANOVA of the three sub_indices on the basis of development stage

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of sub_index 1 is the same across categories of STAGE.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of sub_index 2 is the same across categories of STAGE.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of sub_index 3 is the same across categories of STAGE.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

The final RCI is computed as weighted average of the three sub_indices, with weights defined on the basis of the development stage of the region. These scores are named 'weighted RCI' and are displayed in Table 99. The map of the weighted RCI at the regional level is shown in Figure 6-6. Values are normalized using the min-max transformation and classified into six classes.

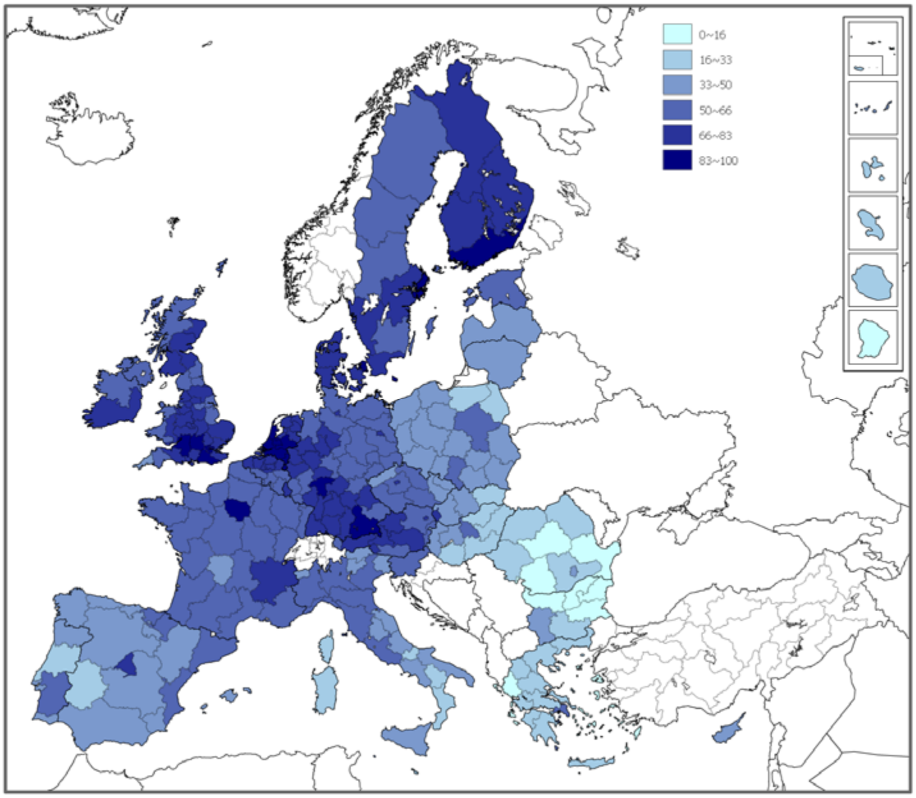


Figure 6-6: Map of the weighted RCI (min-max normalized values)

For the sake of completeness, we have also computed the un-weighted RCI as simple average of the 11th sub-scores. Figure 6-7 shows the corresponding map.

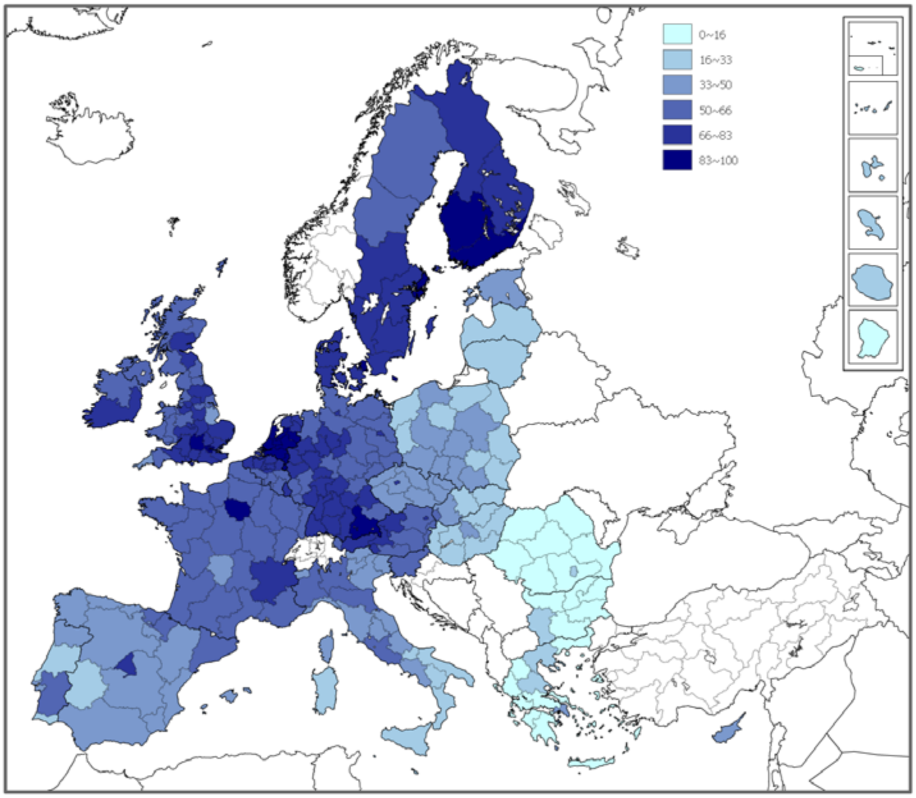


Figure 6-7: Map of the unweighted RCI (min-max normalized values)

When comparing Figure 6-6 and Figure 6-7, it can be noted that the unweighted approach leads to slightly lower scores and this is more evident for medium-stage regions - Eastern European regions, some regions in Greece, Southern Italy, Spain and Portugal - which score less with respect to the weighted RCI computation.

Figure 6-8 displays the scatter-plot of the weighted (on the x-axis) and unweighted (on the y-axis) RCI scores separately for the three development stages. Trend lines are the least squares regression lines computed for the three groups. For all the regression lines the coefficient of determination R^2 is very high (>0.90) and slope coefficients are all above 0.93, meaning that for all the three groups of countries the unweighted RCI score is slightly lower that the weighted one.

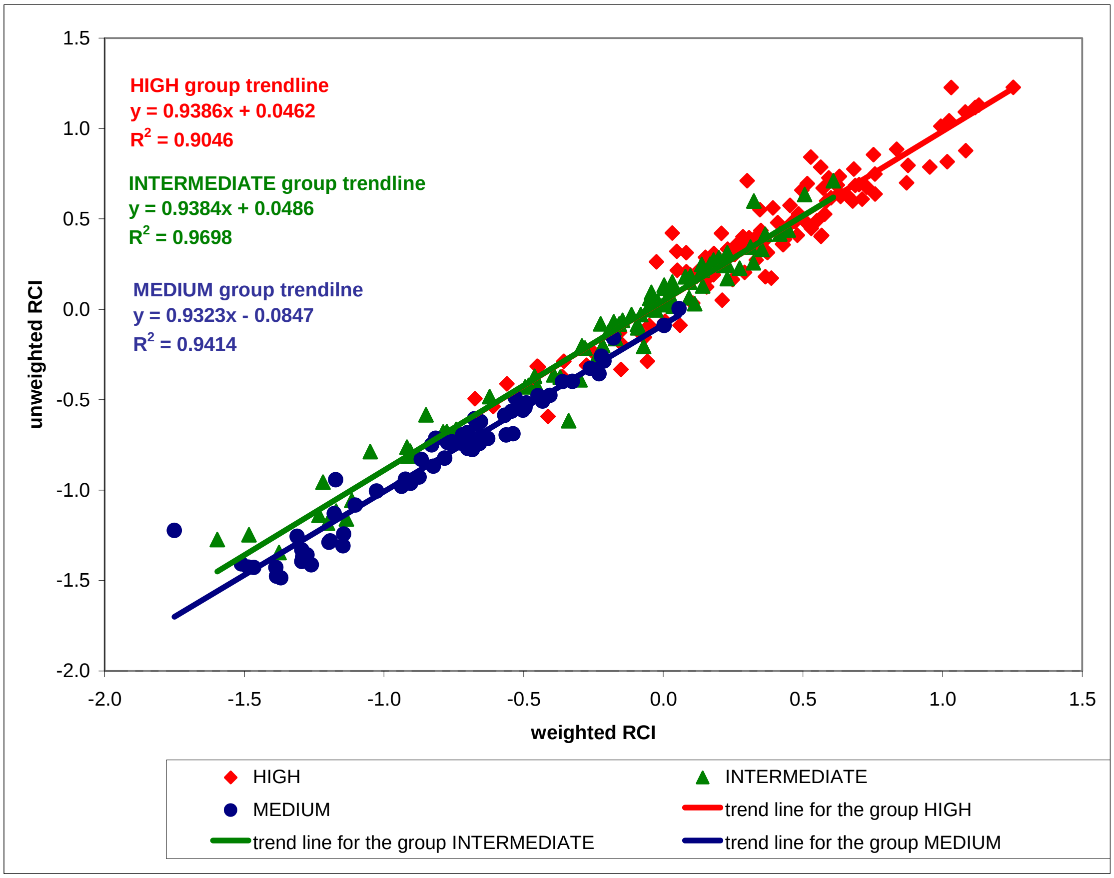


Figure 6-8: Scatterplot between weighted and unweighted RCI scores

As done for the three sub_indices, an ANOVA test of the weighted RCI score is computed with the development stage as classification variable. RCI averages are significantly different for the different development stages with increasingly higher means corresponding to increasing level of the region's development (Table 98).

Table 98: Comparison of average RCI scores across different development stages

	N	Mean	Std. Deviation
MEDIUM	66	-.8017	.40467
INTERMEDIATE	85	-.2206	.50493
HIGH	117	.3538	.39763
Total	268	-.1130	.63653

ANOVA

weighted_RCI

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	57.780	2	28.890	151.900	.000
Within Groups	50.401	265	.190		
Total	108.181	267			

Finally, Table 99 shows reordered regions, from best to worst, their weighted RCI score and the corresponding rank (low ranks are associated to high RCI scores). Hereafter, these ranks are referred as 'reference ranks' and the weighted RCI is simply called RCI.

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Table 99: RCI scores and ranks

reordered regions (best to worst)	weighted RCI	reference rank	reordered regions (best to worst)	weighted RCI	reference rank	reordered regions (best to worst)	weighted RCI	reference rank
NL31	1.253	1	UKK4	0.230	91	ITE2	-0.370	181
DK01	1.130	2	DEF0	0.229	92	ES11	-0.393	182
NL32	1.116	3	DED2	0.227	93	CZ07	-0.406	183
UKI	1.082	4	UKE3	0.216	94	ITD2	-0.413	184
SE11	1.081	5	ITC4	0.211	95	PT16	-0.432	185
FI18	1.031	6	SE21	0.208	96	ES41	-0.446	186
NL33	1.024	7	DE42	0.199	97	PL51	-0.448	187
FR10	1.017	8	DE73	0.181	98	ES13	-0.451	188
NL41	0.993	9	DED3	0.180	99	ITF1	-0.451	189
UKJ1	0.954	10	FR42	0.179	100	ES61	-0.460	190
DE21	0.876	11	DE24	0.179	101	ITD1	-0.478	191
UKJ2	0.871	12	DEB1	0.167	102	ES12	-0.482	192
NL22	0.835	13	ES51	0.155	103	CZ04	-0.491	193
UKK1	0.759	14	FR82	0.152	104	PT11	-0.493	194
DE71	0.758	15	DEC0	0.151	105	PL11	-0.495	195
NL42	0.752	16	UKC2	0.141	106	ES62	-0.495	196
BE00	0.729	17	DE22	0.140	107	CZ08	-0.503	197
UKH2	0.711	18	DEB2	0.138	108	PL41	-0.511	198
AT13	0.700	19	DEG0	0.138	109	ITF3	-0.530	199
DE60	0.687	20	AT12	0.128	110	LT00	-0.538	200
NL21	0.682	21	FR52	0.112	111	PL63	-0.543	201
UKJ3	0.678	22	ES21	0.106	112	ES23	-0.560	202
BE21	0.658	23	DE93	0.097	113	BG41	-0.562	203
DE11	0.635	24	DE94	0.097	114	PL52	-0.568	204
DE12	0.633	25	FR62	0.096	115	ES53	-0.609	205
SE23	0.630	26	UKN0	0.092	116	ES42	-0.621	206
DEA2	0.627	27	AT21	0.083	117	HU21	-0.628	207
NL11	0.623	28	SE33	0.082	118	PL32	-0.652	208
DK04	0.614	29	DED1	0.080	119	PL42	-0.654	209
DK02	0.608	30	BE33	0.079	120	HU22	-0.658	210
LU00	0.600	31	ITD5	0.060	121	ITF4	-0.668	211
SE22	0.593	32	UKL1	0.056	122	ITC2	-0.674	212
DEA1	0.585	33	AT34	0.049	123	ITG1	-0.676	213
BE23	0.578	34	SE31	0.048	124	PL31	-0.679	214
DK03	0.572	35	UKE1	0.035	125	PL33	-0.684	215
CZ01	0.567	36	FR51	0.035	126	LV00	-0.700	216
UKM2	0.565	37	DEE0	0.032	127	SK03	-0.700	217
NL23	0.564	38	FI20	0.032	128	PL43	-0.718	218
UKD2	0.550	39	IE01	0.031	129	PL61	-0.726	219
UKH1	0.530	40	AT11	0.021	130	ES70	-0.742	220
FI19	0.528	41	UKC1	0.015	131	PT18	-0.756	221
SE12	0.515	42	FR30	0.007	132	ITF6	-0.772	222
IE02	0.512	43	ITE4	0.006	133	MT00	-0.775	223
DE30	0.506	44	DE41	0.004	134	GR12	-0.783	224
NL34	0.496	45	DE80	0.003	135	ITF2	-0.788	225
DE25	0.484	46	SI01	0.003	136	ES43	-0.815	226
UKE2	0.480	47	FR24	-0.018	137	PL34	-0.823	227
DE13	0.472	48	SE32	-0.025	138	SK04	-0.829	228
DE14	0.461	49	FR41	-0.027	139	FR83	-0.849	229
DK05	0.454	50	FR22	-0.035	140	PL62	-0.866	230
UKH3	0.447	51	BE35	-0.043	141	HU33	-0.874	231
UKF2	0.434	52	BE32	-0.049	142	HU31	-0.905	232
UKD3	0.430	53	PT17	-0.050	143	PT15	-0.906	233
UKG1	0.429	54	HU10	-0.057	144	ITG2	-0.915	234
BE25	0.428	55	FR23	-0.058	145	ITF5	-0.918	235
ES30	0.427	56	ITD3	-0.067	146	HU23	-0.923	236
UKJ4	0.417	57	PL12	-0.070	147	HU32	-0.937	237
DEB3	0.410	58	FR61	-0.081	148	GR14	-1.026	238
NL12	0.392	59	ITC1	-0.084	149	FR92	-1.049	239
UKM5	0.386	60	UKM6	-0.091	150	GR23	-1.103	240
UKF1	0.373	61	UKD1	-0.092	151	GR24	-1.115	241
UKE4	0.366	62	FR81	-0.114	152	GR43	-1.135	242
SK01	0.366	63	FR72	-0.146	153	BG42	-1.144	243
DEA3	0.365	64	GR30	-0.152	154	RO11	-1.146	244
FR71	0.360	65	ITE1	-0.154	155	GR25	-1.172	245
AT31	0.357	66	ES22	-0.156	156	FR94	-1.173	246
UKK2	0.353	67	FR26	-0.158	157	GR11	-1.178	247
DE26	0.349	68	UKF3	-0.170	158	RO42	-1.193	248
NL13	0.346	69	FR21	-0.176	159	RO31	-1.197	249
UKG3	0.345	70	FR53	-0.176	160	PT30	-1.202	250
UKL2	0.333	71	FR43	-0.177	161	FR91	-1.219	251
DE92	0.331	72	EE00	-0.178	162	GR13	-1.233	252
FI13	0.324	73	FR25	-0.198	163	RO21	-1.260	253
UKG2	0.322	74	CZ03	-0.212	164	BG32	-1.275	254
DE72	0.313	75	ES52	-0.217	165	BG34	-1.291	255
BE22	0.312	76	CZ06	-0.221	166	BG33	-1.294	256
DE23	0.307	77	BE34	-0.225	167	RO12	-1.294	257
DEA5	0.307	78	PL22	-0.230	168	GR21	-1.311	258
DE27	0.304	79	CZ02	-0.238	169	RO41	-1.369	259
FI1A	0.300	80	ITC3	-0.255	170	GR42	-1.376	260
UKM3	0.291	81	CZ05	-0.261	171	RO22	-1.385	261
DE50	0.285	82	ITD4	-0.275	172	BG31	-1.387	262
AT33	0.280	83	UKK3	-0.281	173	GR22	-1.465	263
AT32	0.275	84	FR63	-0.291	174	ES63	-1.483	264
UKD4	0.273	85	CY00	-0.298	175	PT20	-1.485	265
DEA4	0.266	86	PL21	-0.325	176	GR41	-1.511	266
AT22	0.256	87	RO32	-0.339	177	ES64	-1.597	267
SI02	0.248	88	ES24	-0.356	178	FR93	-1.750	268
UKD5	0.231	89	SK02	-0.361	179			
DE91	0.230	90	ITE3	-0.362	180			

6.2 Country competitiveness scores - CCI

An indicator of competitiveness on the country level has been computed as a population weighted average of the regional competitiveness scores RCI of each country. Table 100 shows the individual country scores (a) and the country ranking (b), while Figure 6-9 shows the country score map.

Table 100: Competitiveness scores at the country level

a) Country competitiveness index

conuntry-code	CCI	Min_max normalized CCI
BE	0.416	76
BG	-1.072	5
CZ	-0.223	46
DK	0.742	92
DE	0.391	75
EE	-0.178	48
IE	0.383	75
GR	-0.743	20
ES	-0.214	46
FR	0.169	65
IT	-0.250	44
CY	-0.298	42
LV	-0.700	23
LT	-0.538	30
LU	0.600	85
HU	-0.612	27
MT	-0.775	19
NL	0.904	100
AT	0.312	71
PL	-0.468	34
PT	-0.437	35
RO	-1.167	0
SI	0.116	62
SK	-0.501	32
FI	0.721	91
SE	0.552	83
UK	0.488	80

b) Country Competitiveness Index ranking

CCI ranking	
1	NL
2	DK
3	FI
4	LU
5	SE
6	UK
7	BE
8	DE
9	IE
10	AT
11	FR
12	SI
13	EE
14	ES
15	CZ
16	IT
17	CY
18	PT
19	PL
20	SK
21	LT
22	HU
23	LV
24	GR
25	MT
26	BG
27	RO

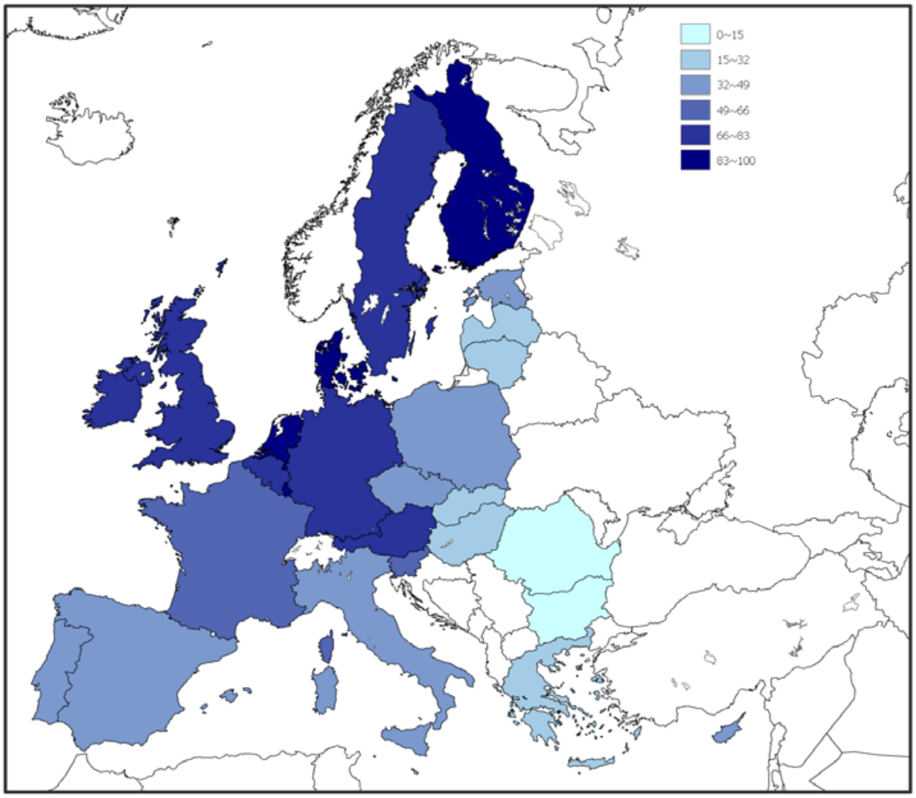


Figure 6-9: Country Competitiveness Index map (min-max normalized values as shown in Table 100)

In Table 101 we compare the country ranking from the Country Competitiveness Index with the one of the 2009/2010 edition[17] of the Global Competitiveness Index, the world's reference index for country competitiveness and the source of the framework structure for the computation of the RCI. As expected the differences are not large. For eight countries the shift in rank is higher or equal to four, with only Luxembourg which moves upward six positions with respect to WEF-GCI (i.e, we rank Luxembourg better than WEF). These differences may be easily explained by the fact that, even if the framework of the two composites is similar, data sources, geographical level and the method followed for the construction of the RCI score are substantially different in the two cases.

[17] http://www.weforum.org/en/initiatives/gcp/Global%20Competitiveness%20Report/index.htm

Table 101: Comparison between CCI 2010 and GCI 2009-2010

country-code	CCI rank	GCI 2009-2010 rank	diff
NL	1	5	-4
DK	2	2	0
FI	3	3	0
LU	4	10	-6
SE	5	1	4
UK	6	6	0
BE	7	9	-2
DE	8	4	4
IE	9	11	-2
AT	10	8	2
FR	11	7	4
SI	12	16	-4
EE	13	15	-2
ES	14	13	1
CZ	15	12	3
IT	16	20	-4
CY	17	14	3
PT	18	17	1
PL	19	18	1
SK	20	19	1
LT	21	22	-1
HU	22	23	-1
LV	23	25	-2
GR	24	26	-2
MT	25	21	4
BG	26	27	-1
RO	27	24	3

Figure 6-10 provides a clear picture of the countries whose rank mostly deviates from the WEF-GCI rank.

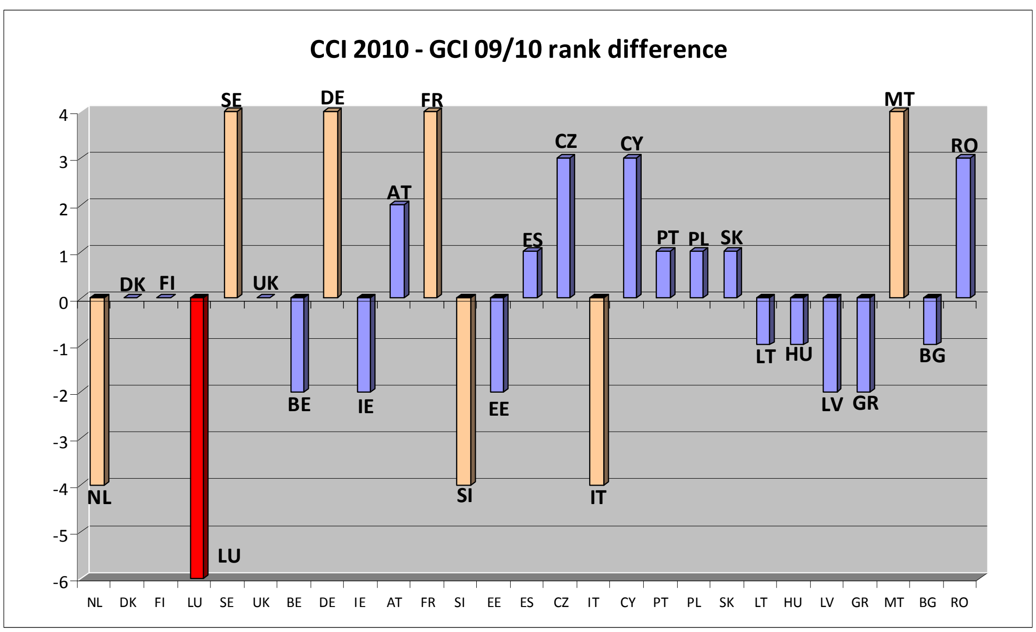


Figure 6-10: CCI 2010 – GCI 2009-2010 rank difference

6.3 *Robustness analysis of the RCI*

As always in composite indicator analysis, the setting up of the final index is based upon a series of choices. Some of them may be subjective, at least to some extent, or driven by mathematical simplicity or experts' opinion. The aim of the robustness analysis is to examine the extent to which the final ranking depends on the set of choices made and the analysis typically involves the simultaneous variation of the set of the uncertain parameters in a pre-selected interval.

The framework of a composite is usually assumed to be fixed as its choice is mainly driven by socio-economic aspects and experts' opinion. The indicators which populate the pillars in the framework are generally chosen by integrating experts' judgment, data availability and checks on statistical consistency, as in the RCI case. Transformation and normalization methods may be also checked via uncertainty analysis. For RCI the adopted transformations have been fully justified by a detailed univariate analysis carried out indicator by indicator (section 5). The aggregation and weighting scheme is another important source of uncertainty in CIs. In the case of RCI, the choice of simple average aggregation at the pillar level has been verified and supported case by case by multivariate statistical analyses (Section 5). Thus, other choices have been considered uncertain and checked by means of an uncertain analysis -UA - (OECD, 2008; Saltelli et al. 2008) detailed in the following.

In the RCI construction the uncertain analysis is carried out considering the following parameters:

- the second threshold for the computation of the development stage - t_2;
- the set of weights assigned to the three groups of pillars of the medium, intermediate and high stages of development – w_{M1}, w_{M2}, w_{M3}, w_{I1}, w_{I2}, w_{I3}, w_{H1}, w_{H2}, w_{H3};

with a the total number of runs of 1200, each corresponding to a different set of parameter values. Each run can be viewed as a particular scenario for the RCI computation.

Parameter t_2 is simply sampled from the continuous uniform distribution U[95,105] centered in the reference value, $t_{2\ ref} = 100$.

Parameters w_is are instead limited by the constraint:

$$\sum_{i=1}^{3} w_{ji} = 1 \qquad j = M, I, H$$

The sampling strategy for w_is is slightly more complicated. First, the initial distribution of each parameter is assumed to be a continuous uniform distribution centered in the corresponding reference value (reference values are displayed in Figure 6-1). The choice of the range of uncertainty was driven by to two opposite needs: on the one hand, there is the need to anticipate the criticism that the assumptions of the uncertainty analysis are not 'wide enough'; on the other hand, there is the need to not completely spoil the weighting structure of the RCI, which would make the classification of regions into different development stages pointless. Following this trade off the distributions assigned to the set of weights of RCI are shown in Table 102 and sketched in Figure 6-11.

Table 102: range of variation assigned to weights w_i

Parameter	Reference value	Range of variability
w_{M1}	0.4	U[0.3,0.5]
w_{M2}	0.5	U[0.4,0.6]
w_{M3}	0.1	U[0.05,0.15]
w_{I1}	0.3	U[0.2,0.4]
w_{I2}	0.5	U[0.4,0.6]
w_{I3}	0.2	U[0.1,0.3]
w_{H1}	0.2	U[0.1,0.3]
w_{H2}	0.5	U[0.4,0.6]
w_{H3}	0.3	U[0.2,0.4]

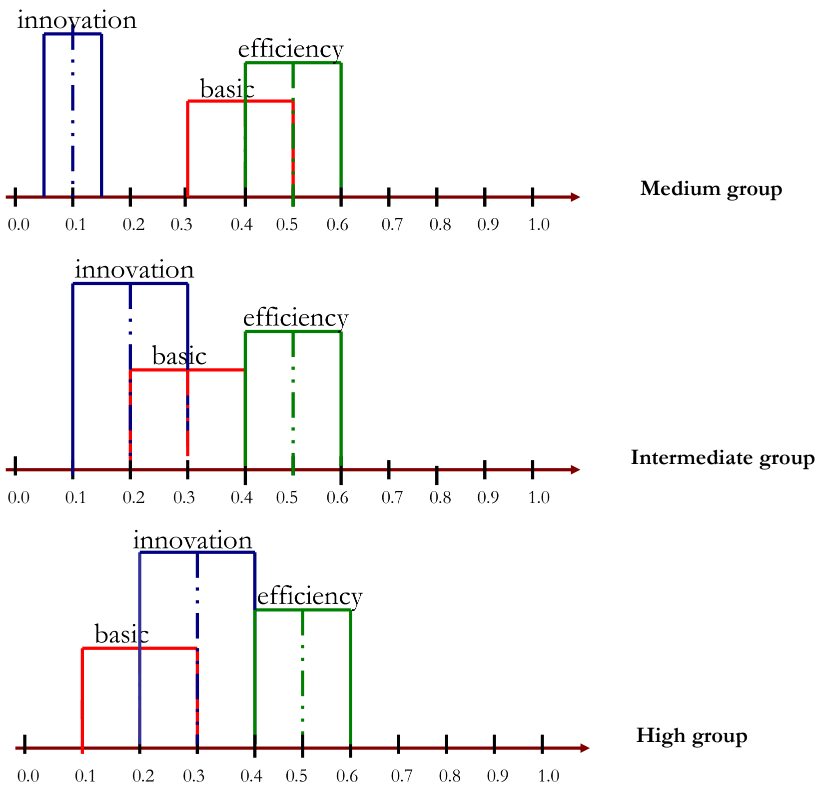


Figure 6-11: Sketch of uncertainty ranges assigned to the RCI set of weights

Due to weight constraints, values of w_is cannot be independently sampled from these distributions. Instead, a check is added in order to end up with a consistent set of weights for each development stage and a weight permutation is performed to balance the sample. For this reason the final distributions of weights is no more perfectly uniform, but has some 'very' low and high values as shown in Figure 6-12, Figure 6-13 and Figure 6-14.

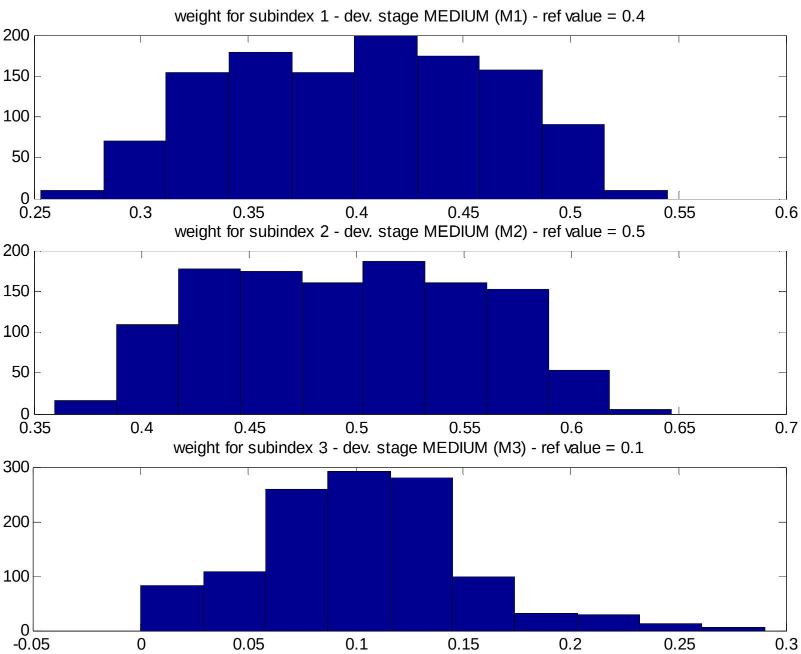


Figure 6-12: Final distributions of weights for the MEDIUM development stage (1200 runs)

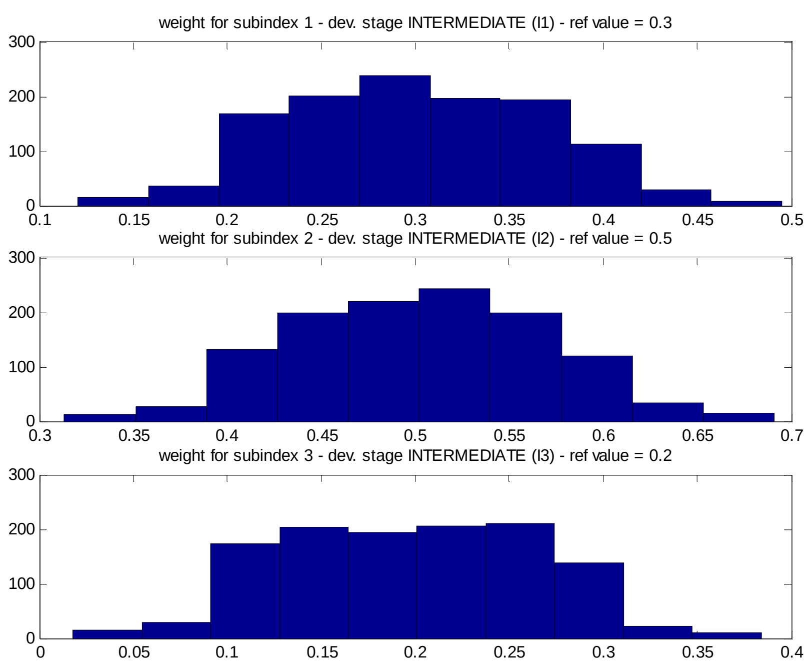


Figure 6-13: Final distributions of weights for the INTERMEDIATE development stage (1200 runs)

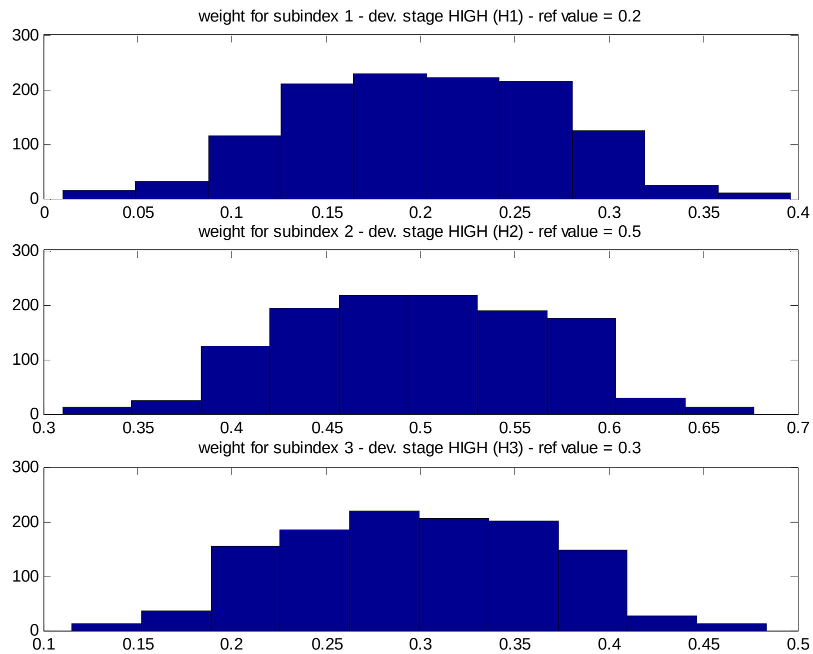
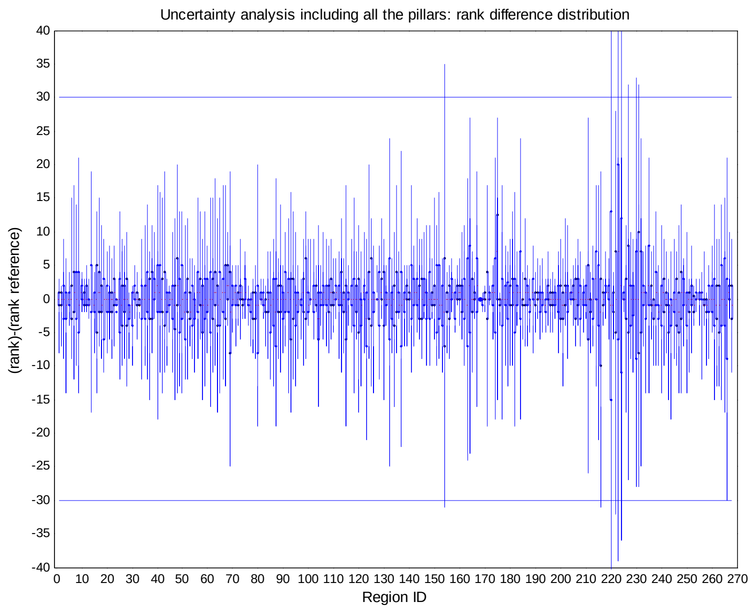


Figure 6-14: Final distributions of weights for the HIGH development stage (1200 runs)

UA results are displayed in Figure 6-15. For each region, it shows the boxplot of rank differences *RD*, i.e. the difference between the rank corresponding to the modified scenario and the reference rank. Vertical lines which cross the boxes represent all the 1200 values of rank difference computed for the region, actually showing the whole distribution of *RD*. Two horizontal lines at the values -30 and +30 have been added to the figure to show a tolerance interval of about ±10% of shift of *RD*. At a first glance, it can be seen that the ranking is rather robust. For only 9 regions out of 268 (about 2% of the cases) *RD* values go outside the [-30; +30] band. They are listed in Figure 6-15 next to the picture.



Regions which show highest variation:

HU10	154	Közép-Magyarország
SK01	216	Bratislavský kraj
FI13	220	Itä-Suomi
FI19	222	Länsi-Suomi
FI1A	223	Pohjois-Suomi
FI20	224	Åland
SE21	227	Småland med öarna
SE31	230	Norra Mellansverige
SE32	231	Mellersta Norrland

Figure 6-15: Boxplots of ranking differences and regions with shifts higher than ±30 positions

Results shown in Table 103 are the frequencies of each region rank calculated over all the 1200 simulated scenarios. The higher the score the lower the rank (that is best performers are assigned the lowest ranks).

Frequency distributions are classified into 27 classes (1 -|10, 11-|20, …. 261-|268). Such frequency matrix has a twofold aim: to show most and least stable regions while providing a synthesized picture of the region ranking. The most stable regions, with frequencies higher or equal to 95% in one interval, are highlighted in blue. 'Volatile' regions are considered as those regions whose rank values spam at least four rank intervals. They are highlighted in orange. The top elements in the matrix correspond to the regions with very stable and high score on competitiveness. Within this group, the ones which are always in the top ten for each simulated scenario are:

NL31	168	Utrecht-The Netherlands
DK01	24	Hovedstaden-Denmark
NL32	169	Noord-Holland-The Netherlands
UKI00	253	Inner London + Outer London-United Kingdom
SE11	225	Stockholm-Sweden

FI18	221	Etelä-Suomi-Finland
NL33	170	Zuid-Holland- The Netherlands

At the other end of the RCI classification one finds:

PT20	204	Região Autónoma dos Açores
GR41	81	Voreio Aigaio-Greece
ES64	101	Ciudad Autónoma de Melilla-Spain
FR93	127	Guyane-France

These regions are really low performers as they rank among the worst ten for all the 1200 different choices of RCI parameters.

Table 103: Frequency matrix of the regions rank for the RCI (low ranks correspond to high RCI values)

Region	1-|10	11-|20	21-|30	31-|40	41-|50	51-|60	61-|70	71-|80	81-|90	91-|100	101-|110	111-|120	121-|130	131-|140	141-|150	151-|160	161-|170	171-|180	181-|190	191-|200	201-|210	211-|220	221-|230	231-|240	241-|250	251-|260	261-|268
NL31	100																										
DK01	100																										
NL32	100																										
UKI00	98.75																										
SE11	100																										
FI18	100																										
NL33	99.25																										
FR10	75.167	24.833																									
NL41	77	23																									
UKJ1	44.25	55.75																									
DE21	35.917	64																									
UKJ2	25.333	74.667																									
NL22	33.167	66.167																									
UKK1		99.833																									
DE71	10.75	71.667	16.75																								
NL42		100																									
BE00		99.5																									
UKH2		82.75	17.25																								
AT13		65	33.333																								
DE60		50.083	48.083																								
NL21		6.1667	93.833																								
UKJ3		14.333	82.833																								
BE21		35.167	41.167	22.333																							
DE11		23.333	62	13.75																							
DE12			99.833																								
SE23			94.833	5.1667																							
DEA2			93.167	6.5																							
NL11		29.417	31.75	23.75	11.083																						
DK04			64.75	34.667																							
DK02			57.583	42.417																							
LU00			38.667	50.25	10.667																						
SE22			23.083	75.833																							
DEA1			33.833	35.333	26.917																						
BE23			6.8333	89.083																							
DK03				99.667																							
CZ01			6.4167	83.583	10																						
UKM2			8.1667	69.667	22.083																						
NL23				56.667	43.333																						
UKD2			12.583	57.917	27.083																						
UKH1				42	53.417																						
FI19					94.833																						
SE12				31.833	56.167	11.25																					
IE02					97.917																						
DE30				24.167	51.083	24.083																					
NL34				7.3333	82.417	10.25																					
DE25				18.833	50.833	29.417																					
UKE2		5.0833	13.5	18.5	18.417	20.5	10.917	8.5																			
DE13				5.5833	53.75	39.417																					
DE14				27.25	28.167	34.583	6.5833																				
DK05				19.5	32.75	38	5																				
UKH3					76.583	23.417																					
UKF2					43.917	45.75	5.9167																				
UKD3				5.6667	29.25	51.417	11.667																				
UKG1					10	90																					
BE25					6	91.833																					
ES30					20.833	40.917	21.5	11.917																			
UKJ4		6	9	13.583	21.167	16.5	10.667	11.833	8.25																		
DEB3						57.917	34.25	5.9167																			
NL12						77.25	22.75																				
UKM5						58.25	41.75																				
UKF1						46.75	30.25	19.25																			
UKE4						29.917	69.167																				
SK01						22.75	70.333	6.9167																			
DEA3						30.833	37.75	27.083																			
FR71							91.5	6.8333																			
AT31						12.083	63.417	24.5																			
UKK2						13.167	53.083	33.083																			
DE26							76.75	23.167																			
NL13							60.75	38																			
UKG3							46.833	50.667																			
UKL2							40	45.583	9.5																		
DE92						18.667	27.833	30.417	19.417																		
FI13							26.667	66.5	6.75																		
UKG2							15.583	70.917	12.75																		
DE72						7.8333	25.667	32.667	28.833																		
BE22							22.75	48.833	26.833																		
DE23						19.167	16.667	17.917	25.25	10.667																	
DEA5							6.6667	72.75	20.167																		
DE27							5	73.25	21.75																		
FI1A							10.167	45.833	42.417																		
UKM3								53.75	43.333																		
DE50								63.917	36.083																		
AT33								47.583	48.333																		
AT32						6.8333	17.917	21.167	29.75	19.167																	
UKD4								8.9167	59.583	26.5																	
DEA4									87.333	12.417																	
AT22									84.5	15.5																	
SI02									48	48.583																	
UKD5									59.833	39.833																	
DE91									45.333	54.083																	

Region	1-|10	11-|20	21-|30	31-|40	41-|50	51-|60	61-|70	71-|80	81-|90	91-|100	101-|110	111-|120	121-|130	131-|140	141-|150	151-|160	161-|170	171-|180	181-|190	191-|200	201-|210	211-|220	221-|230	231-|240	241-|250	251-|260	261-|268
UKK4									37	50.25	11.667																
DEF0									19.583	32.583	25	14.667	5.6667														
DED2									15.75	79.083	5.1667																
UKE3									24.917	62.667	12																
ITC4									21.5	48.333	21.667	6.75															
SE21										54.083	36.25	5															
DE42									20.75	27.917	21.333	18.417	7.5833														
DE73									28	45.583	15.417	6.0833															
DED3										43.5	47.25	8.9167															
FR42									20.083	25	16.667	14.833	12.667	5.3333													
DE24										41.167	48.25	9.4167															
DEB1										35.25	51.167	13															
ES51										33.5	54.417	12.083															
FR82										21	69.25	9.75															
DEC0										30.5	44.417	23.083															
UKC2								11.833	17.25	12.333	9.25	8.3333	10.083	10.25	9.25	5											
DE22										25.167	50	23.667															
DEB2											52.833	42.167															
DEG0										15.917	45.667	36															
AT12											43.417	53.25															
FR52									8.5	21.75	18	15.917	15.667	13.667													
ES21											39.083	56.583															
DE93											40.917	54.667															
DE94											38.917	60.083															
FR62										10	32.417	36.75	19.417														
UKN0											17	49.667	32.667														
AT21											10.167	57.583	31.083														
SE33											18.333	39.583	37.583														
DED1											21.333	30.5	33.417	11.75													
BE33												50.833	40.75														
ITD5												61.167	36.75														
UKL1										6.1667	21.333	22.667	30.833	15.167													
AT34										15.583	15.5	13.333	22.917	17.5	8.8333												
SE31												42.333	57.667														
UKE1												37.667	59														
FR51										9.0833	17	14.083	15.5	14.75	13.75	12											
DEE0													82.167	15.833													
FI20													69.167	27.417													
IE01												7.3333	48.917	40.167													
AT11													44.583	55													
UKC1												8	39.167	49.083													
FR30													42.333	56.833													
ITE4													31.25	68.667													
DE41												9.3333	34.5	35.5	17.5												
DE80													12.417	83.083													
SI01												11.333	26.833	27.25	26.5	5.25											
FR24														96.917													
SE32													44.167	45.583	10.25												
FR41													14.083	73.75	11.75												
FR22														51.25	48.5												
BE35														37.5	62.5												
BE32													13.167	29.917	36.25	15.75											
PT17													5.25	34	48.833	11.583											
HU10														27.833	65.833	5.8333											
FR23														7.9167	87.333												
ITD3														15.333	70.5	14.083											
PL12															100												
FR61															99.583												
ITC1															41.083	45.083	11										
UKM6															54.667	45.333											
UKD1														6.6667	34.083	54.75											
FR81															25.333	74.667											
FR72															35.917	63.75											
GR30															26.583	73.417											
ITE1														9.1667	25.917	62.083											
ES22																95.75											
FR26																98.583											
UKF3																83.25	14.833										
FR21															7.4167	77.167	15.417										
FR53																63	33.5										
FR43																13.167	86.833										
EE00																28.417	68.833										
FR25																23.167	76.417										
CZ03																14.417	78.417	7.1667									
ES52																	95.917										
CZ06																	75.25	21.417									
BE34																	97.083										
PL22																	72.833	27									
CZ02																	70.083	29.917									
ITC3																	56	44									
CZ05																	51.5	48.5									
ITD4																	50.5	49.5									
UKK3																	10.5	89.5									
FR63																	8.1667	91.833									
CY00																	12.417	79.083	8.1667								
PL21																		95.083									
RO32																		99.417									
ES24																		57.5	41								
SK02																		52.167	47.5								
ITE3																		43.833	56.167								
ITE2																		47.167	34.917	15.167							

Region	1-|10	11-|20	21-|30	31-|40	41-|50	51-|60	61-|70	71-|80	81-|90	91-|100	101-|110	111-|120	121-|130	131-|140	141-|150	151-|160	161-|170	171-|180	181-|190	191-|200	201-|210	211-|220	221-|230	231-|240	241-|250	251-|260	261-|268
ES11																		32.583	67.417								
CZ07																		9.6667	90.333								
ITD2																		42.75	56.083								
PT16																			91								
ES41																		10.75	59.417	27.667							
PL51																		5.75	65.417	28.833							
ES13																			53.417	43.917							
ITF1																			66.167	33.833							
ES61																			65.583	34.417							
ITD1																			25.75	74.25							
ES12																			32.333	67.667							
CZ04																			13.917	86.083							
PT11																			41.417	42.25	15.25						
PL11																			31.333	60.667	8						
ES62																			19.333	76.833							
CZ08																				87.75	10.417						
PL41																				93.333	6.5						
ITF3																			24.5	28.75	35.667	8.5					
LT00																				56.583	43.417						
PL63																				43.917	54.417						
ES23																				19.5	80.5						
BG41																					99.5						
PL52																					99.917						
ES53																				5.8333	93.667						
ES42																				26.5	54.667	15.417					
HU21																				15.75	79.417						
PL32																				16.083	76	7.9167					
PL42																				6.3333	53.583	39.917					
HU22																					69.333	30.667					
ITF4																					60.333	39.5					
ITC2																					25.667	74.333					
ITG1																					10.583	89.417					
PL31																						96.75					
PL33																						99.917					
LV00																						89.5	9.0833				
SK03																						99.833					
PL43																						83.417	16.583				
PL61																					6.8333	49.75	43				
ES70																						65.167	34.833				
PT18																						60.333	39.667				
ITF6																						31.5	66.417				
MT00																							99.833				
GR12																							96				
ITF2																							100				
ES43																							99.167				
PL34																							97.417				
SK04																							93	7			
FR83																							98.333				
PL62																						8.5	49.583	41.917			
HU33																							33.167	66.833			
HU31																							19.25	80.75			
PT15																								98.333			
ITG2																								97.167			
ITF5																								100			
HU23																								100			
HU32																								100			
GR14																								100			
FR92																								93.25	6.75		
GR23																								59.25	40.75		
GR24																								35.833	64.167		
GR43																									99.833		
BG42																								10.25	89.25		
RO11																									100		
GR25																									100		
FR94																									98.333		
GR11																									94.167		
RO42																									100		
RO31																									98		
PT30																									68.083	31.917	
FR91																									18.083	81.917	
GR13																										98.833	
RO21																										96.417	
BG32																									19.5	74.333	6.1667
BG34																										99.917	
BG33																										98.417	
RO12																										100	
GR21																										97.083	
RO41																										90.583	9.4167
GR42																										98.667	
RO22																											96.75
BG31																											95.75
GR22																										7.0833	92.917
ES63																										8.5833	91.417
PT20																											100
GR41																											100
ES64																											100
FR93																											100

We next present the median performance of the regions with the 90% confidence interval computed across all the 1200 scenarios for each region (Figure 6-16). Regions are reordered from best to worst performers according to their median rank (in red). Error bars represent the 5th and 95th percentiles of the rank distribution for each region. Regions for which the width of the estimated 90% confidence interval (computed as difference between 95% and 5% percentiles across 1200 simulations) is higher than 30, meaning an oscillation of the region rank of thirty positions wide, are highlighted in the Figure. Overall only eight regions belong to this class. The analysis of the picture highlights, in agreement with all other UA results, that the RCI is rather robust and stable with respect to the selected sources of uncertainties. The narrow confidence interval estimated for all the regions suggests that there are no hotspots in the graph, in terms of volatile ranks. The difference between the median rank and the reference rank (computed with all parameters set to their reference value) goes from a minimum of -7 to a maximum of +3.

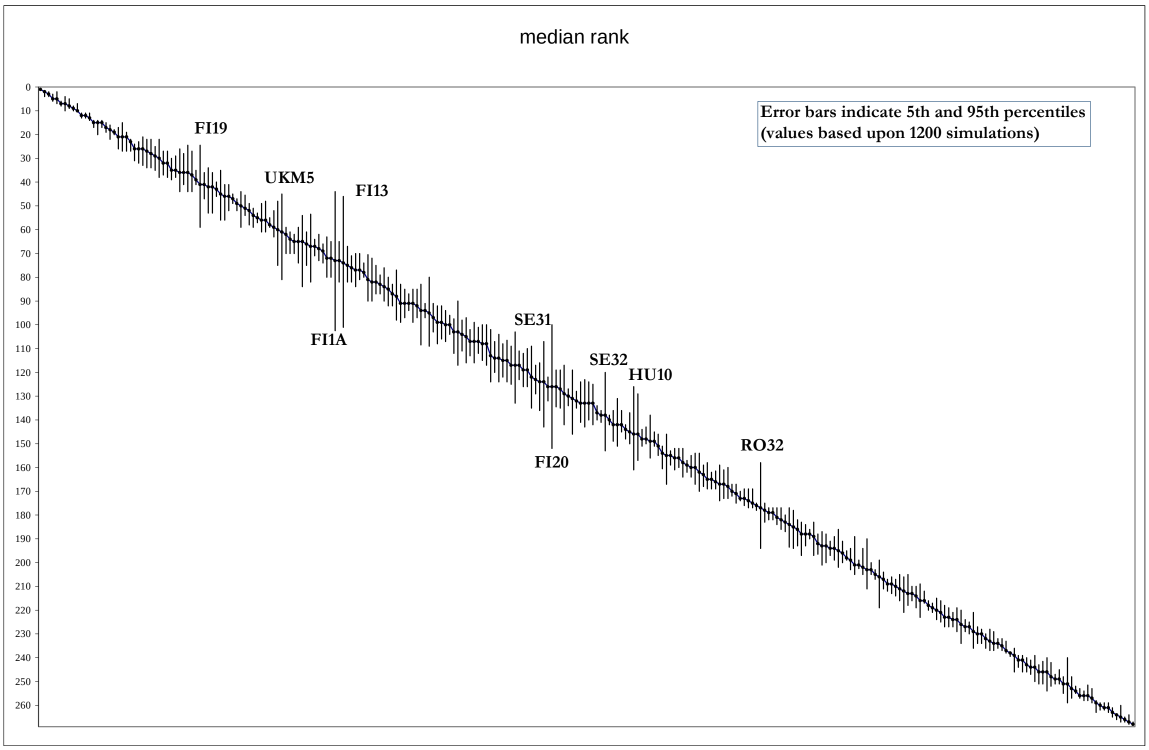


Figure 6-16: Median and 90% confidence intervals (across 1200 simulations) for the RCI ranks (displayed regions are those for which the estimated 90% CI is higher than 30 positions wide)

Finally, the distribution of the shift in rank for all the countries and all the simulations is shown in Figure 6-17. It provides an overall glance of the RCI robustness with respect to the sources of uncertainty under investigation and shows a clear pick around zero. A closer look at the distribution highlights that in more than 80% of the cases the shift in rank is at most of 5 positions.

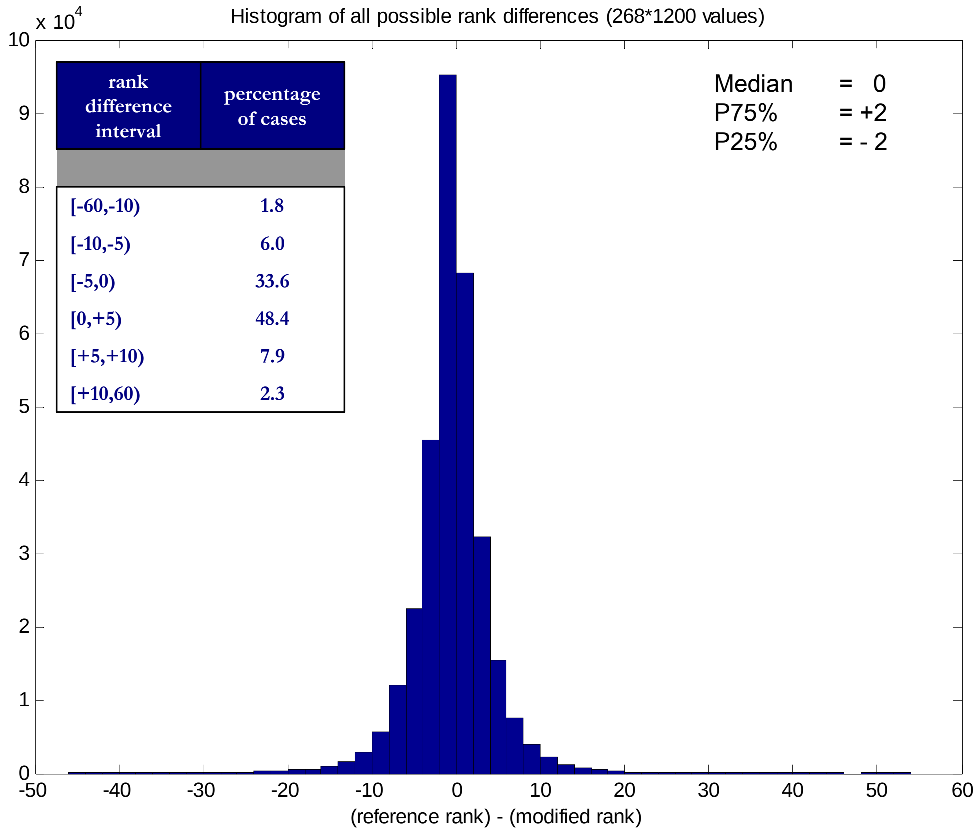


Figure 6-17: Histogram of the overall shift in ranks.

The effect of discarding one pillar at a time

To evaluate the balance among the pillars included in the RCI framework, it is interesting to quantify the effect of discarding one pillar at a time on final scores. To this aim, all the uncertain parameters are set back to their reference values and we compute regional scores discarding one pillar at a time. Eleven simulations are run each discarding one pillar at a time.

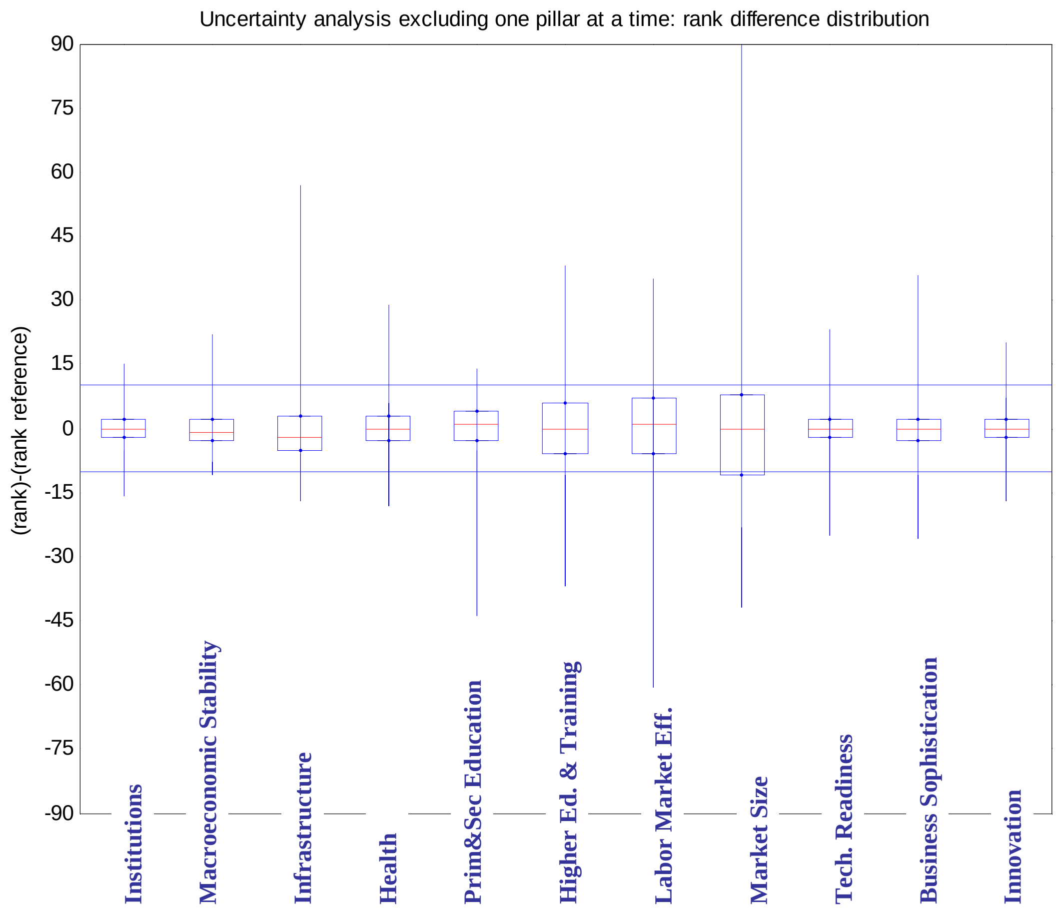


Figure 6-18: Effect of discarding one pillar at a time on RCI reference ranks

Figure 6-18 summarizes results of this analysis. Boxplots refer to the different simulations discarding one pillar at a time and display the interquartile range of the distribution of the difference between the modified rank, obtained without one pillar, and the reference rank, computed on the basis of the reference RCI score (see Table 99). Vertical lines show the entire range of variation of the rank difference distribution for each simulation. All the interquartile ranges are between the band -10 and +10, meaning that, for all the simulations, 75% of the times the maximum shift of the region rank is up to 10 positions wide. This indicates a very balanced role of the pillars. The most influencing pillars are Higher Education/ Training and Lifelong Learning, Labor Market Efficiency and Market Size. These results are strictly related to the fact that these three pillars are featuring medium-stage economies which are assigned, on average across the three development stages, the highest weights (see Figure 6-1).

Compensability effects at a glance

As most composite indicators, RCI is an aggregation of several indicators describing related but different factors. In this kinD of setting the aggregation always implies taking a position on the key issue of compensability. 'Compensability' is here understood as the:

> *existence of trade-off, i.e. the possibility of offsetting a disadvantage on some criteria by a sufficiently large advantage on another criterion* (Munda, 2008, pg. 71).

RCI has the mathematical form of a linear aggregation. It intrinsically entails compensability at all its computational levels: from the 'micro' level of sub-sub-pillars to the 'macro' level of sub-indices (basic, efficiency and innovation).

RCI is then affected by compensability, but to what extent? Various approaches may be used to assess the level of compensability of composite indicators, most of them are based on fully compensatory or fully non compensatory multi-criteria methods (see Munda, 2008 for a review). Our approach is here to provide a quick glance of compensability issues by means of the Ordered Weighted Averaging (OWA), originally proposed by Yager (Yager, 1988 and 1996). The OWA method consists of a family of operators which, for any given object (country, region, individual, ….), map a set of (*k*) real values $\{x_1, x_2, ..., x_k\}$, indicators observed for that object, into a single index depending on a set of weights $\{w_1, w_2, ..., w_k\}$:

$$f_{\mathrm{OWA}}(x_1, x_2, ..., x_k) = \sum_{i=1}^{k} w_i x_{(i)} \quad w_i \in [0,1] \qquad \sum_{i=1}^{k} w_i = 1 \qquad \text{6-1}$$

where $x_{(i)}$ is the i-th largest x_i, that is $\{x_{(1)}, x_{(2)}, \ldots, x_{(k)}\}$ is the series of x_i values reordered in descending order. Operators f_{OWA} are not a weighted average since the set of weights depends only on the i-th ordered position without considering the original set of indicators. The interesting feature of the OWA operators is that they embed many different types of aggregations depending on the set of weights w_i. If the need is to emphasize higher (lower) values of x_i's then the first weights should be assigned higher (lower) values. A number of special cases can be defined for the OWA operators. Among these, the following three have a special role:

a. Purely optimistic operator: $f^{O}_{\text{OWA}}(x_1, x_2, \ldots, x_k) = \sum_{i=1}^{k} w_i^O x_{(i)} \quad w_i^O = \{1,0,\ldots,0\}$

b. Purely pessimistic operator: $f^{\text{P}}_{\text{OWA}}(x_1, x_2, \ldots, x_k) = \sum_{i=1}^{k} w_i^P x_{(i)} \quad w_i^P = \{0,0,\ldots,1\}$

c. Average operator: $f^{\text{A}}_{\text{OWA}}(x_1, x_2, \ldots, x_k) = \sum_{i=1}^{k} w_i^A x_{(i)} \quad w_i^A = \left\{\frac{1}{k}, \frac{1}{k}, \ldots, \frac{1}{k}\right\}$

The optimistic operator f^{O}_{OWA} includes in the computation only the highest value of the x_i thus meaning full compensability among indicators. This is implicitly equivalent to an '*or*' multiple criteria condition, where the satisfaction of at least one criterion is enough.

On the other hand, the pessimistic operator f^{P}_{OWA} takes into account only the lowest value of the indicators, thus meaning no compensation at all across indicators. The worst case is taken as representative and this is equivalent to an '*and*' condition: all criteria must be satisfied.

in many cases the type of aggregation operator lies somewhere between these two extremes, as the f^{A}_{OWA} operator which is the simple arithmetic mean with equal weights.

In the case of RCI the three scenarios are computed at the sub_index level: for each pillar group and for each region the corresponding sub_index is computed using both f^{O}_{OWA} and f^{P}_{OWA} (the average OWA is equal to the sub_indices shown in Table 94, Section 6.1). These values are then compared to the reference RCI score, computed with the set of weights at their reference value according to the region development stage.

Figure 6-19 shows the reference RCI value, computed using average OWA operator for all the three sub_indices, and the 'optimistic' (blue line) and 'pessimistic' (red line) RCI scores. As expected, the two lines are always located respectively above and below the reference line, with the space between the two slightly increasing going form left to right of the picture (that is from best to worst regions). The important piece of information that can be deduced from this figure is the range of variability of each region. Indeed, regions with very low pessimistic RCI scores are also those with very high optimistic RCI scores. These regions (highlighted in Figure 6-19) are mostly influenced by compensability effects so that a change in the weighting scheme highly affects their final score. Their wide range of variability, associated to the different OWA operators, indicates high levels of heterogeneity of the sub-scores across each pillar group. In total about 15 regions seem to have a high range of variation. Further, as the distance between the average trend of the blue and the red line tends to increase going from left to right, low performing regions are more affected by compensability issues than the others.

Overall, given that the two OWA operators f^{O}_{OWA} and f^{P}_{OWA} are at the extreme ends of the aggregation decision-making process, OWA results can be considered rather satisfactory.

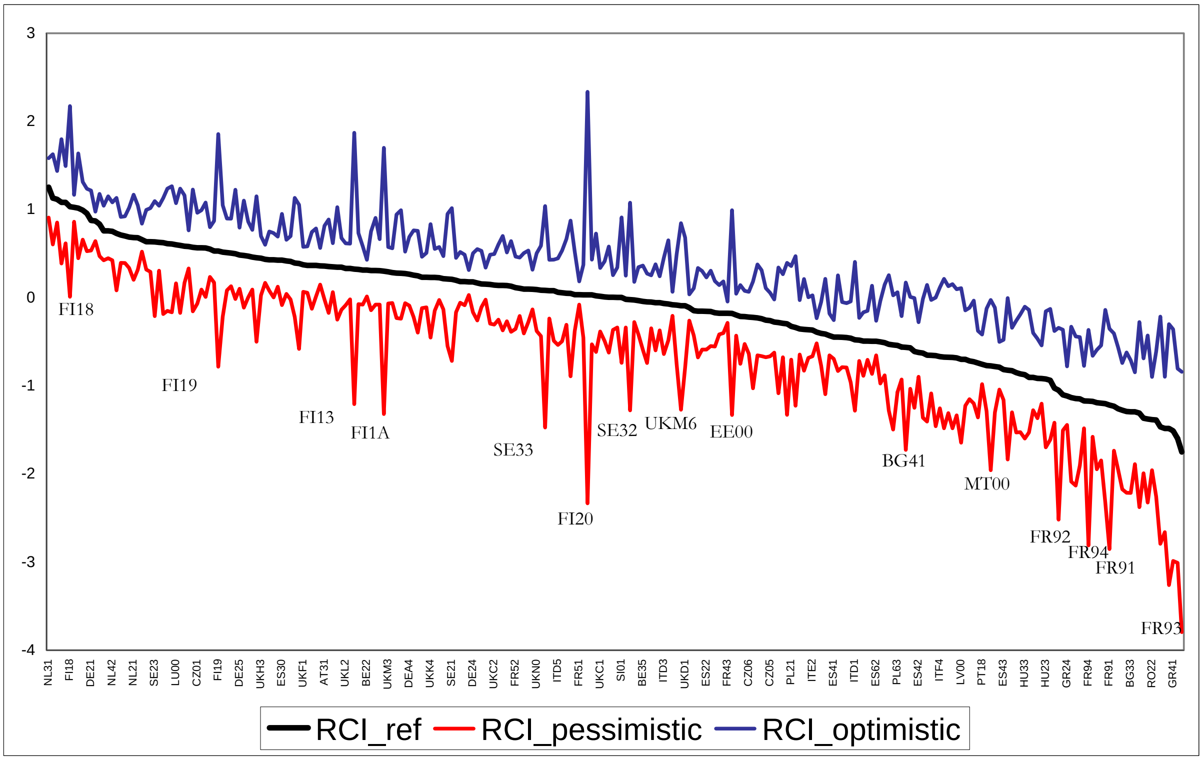


Figure 6-19: RCI scores computed with OWA operators

In conclusion, the uncertainty analysis detailed in this section supports the robustness of RCI. The index provides a synthetic picture of the level of competitiveness of Europe at the NUTS2 level representing a well balanced plurality of different fundamental aspects.

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1.1.07 Gross fixed capital formation
1.1.08 Gross fixed capital formation
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2.1.04 Total general government debt
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2.3.04 Country credit rating
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2.3.06 Exchange rate stability
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2.3.09 Adaptability of government policy
2.3.10 Government decisions
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3.2.02 Unit labor costs in the manufacturing sector
3.2.03 Remuneration in services professions
3.2.04 Remuneration of management
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3.2.09 Employee training
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3.2.11 Labor force
3.2.12 Labor force growth
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3.2.14 Female labor force
3.2.15 Foreign labor force
3.2.16 Skilled labor
3.2.17 Finance skills
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3.2.19 Brain drain
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3.4.02 Ethical practices
3.4.03 Credibility of managers
3.4.04 Corporate boards
3.4.05 Auditing and accounting practices
3.4.06 Shareholder value
3.4.07 Customer satisfaction
3.4.08 Entrepreneurship
3.4.09 Social responsibility
3.4.10 Health, safety & environmental concerns

3.5 Attitudes and Values
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3.5.02 Image abroad
3.5.03 National culture
3.5.04 Flexibility and adaptability
3.5.05 Need for economic and social reforms
3.5.06 Value system
3.5.07 Corporate values

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4.1.02 Arable area
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4.1.04 Access to commodities
4.1.05 Urbanization
4.1.06 Population - market size
4.1.07 Population under 15 years
4.1.08 Population over 65 years
4.1.09 Dependency ratio
4.1.10 Roads
4.1.11 Railroads
4.1.12 Air transportation
4.1.13 Quality of air transportation
4.1.14 Distribution infrastructure
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4.1.16 Maintenance and development
4.1.17 Energy infrastructure
4.1.18 Future energy supply
4.1.19 Total indigenous energy production
4.1.20 Total indigenous energy production per capita
4.1.21 Total indigenous energy production
4.1.22 Total final energy consumption
4.1.23 Total final energy consumption per capita
4.1.24 Electricity costs for industrial clients
4.2 Technological Infrastructure
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4.2.03 International fixed telephone costs
4.2.04 Mobile telephone subscribers
4.2.05 Mobile telephone costs
4.2.06 Communications technology
4.2.07 Computers in use
4.2.08 Computers per capita
4.2.09 Internet users
4.2.10 Internet costs
4.2.11 Broadband subscribers
4.2.12 Broadband costs
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4.2.14 Technological cooperation
4.2.15 Public and private sector ventures
4.2.16 Development and application of technology
4.2.17 Funding for technological development
4.2.18 Technological regulation
4.2.19 High-tech exports
4.2.20 High-tech exports
4.2.21 Cyber security
4.3 Scientific Infrastructure
4.3.01 Total expenditure on R&D
4.3.02 Total expenditure on R&D
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4.4.04 Health infrastructure
4.4.05 Life expectancy at birth
4.4.06 Healthy life expectancy
4.4.07 Infant mortality
4.4.08 Medical assistance
4.4.09 Urban population
4.4.10 Human development index
4.4.11 Health problems
4.4.12 Energy intensity
4.4.13 Paper and cardboard recycling rate
4.4.14 Waste water treatment plants
4.4.15 CO2 emissions
4.4.16 CO2 emissions intensity
4.4.17 Renewable energies
4.4.18 Ecological footprint
4.4.19 Sustainable development
4.4.20 Pollution problems
4.4.21 Environmental laws
4.4.22 Quality of life
4.5 Education
4.5.01 Total public expenditure on education
4.5.02 Total public expenditure on education per capita
4.5.03 Pupil-teacher ratio (primary education)
4.5.04 Pupil-teacher ratio (secondary education)
4.5.05 Secondary school enrollment
4.5.06 Higher education achievement
4.5.07 Student mobility inbound
4.5.08 Student mobility outbound
4.5.09 Educational assessment
4.5.10 English proficiency
4.5.11 Educational system
4.5.12 University education
4.5.13 Management education
4.5.14 Illiteracy
4.5.15 Economic literacy
4.5.16 Education in finance
4.5.17 Language skills
4.5.18 Qualified engineers
4.5.19 Knowledge transfer

Table A_3: Data sources (Huggins and Davies, 2006, pp. 36-37)

Data Sources

Europe

Eurostat - http://epp.eurostat.ec.europa.eu
EU Regional Policy - http://ec.europa.eu/regional_policy/index_en.htm
Paxis - http://www.cordis.lu/paxis/src/
OECD - http://oecd.org/statistics
International Reports - http://www.internationalreports.net/europe/
Innovating Regions in Europe - http://www.innovating-regions.org/
UK Trade and Investment Country Profiles - http://www.tradepartners.gov.uk
Business Patrol Country Reports - http://www.businesspatrol.com/

Austria

Austria Business Agency - http://www.aba.gv.at/en/pages/

Belgium

Fedichem - http://www.fedichem.be/EN/homeen.htm
Invest in Belgium - http://investinbelgium.fgov.be/
http://www.invest.belgium.be/
Agency for Foreign Trade - http://www.obcebdbh.be/menu/menule.html?ver=en
The Belgium Portal for Research and Innovation - http://www.research.be/
Brussels Enterprise Agency - www.investinbrussels.com

Finland

Invest in Finland - http://www.investinfinland.fi/
Association of Biotechnology Industry in Finland - http://www.finbio.net
Virtual Finland - http://virtual.finland.fi/
Finnish Regional Councils - http://www.reg.fi/english/engindex.html
Finnish Bioindustries - http://www.finbio.net/home.htm
Otaniemi Science Park Website - http://www.otech.fi/eng/
Uusimaa Regional Council - http://www.uudenmaanliitto.fi/eng/
Council of Oulu Region - http://www.pohjois-pohjanmaa.fi/k/e/kehys.htm
City of Helsinki - http://www.hel.fi

France

Tourist website of Paris-Ile de France Region - http://www.paris-ile-de-france.com/AN-world/home/home.asp?pays=UK

Germany

Elan - http://www.elanit.com/immediacy/main.asp?page=1918
Invest in Germany - http://www.invest-in-germany.de/en/
Invest in Baden-Wurtemburg - www.bw-invest.com
Invest in Bavaria - www.invest-in-bavaria.com
Ministry of State of Baden-Württemberg - http://www.baden-wuerttemberg.de/english/investieren/index.html
The Hessen Website - http://www.invest-in-hessen.de/she/index_js.htm

Ireland

IDA Ireland - http://www.idaireland.com/home/index.asp

Italy

Invest in Italy - http://www.investinitaly.com/
Invest in Emilia-Romagna - http://www.investinemiliaromagna.it/invest_inglese/index_eng.htm
Union Camere Emilia-Romagna - http://www.rer.camcom.it/welcome/default.htm
Invest in South Italy - http://www.italydati.it/asp/default.asp
Italian Biotech Directory - http://www.biodirectory.it/index.html

Luxembourg

Statistic Office - http://www.statec.lu/html_en/index.html
Luxembourg Tourist Office in London - http://www.luxembourg.co.uk/
Luxembourg Board of Economic Development, Ministry of the Economy - http://www.bed.public.lu/

Norway

Norway in the UK - http://www.norway.org.uk/

Sweden

Invest in Sweden Agency - www.isa.se
Gateway to Sweden - http://www.sweden.se/
Swedish Institute - www.si.se
Swiss Representations in Australia - http://www.eda.admin.ch/australia_all/e/home.html
http://www.itsweden.com/
www.biosweden.org
Swedish Science and Technology Park - www.swedepark.se
The Swedish Research Council - http://www.vr.se/english/index.asp
Education and Research in Sweden - http://utbildning.regeringen.se/inenglish/educresearch/research.htm
Stockholm County Council - http://www.sll.se/international/default.asp
City of Stockholm - www.stockholm.se
Business Arena Stockholm - http://www.bas.stockholm.se/
TIME:Stockholm - http://www.time.stockholm.se/eng/index.html
Karolinska Institutet - www.ki.se
Kista Science Park - http://www.kista.com/

Switzerland

Science and Innovation in Switzerland - http://www.swiss-science.org/
Location Switzerland - http://www.standortschweiz.ch/seco/internet/en/index.html

United Kingdom

UK Trade and Investment - http://www.invest.uk.com/
Department of Trade and Industry - www.dti.gov.uk

Appendix B – Indicator on the strength of regional clusters

We are proposing to use the 'European Cluster Observatory' database for measuring the development level of clusters at the regional level.

The European Cluster Observatory (www.clusterobservatory.eu) (ECO) is a new platform for information on clusters produced by the Center for Strategy and Competitiveness at the Stockholm School of Economics and financed by DG Enterprise and Industry, under the Europe INNOVA programme.

The Cluster Mapping part of the ECO considers regions, at the spatial level, and sectors, at the industrial level. By combining the two dimensions of geography and industry, it statistically traces regional agglomerations of employment[18], defined as statistical regional clusters, across EU 27 at the NUTS 2 level. Exceptions are Belgium, Greece, and the Netherlands, where the NUTS 1 level is used in order to obtain comparability in terms of land area and employment, and for Ireland due to data availability.

The database evaluates the strength of regional clusters based on three criteria – size, focus and specialization, and consequently assigns each cluster from one (less strong) to three stars (very strong).

The rationale behind the *size* measure implies that if employment reaches a sufficient share in proportion to total European employment, it is more likely that meaningful economic effects will be present. Thus, if a cluster is in the top 10% of all clusters within the same cluster category in terms of the number of employees, it is evaluated as strong and receives a star.

The *specialization* measure compares the proportion of employment in a cluster category in a region over the total employment in the same region, to the proportion of total European employment in that cluster category over total European employment. If a cluster category receives a quotient of 2 or more, it is evaluated as strong and receives a star. The rationale is that if a region is more specialized in a specific cluster category than the overall economy across all regions, this is likely to be an indication that the economic effects of the regional

[18] EU employment data is collected from the Labour Force Survey (LFS) and from the Structural Business Statistics (SBS), administrated by Eurostat and has been integrated with data from National Statistical Offices. A detailed list of all sources is available at: http://www.clusterobservatory.eu/index.php?id=47&nid.

cluster have been strong enough to attract related economic activity from other regions to this location, and consequently spillovers and linkages will be stronger.

The *focus* measure shows the extent to which the regional economy is focused on the industries comprising the cluster category. It relates employment in the cluster to total employment in the region. The top 10% of clusters which account for the largest proportion of their region's total employment are evaluated as strong and receive a star

The general logic of the database is that the higher the number of stars, the larger and more specialized the regional cluster.

Below is an example of the information available from the Observatory:

European Cluster Observatory

Cluster Mapping Database

Home
Cluster Mapping
Cluster Organisations
Cluster Policies
Cluster Library
Join Observatory
Methodology
Links
Contact

Search

» Search

Region	Cluster category	Data
Austria, all	**All**	**Star**
» Select country/region	» Select cluster category	» Se

map | table

All regional clusters in Austria

1, 2 and 3 star regional clusters

Region	Cluster category	Employees	Size	Spec.	Focus	Stars
Wien	Transportation	80 002	1.30%	2.69	9.02%	***
Tirol	Hospitality	29 486	0.80%	5.36	10.68%	***
Wien	Finance	64 639	0.91%	1.89	7.29%	**
Oberösterreich	Production Tech.	17 696	0.78%	2.54	3.14%	**
Salzburg	Hospitality	17 152	0.47%	3.17	6.32%	**
Wien	Communications	14 224	1.79%	3.70	1.60%	**
Steiermark	Automotive	12 782	0.49%	2.10	2.97%	**
Kärnten	Hospitality	11 239	0.31%	2.89	5.76%	**
Vorarlberg	Hospitality	7 058	0.19%	2.35	4.67%	**
Vorarlberg	Textiles	5 488	0.30%	3.71	3.64%	**
Oberösterreich	Sporting	3 211	1.51%	4.92	0.57%	**
Salzburg	Sporting	1 738	0.82%	5.54	0.64%	**

In order to evaluate the state of cluster development in a NUTS 2 region, we propose to use two indicators – the number of clusters and the relative strength (measured as the number of starts given to a cluster). Thus, we imply a relation where regions with more regional clusters and higher strength (given by the median number of stars per region) imply higher competitiveness.

Data limitation have led to the use of employment data for identifying and evaluating clusters in the ECO database, creating a bias towards employment-intensive clusters as both the size and focus measures are sensitive to the size of employment. Thus, in order to account for the importance of and emphasize the role of technology and knowledge-intensive clusters for the innovative capacity of regions and their competitiveness, we suggest complementing the overall evaluation of cluster development within a region (measured as the total number of clusters and their relative strength) by adding the number and relative strength of technology and knowledge-intensive clusters only.

Out of the 38 cluster categories[19] used by the European Cluster Observatory, we have identified the following 14 as being technology and knowledge-intensive[20] cluster categories:

- Aerospace
- Analytical Instruments
- Automotive
- Business Services
- Chemical Products
- Communications Equipment
- Education and Knowledge Creation
- Heavy Machinery
- Financial Services
- Information Technology
- Medical Devices
- Biopharmaceuticals
- Power Generation and Transmission
- Production Technology

Thus, we are proposing to consider four sub_indicators (number of clusters and their relative strength for all cluster categories and number of clusters and their relative strength for knowledge-intensive category) to be aggregated into a single indicator for the overall measure for the level of cluster development in regions and included in the Business sophistication pillar (Sect. 3.10, main text).

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[19] The full list of cluster categories is available at http://www.clusterobservatory.eu/index.php?id=46&nid.

[20] We have used the identification of Technology and Knowledge-intensive sectors used by Eurostat and available at http://europa.eu.int/estatref/info/sdds/en/hrst/hrst_sectors.pdf

Appendix C – List of candidate indicators

pillar		indicator id	Indicators	source	geographical level	unit of measurement	periodicity	reference year taken	Notes	included (I)/ discarded (D)	reason for discarding
Institutions	1	1.1	Corruption is a major problem in (OUR COUNTRY)	Special Eurobarometer 325	country	survey data - % of respondents	one time 2009	2009		I	
Institutions	1	1.2	There is corruption in regional institutions in (OUR COUNTRY)	Special Eurobarometer 325	country	survey data - % of respondents	one time 2009	2009		I	
Institutions	1	1.3	Perceived extent to which the state budget is defrauded	Flash Eurobarometer 2008	country	survey data - % of respondents	one time 2008	2008		I	
Institutions	1	1.4	Perceived extent of corruption or other wrongdoing in the national government institutions	Flash Eurobarometer 2008	country	survey data - % of respondents	one time 2008	2008		I	
Institutions	1	1.5	Voice and accountability	Worldbank Worldwide Governance Indicators	country	score ranging from -2.5 to 2.5 & % rank (0-100)	yearly	2008		I	
Institutions	1	1.6	Political stability	Worldbank Worldwide Governance Indicators	country	score ranging from -2.5 to 2.5 & % rank (0-100)	yearly	2008		I	
Institutions	1	1.7	Government effectiveness	Worldbank Worldwide Governance Indicators	country	score ranging from -2.5 to 2.5 & % rank (0-100)	yearly	2008		I	
Institutions	1	1.8	Regulatory quality	Worldbank Worldwide Governance Indicators	country	score ranging from -2.5 to 2.5 & % rank (0-100)	yearly	2008		I	
Institutions	1	1.9	Rule of law	Worldbank Worldwide Governance Indicators	country	score ranging from -2.5 to 2.5 & % rank (0-100)	yearly	2008		I	
Institutions	1	1.10	Control of corruption	Worldbank Worldwide Governance Indicators	country	score ranging from -2.5 to 2.5 & % rank (0-100)	yearly	2008		I	
Institutions	1	1.11	Easy of doing business	Worldbank	country	rank out of 181 (better express as percentage out of 181)	yearly	June 2008-May 2009		I	
Macroeconomic stability	2	2.1	General government deficit/surplus	Eurostat	country	% of GDP	yearly	average 2006-2008		I	
Macroeconomic stability	2	2.2	Income, saving and net lending/borrowing	Eurostat	country	% of GDP	yearly	average 2006-2008		I	
Macroeconomic stability	2	2.3	Inflation	Eurostat	country	% annual change	yearly	average 2006-2008		I	

Macroeconomic stability	2	2.4	Long-term bond yields	Eurostat	country	annual average rate of change	yearly	average 2006-2008		I	
Macroeconomic stability	2	2.5	Government gross debt	Eurostat	country	% of GDP	yearly	average 2006-2008		D	multivariate analysis
Infrastructure	3	3.1	Motorway density	Eurostat/DG TREN/EuroGeographics/National Statistical Institutes	NUTS2	combined index (average pop/area), EU27=100	yearly	2006		I	
Infrastructure	3	3.2	Railway density	Eurostat/DG TREN/EuroGeographics/National Statistical Institutes	NUTS2	combined index (average pop/area), EU27=100	yearly	2007		I	
Infrastructure	3	3.3	Number of passenger flights (accessible within 90' drive)	Eurostat/EuroGeographics/National Statistical Institutes	NUTS2	daily no. of passenger flights	yearly (from 2006 onwards)	2007		I	
Health	4	4.1	Hospital beds	Eurostat Regional Health Statistics	NUTS2	number of hospital beds/100,000 inhabitants	yearly	2007		D	multivariate analysis
Health	4	4.2	Road fatalities	Eurostat, CARE, ITF, NSIs, DG Regional Policy	NUTS2	number of deaths in road accidents per million inhabitants	yearly	average 2004-2006		I	
Health	4	4.3	Healthy life expectancy	Eurostat, DG Regional Policy	NUTS2	number of years of healthy life expected	yearly	2007		I	
Health	4	4.4	Infant mortality	Eurostat Regional Health Statistics	NUTS2	number of deaths of children under 1 year of age during the year to the number of live births in that year	yearly	2007		I	
Health	4	4.5	Cancer disease death rate	DG Regional Policy	NUTS2	standardized cancer death rate for population under 65 (neoplasm C00-D48)	yearly	average 2006-2008		I	
Health	4	4.6	Heart disease death rate	Eurostat, DG Regional Policy	NUTS2	standardized heart diseases death rate for population under 65 (diseases of the circulatory system I00-I99)	yearly	average 2006-2008		I	
Health	4	4.7	Suicide death rate	Eurostat, DG Regional Policy	NUTS2	standardized death rate for suicide for population under 65 (intentional self-harm X60-X84)	yearly	average 2006-2008		I	
Quality of primary & secondary education	5	5.1	Share of low-achieving 15 years olds in reading	OECD Programme for International Student Assessment (PISA)	country	% of students with reading proficiency level 1 or below	every three years	2006		I	
Quality of primary & secondary education	5	5.2	Share of low-achieving 15 years olds in math	OECD Programme for International Student Assessment (PISA)	country	% of students with math proficiency level 1 or below	every three years	2006		I	
Quality of primary & secondary education	5	5.3	Share of low-achieving 15 years olds in science	OECD Programme for International Student Assessment (PISA)	country	% of students with science proficiency level 1 or below	every three years	2006		I	

Quality of primary & secondary education	5	5.4	**Teacher/pupil ratio**	**Eurostat Educational Statistics**	country	ratio of students to teachers (ISCED 1-3)	yearly	2007		D	multivariate analysis
Quality of primary & secondary education	5	5.5	**Financial aid to students ISCED 1-4**	**Eurostat Educational Statistics**	country	% of total public expenditure on education	yearly	2006		D	multivariate analysis
Quality of primary & secondary education	5	5.6	**Public expenditure ISCED 1**	**Eurostat Educational Statistics**	country	% of GDP	yearly	2006		D	multivariate analysis
Quality of primary & secondary education	5	5.7	**Public expenditure ISCED 2-4**	**Eurostat Educational Statistics**	country	% of GDP	yearly	2006		D	multivariate analysis
Quality of primary & secondary education	5	5.8	**Participation in early childhood education**	**Eurostat Educational Statistics**	country	% of pupils between 4-years-olds and starting of compulsory primary	yearly	2007		D	multivariate analysis
Higher education & training	6	6.1	**Population aged 25-64 with higher educational attainment (ISCED 5-6)**	**Eurostat (LFS)**	NUTS2	% of total population of age group	yearly	2007		I	
Higher education & training	6	6.2	**Lifelong learning**	**Eurostat Regional Education Statistics**	NUTS 2	% of population aged 25-64 participating in education and training	yearly	2007		I	
Higher education & training	6	6.3	**Early school leavers**	**Eurostat Structural Indicators**	NUTS2	% of the population aged 18-24 having attained at most lower secondary school and not going further	yearly	average 2006/2007		I	
Higher education & training	6	6.4	**Accessibility to universities**	**Nordregio, EuroGeographics, GISCO, EEA ETC-TE**	NUTS2	% of regional population at more than 60 minutes from the nearest university	one time 2006	2006		I	
Higher education & training	6	6.5	**Higher education expenditure**	**Eurostat Educational Statistics**	country	total public expenditure as % of GDP at levels ISCED 5-6	yearly	2006	imputed at the NUTS 2 level according to the imputation method described in section 4.2.1	I	
Labor market efficiency	7	7.1	**Employment rate (excluding agriculture)**	**Eurostat Regional Labour Market Statistics (LFS)**	NUTS 2	% of population 15-64 years	yearly	2008		I	
Labor market efficiency	7	7.2	**Long-term unemployment**	**Eurostat Regional Labour Market Statistics (LFS)**	NUTS 2	% of labor force unemployed for 12 months or more	yearly	2008		I	
Labor market efficiency	7	7.3	**Unemployment rate**	**Eurostat Regional Labour Market Statistics (LFS)**	NUTS 2	% of active population	yearly	2008		I	
Labor market efficiency	7	7.4	**Job mobility**	**Eurostat Regional Labour Market Statistics (LFS)**	NUTS 2	% of total employment (people who started to work for the current employer or as self-employed in the last 2 years)	yearly	2007		D	multivariate analysis
Labor market efficiency	7	7.5	**Labor productivity**	**Eurostat Regional Labour Market Statistics (LFS)**	NUTS 2	GDP/person employed in industry and services (€), Index, EU27 = 100	yearly	2007		I	

Labor market efficiency	7	7.6	Gender balance unemployment	Eurostat, DG Regional Policy	NUTS 2	% difference between female and male unemployed	yearly	2008		I	
Labor market efficiency	7	7.7	Gender balance employment	Eurostat, DG Regional Policy	NUTS 2	% difference between female and male unemployed	yearly	2008		I	
Labor market efficiency	7	7.8	Female unemployment	Eurostat Regional Labour Market Statistics (LFS)	NUTS 2	% of female unemployed	yearly	2008		I	
Labor market efficiency	7	7.9	Labor market policies	Eurostat Labor Market Policy Statistics	country	% of GDP spent on public expenditure on labor market policies	yearly	2007	imputed at the NUTS 2 level according to the imputation method described in section 4.2.1	D	multivariate analysis
Market size	8	8.1	GDP	Eurostat Regional Economic Accounts	NUTS2	PPS index (EU27=100)	yearly	2007		I	
Market size	8	8.2	Compensation of employees	Eurostat Regional Economic Accounts	NUTS2	millions of euro	yearly	2006		I	
Market size	8	8.3	Disposable income	Eurostat, DG Regional Policy estimates	NUTS2	net adjusted disposable household income in millions of ppcs	yearly	2006		I	
Market size	8	8.4	Potential market size expressed in GDP	Eurostat, DG Regional Policy estimates	NUTS2	index GDP (pps) EU27=100	yearly	2007		I	
Market size	8	8.5	Potential market size expressed in population	Eurostat, DG Regional Policy estimates	NUTS2	index population EU27=100	one time 2000	2000		I	
Technological readiness	9	9.1	Households with access to broadband	Eurostat Regional Information Statistics	NUTS2	% of total households	yearly	2009		I	
Technological readiness	9	9.2	Individuals who ordered goods or services over the Internet for private use	Eurostat Regional Information Statistics	NUTS2	% of individuals	yearly	2009		I	
Technological readiness	9	9.3	Household with access to internet	Eurostat Regional Information Statistics	NUTS2	% of total households	yearly	2009		I	
Technological readiness	9	9.4	Enterprises use of computers	Eurostat Community Survey on ICT usage and e-commerce	country	% of enterprises	yearly	2009	regional data available for some countries but not all, so country values have been taken instead	I	
Technological readiness	9	9.5	Enterprises having access to Internet	Eurostat Community Survey on ICT usage and e-commerce	country	% of enterprises	yearly	2009	regional data available for some countries but not all, so country values have been taken instead	I	
Technological readiness	9	9.6	Enterprises having a website or a homepage	Eurostat Community Survey on ICT usage and e-commerce	country	% of enterprises	yearly	2009	regional data available for some countries but not all, so country values have been taken instead	I	

Technological readiness	9	9.7	**Enterprises using Intranet**	**Eurostat Community Survey on ICT usage and e-commerce**	country	% of enterprises	yearly	2009		I		
Technological readiness	9	9.8	**Enterprises using internal networks (e.g. LAN)**	**Eurostat Community Survey on ICT usage and e-commerce**	country	% of enterprises	yearly	2009		I		
Technological readiness	9	9.9	**Persons employed by enterprises which use Extranet**	**Eurostat Community Survey on ICT usage and e-commerce**	country	% of employees	yearly	2009		I		
Technological readiness	9	9.10	**Persons employed by enterprises which have access to the Internet**	**Eurostat Community Survey on ICT usage and e-commerce**	country	% of employees	yearly	2009		I		
Business sophistication	10	10.1	**Employment in the "Financial intermediation, real estate, renting and business activities" NACE sectors (J_K)**	**Eurostat Regional Labour Market Statistics**	NUTS2	% of total employment	yearly	2007		I		
Business sophistication	10	10.2	**Gross Value Added (GVA) at basic prices for NACE sectors J_K (NACE)**	**Eurostat Regional Economic Statistics**	NUTS2	% of total GVA	yearly	2007		I		
Business sophistication	10	10.3	**FDI intensity**	**ISLA-Bocconi**	NUTS2	number of new foreign firms per mln. inhabitant	every three years	average 2005-2007		I		
Business sophistication	10	10.4	**Aggregate indicator for strength of regional clusters**	**European Cluster Observatory**	NUTS 2	score (for more details see Appendix B)	reference year 2006	2006		I		
Business sophistication	10	10.5	**Venture capital (investments early stage)**	**Eurostat, European Private Equity and Venture Capital Association (EVCA)**	country	% of GDP	yearly	2007		D	high percentage of missing values	
Business sophistication	10	10.6	**Venture capital (expansion-replacement)**	**Eurostat, European Private Equity and Venture Capital Association (EVCA)**	country	% of GDP	yearly	2007		D	high percentage of missing values	
Business sophistication	10	10.7	**Venture capital (buy outs)**	**Eurostat, European Private Equity and Venture Capital Association (EVCA)**	country	% of GDP	yearly	2007		D	high percentage of missing values	
Innovation	11	11.1	**Innovation patent applications**	**OECD REGPAT**	NUTS2	number of applications per million inhabitants	yearly	average 2005-2006		I		
Innovation	11	11.2	**Total patent applications**	**OECD REGPAT**	NUTS2	number of applications per million inhabitants	yearly	average 2005-2006		I		
Innovation	11	11.3	**Core Creativity Class employment**	**Eurostat (LFS)**	NUTS 2	% of population aged 15-64	yearly	average 2006-2007		I		
Innovation	11	11.4	**Knowledge workers**	**Eurostat (LFS)**	NUTS 2	% of total employment	yearly	2006		I		
Innovation	11	11.5	**Scientific publications**	**Thomson Reuters Web of Science & CWTS database (Leiden University)**	NUTS2	publications per million inhabitants	yearly	average 2005-2006		I		

Innovation	11	11.6	**Total intramural R&D expenditure**	**Eurostat Regional Science and Technology Statistics**	NUTS2	% of GDP	yearly	2007		I	
Innovation	11	11.7	**Human Resources in Science and Technology (HRST)**	**Eurostat Regional Science and Technology Statistics**	NUTS2	% of labour force	yearly	2008		I	
Innovation	11	11.8	**Employment in technology and knowledge-intensive**	**Eurostat Regional Science and Technology Statistics**	NUTS2	% of total employment	yearly	2008		I	
Innovation	11	11.9	**High-tech inventors**	**OECD REGPAT**	NUTS2	number of inventors (authors of high technology EPO patent applications) per million inhabitants	yearly	average 2005-2006		I	
Innovation	11	11.10	**ICT inventors**	**OECD REGPAT**	NUTS2	number of inventors (authors of ICT EPO patent applications) per million inhabitants	yearly	average 2005-2006		I	
Innovation	11	11.11	**Biotechnology inventors**	**OECD REGPAT**	NUTS2	number of inventors (authors of biotechnology EPO patent applications) per million inhabitants	yearly	average 2005-2006		I	

Appendix D – NUTS 2 region description and population size

NUTS2 regions and their population size 2004-2008

Region Code	Region ID	geo/time	2004	2005	2006	2007	2008	mean_pop_04_08
BE21	1	Prov. Antwerpen	1668812	1676858	1688493	1700570	1715707	1690088
BE22	2	Prov. Limburg (B)	805786	809942	814658	820272	826690	815470
BE23	3	Prov. Oost-Vlaanderen	1373720	1380072	1389450	1398253	1408484	1389996
BE25	4	Prov. West-Vlaanderen	1135802	1138503	1141866	1145878	1150487	1142507
BE32	5	Prov. Hainaut	1283200	1286275	1290079	1294844	1300097	1290899
BE33	6	Prov. Liège	1029605	1034024	1040297	1047414	1053722	1041012
BE34	7	Prov. Luxembourg (B)	254120	256004	258547	261178	264084	258787
BE35	8	Prov. Namur	452856	455863	458574	461983	465380	458931
BE00	9	Bruxelles Capital + Vlaams Brabant + Brabant Wallon	2392520	2408311	2429418	2454142	2482215	2433321
BG31	10	Severozapaden	991165	974704	957947	943664	929872	959470
BG32	11	Severen tsentralen	967046	958755	949401	941240	931950	949678
BG33	12	Severoiztochen	1005991	1001668	996831	993549	992081	998024
BG34	13	Yugoiztochen	1146704	1139926	1134741	1129846	1125982	1135440
BG41	14	Yugozapaden	2110036	2114815	2118855	2116791	2114568	2115013
BG42	15	Yuzhen tsentralen	1580331	1571181	1560975	1554200	1545785	1562494
CZ01	16	Praha	1165581	1170571	1181610	1188126	1212097	1183597
CZ02	17	Strední Cechy	1135795	1144071	1158108	1175254	1201827	1163011
CZ03	18	Jihozápad	1175654	1175330	1179294	1184543	1194338	1181832
CZ04	19	Severozápad	1125117	1126721	1127447	1127867	1138629	1129156
CZ05	20	Severovýchod	1480771	1480144	1483423	1488168	1497560	1486013
CZ06	21	Jihovýchod	1640081	1640354	1641125	1644208	1654211	1643996
CZ07	22	Strední Morava	1228179	1225832	1229303	1229733	1232571	1229124
CZ08	23	Moravskoslezsko	1260277	1257554	1250769	1249290	1249897	1253557
DK01	24	Hovedstaden	:	:	:	1636749	1645825	1641287
DK02	25	Sjælland	:	:	:	816118	819427	817773
DK03	26	Syddanmark	:	:	:	1189817	1194659	1192238
DK04	27	Midtjylland	:	:	:	1227428	1237041	1232235
DK05	28	Nordjylland	:	:	:	576972	578839	577906
DE11	29	Stuttgart	3994612	4003172	4007373	4005380	4007095	4003526
DE12	30	Karlsruhe	2722550	2727733	2732455	2734260	2739274	2731254
DE13	31	Freiburg	2178813	2185027	2190727	2193178	2196410	2188831
DE14	32	Tübingen	1796581	1801487	1805146	1805935	1806976	1803225
DE21	33	Oberbayern	4195673	4211118	4238195	4279112	4313446	4247509
DE22	34	Niederbayern	1194472	1196178	1196923	1193820	1194138	1195106
DE23	35	Oberpfalz	1089826	1090289	1089543	1087939	1086684	1088856
DE24	36	Oberfranken	1109674	1106541	1101390	1094525	1088845	1100195
DE25	37	Mittelfranken	1706615	1708972	1712275	1712622	1714123	1710921
DE26	38	Unterfranken	1344740	1344629	1341481	1337876	1334767	1340699
DE27	39	Schwaben	1782386	1786166	1788919	1786764	1788329	1786513
DE30	40	Berlin	3388477	3387828	3395189	3404037	3416255	3398357
DE41	41	Brandenburg - Nordost	1167493	1163924	1159168	1153722	1147653	1158392
DE42	42	Brandenburg - Südwest	1407028	1403780	1400315	1394050	1388084	1398651
DE50	43	Bremen	663129	663213	663467	663979	663082	663374
DE60	44	Hamburg	1734083	1734830	1743627	1754182	1770629	1747470
DE71	45	Darmstadt	3762995	3775025	3778124	3772906	3780232	3773856
DE72	46	Gießen	1065467	1064228	1061323	1057553	1053259	1060366
DE73	47	Kassel	1260966	1258512	1252907	1244900	1239064	1251270
DE80	48	Mecklenburg-Vorpommern	1732226	1719653	1707266	1693754	1679682	1706516
DE91	49	Braunschweig	1662595	1658918	1650435	1641776	1633318	1649408
DE92	50	Hannover	2167157	2166626	2163919	2160253	2156841	2162959
DE93	51	Lüneburg	1698434	1702971	1704133	1702938	1701132	1701922
DE94	52	Weser-Ems	2465229	2472394	2475459	2477718	2480393	2474239
DEA1	53	Düsseldorf	5245132	5237855	5226648	5217129	5208288	5227010
DEA2	54	Köln	4350368	4363797	4378622	4384669	4391062	4373704
DEA3	55	Münster	2625745	2624489	2622623	2619372	2614361	2621318
DEA4	56	Detmold	2071803	2072488	2069758	2065413	2059198	2067732
DEA5	57	Arnsberg	3786638	3776723	3760454	3742162	3723712	3757938
DEB1	58	Koblenz	1527919	1527507	1521494	1513939	1507919	1519756
DEB2	59	Trier	513755	513861	513363	515819	515972	514554
DEB3	60	Rheinhessen-Pfalz	2017008	2019737	2023986	2023102	2021752	2021117
DEC0	61	Saarland	1061376	1056417	1050293	1043167	1036598	1049570
DED1	62	Chemnitz	1568153	1553406	1537203	1520537	1503723	1536604
DED2	63	Dresden	1674343	1667676	1662482	1657114	1646716	1661666
DED3	64	Leipzig	1078941	1075202	1074069	1072123	1069761	1074019
DEE0	65	Sachsen-Anhalt	2522941	2494437	2469716	2441787	2412472	2468271
DEF0	66	Schleswig-Holstein	2823171	2828760	2832950	2834254	2837373	2831302
DEG0	67	Thüringen	2373157	2355280	2334575	2311140	2289219	2332674
EE00	68	Estonia	1351069	1347510	1344684	1342409	1340935	1345321
IE01	69	Border, Midlands and Western	1073820	1098144	1126474	1153796	1179280	1126303
IE02	70	Southern and Eastern	2953912	3011029	3082545	3158730	3222055	3085654
GR11	71	Anatoliki Makedonia, Thraki	605565	607847	607460	607205	606684	606952
GR12	72	Kentriki Makedonia	1909297	1911508	1919401	1927823	1935660	1920738
GR13	73	Dytiki Makedonia	294470	294508	294155	293864	293519	294103
GR14	74	Thessalia	737340	737583	737144	737034	736079	737036
GR21	75	Ipeiros	340854	341851	345100	348520	351786	345622
GR22	76	Ionia Nisia	218594	220398	223149	225879	228572	223318
GR23	77	Dytiki Ellada	730238	732292	734505	736899	738955	734578
GR24	78	Sterea Ellada	559351	558503	557364	556441	555069	557346
GR25	79	Peloponnisos	599199	598156	596621	595092	593378	596489
GR30	80	Attiki	3940099	3973326	4001911	4032456	4061326	4001824
GR41	81	Voreio Aigaio	203169	202402	201731	201083	200517	201780
GR42	82	Notio Aigaio	302549	303114	303980	304975	305966	304117
GR43	83	Kriti	599925	601263	602658	604469	606274	602918

ES11	84	Galicia	2706126	2712162	2718490	2723915	2735078	2719154
ES12	85	Principado de Asturias	1060065	1059133	1058330	1058059	1059136	1058945
ES13	86	Cantabria	545125	551085	557226	563611	570613	557532
ES21	87	Pais Vasco	2094909	2103441	2113052	2124235	2138739	2114875
ES22	88	Comunidad Foral de Navarra	573038	580616	588306	596236	606234	588886
ES23	89	La Rioja	288384	294347	300821	306254	311773	300316
ES24	90	Aragón	1228886	1243464	1258847	1275904	1297581	1260936
ES30	91	Comunidad de Madrid	5705620	5821054	5938391	6052583	6189297	5941389
ES41	92	Castilla y León	2462169	2469303	2477128	2486166	2501860	2479325
ES42	93	Castilla-la Mancha	1823013	1856787	1892657	1929947	1977596	1896000
ES43	94	Extremadura	1066149	1068799	1071339	1074419	1078908	1071923
ES51	95	Cataluña	6637355	6784145	6936148	7085308	7238051	6936201
ES52	96	Comunidad Valenciana	4400459	4518126	4641240	4759263	4892475	4642313
ES53	97	Illes Balears	931831	957953	985620	1014405	1045008	986963
ES61	98	Andalucia	7552978	7670365	7794121	7917397	8046131	7796198
ES62	99	Región de Murcia	1265983	1300083	1335347	1370802	1411623	1336768
ES63	100	Ciudad Autónoma de Ceuta (ES)	71456	71372	71414	71561	71989	71558
ES64	101	Ciudad Autónoma de Melilla (ES)	66956	67102	66412	67556	69699	67545
ES70	102	Canarias (ES)	1864840	1908698	1953361	1997010	2041468	1953075
FR10	103	Île de France	11319972	11399319	11532398	11616500	:	11467047
FR21	104	Champagne-Ardenne	1338759	1337672	1338850	1336000	:	1337820
FR22	105	Picardie	1877194	1880890	1894355	1898000	:	1887610
FR23	106	Haute-Normandie	1802229	1805955	1811055	1813000	:	1808060
FR24	107	Centre	2487618	2496654	2519567	2529500	:	2508335
FR25	108	Basse-Normandie	1442873	1445732	1456793	1460000	:	1451350
FR26	109	Bourgogne	1621257	1622542	1628837	1630000	:	1625659
FR30	110	Nord - Pas-de-Calais	4027031	4032135	4018644	4021500	:	4024828
FR41	111	Lorraine	2331578	2334245	2335694	2336500	:	2334504
FR42	112	Alsace	1794987	1806069	1815493	1826000	:	1810637
FR43	113	Franche-Comté	1138410	1141861	1150624	1154500	:	1146349
FR51	114	Pays de la Loire	3372044	3400745	3450329	3480500	:	3425905
FR52	115	Bretagne	3037548	3062117	3094534	3118500	:	3078175
FR53	116	Poitou-Charentes	1695885	1705347	1724123	1734000	:	1714839
FR61	117	Aquitaine	3054252	3080091	3119778	3146500	:	3100155
FR62	118	Midi-Pyrénées	2707262	2734954	2776822	2806000	:	2756260
FR63	119	Limousin	722644	724243	730920	733000	:	727702
FR71	120	Rhône-Alpes	5907972	5958320	6021293	6073500	:	5990271
FR72	121	Auvergne	1328308	1331380	1335938	1339000	:	1333657
FR81	122	Languedoc-Roussillon	2466221	2496871	2534144	2565000	:	2515559
FR82	123	Provence-Alpes-Côte d'Azur	4713095	4750947	4815232	4855000	:	4783569
FR83	124	Corse	274474	276911	294118	298500	:	286001
FR91	125	Guadeloupe (FR)	439998	444002	436926	439000	:	439982
FR92	126	Martinique (FR)	393005	396001	397732	400000	:	396685
FR93	127	Guyane (FR)	193997	197997	205954	213500	:	202862
FR94	128	Reunion (FR)	763204	774596	781962	790500	:	777566
ITC1	129	Piemonte	4270215	4330172	4341733	4352828	4401266	4339243
ITC2	130	Valle d'Aosta/Vallée d'Aoste	122040	122868	123978	124812	125979	123935
ITC3	131	Liguria	1577474	1592309	1610134	1607878	1609822	1599523
ITC4	132	Lombardia	9246796	9393092	9475202	9545441	9642406	9460587
ITD1	133	Provincia Autonoma Bolzano-Bozen	471635	477067	482650	487673	493910	482587
ITD2	134	Provincia Autonoma Trento	490829	497546	502478	507030	513357	502248
ITD3	135	Veneto	4642899	4699950	4738313	4773554	4832340	4737411
ITD4	136	Friuli-Venezia Giulia	1198187	1204718	1208278	1212602	1222061	1209169
ITD5	137	Emilia-Romagna	4080479	4151369	4187557	4223264	4275802	4183694
ITE1	138	Toscana	3566071	3598269	3619872	3638211	3677048	3619894
ITE2	139	Umbria	848022	858938	867878	872967	884450	866451
ITE3	140	Marche	1504827	1518780	1528809	1536098	1553063	1528315
ITE4	141	Lazio	5205139	5269972	5304778	5493308	5561017	5366843
ITF1	142	Abruzzo	1285896	1299272	1305307	1309797	1323987	1304852
ITF2	143	Molise	321697	321953	320907	320074	320838	321094
ITF3	144	Campania	5760353	5788986	5790929	5790187	5811390	5788369
ITF4	145	Puglia	4040990	4068167	4071518	4069869	4076546	4065418
ITF5	146	Basilicata	597000	596546	594086	591338	591001	593994
ITF6	147	Calabria	2011338	2009268	2004415	1998052	2007707	2006156
ITG1	148	Sicilia	5003262	5013081	5017212	5016861	5029683	5016020
ITG2	149	Sardegna	1643096	1650052	1655677	1659443	1665617	1654777
CY00	150	Cyprus	730367	749175	766414	778684	789258	762780
LV00	151	Latvia	2319203	2306434	2294590	2281305	2270894	2294485
LT00	152	Lithuania	3445857	3425324	3403284	3384879	3366357	3405140
LU00	153	Luxembourg (Grand-Duché)	454960	461230	469086	476187	483799	469052
HU10	154	Közép-Magyarország	2829704	2840972	2855670	2872678	2897317	2859268
HU21	155	Közép-Dunántúl	1112984	1110897	1108124	1107453	1104841	1108860
HU22	156	Nyugat-Dunántúl	1003185	1000348	1000142	999361	997939	1000195
HU23	157	Dél-Dunántúl	983612	977465	970700	967677	960088	971908
HU31	158	Észak-Magyarország	1280040	1271111	1261489	1251441	1236690	1260154
HU32	159	Észak-Alföld	1547003	1541818	1533162	1525317	1514020	1532264
HU33	160	Dél-Alföld	1360214	1354938	1347294	1342231	1334506	1347837
MT00	161	Malta	399867	402668	404346	407810	410290	404996
NL11	162	Groningen	574384	575072	574042	573614	573459	574114
NL12	163	Friesland (NL)	642066	642977	642230	642209	643189	642534
NL13	164	Drenthe	482415	483369	484481	486197	488135	484919
NL21	165	Overijssel	1105512	1109432	1113529	1116374	1119994	1112968
NL22	166	Gelderland	1966929	1972010	1975704	1979059	1983869	1975514
NL23	167	Flevoland	359904	365859	370656	374424	378688	369906
NL31	168	Utrecht	1162258	1171291	1180039	1190604	1201350	1181108
NL32	169	Noord-Holland	2587265	2599103	2606584	2613070	2626163	2606437
NL33	170	Zuid-Holland	3451942	3458381	3458875	3455097	3461435	3457146
NL34	171	Zeeland	379028	379978	380186	380497	380585	380055
NL41	172	Noord-Brabant	2406994	2411359	2415946	2419042	2424827	2415634
NL42	173	Limburg (NL)	1139335	1136695	1131938	1127805	1123705	1131896

AT11	174	Burgenland (A)	276640	278215	279317	280257	281190	279124
AT12	175	Niederösterreich	1556956	1569596	1581422	1589580	1597240	1578959
AT13	176	Wien	1598626	1626440	1651437	1664146	1677867	1643703
AT21	177	Kärnten	559078	559891	560300	560407	561094	560154
AT22	178	Steiermark	1192014	1197527	1202087	1203918	1205909	1200291
AT31	179	Oberösterreich	1389170	1396228	1402050	1405674	1408165	1400257
AT32	180	Salzburg	523185	526017	528351	529574	530576	527541
AT33	181	Tirol	686410	691783	697435	700427	703512	695913
AT34	182	Vorarlberg	358043	360827	363526	364940	366377	362743
PL11	183	Lódzkie	2597094	2587702	2577465	2566198	2555898	2576871
PL12	184	Mazowieckie	5135732	5145997	5157729	5171702	5188488	5159930
PL21	185	Malopolskie	3252949	3260201	3266187	3271206	3279036	3265916
PL22	186	Slaskie	4714982	4700771	4685775	4669137	4654115	4684956
PL31	187	Lubelskie	2191172	2185156	2179611	2172766	2166213	2178984
PL32	188	Podkarpackie	2097248	2097975	2098263	2097564	2097338	2097678
PL33	189	Swietokrzyskie	1291598	1288693	1285007	1279838	1275550	1284137
PL34	190	Podlaskie	1205117	1202425	1199689	1196101	1192660	1199198
PL41	191	Wielkopolskie	3359932	3365283	3372417	3378502	3386882	3372603
PL42	192	Zachodniopomorskie	1696073	1694865	1694178	1692838	1692271	1694045
PL43	193	Lubuskie	1008786	1009168	1009198	1008520	1008481	1008831
PL51	194	Dolnoslaskie	2898313	2893055	2888232	2882317	2878410	2888065
PL52	195	Opolskie	1055667	1051531	1047407	1041941	1037088	1046727
PL61	196	Kujawsko-Pomorskie	2068142	2068258	2068253	2066371	2066136	2067432
PL62	197	Warminsko-Mazurskie	1428885	1428714	1428601	1426883	1426155	1427848
PL63	198	Pomorskie	2188918	2194041	2199043	2203595	2210920	2199303
PT11	199	Norte	3711797	3727310	3737791	3744341	3745236	3733295
PT15	200	Algarve	405380	411468	416847	421528	426386	416322
PT16	201	Centro (PT)	2366691	2376609	2382448	2385891	2385911	2379510
PT17	202	Lisboa	2740237	2760697	2779097	2794226	2808414	2776534
PT18	203	Alentejo	767549	767679	765971	764285	760933	765283
PT20	204	Região Autónoma dos Açores (PT)	240024	241206	242241	243018	244006	242099
PT30	205	Região Autónoma da Madeira (PT)	243007	244286	245197	245806	246689	244997
RO11	206	Nord-Vest	2743281	2742676	2729181	2729256	2724176	2733714
RO12	207	Centru	2543512	2533421	2534378	2524176	2524628	2532023
RO21	208	Nord-Est	3742868	3735512	3734946	3727910	3722553	3732758
RO22	209	Sud-Est	2855044	2849959	2843624	2834335	2825756	2841744
RO31	210	Sud - Muntenia	3350248	3338195	3321392	3304840	3292036	3321342
RO32	211	Bucuresti - Ilfov	2208254	2209768	2215701	2232162	2242002	2221577
RO41	212	Sud-Vest Oltenia	2325020	2313903	2301833	2285733	2270776	2299453
RO42	213	Vest	1943025	1935094	1929158	1926707	1926700	1932137
SI01	214	Vzhodna Slovenija	1078747	1077922	1078992	1080901	1087771	1080867
SI02	215	Zahodna Slovenija	917686	919668	924366	929476	938095	925858
SK01	216	Bratislavský kraj	599787	601132	603699	606753	610850	604444
SK02	217	Západné Slovensko	1863932	1863940	1863056	1862227	1863740	1863379
SK03	218	Stredné Slovensko	1352452	1352497	1351882	1351088	1350366	1351657
SK04	219	Východné Slovensko	1563882	1567253	1570543	1573569	1576042	1570258
FI13	220	Itä-Suomi	669354	667056	664196	660859	657257	663744
FI18	221	Etelä-Suomi	2569358	2580801	2595823	2613925	2632744	2598530
FI19	222	Länsi-Suomi	1325241	1330371	1334293	1338973	1344565	1334689
FI1A	223	Pohjois-Suomi	629432	631853	634502	636275	638765	634165
FI20	224	Åland	26347	26530	26766	26923	27153	26744
SE11	225	Stockholm	1860872	1872900	1889945	1918104	1949516	1898267
SE12	226	Östra Mellansverige	1509841	1514549	1518077	1524509	1534529	1520301
SE21	227	Småland med öarna	798528	799739	800054	802247	805353	801184
SE22	228	Sydsverige	1302586	1311254	1320160	1335936	1351257	1324239
SE23	229	Västsverige	1796314	1805683	1814323	1827143	1838691	1816431
SE31	230	Norra Mellansverige	826949	826188	825037	824853	825000	825605
SE32	231	Mellersta Norrland	371750	371619	370764	370998	370386	371103
SE33	232	Övre Norrland	508830	509460	509392	509467	508195	509069
UKC1	233	Tees Valley and Durham	1150800	1153900	1156100	1161400	:	1155550
UKC2	234	Northumberland, Tyne and Wear	1393000	1394000	1396600	1398700	:	1395575
UKD1	235	Cumbria	492800	495000	495900	496500	:	495050
UKD2	236	Cheshire	991100	994900	998400	1001700	:	996525
UKD3	237	Greater Manchester	2530700	2538400	2548600	2558000	:	2543925
UKD4	238	Lancashire	1435200	1443000	1448100	1450600	:	1444225
UKD5	239	Merseyside	1360400	1358300	1355500	1351900	:	1356525
UKE1	240	East Yorkshire and Northern Lincolnshire	892000	898500	903000	906300	:	899950
UKE2	241	North Yorkshire	766300	773600	780200	786100	:	776550
UKE3	242	South Yorkshire	1276300	1283500	1290300	1296200	:	1286575
UKE4	243	West Yorkshire	2111100	2130200	2151500	2171200	:	2141000
UKF1	244	Derbyshire and Nottinghamshire	2014200	2027900	2040300	2051200	:	2033400
UKF2	245	Leicestershire, Rutland and Northants	1588100	1603600	1622200	1641200	:	1613775
UKF3	246	Lincolnshire	670500	677900	683400	689500	:	680325
UKG1	247	Herefordshire, Worcestershire and Warks	1237100	1243300	1250000	1256800	:	1246800
UKG2	248	Shropshire and Staffordshire	1501900	1507300	1511700	1515500	:	1509100
UKG3	249	West Midlands	2580200	2588100	2597000	2602000	:	2591825
UKH1	250	East Anglia	2231000	2254900	2277800	2299000	:	2265675
UKH2	251	Bedfordshire, Hertfordshire	1623200	1631600	1643400	1655600	:	1638450
UKH3	252	Essex	1638700	1650500	1663600	1679200	:	1658000
UKI00	253	Inner London + Outer London	7376600	7422600	7484200	7534600	:	7454500
UKJ1	254	Berkshire, Bucks and Oxfordshire	2119900	2134100	2151800	2170100	:	2143975
UKJ2	255	Surrey, East and West Sussex	2577400	2589500	2605200	2625000	:	2599275
UKJ3	256	Hampshire and Isle of Wight	1801900	1812300	1824400	1837300	:	1818975
UKJ4	257	Kent	1606800	1618900	1629700	1640800	:	1624050
UKK1	258	Gloucestershire, Wiltshire and Bristol/Bath area	2207000	2227500	2247500	2268200	:	2237550
UKK2	259	Dorset and Somerset	1206600	1211600	1217100	1225300	:	1215150
UKK3	260	Cornwall and Isles of Scilly	514900	519300	524000	529000	:	521800
UKK4	261	Devon	1094900	1105900	1116800	1128500	:	1111525
UKL1	262	West Wales and The Valleys	1871700	1877600	1881900	1888500	:	1879925
UKL2	263	East Wales	1067100	1072400	1077800	1084400	:	1075425
UKM2	264	Eastern Scotland	1914335	1927555	1941045	1956630	:	1934891
UKM3	265	South Western Scotland	2281495	2282733	2283402	2285807	:	2283359
UKM5	266	North Eastern Scotland	436775	438310	441240	445780	:	440526
UKM6	267	Highlands and Islands	435296	438003	440164	442333	:	438949
UKN0	268	Northern Ireland	1706475	1717365	1733013	1750384	:	1726809

Appendix E -- Definition of Potential Market Size in terms of GDP

The indicator on "potential market size", denoted 'potential GDP' in the MARKET SIZE pillar, provides an estimate of the GDP available within a pre-defined neighborhood, and taking into account the distance within this neighborhood.

Basic data necessary for the computation:

a) GDP/head in PPS, expressed as index of EU27 average, at NUTS2 level (source: Eurostat);

b) population distribution grid, at 1 km² resolution (= POPL_01) (sources: JRC population disaggregation grid, national statistical institutes, REGIO-GIS);

c) NUTS2 polygon geometry (and a derived 1 km² grid version of the NUTS2 geometry) (sources: Eurostat-GISCO and REGIO-GIS).

The computation of Potential Market Size expressed in GDP consists of the following steps:

1. To estimate GDP at the level of raster cells, values of regional GDP/head are transformed into a grid with 1 km² resolution: this grid (= GDPPC_01) is the raster version of the NUTS2 GDP/head map. The GDP/head grid is then multiplied by the population grid, to obtain an estimate of GDP per raster cell. This estimate assumes a uniform distribution of GDP/head throughout the NUTS2 region.

   GDP_01 = GDPPC_01 * POPL_01

   Further steps in the analysis are carried out at the level of 10*10 km raster cells. Therefore, the 1 km² GDP grid is aggregated to 100 km² grid cells, by summing the GDP over the 1 km² cells (result = GDP_10).

2. Around each 100 km² cell, a circular neighborhood with a radius of 100 km is defined. In this neighborhood, each cell obtains a weight varying between 100 in the centre of the neighborhood, and 0 at the outer limits of the neighborhood. For each cell of the territory, the focal sum of GDP in the neighborhood is calculated, weighted by the cell weights (i.e. inverse distance weighted). Finally, this sum is divided by 100 (because the maximum cell weight is 100).

3. To obtain regional and EU averages, the results at cell level is averaged at the level of NUTS2 regions or countries. In this way the cell values and the regional averages can be expressed as index of the European average. This transformation allows for an easier interpretation of the results: the index figure expresses how the GDP available in the neighborhood relates to the average GDP available in any neighborhood of the same size throughout the Union.

Appendix F – Stages of development of EU NUTS 2 regions

region_code	region	GDP (PPP per inhabitant in % of EU average) 2007	development stage
BE00	Bruxelles Capital+Vlaams Brabant+Brabant Wallon	154.6	HIGH
BE21	Prov. Antwerpen	135.7	HIGH
BE22	Prov. Limburg (B)	96.2	INTERMEDIATE
BE23	Prov.Oost Vlaanderen	104.6	HIGH
BE25	Prov. West-Vlaanderen	110.1	HIGH
BE32	Prov. Hainaut	75.3	INTERMEDIATE
BE33	Prov. Liège	85.3	INTERMEDIATE
BE34	Prov. Luxembourg (B)	78.1	INTERMEDIATE
BE35	Prov. Namur	79.7	INTERMEDIATE
BG31	Severozapaden	25.6	MEDIUM
BG32	Severen tsentralen	26.7	MEDIUM
BG33	Severoiztochen	32.4	MEDIUM
BG34	Yugoiztochen	30.7	MEDIUM
BG41	Yugozapaden	62.0	MEDIUM
BG42	Yuzhen tsentralen	27.2	MEDIUM
CZ01	Praha	171.8	HIGH
CZ02	Strední Cechy	75.2	INTERMEDIATE
CZ03	Jihozápad	71.1	MEDIUM
CZ04	Severozápad	61.7	MEDIUM
CZ05	Severovýchod	65.9	MEDIUM
CZ06	Jihovýchod	71.7	MEDIUM
CZ07	Strední Morava	62.3	MEDIUM
CZ08	Moravskoslezsko	67.5	MEDIUM
DK01	Hovedstaden	150.3	HIGH
DK02	Sjælland	91.4	INTERMEDIATE
DK03	Syddanmark	113.3	HIGH
DK04	Midtjylland	115.4	HIGH
DK05	Nordjylland	110.0	HIGH
DE11	Stuttgart	141.4	HIGH
DE12	Karlsruhe	132.2	HIGH
DE13	Freiburg	114.2	HIGH
DE14	Tübingen	125.3	HIGH
DE21	Oberbayern	164.7	HIGH
DE22	Niederbayern	115.8	HIGH
DE23	Oberpfalz	122.1	HIGH
DE24	Oberfranken	113.1	HIGH
DE25	Mittelfranken	132.5	HIGH
DE26	Unterfranken	117.5	HIGH
DE27	Schwaben	120.9	HIGH
DE30	Berlin	97.8	INTERMEDIATE
DE41	Brandenburg - Nordost	76.1	INTERMEDIATE
DE42	Brandenburg - Südwest	87.3	INTERMEDIATE
DE50	Bremen	158.6	HIGH
DE60	Hamburg	192.0	HIGH
DE71	Darmstadt	156.1	HIGH
DE72	Gießen	107.5	HIGH
DE73	Kassel	115.2	HIGH
DE80	Mecklenburg-Vorpommern	81.1	INTERMEDIATE
DE91	Braunschweig	111.4	HIGH

DE92	Hannover	110.8	HIGH
DE93	Lüneburg	83.7	INTERMEDIATE
DE94	Weser-Ems	101.0	HIGH
DEA1	Düsseldorf	127.6	HIGH
DEA2	Köln	118.0	HIGH
DEA3	Münster	98.3	INTERMEDIATE
DEA4	Detmold	109.4	HIGH
DEA5	Arnsberg	106.3	HIGH
DEB1	Koblenz	97.5	INTERMEDIATE
DEB2	Trier	94.2	INTERMEDIATE
DEB3	Rheinhessen-Pfalz	106.3	HIGH
DEC0	Saarland	114.5	HIGH
DED1	Chemnitz	82.6	INTERMEDIATE
DED2	Dresden	87.7	INTERMEDIATE
DED3	Leipzig	88.6	INTERMEDIATE
DEE0	Sachsen-Anhalt	83.6	INTERMEDIATE
DEF0	Schleswig-Holstein	99.5	INTERMEDIATE
DEG0	Thüringen	83.0	INTERMEDIATE
EE00	Estonia	68.8	MEDIUM
IE01	Border, Midlands and Western	99.2	INTERMEDIATE
IE02	Southern and Eastern	166.1	HIGH
GR11	Anatoliki Makedonia, Thraki	62.1	MEDIUM
GR12	Kentriki Makedonia	72.5	MEDIUM
GR13	Dytiki Makedonia	75.8	INTERMEDIATE
GR14	Thessalia	68.2	MEDIUM
GR21	Ipeiros	68.3	MEDIUM
GR22	Ionia Nisia	74.0	MEDIUM
GR23	Dytiki Ellada	59.8	MEDIUM
GR24	Sterea Ellada	83.9	INTERMEDIATE
GR25	Peloponnisos	75.7	INTERMEDIATE
GR30	Attiki	128.1	HIGH
GR41	Voreio Aigaio	66.6	MEDIUM
GR42	Notio Aigaio	96.2	INTERMEDIATE
GR43	Kriti	83.7	INTERMEDIATE
ES11	Galicia	88.8	INTERMEDIATE
ES12	Principado de Asturias	96.9	INTERMEDIATE
ES13	Cantabria	105.4	HIGH
ES21	Pais Vasco	136.8	HIGH
ES22	Comunidad Foral de Navarra	132.2	HIGH
ES23	La Rioja	112.0	HIGH
ES24	Aragón	114.4	HIGH
ES30	Comunidad de Madrid	136.8	HIGH
ES41	Castilla y León	101.4	HIGH
ES42	Castilla-la Mancha	81.5	INTERMEDIATE
ES43	Extremadura	72.4	MEDIUM
ES51	Cataluña	123.3	HIGH
ES52	Comunidad Valenciana	95.3	INTERMEDIATE
ES53	Illes Balears	113.8	HIGH
ES61	Andalucia	81.2	INTERMEDIATE
ES62	Región de Murcia	86.9	INTERMEDIATE
ES63	Ciudad Autónoma de Ceuta (ES)	97.3	INTERMEDIATE
ES64	Ciudad Autónoma de Melilla (ES)	94.5	INTERMEDIATE

ES70	Canarias (ES)	92.8	INTERMEDIATE
FR10	Île de France	168.7	HIGH
FR21	Champagne-Ardenne	99.7	INTERMEDIATE
FR22	Picardie	85.7	INTERMEDIATE
FR23	Haute-Normandie	98.4	INTERMEDIATE
FR24	Centre	95.3	INTERMEDIATE
FR25	Basse-Normandie	88.3	INTERMEDIATE
FR26	Bourgogne	94.5	INTERMEDIATE
FR30	Nord - Pas-de-Calais	88.2	INTERMEDIATE
FR41	Lorraine	88.7	INTERMEDIATE
FR42	Alsace	102.2	HIGH
FR43	Franche-Comté	90.1	INTERMEDIATE
FR51	Pays de la Loire	97.7	INTERMEDIATE
FR52	Bretagne	94.7	INTERMEDIATE
FR53	Poitou-Charentes	90.4	INTERMEDIATE
FR61	Aquitaine	98.2	INTERMEDIATE
FR62	Midi-Pyrénées	97.3	INTERMEDIATE
FR63	Limousin	87.7	INTERMEDIATE
FR71	Rhône-Alpes	109.5	HIGH
FR72	Auvergne	91.4	INTERMEDIATE
FR81	Languedoc-Roussillon	85.6	INTERMEDIATE
FR82	Provence-Alpes-Côte d'Azur	102.2	HIGH
FR83	Corse	84.5	INTERMEDIATE
FR91	Guadeloupe (FR)	76.4	INTERMEDIATE
FR92	Martinique (FR)	75.1	INTERMEDIATE
FR93	Guyane (FR)	48.7	MEDIUM
FR94	Reunion (FR)	62.5	MEDIUM
ITC1	Piemonte	113.6	HIGH
ITC2	Valle d'Aosta/Vallée d'Aoste	118.6	HIGH
ITC3	Liguria	106.8	HIGH
ITC4	Lombardia	134.8	HIGH
ITD1	Provincia Autonoma Bolzano-Bozen	134.5	HIGH
ITD2	Provincia Autonoma Trento	122.0	HIGH
ITD3	Veneto	121.6	HIGH
ITD4	Friuli-Venezia Giulia	116.6	HIGH
ITD5	Emilia-Romagna	128.0	HIGH
ITE1	Toscana	112.8	HIGH
ITE2	Umbria	96.9	INTERMEDIATE
ITE3	Marche	105.5	HIGH
ITE4	Lazio	122.3	HIGH
ITF1	Abruzzo	85.3	INTERMEDIATE
ITF2	Molise	77.9	INTERMEDIATE
ITF3	Campania	65.9	MEDIUM
ITF4	Puglia	66.8	MEDIUM
ITF5	Basilicata	75.0	INTERMEDIATE
ITF6	Calabria	65.8	MEDIUM
ITG1	Sicilia	66.0	MEDIUM
ITG2	Sardegna	78.4	INTERMEDIATE
CY00	Cyprus	93.6	INTERMEDIATE
LV00	Latvia	55.7	MEDIUM
LT00	Lithuania	59.3	MEDIUM
LU00	Luxembourg (Grand-Duché)	275.2	HIGH

HU10	Közép-Magyarország	102.9	HIGH
HU21	Közép-Dunántúl	58.2	MEDIUM
HU22	Nyugat-Dunántúl	61.5	MEDIUM
HU23	Dél-Dunántúl	42.7	MEDIUM
HU31	Észak-Magyarország	40.1	MEDIUM
HU32	Észak-Alföld	39.4	MEDIUM
HU33	Dél-Alföld	41.8	MEDIUM
MT00	Malta	76.4	INTERMEDIATE
NL11	Groningen	164.9	HIGH
NL12	Friesland (NL)	107.5	HIGH
NL13	Drenthe	103.6	HIGH
NL21	Overijssel	114.7	HIGH
NL22	Gelderland	113.5	HIGH
NL23	Flevoland	107.3	HIGH
NL31	Utrecht	155.4	HIGH
NL32	Noord-Holland	150.1	HIGH
NL33	Zuid-Holland	136.6	HIGH
NL34	Zeeland	121.6	HIGH
NL41	Noord-Brabant	134.4	HIGH
NL42	Limburg (NL)	119.4	HIGH
AT11	Burgenland (A)	81.3	INTERMEDIATE
AT12	Niederösterreich	100.1	HIGH
AT13	Wien	163.1	HIGH
AT21	Kärnten	104.6	HIGH
AT22	Steiermark	106.1	HIGH
AT31	Oberösterreich	119.9	HIGH
AT32	Salzburg	139.5	HIGH
AT33	Tirol	128.2	HIGH
AT34	Vorarlberg	128.1	HIGH
PL11	Lódzkie	50.0	MEDIUM
PL12	Mazowieckie	87.1	INTERMEDIATE
PL21	Malopolskie	46.7	MEDIUM
PL22	Slaskie	57.8	MEDIUM
PL31	Lubelskie	36.9	MEDIUM
PL32	Podkarpackie	36.7	MEDIUM
PL33	Swietokrzyskie	41.9	MEDIUM
PL34	Podlaskie	40.4	MEDIUM
PL41	Wielkopolskie	56.9	MEDIUM
PL42	Zachodniopomorskie	48.9	MEDIUM
PL43	Lubuskie	48.2	MEDIUM
PL51	Dolnoslaskie	59.2	MEDIUM
PL52	Opolskie	45.2	MEDIUM
PL61	Kujawsko-Pomorskie	47.3	MEDIUM
PL62	Warminsko-Mazurskie	40.5	MEDIUM
PL63	Pomorskie	53.6	MEDIUM
PT11	Norte	60.3	MEDIUM
PT15	Algarve	79.6	INTERMEDIATE
PT16	Centro (PT)	64.4	MEDIUM
PT17	Lisboa	104.7	HIGH
PT18	Alentejo	71.9	MEDIUM
PT20	Região Autónoma dos Açores (PT)	67.6	MEDIUM
PT30	Região Autónoma da Madeira (PT)	96.3	INTERMEDIATE

RO11	Nord-Vest	40.2	MEDIUM
RO12	Centru	42.2	MEDIUM
RO21	Nord-Est	26.6	MEDIUM
RO22	Sud-Est	33.8	MEDIUM
RO31	Sud - Muntenia	34.2	MEDIUM
RO32	Bucuresti - Ilfov	92.2	INTERMEDIATE
RO41	Sud-Vest Oltenia	32.7	MEDIUM
RO42	Vest	48.2	MEDIUM
SI01	Vzhodna Slovenija	73.1	MEDIUM
SI02	Zahodna Slovenija	106.7	HIGH
SK01	Bratislavský kraj	160.3	HIGH
SK02	Západné Slovensko	66.1	MEDIUM
SK03	Stredné Slovensko	53.3	MEDIUM
SK04	Východné Slovensko	46.0	MEDIUM
FI13	Itä-Suomi	88.8	INTERMEDIATE
FI18	Etelä-Suomi	135.6	HIGH
FI19	Länsi-Suomi	104.9	HIGH
FI1A	Pohjois-Suomi	102.3	HIGH
FI20	Åland	143.2	HIGH
SE11	Stockholm	164.6	HIGH
SE12	Östra Mellansverige	106.2	HIGH
SE21	Småland med öarna	110.0	HIGH
SE22	Sydsverige	110.1	HIGH
SE23	Västsverige	119.1	HIGH
SE31	Norra Mellansverige	108.1	HIGH
SE32	Mellersta Norrland	108.3	HIGH
SE33	Övre Norrland	115.1	HIGH
UKC1	Tees Valley and Durham	81.5	INTERMEDIATE
UKC2	Northumberland, Tyne and Wear	97.8	INTERMEDIATE
UKD1	Cumbria	89.7	INTERMEDIATE
UKD2	Cheshire	123.7	HIGH
UKD3	Greater Manchester	105.3	HIGH
UKD4	Lancashire	89.9	INTERMEDIATE
UKD5	Merseyside	83.2	INTERMEDIATE
UKE1	East Yorkshire and Northern Lincolnshire	90.5	INTERMEDIATE
UKE2	North Yorkshire	101.2	HIGH
UKE3	South Yorkshire	90.2	INTERMEDIATE
UKE4	West Yorkshire	103.5	HIGH
UKF1	Derbyshire and Nottinghamshire	100.6	HIGH
UKF2	Leicestershire, Rutland and Northants	114.4	HIGH
UKF3	Lincolnshire	83.3	INTERMEDIATE
UKG1	Herefordshire, Worcestershire and Warks	100.6	HIGH
UKG2	Shropshire and Staffordshire	89.0	INTERMEDIATE
UKG3	West Midlands	105.3	HIGH
UKH1	East Anglia	110.4	HIGH
UKH2	Bedfordshire, Hertfordshire	127.0	HIGH
UKH3	Essex	98.0	INTERMEDIATE
UKI	Inner London + Outer London	225.6	HIGH
UKJ1	Berkshire, Bucks and Oxfordshire	156.1	HIGH
UKJ2	Surrey, East and West Sussex	122.4	HIGH
UKJ3	Hampshire and Isle of Wight	116.9	HIGH
UKJ4	Kent	93.4	INTERMEDIATE

UKK1	Gloucestershire, Wiltshire and Bristol/Bath area	128.3	HIGH
UKK2	Dorset and Somerset	97.3	INTERMEDIATE
UKK3	Cornwall and Isles of Scilly	75.2	INTERMEDIATE
UKK4	Devon	88.6	INTERMEDIATE
UKL1	West Wales and The Valleys	73.4	MEDIUM
UKL2	East Wales	110.3	HIGH
UKM2	Eastern Scotland	119.9	HIGH
UKM3	South Western Scotland	103.6	HIGH
UKM5	North Eastern Scotland	152.9	HIGH
UKM6	Highlands and Islands	87.2	INTERMEDIATE
UKN0	Northern Ireland	92.8	INTERMEDIATE

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Abstract
The joint project between DG Joint Research Centre and DG Regional Policy on the construction of the EU Regional Competitiveness Index (RCI) aims at producing a composite indicator which measures the competitiveness of European regions at the NUTS 2 level for all EU Member States.
The concept of competitiveness has been largely discussed over the last decades. A broad notion of competitiveness refers to the inclination and skills to compete, to win and retain position in the market, increasing market share and profitability, thus, being commercially successful.
The concept of regional competitiveness which has gained more and more attention in recent years, mostly due to the increased attention given to regions as key in the organization and governance of economic growth and the creation of wealth. An important example is the special issue of *Regional Studies*, published in 2004, fully devoted to the concept of competitiveness of regions. Regional competitiveness is not only an issue of academic interest but of increasing policy deliberation and action. This is reflected in the interest devoted in the recent years by the European Commission to define and evaluate competitiveness of European regions, an objective closely related to the realization of the Lisbon Strategy on Growth and Jobs.
Why measuring regional competitiveness is so important? Because “if you can not measure it, you can not improve it” (Lord Kelvin). A quantitative score of competitiveness will help Member States in identifying possible regional weaknesses together with factors mainly driving these weaknesses. This in turn will assist regions in the catching up process.
Given the multidimensional nature of the competitiveness concept, the structure of RCI is made of eleven pillars which describe the concept, taking into account its regional dimension, with particular focus on a region’s potential. The long-term perspective is, in fact, essential for European policy and people’s skills are understood to play a key role for EU future, as also underlined by the president of the Lisbon Council in his recent policy brief. For this reason the RCI includes aspects related to short and long-term capabilities of regions, with a special focus on innovation, higher education, lifelong learning and technological availability and use, both at the individual and at the enterprise level.
A number of indicators have been selected to describe these dimensions with criteria based on coverage and comparability as well as within pillar statistical coherence. Most indicators come from Eurostat but where data was not available, alternative source were considered.
A detailed univariate and multivariate statistical analyses have been carried out on the set of candidate indicators for the setting-up and refinement of the composite. Each choice with a certain degree of uncertainty has been submitted to a full robustness analysis to evaluate the level of variability of regions final score and ranking.
The final RCI shows a heterogeneous situation across EU regions with Eastern and Southern European regions showing lower performance while more competitive regions are observed in Northern Europe and parts of Continental Europe.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

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