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Competitiveness implication on human development. European region analysis efficiency

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Abstract

Since the Second World War, there has been a period of great economic growth which has led to a significant increase in Gross Domestic Product per capita (GDP), the intensification of economic exchanges and an increase in competitiveness to maintain the market shares achieved.

In such dynamic context, competitiveness, if correctly managed, can be an powerful engine to improve human well-being.

Knowledge of the level of human development thus becomes a critical variable to be analyzed in order to undertake policies aimed at improving the quality of life.

The analysis that will be carried out draws inspiration from the literature that dealt with comparative studies between the indicators related to competitiveness and those related to human development (HDI). In this sense, the article *The competitiveness of nations and implications for human development* (Ülengin et al., 2010) was a source of inspiration.

Starting from the competitiveness data, this work is meant to provide a picture of the European regions efficiency in their ability to translate a certain amount of competitiveness in human development.

The performance evaluation is made by the application of DEA (Data Envelopment Analysis), in which efficiency is the result of the combination of both competitiveness input (represented by basic sub-indices, efficiency sub-indices and competitiveness sub-indices) and human development output (represented by life expectancy at birth, education and per capita GDP).

Starting from the current efficiency levels, through the non-parametric technique of slack variables, the second step has been to project the outputs on a frontier. This has allowed to identify how inefficient countries can improve their human development performance.

Keywords – Competitiveness; Human development; Efficiency; NUTS 2; DEA VRS; Slack analysis

Paper type – Academic Research Paper

Sommario

Il presente articolo persegue l’obiettivo di indagare come la competitività di un paese possa tradursi in migliori condizioni di vita per i suoi abitanti. In un contesto sempre più sviluppato e competitivo, si

corre il rischio di creare una società che abbia come valori cardine la crescita economica a discapito dell'individuo e del suo benessere. Le questioni dello sviluppo umano, intese come processo di ampliamento delle possibilità umane che consenta agli individui di godere di una vita lunga e sana, sono state recentemente avanzate come l'obiettivo finale dell'attività umana. A tal fine sono stati analizzati i dati della competitività relativi all'anno 2019 e attraverso la DEA (Data Envelopment Analysis) si è valutata l'efficienza delle regioni dell'Unione Europea a trasformare la sua competitività in maggior sviluppo umano. Ciò che è emerso dall'analisi è che le regioni "emergenti" attraverso l'attuazione di adeguate politiche hanno maggiori margini di miglioramento nel trasformare la propria competitività in sviluppo umano rispetto alle economie sviluppate.

Parole chiave – Competitività; Sviluppo umano; Efficienza; NUTS 2; DEA VRS; Analisi slack

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1 Introduction

Nowadays the noun “globalization” is declined in a politic, economic and social perspective, associated with “growth” in an economic context while in a social environment is more commonly linked with the concept of “development”.

It is important though to underline that these two nouns are not synonyms:

- Growth is a concept referring to the ability of an economic system to increase the availability of goods and services capable of satisfying the needs of a country. The more capacity a territory has in this sense, the more attractive and competitive it will be. Growth is usually quantified through Gross Domestic Product per capita (GDP).
- Development, on the other hand, includes elements of quality of life of a social and cultural nature. It is in this context that the Human Development Index takes hold, which evaluates a country based on:
 1. Longevity: in terms of the ability to live long and in good health;
 2. Knowledge: measured by the level of education;
 3. Access to resources as the end of a decent standard of living: measured through their per capita domestic product, expressed in US dollars at purchasing power parity.

Starting from these definitions is easy to understand how a country growth is part of a more complex development process.

The objective to be pursued with this study is to propose a methodology to objectively and efficiently analyze the relationship that is established between the competitiveness of a country and its human development. The analysis was carried out on the regions of the European Union (NUTS 2) by examining 197 regions. This measurement is first carried out by analyzing the clusters, then proceeding with the DEA (Data Envelopment Analysis) and slack analysis. The model used is output-oriented efficiency in which Regional Competitiveness Indicators (RCI) are taken as input variables and human development indicators as output variables.

2 Evaluation and competitiveness components: A brief review of the literature

The noun globalization, in its more general conception, identifies the expansion and the intensification of relations of exchange, traffic and communication beyond national borders (Habermas, 1996), it therefore refers to a process of growing interconnection of economic, political and cultural dynamics resulting in a reduction in the distances between individual states.

It is in a more and more interconnect context that was found the European Union. Established after the Second World War, it has been configured as an economic and political union of 27 member States with a supranational nature.

Among the formally declared purposes it is possible to identify the increase in the well-being of its citizens and the creation of a highly competitive market economy to make the most of the opportunities that globalization offers (TUE, Tit. I - Article 3).

Competitiveness, therefore, is essential to achieve efficiency objectives both in the field of research and innovation, and in terms of entrepreneurship and competition, education and training.

According with Professor Jan Fagerberg (Fagerberg, 1996) competitiveness indeed can be defined as the capacity of a country to ensure high life standard of living for its citizen not only in the short period but also in the long period. The author sustain also that two main roles are needed to achieve competitiveness: productivity in the short period and innovation in the long term.

To evaluate the competitiveness of each nation, non-profit foundations such as the WEF (World Economic Forum) and IMD (Institute for Management Development) starting from 2004, have set up the Global Competitiveness Report (Sala-i-Martin & Artadi, 2004) which classifies nations based on the Global Competitiveness Index.

The analysis is made with a reference to the Regional Competitiveness Index (RCI), which is based on the approach used in the Global Competitiveness Index of the World Economic Forum.

The RCI extends the traditional competitiveness analysis from a pure economic perspective to an evaluation that includes also social elements such as innovation, quality of the institutions, transportations and infrastructures (Annoni & Dijkstra, 2017). This means that RCI is the first measure capable to give an European perspective on EU regions competitiveness, tracking and evaluating the ability of the countries to provide to their citizen well-being (Aiginger, 1998) identifying the factors that define the economic prosperity on the mid-long period.

The Global Competitiveness Index (GCI), as the Regional Competitiveness Index, gives a holistic and panoramic perspective of the critical factors on which is necessary work to increase both the productivity and the competitiveness (Lopez-Claros et al., 2006). These factors have been grouped in 111 pillars, able to describe different aspects of competitiveness showing insights useful to evaluate strengths and weaknesses.

These pillars include macroeconomic and microeconomic factors such as: Institutions, Infrastructure, Macroeconomic Stability, Health and Primary Education, Higher Education, Lifelong Learning, Market Efficiency, Technology Readiness, Business Sophistication, Innovation (Schwab, 2014).

It is important to underline how none of them taken alone, can ensure competitiveness given that the determinants have a different weight in relation to the development phase of the country. It may happen that a factor that drives productivity in a certain country does not necessarily correspond to that that drives another country (Lopez-Claros et al., 2006). According to this principle, the development pillars can be divided in three sub-indices (Schwab, 2009):

1. base sub-index: it includes institutions, infrastructure, macroeconomics, health and primary education. In this phase, development is made possible thanks to the application of competitive prices; these are essential drivers of any type of economy (1st stage of development);
2. efficiency sub-index: it includes the critical pillars for countries in the efficiency-driven phase (education and training, higher education and training, market efficiency, technological readiness). In this phase, the efficiency of production allows the country to be competitive (2nd phase of development);
3. innovation sub-index: include all the pillars of corporate sophistication and innovation. In this phase it is possible to be competitive because it is possible to produce products using the most advanced production and organization methods.

The pillars thus conceived emphasize basic issues in less developed regions and innovative capacities in regions that enjoy a greater degree of industrialization. For example, innovation and the sophistication of goods account for 10% of final values in economies based on efficiency and 30% in those driven by innovation.

At this point, a country's performance based on the overall results of the GCI and its components is reported as a "progress score" on a scale of 0 to 100, where 100 represents the "frontier" that should be aimed at so that a certain problem ceases to be an obstacle to productivity growth (Schwab, 2009).

However, as also reported in the *Global Competitiveness Report 2019* for governments to make technology and innovation part of the DNA of an economy is a challenge, yet they must make this change possible through investment in human capital to mitigate the unintended negative impacts of technological advances on income distribution and social cohesion. The mere evaluation of economic growth, GDP or competitiveness are not sufficient to describe the well-being of a nation. Among the main limitations of the reports published by the WEF it is possible to precisely find this deficiency: the WEF has not yet analyzed whether a highly competitive country is also able to use this advantage to translate it into greater human development and well-being for the nation.

In this regard, it should be noted that there is a significant relationship between economic growth and human development. Economic growth certainly corresponds to an improvement in human well-being, but the extent to which one influences the other must be assessed. The countries that decide to favor economic growth often descend into a vicious cycle of growth that can have negative impacts

in terms of investment and income redistribution; while those who prefer human development are able to establish a virtuous cycle with positive effects in the long term (Ranis et al., 2000).

For this reason, human development has recently been advanced as the goal of human activity instead of economic growth.

3 Human development and its components: A brief review of the literature

The ultimate overcoming of the study of GDP as the only tool for assessing economic growth took place in 1990 with the construction of the Human Development Index (Human Development Index, HDI) by UNDP (United Nations Development Program) under the guide of Amartya Sen, with the aim to shift the development focus from GDP to person-centered policies. At the basis of the construction of the HDI it is placed the capability approach of Sen (1999), according to which economic growth is only a means for achieving human well-being and freedom. The original definition was given in the Human Development Report describing it as “a process of expanding human possibilities that allows individuals to enjoy a long and healthy life, to be educated and to have access to an income level that guarantees a standard of living dignified” (United Nations Development Program, 2010, p. 3). From this definition it can be deduced that the human need is not only for real income, but also for health, education, social inclusion and empowerment.

The human development index, conceived in this way, is made up of three dimensions:

1. Life expectancy at birth indirectly calculates the state of health. It is an indicator that, given the economic and socio-health conditions of a particular country, allows for predictions on the life expectancy of a newborn child.
2. The level of education (Corduas, 2013): represented by the adult literacy rate and the average number of years of study. It is a single index that is derived from the weighting of:
 - literacy rate: assigns a weight of 2/3 with respect to the result;
 - average number of years of study with a weight equal to 1/3.
3. GDP per capita, calculated based on two transformations of the data:
 - to consider the purchasing power of the local currency so that it is not penalized by an unfavorable exchange ratio;
 - to enhance the fact that the increase in income does not increase well-being in a linear way; ex. an income increases of \$ 1.000 takes on a different meaning in a family if the starting income is \$ 1.000 (+100%) or \$ 20.000 (+5%).

The scores for the three HDI dimensional indexes are then aggregated into a composite index using the geometric mean of the indexes normalized for each of the three dimensions, returning a value between 0 and 1; the closer it is to unity, the greater is human development which makes it possible to achieve the three goals of a life expectancy at birth of 85 years, access to education for all, a decent level of income (United Nations Development Programme, 2020).

The Human Development Index, conceived in this way, by combining economic factors with social factors over time, has established itself as one of the most used tools at an international level to measure the social and economic well-being of countries around the world.

4 Relation between competitiveness and human development

A study conducted by the economist (Davies & Quinlivan, 2006) suggests a significantly positive relationship between improvements in social well-being and an increase in trade (understood as a share of GDP). The study found that an increase in trade is associated with a subsequent series of increases in human development growth. Underlying this theory is the principle according to which a greater number of exchanges translates into a greater GDP which in turn generates a better standard of living, an increase in education levels and better health care.

Moreover, this relationship is not only positive, but it is also bilateral as stated by the economist Lucas (1988) since on the one hand it is true that the growth of a country translates into more resources to be allocated to education, to better health care, but it is also true that the availability of an adequately educated workforce is a crucial condition that triggers openness to international trade. To be competitive it is necessary to invest in human capital to have a skilled workforce, which entails greater remuneration and hence an increase in per capita GDP.

It is therefore possible to imagine a threshold value in the stock of human capital above which a virtuous circle of economic and human growth is triggered.

4.1 Methodology

Given the positive correlation between competitiveness and human development, the objective that this analysis pursues is to measure the efficiency with which European regions use their competitiveness for the benefit of their citizens. The pioneer in calculating the social efficiency of countries was Despotis (2005) who used GDP per capita as an input and education and life expectancy as an output.

It was decided to begin the study with the Cluster Analysis with the goal of verify if there is a national component of the regions. The Cluster Analysis, in fact, allows to identify one or more partitions in the set of statistical units distinguishable into groups (clusters) (Gan et al., 2007) so that the groups have the characteristics of internal cohesion, i.e. the assigned units to the same group must be similar to each other. An analysis of the main components will then be carried out with the aim of reducing the dimensionality of the dataset without losing the original information.

Once the main components of our dataset have been identified, our Data Envelopment Analysis will be carried out.

4.2 Why use data envelopment analysis

The DEA method, developed in its first formulation by Charnes et al. (1978), is a “data-oriented” approach, aimed at evaluating the efficiency of the performance of a set of homogeneous production units, called Decision Making Units (DMUs).

The DEA is a widely used model since it is:

- a non-parametric mathematical method that presents an empirical orientation (Mariano & Rebelatto, 2014);
- does not require a priori assumptions;
- is aimed at the search for the efficient frontier as it expresses the maximum number of outputs that can be produced per unit of input, thus representing the production limit determined by the technology of a sector (Cook & Zhu, 2014).

This frontier separates efficient DMUs, located on the boundaries of the frontier, from inefficient ones. The distance of a DMU from the frontier provides an indication of best practices by serving as an analysis for less efficient ones (Charnes et al., 1985).

The logic of the analysis provides that the units with the highest index make up the efficient productivity frontier (index equal to 1). A score lower than 1 indicates that there is a combination that allows you to create a specific output using fewer inputs or vice versa; therefore, those who have an outcome between 1 and 0 will be increasingly distant from this frontier, realizing inefficient performances.

The choice to use the data wrapping analysis (DEA) in this analysis is given by the fact that it allows to evaluate the efficiency of each decision-making unit, which in our case are represented by the regions of the European Union, to translate the inputs (competitiveness data) in the best possible output levels, in terms of human development. This is possible because the DEA compares its technology with all the

other possible technologies deriving from the linear combination of the observed productions for the other production units considered.

To apply the analysis, we can use different models that differ based on the assumptions, distinguishing:

- orientation;
- combination of input and output.
- returns to scale; designates the two main DEA models: Constant Return to Scale (CRS) (Charnes et al., 1985) and Variable Return to Scale (VRS: to account for variable returns to scale).

The basic formulation of the CRS and VRS model (Banker et al., 1984), in their two orientations, can be described as:

Table 1 - DEA radial models in the form of multipliers

Model	Input Oriented	Output Oriented
CRS	$MAX \sum_{i=1}^m u_i \cdot y_{i0}$	$MIN \sum_{j=1}^n v_j \cdot x_{j0}$
	Subject to:	Subject to:
	$\sum_{j=1}^n v_j \cdot x_{jo} = 1$	$\sum_{i=1}^m u_i \cdot y_{io} = 1$
	$\sum_{i=1}^m u_i \cdot y_{ik} - \sum_{j=1}^n v_j \cdot x_{jk} \leq 0 \text{ for } k = 1, 2, \dots, h$	$\sum_{i=1}^m u_i \cdot y_{ik} - \sum_{j=1}^n v_j \cdot x_{jk} \leq 0 \text{ for } k = 1, 2, \dots, h$
VRS	$MAX \sum_{i=1}^m u_i \cdot y_{i0} + w$	$MIN \sum_{j=1}^n v_j \cdot x_{j0} - w$
	Subject to:	Subject to:
	$\sum_{j=1}^n v_j \cdot x_{jo} = 1$	$\sum_{i=1}^m u_i \cdot y_{io} = 1$
	$\sum_{i=1}^m u_i \cdot y_{ik} - \sum_{j=1}^n v_j \cdot x_{jk} + w \leq 0 \text{ for } k = 1, 2, \dots, h$	$\sum_{i=1}^m u_i \cdot y_{ik} - \sum_{j=1}^n v_j \cdot x_{jk} + w \leq 0 \text{ for } k = 1, 2, \dots, h$
	<i>w without sign restriction</i>	<i>w without sign restriction</i>

h represents the number of the DMUs analyzed;
 m represents the number of outputs analyzed;
 n represents the number of inputs analysed;
 w represents the scale factor;
 u_i represents the weight of output i for the DMU under analysis;
 v_j represents the weight of input j for the DMU under analysis;
 x_{jo} represents the amount of input j of the DMU under analysis;
 x_{jk} represents the amount of input j of DMU k ;
 y_{io} represents the amount of output i of the DMU under analysis;
 y_{ik} represents the amount of output i of DMU k

Source: Mariano e Rebelatto (2014)

Between the CRS and VRS method it was decided to use the VRS model as it allows to adapt specifically to the effects of scale, making it possible to make a relative comparison between regions with different financial conditions.

4.3 European region efficiency analysis: A case study

The analysis that will be conducted below is made with reference to the NUTS 2 regions of the 27 member states of the European Union; the countries of Malta and the United Kingdom. The regions for which complete data were not available are excluded from the analysis.

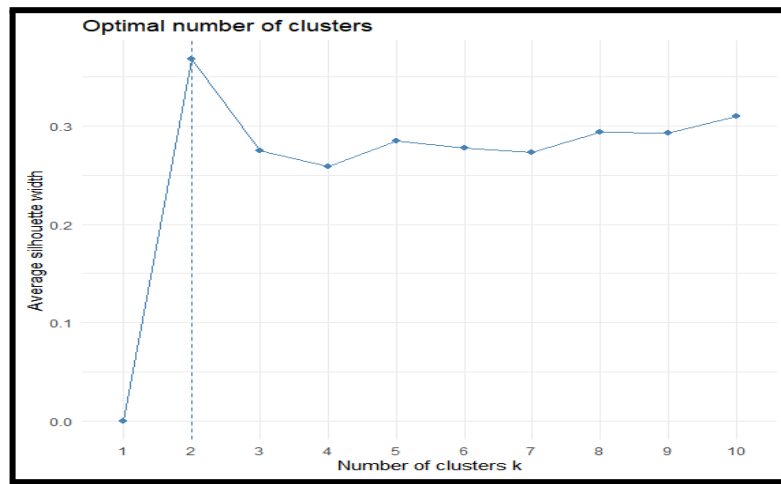
To carry out the analysis, the R statistical program was used. As regards the choice of data, the INPUTs were distinguished in the basic, efficiency and innovation sub-index. The data was generated from over 70 comparable indicators and indicates a region's ability to offer an attractive and sustainable environment for businesses and residents; refer to the year 2019. They are extrapolated from the report "the European index on regional competitiveness" drawn up by the European commission.

As regards the outputs, however, both "Life expectancy at birth" and "GDP per capita PPP" are extrapolated from the Eurostat website. GDP is calculated by adjusting the purchasing power parity and therefore considering the different cost of living in different countries. The data on "schooling" is obtained as *gross enrollment ratio*, calculated by dividing the number of students by the total population in the official age group corresponding to these levels. This value can be higher than 100% in the case of inclusion of students who have made early or late entries into the world of education or in the case of large cities that welcome a greater number of students than the suburbs.

To proceed with the analysis, the first thing done has been the *cluster analysis* to specify the general stage of development of the countries and to analyse the relationship between the different groups to which the countries may belong.

Before continuing with the analysis, it was considered useful to proceed with the standardisation of the x and y variables to release them from the unit of measurement of the starting variable. Standardisation, in fact, allows you to compare variables that have means and standard deviations measured on different units of measurement or order of magnitude¹.

Figure 1 - Cluster analysis



Source: our elaboration with R studio

Once the data was standardized, it was possible to proceed with the identification of the optimal number of clusters. The evaluation was conducted using the command `fviz_nbclust` of R, using PAM (*Partition Around Medoids*) algorithm and the *silhouette* method:

- algorithm aims to find a sequence of objects called “medoids” that are located at the center of the clusters. The goal of the algorithm is to minimize the average dissimilarity of objects to their closest selected object;

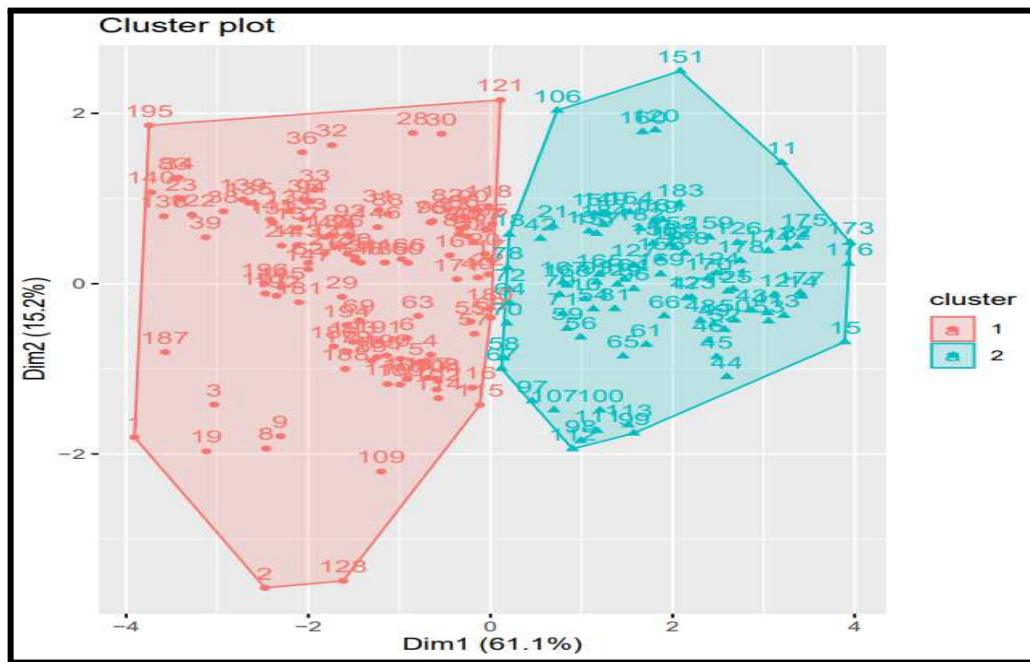
¹ Standardization is a recommended procedure in all cases in which a comparison is made between variables that have different units of measurement/orders of magnitude. For example:

1) Before a cluster analysis. This is because grouping techniques are based on calculating the distances between observations.
2) Before an analysis of the main components. This methodology attributes a different weight to the variables based on their variances.

- *silhouette* method (Kaufman & Rousseeuw, 1990) has been chosen with the aim both the average distance of each point from the other points of the cluster to which it belongs and the average distance from the points of the closest cluster, the greater the average value of this index, the higher the consistency of the analysis for the number k of corresponding clusters.

The analysis shows that the optimal number of clusters is equal to 2, as can be seen from Figure 1.

Figure 2 - Cluster plot



Source: our elaboration with R studio

Table 2 - Regions of the European Union (clusters 1 and 2)

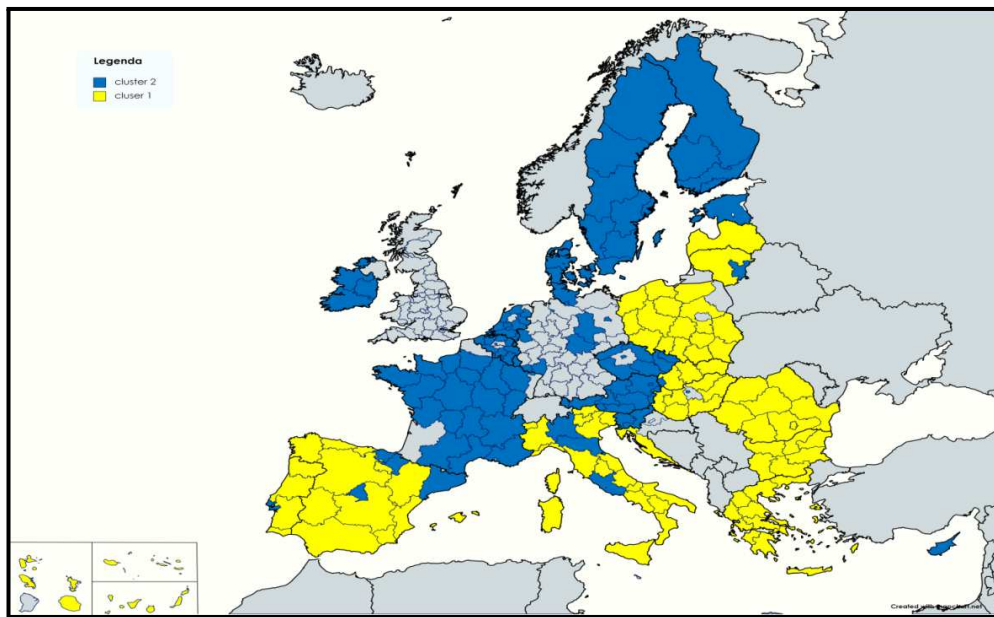
Region NUTS 2	Cl.	Region NUTS 2	Cl.	Region NUTS 2	Cl.	Region NUTS 2	Cl.
Bruxelles / Brussel	2	Anatoliki Makedonia	1	Guadeloupe	1	Sostinés regionas	2
Oost-Vlaanderen	2	Attiki	1	Haute-Normandie	2	Luxembourg	2
Antwerp	2	Dytiki Ellada	1	Île-de-France	2	Del-Alfold	1
Hainaut	2	Dytiki Makedonia	1	Languedoc-Roussillon	2	Del-Dunantul	1
Luxembourg (BE)	2	Ionia Nisia	1	Limousin	2	Eszak-Alfold	1
Liège	2	Ipeiros	1	Lorraine	2	Eszak-Magyarország	1
Namur	2	Kentriki Makedonia	1	Mayotte	1	Kozep-Dunantul	1
West-Vlaanderen	2	Kriti	1	Midi-Pyrénées	2	Budapest	2
Limburg	2	Notio Aigaio	1	Pays de la Loire	2	Nyugat-Dunantul	1

Yugozapaden	1	Peloponnese	1	Picardie	2	Drenthe	2
Yuzhen tsentralen	1	Stereia Ellada	1	Poitou-Charentes	2	Friesland	2
Severoiztochen	1	Thessalia	1	Provence-Alpes	2	Gheldria	2
Severen tsentralen	1	Voreio Aigaio	1	La Réunion	1	Groningen	2
Yugoiztochen	1	Andalusia	1	Rhône-Alpes	2	Limburg	2
Severozapaden	1	Aragon	1	Bretagne	2	Noord-Brabant	2
Jihovychod	2	Canary Islands	1	Jadranska Hrvatska	1	Noord-Holland	2
Jihozapad	2	Cantabria	1	Abruzzo	1	Overijssel	2
Moravskoslezsko	2	Castilla y León	1	Basilicata	1	Zeeland	2
Prague	2	Castilla-La Mancha	1	Calabria	1	Zuid-Holland	2
Severovychod	2	Catalonia	2	Campania	1	Utrecht	2
Severozapad	2	Ciudad de Ceuta	1	Emilia-Romagna	2	Wien	2
Střední Morava	2	Comunidad de Madrid	2	Friuli-Venezia Giulia	1	Oberösterreich	2
Hovedstaden	2	Comunidad Foral de Navarra	2	Lazio	2	Vorarlberg	2
Midtjylland	2	Comunidad Valenciana	1	Liguria	1	Steiermark	2
Nordjylland	2	Estremadura	1	Lombardia	2	Salzburg	2
Sjælland	2	Ciudad Autónoma de Melilla	1	Marche	1	Burgenland	2
Syddanmark	2	Galicia	1	Molise	1	Tirol	2
Thüringen	2	La Rioja	1	Piemonte	1	Kärnten	2
Schleswig-Holstein	2	Pais Vasco	2	Bolzano	1	Dolnośląskie	1
Sachsen-Anhalt	2	Principado de Asturias	1	Trento	1	Śląskie	1
Saarland	2	Región de Murcia	1	Puglia	1	Lodzkie	1
Rhein Hessen-Pfalz	2	Illes Balears	1	Sardegna	1	Lubuskie	1
Düsseldorf	2	Auvergne	2	Sicilia	1	Małopolskie	1
Hamburg	2	Basse-Normandie	2	Toscana	1	Mazowieckie	1
Bremen	2	Bourgogne	2	Umbria	1	Opolskie	1
Berlin	2	Centre - Val de Loire	2	Valle d'Aosta	1	Podkarpackie	1
Eesti	2	Champagne-Ardenne	2	Veneto	1	Pomorskie	1
Dublin	2	Corse	1	Kypros	2	Świętokrzyskie	1
Southern (South-West)	2	Martinique	1	Latvija	1	Warmińsko-Mazurskie	1
Wielkopolskie	1	Região Autónoma dos Açores	1	Vzhodna Slovenija	2	Mellersta Norrland	2
Zachodniopomorskie	1	București - Ilfov	1	Bratislavský kraj	2	Norra Mellansverige	2
Kujawsko-pomorskie	1	Centru	1	Stredne Slovensko	1	Ostra Mellansverige	2
Lubelskie	1	Nord-Est	1	Vychodne Slovensko	1	Ovre Norrland	2
Alentejo	1	Nord-Gilet	1	Zapadne Slovensko	1	Smaland med oarna	2
Algarve	1	Sud - Muntenia	1	Aland	2	Stockholm	2
Lisbon Metropolitan Area	2	Sud-Est	1	Etela-Suomi	2	Sydsverige	2
Centru	1	Sud-Vest Oltenia	1	Helsinki-Uusimaa	2	Västsverige	2
Norte	1	Vest	1	Lansi-Suomi	2		

Região Autónoma da Madeira	1	Zahodna Slovenija	2	Pohjois-ja Itä-Suomi	2
Northern and Western	2	Franche-Comté	2	Vidurio ir vakarų Lietuvos	1

Source: our elaboration

Figure 3 - Graphic representation of clusters 1 and 2 of the European NUTS 2 regions



Source: our elaboration on map mapchart.net/europe-nuts2.html

The analysis shows that the two clusters are homogeneous, being able to identify 98 regions in the first cluster and 99 in the second. Overall, from the attribution (Figure 3) it is possible to distinguish a national trend of the regions and at the same time identify a distinction between Northern Europe and Eastern-Mediterranean Europe: in the first cluster, in fact, we can identify the regions of Bulgaria, Greece, Spain, Croatia, Italy, Latvia, Hungary and Poland; while in the second cluster there are: Belgium, Czech Republic, Denmark, Germany, Estonia, Ireland, Iceland, France, Cyprus, Luxembourg, Netherlands, Austria, Slovenia.

It should be noted that in some regions there is an anomalous trend compared to the national trend; this divergence take place when a particular region can be defined as a nation driving force. An example is represented by the Italian case where regions such as Emilia-Romagna, Lazio and Lombardy follow a different trend than the other regions of the country. This difference is because these regions represent the fulcrum of the economy and education. Another example is represented by France where the islands

follow a different trend than the nation: in this case the explanation lies in the fact that these islands are small regions characterized by a local economy. In the case of Hungary and Portugal, however, anomalous values are found in the regions of the capital. These values are present due to the natural traits of capitals: they have agglomeration economies, better connectivity and high levels of human capital, distinguishing itself as the main engine of the economy.

Once the division into clusters has been carried out, the analysis of the main components (PCA) was developed.

The hope in the application of the PCA is that the sample variances of the first Principal Components (PC) are large, while the variances of the others are small enough to be neglected (a variable with a low variability can be treated approximately as a constant).

Figure 4 - Principal components analysis

Importance of components:						
	Comp.1	Comp.2	Comp.3	Comp.4	Comp.5	Comp.6
Standard deviation	1.910155	0.9634468	0.8925671	0.5894601	0.4191385	0.26982395
Proportion of variance	0.611218	0.1554943	0.1334568	0.0582060	0.0294289	0.01219607
Cumulative Proportion	0.611218	0.7667122	0.9001690	0.9583750	0.9878039	1.00000000

Source: our elaboration with R studio

The analysis shows that the first two components alone explain almost 77% of the total variance. It was therefore decided to carry out the Data Envelopment Analysis with only the first two components. Taking as object of study how the competitiveness of a region translates into greater human development, DEA has been applied with the VRS method so to track variable returns to scale and it has been orientated towards the output. In the Table 3 the obtained results are shown:

Table 3 - Results of the DEA

Region NUTS 2	DEA	Region NUTS 2	DEA	Region NUTS 2	DEA	Region NUTS 2	DEA
Bruxelles - Brussel	1.00	Anatoliki Macedonia	0.89	Guadeloupe	0.28	Sostinés regionas	0.50
Oost-Vlaanderen	0.82	Attiki	0.61	Haute-Normandie	0.52	Luxembourg	0.63
Antwerp	0.67	Dytiki Ellada	0.66	Île-de-France	1.00	Del-Alfold	0.00
Hainaut	0.04	Dytiki Makedonia	0.35	Languedoc-Roussillon	0.67	Del-Dunantul	0.00
Luxembourg (BE)	0.10	Ionia Nisia	0.06	Limousin	0.60	Eszak-Alfold	0.00
Liège	0.11	Ipeiros	1.00	Lorraine	0.51	Eszak-Magyarország	0.00
Namur	0.12	Kentriki Macedonia	0.49	Mayotte	0.00	Kozep-Dunantul	0.00
West-Vlaanderen	0.63	Kriti	0.55	Midi-Pyrénées	0.81	Budapest	1.00
Limburg	0.52	Notio Aigaio	1.00	Pays de la Loire	0.34	Nyugat-Dunantul	0.00

Yugozapaden	0.00	Peloponnese	0.81	Picardie	0.45	Drenthe	0.06
Yuzhen tsentralen	0.01	Stereia Ellada	1.00	Poitou-Charentes	0.64	Friesland	0.09
Severoiztochen	0.00	Thessalia	0.60	Provence-Alpes- Côte Azur	0.60	Gheldria	0.21
Severen tsentralen	0.00	Voreio Aigaio	1.00	La Réunion	0.30	Groningen	0.18
Yugoiztochen	0.00	Andalusia	0.50	Rhône-Alpes	0.78	Limburg	0.24
Severozapaden	0.00	Aragon	0.72	Bretagne	0.56	Noord-Brabant	0.39
Jihovychod	0.00	Canary Islands	0.53	Jadranska Hrvatska	0.00	Noord-Holland	0.61
Jihozapad	0.00	Cantabria	0.37	Abruzzo	0.38	Overijssel	0.19
Moravskoslezsko	0.00	Castilla y León	0.63	Basilicata	0.53	Zeeland	0.29
Prague	1.00	Castilla-La Mancha	0.63	Calabria	0.26	Zuid-Holland	0.34
Severovychod	0.00	Catalonia	0.80	Campania	0.12	Utrecht	0.59
Severozapad	0.00	Ciudad de Ceuta	0.09	Emilia-Romagna	0.55	Wien	0.31
Střední Morava	0.00	Comunidad de Madrid	0.91	Friuli-Venezia Giulia	0.47	Oberösterreich	0.27
Hovedstaden	0.47	Comunidad Foral de Navarra	0.78	Lazio	0.50	Vorarlberg	0.53
Midtjylland	0.26	Comunidad Valenciana	0.49	Liguria	0.43	Steiermark	0.27
Nordjylland	0.13	Estremadura	0.38	Lombardia	0.63	Salzburg	0.56
Sjælland	0.00	Ciudad Autónoma de Melilla	0.37	Marche	0.51	Burgenland	0.23
Syddanmark	0.19	Galicia	0.40	Molise	0.32	Tirol	0.47
Thüringen	0.65	La Rioja	0.71	Piemonte	0.39	Kärnten	0.22
Schleswig-Holstein	0.16	Pais Vasco	0.60	Bolzano	1.00	Dolnośląskie	0.00
Sachsen-Anhalt	0.59	Principado de Asturias	0.29	Trento	0.93	Śląskie	0.00
Saarland	0.09	Región de Murcia	0.46	Puglia	0.38	Lodzkie	1.00
Rheinessen-Pfalz	0.61	Illes Balears	0.97	Sardegna	0.51	Lubuskie	0.00
Düsseldorf	0.25	Auvergne	0.63	Sicilia	0.14	Małopolskie	0.00
Hamburg	0.68	Basse-Normandie	0.52	Toscana	0.51	Mazowieckie	0.00
Bremen	0.31	Bourgogne	0.59	Umbria	0.44	Opolskie	0.00
Berlin	0.62	Centre - Val de Loire	0.58	Valle d'Aosta	0.79	Podkarpackie	0.00
Estonia	0.00	Champagne-Ardenne	0.55	Veneto	0.57	Pomorskie	0.00
Dublin	0.94	Corse	0.87	Kypros	0.85	Świętokrzyskie	0.00
Southern (South-West)	1.00	Martinique	0.31	Latvija	0.00	Warmińsko-Mazurskie	0.00
Northern and Western	0.34	Franche-Comté	0.62	Vidurio ir vakarų Lietuvos	0.31	Wielkopolskie	0.78
Zachodniopomorskie	0.00	București Ilfov	1.00	Bratislavský kraj	0.49	Norra Mellansverige	0.26
Kujawsko-pomorskie	0.00	Centru	0.00	Stredne Slovensko	0.00	Ostra Mellansverige	0.30
Lubelskie	0.00	Nord-Est	0.00	Vychodne Slovensko	0.04	Ovre Norrland	0.35
Alentejo	0.26	Nord-Gilet	0.00	Zapadne Slovensko	0.00	Smaland med oarna	0.35
Algarve	0.34	Sud - Muntenia	0.00	Aland	0.70	Stockholm	1.00
Lisbon Metropolitan Area	0.28	Sud-Est	0.00	Etela-Suomi	0.26	Sydsverige	0.30
Centro Città	0.34	Sud-Vest Oltenia	0.00	Helsinki-Uusimaa	0.62	Västsverige	0.39
Norte	0.45	Vest	0.00	Lansi-Suomi	0.31		

Região Autónoma da Madeira	0.00	Zahodna Slovenija	0.36	Pohjois-ja Itä-Suomi	0.26
Região Autónoma dos Açores	0.16	Vzhodna Slovenija	0.00	Mellersta Norrland	0.28

Source: our elaboration

The DEA scores can be interpreted in such a way that countries that have scores equal to 1 are deemed to be efficient, therefore they use competitiveness efficiently for the human development of their citizens. Countries with scores below 1 have relatively lower levels of human development up to countries with scores equal to 0 which are totally inefficient.

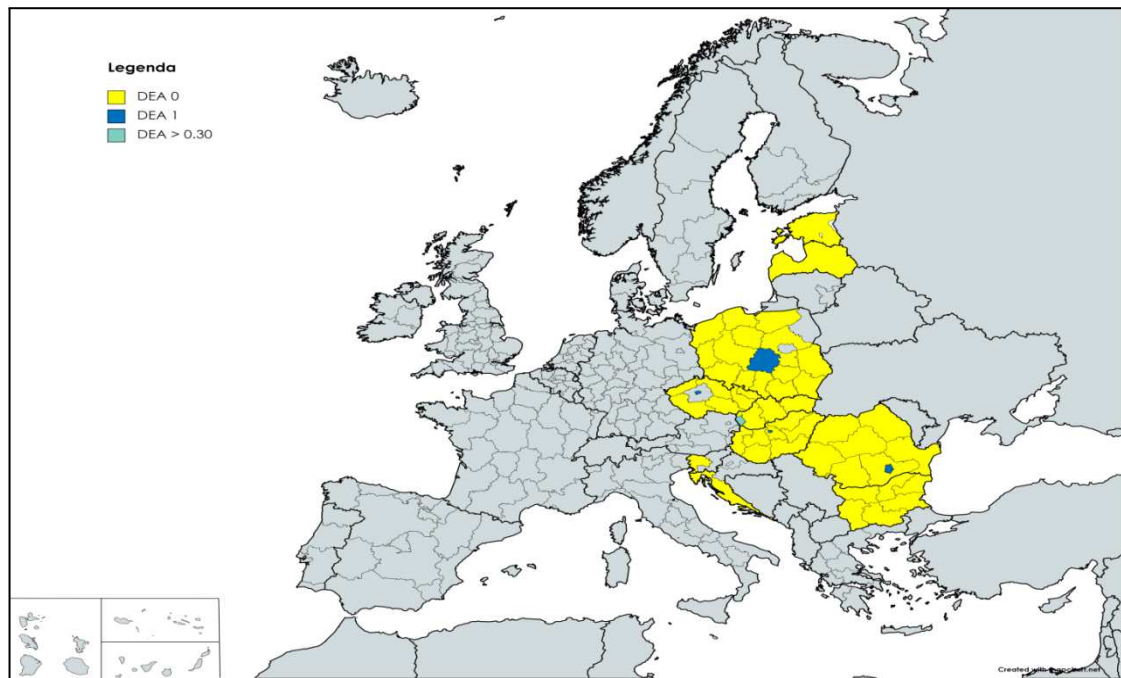
Overall, how of the 197 regions analysed, 13 have a value equal to 1 and are represented by Brussels, Prague, south-west region of Ireland, Ipeiros, Notio Aigaio, Sterea Ellada, Voreio Aigaio, Île-de-France, Bolzano, Budapest, Lodzkie, Bucharest, Stockholm. The regions with a value of 0 are 46 and are attributable to the states of Bulgaria, the Czech Republic, Estonia, Latvia, Hungary, Poland, Romania, Slovakia and the regions of Sjælland, Mayotte, Vzhodna Slovenija.

It is interesting to note that even in this case the totally inefficient units follow a geographical trend, generally localized in Eastern Europe. In confirmation of what was identified in the cluster analysis, also in this case in the totally inefficient regions are identifiable anomalous values with efficiency peaks in the regions of the capitals or large cities that host agglomeration economies such as Prague for the Czech Republic, Bucharest in Romania, Budapest for Hungary, Lodzkie for Poland as illustrated in Figure 5.

From the analysis of the data, it is shown how for the regions of Bulgaria, Latvia, Romania, Croatia and Hungary both the RCI and HDI values are remarkably low, touching the threshold of 1.86 (on a scale of 100) in the basic sub-index regarding the north-east region of Romania. These countries are currently totally inefficient as they have low levels of both human development (in particular for life expectancy at birth which is significantly lower than the rest of European countries) and competitiveness. These results are in line with the level of development of these regions which today are considered as emerging economies, still characterized by a small economy and a medium-low GDP per capita. The regions of Poland, on the other hand, have significantly higher values in terms of RCI, especially in terms of the efficiency sub-index, but not sufficient to guarantee an improvement in the well-being of citizens, managing to be efficient only in the Lodzkie and Wielkopolskie region. Ultimately, among the inefficient regions there are Slovakia, Estonia and the Czech Republic which, despite having sufficiently high levels of HDI and RCI, are unable to be efficient, this result suggests that they are not using their competitiveness efficiently to translate it into citizens' quality of life.

With reference to these regions, it remains to underline that for the larger states it is still possible to identify a leading region of the country. The capital Prague, for example, manages to offer the best results at national level both in terms of RCI and HDI, managing to provide the best efficiency performance in translating competitiveness into human development. The same situation is observed in Budapest and Bucharest.

Figure 5 - Eastern European regions with inefficient DEA



Source: our elaboration on map mapchart.net/europe-nuts2.html

A particular case is offered by Lithuania which, in the context of Eastern Europe, achieves higher efficiency performance than its neighboring countries, approaching the reality of the rest of Europe.

The situation is different for the other European nations where it is possible to identify a more heterogeneous trend of the regions by distinguishing countries that are more efficient than others.

It is interesting to note the situation in the Mediterranean which can assume higher average efficiency values than some northern European countries despite lower RCI and HDI values.

A representative example is given by the comparison between Italy and Germany: the two nations have on average the same efficiency in transforming their competitiveness into human development, this happens even though Germany performs better than Italy. From the analysis of the data, it is possible to note how Germany can achieve satisfactory results in terms of RCI, reaching values of up to

90% within the efficiency sub-index (the highest Italian value is just over 68%), or per capita GDP equal to 61,000 PPPs (the highest value in Italy is 48,000), nevertheless, the two nations achieve, on average, a DEA equal to 49%. This result suggests that Italy's performance in terms of human development is relatively high compared to competitiveness to the detriment of Germany, which is not using its competitiveness efficiently to improve the quality of life of its citizens.

Going into more detail, it is possible to see how the Italian reality achieves heterogeneous efficiency performances, managing to compensate for very low performances (0.12 in Campania) with maximum efficiency values (1 in Bolzano). The results therefore reflect the actual situation of the country where it is still possible to observe lower percentages in the southern regions such as Campania, Puglia and Calabria, while higher results are recorded in the cities of Bolzano, Valle d'Aosta, Trento (all cities that always conquer the first places in the rankings of cities with better quality of life).

A similar trend to the Italian situation is also recorded for other Mediterranean regions including Spain with values between 0.09 and 0.97 and France where Mayotte is totally inefficient while Île-de-France reaches maximum efficiency. It should be noted that also in France the lowest trend is recorded by an island while the highest one is from the capital area.

Also, for these regions the RCI values have room for improvement with average values between 39-63%, nevertheless they manage to positively translate their competitiveness into human development.

An anomalous data within the Mediterranean is given by Portugal and Greece which follow opposite trends: it is shown how Greece reaches several maximum efficiency peaks ($DEA = 1$) for the cities of Ipeiros, Notio Aigaio, Sterea Ellada, Voreio Aigaio while the lowest value is given by Ionia Nisia with 0.06. These results are achieved despite the regions recording the lowest values in the RCI Mediterranean area. Conversely, Portugal achieves worse results by touching 0 for Região Autónoma da Madeira (also in this case it is an island and therefore a small economy) while the north of the state reaches the threshold of 45%, a threshold anyway far from maximum efficiency. These values explain how Portugal still has to work to improve the well-being of its citizens since it fails to translate encouraging competitive data into an adequate level of human development. Slovenia has a trend in line with the other Mediterranean regions.

Analysing the regions of northern Europe, however, generally, together with Germany, the Netherlands, Austria, Sweden, Denmark and Finland are not efficient in transforming their competitiveness into better living conditions for their citizens. The results are indeed surprising in consideration that these countries have high values both in terms of RCI and HDI. Also for this European area it is possible to observe similarities and differences compared to southern Europe: the first differentiating factor is that these regions there have no fluctuating trends characterized by positive

or negative peaks but are outlined by more harmonious values. An element of similarity with the rest of the continent, on the other hand, that is also for these countries values of maximum efficiency or in any case higher, are obtained in the capital region: this is true for Sweden with Stockholm which records the maximum efficiency, it is true for Finland where the capital does not reach its maximum but still obtains the highest value in the nation. The same is also applicable for the other regions.

4.4 Slack variables analysis

Starting from the levels of efficiency achieved by the individual regions, it is interesting to study how, based on the current levels of competitiveness, inefficient countries can improve their human development performance by directly dealing with the gap variables, i.e. the excesses of inputs and the scarcity of outputs (slack).

This analysis is possible by applying the Slacked Based Measur (SBM) model.

The Slacked Based Measur model, originally developed by Tone (2001), projects the observations at the furthest point from the efficiency boundary, in order to minimize the objective function in relation to the maximum compensation amounts (Choi et al., 2012).

In SBM the difference between the value of the projection and the effective value is used to give an interpretation of the input and output variables. In fact, thanks to the slack (or waste) variables it is possible to highlight to what extent it is necessary to “adjust” the values of the inputs and / or outputs so to eliminate any inefficiencies. According to this model, a DMU is considered efficient if and only its efficiency is equal to the unity and all the slack variables are zero. The presence of slack indicates in fact, that the DMU is not efficient and that it would therefore be possible to maintain the same output level by reducing the inputs used.

In order to describe the phenomenon, the slack variables are exposed with the following terminology:

$$s_h^+ = \text{output-slacks}$$

$$s_i^- = \text{input-slacks}$$

Also in this case it was decided to use the VRS model in order to consider the returns to scale, and it is for this reason that the efficient frontier, always defined on the basis of the most efficient DMUs, is a convex function.

Given K DMUs ($j = 1, \dots, K$), each of which produces N outputs ($y_{j1}, \dots, y_{jN}$) using M inputs ($x_{j1}, \dots, x_{jM}$), it is to consider a generic DMU j_0 .

Indicated with:

λ_j the weights with which the various units intervene in the linear combinations that define the inputs of the reference virtual unit;

s_i^- slack-input;

s_h^+ slack-output;

θ_0 the measure of generic efficiency-input DMU j_0 ;

ϕ_0 a variable from which is obtained the measure of generic efficiency-output DMU j_0 ;

ε a very small quantity appropriately chosen (smaller than any positive number).

It is going to be:

$$\max \quad \phi_0 + \varepsilon \left[\sum_{i=1}^M s_i^- + \sum_{h=1}^N s_h^+ \right]$$

s.t.

$$\sum_{j=1}^K \lambda_j = 1$$

$$\sum_{j=1}^K \lambda_j y_{hj} = \phi_0 y_{hj0} + s_h^+ \quad (h = 1, \dots, N)$$

$$\sum_{j=1}^K \lambda_j x_{ij} = x_{ij0} - s_i^- \quad (i = 1, \dots, M)$$

$$\lambda_j, s_i^-, s_h^+ \geq 0$$

$$0 < \varepsilon < 1$$

The optimal solution is called maximum slack solution, and if s_h^+ and s_i^- are both equal to zero, then the solution will be “zero-slack”. The zero-slack solution is an important efficiency indicator since at this level is not possible save inputs or increase output without worsening other inputs or outputs (Cooper et al., 2007).

In this sense, the Slacked Based Measur model turns out to be fundamental because it provides useful information indispensable for making appropriate decisions, defines the direction to be taken by indicating the “critical” input and output factors and determining the values that should be achieved.

The results that emerged from the analysis are shown in the following table (Tab. 4).

Table 4 - Slack analysis results

Region	Slack	Region	Slack	Region	Slack	Region	Slack
Bruxelles (Brussel)	1.00	Anatoliki Macedonia	1.00	Guadeloupe	0.58	Sostinès regionas	0.61
Oost-Vlaanderen	1.00	Attiki	0.59	Haute-Normandie	0.39	Luxembourg	0.59
Antwerp	0.68	Dytiki Ellada	0.99	Île-de-France	1.00	Del-Alfold	0.52
Hainaut	0.49	Dytiki Makedonia	1.00	Roussillon	0.40	Del-Dunantul	0.48
Luxembourg (BE)	0.48	Ionía Nisia	1.00	Limousin	0.36	Eszak-Alfold	0.53
Liège	0.49	Ipeiros	1.00	Lorraine	0.33	Eszak-Magyarország	0.45
Namur	0.49	Kentriki Macedonia	0.56	Mayotte	1.00	Közép-Dunantul	0.48
West-Vlaanderen	0.68	Kriti	0.78	Midi-Pyrénées	0.49	Budapest	1.00
Limburg	0.65	Notio Aigaio	1.00	Pays de la Loire	0.51	Nyugat-Dunantul	0.51
Jugozapaden	0.60	Peloponnese	0.99	Picardie	0.35	Drenthe	0.37
Yuzhen tsentralen	0.52	Stereá Ellada	0.94	Poitou-Charentes	0.42	Friesland	0.40
Severoiztochen	0.63	Thessalia	0.89	Provence-Alpes-Côte Azur	0.48	Gheldria	0.40
Severen tsentralen	1.00	Voreio Aigaio	1.00	La Réunion	0.49	Groningen	0.44
Yugoiztochen	0.76	Andalusia	0.64	Rhône-Alpes	0.54	Limburg	0.43
Severozapaden	1.00	Aragon	0.98	Bretagne	0.39	Noord-Brabant	0.48
Jihovychod	0.40	Canary Islands	0.86	Jadranska Hrvatska	0.51	Noord-Holland	0.60
Jihozapad	0.41	Cantabria	0.64	Abruzzo	0.78	Overijssel	0.42
Moravskoslezsko	0.37	Castilla y León	1.00	Basilicata	0.99	Zeeland	0.43
Prague	1.00	Castilla-La Mancha	1.00	Calabria	1.00	Zuid-Holland	0.44
Severovychod	0.39	Catalonia	0.80	Campania	0.83	Utrecht	0.52
Severozapad	0.35	Ciudad Autónoma de Ceuta	1.00	Emilia-Romagna	0.70	Wien	0.56
Střední Morava	0.42	Comunidad de Madrid	1.00	Friuli-Venezia Giulia	0.69	Oberösterreich	0.53
Hovedstaden	0.59	Comunidad Foral de Navarra	0.99	Lazio	0.70	Vorarlberg	0.59
Midtjylland	0.46	Comunidad Valenciana	0.59	Liguria	0.69	Steiermark	0.47
Nordjylland	0.48	Estremadura	1.00	Lombardia	0.76	Salzburg	0.65
Sjælland	0.37	Ciudad Autónoma de Melilla	0.92	Marche	0.81	Burgenland	0.36
Syddanmark	0.49	Galicia	0.75	Molise	0.86	Tirol	0.58
Thüringen	0.33	La Rioja	0.85	Piemonte	0.64	Kärnten	0.47
Schleswig-Holstein	0.45	Pais Vasco	0.70	Bolzano	1.00	Dolnośląskie	0.46

Sachsen-Anhalt	0.35	Principado de Asturias	0.54	Trento	1.00	Śląskie	0.40
Saarland	0.43	Región de Murcia	0.65	Puglia	1.00	Lodzkie	0.41
Rheinessen-Pfalz	0.41	Illes Balears	0.96	Sardegna	1.00	Lubuskie	0.41
Düsseldorf	0.47	Auvergne	0.38	Sicilia	1.00	Małopolskie	0.36
Hamburg	0.67	Basse-Normandie	0.39	Toscana	0.75	Mazowieckie	0.36
Bremen	0.55	Bourgogne	0.41	Umbria	0.95	Opolskie	0.40
Berlin	0.45	Centre-Val de Loire	0.38	Valle d'Aosta	0.89	Podkarpackie	0.43
Estonia	0.42	Champagne-Ardenne	0.46	Veneto	0.76	Pomorskie	0.41
Dublin	0.88	Corse	0.70	Kypros	0.46	Świętokrzyskie	0.43
Southern	1.00	Martinique	0.50	Lettonia	0.49	Warmińsko-Mazurskie	0.42

Source: our elaboration

The analysis shows that by working on the critical variables, the regions that can reach maximum efficiency go from 13 to 32 regions, while totally inefficient regions are less. The most interesting results may be recorded in the regions of Eastern Europe which, by implementing the right policies, would be able to achieve efficiency measures in line with the rest of Europe; an example is represented by regions such as Yugozapaden (Bulgaria), Jihovychod (Czech Republic), Del-Alfold (Hungary) but more generally all of Eastern Europe records considerable efficiency gains going from values equal to 0 or close to 0, managing to touch minimum levels ranging from 0.39 upwards. Similar trends are also recorded for some of the large economies such as Belgium where it is possible to record how a DEA of 0.12 for the Namur region can increase its efficiency up to 0.49 as well as Liège go from 0.11 to 0.49.

The margins for improvement of the Mediterranean countries are also interesting, as they have the possibility of significantly increasing their efficiency, an example can be the Italian case which shows how implementing the right corrective measures, the efficiency values can be achieved in 6 regions (Nowadays there is only one region with maximum efficiency). Greece, on the other hand, would go from 4 to 6 regions.

As regards France, it should be emphasized that, based on current values, it is already maximizing its efficiency to the point that a change in the management of inputs / outputs would correspond to a loss of efficiency. In the Mediterranean area it is the only one to register this trend.

Finally, is reported how the geographically northern regions are already in a condition of maximum (or almost maximum) efficiency, with reference to the current inputs / outputs, so that a change in their management would lead either to a worsening of efficiency or to a modest increase such as eg. Germany or Ireland.

5 Conclusions

The aim of this study is to analyze how competitiveness can be exploited to provide a more dignified life to its citizens. The evaluation was carried out in terms of efficiency in converting competitiveness into human development through the DEA. To applying the DEA, it was decided to use the RCI scores relating to the basic, efficiency and innovation sub-index as inputs, while the scores of life expectancy, gross schooling rate and pro-GDP understand PPP were taken as output. Before proceeding with the definition of the efficiency of the states, an analysis of the clusters was carried out to verify if it was possible to make a distinction between the European regions. In fact, from the analysis it emerged that Europe can be distinguished in northern Europe and south-eastern Europe. At this point we proceeded with the application of the DEA to evaluate the results and progress. The scores obtained by the DEA offer a distinction of Europe in the east-north-Mediterranean. In particular, it can be read how Eastern Europe is characterized, to date, by maximum inefficiency ($DEA = 0$). These countries, currently considered emerging, are characterized by having relatively low levels of both HDI and RCI. With reference to Mediterranean Europe, the situation is fluctuating, recording values ranging from maximum efficiency to maximum inefficiency. It should be emphasized, however, that very low values are recorded in small economic realities while the maximum efficiency occurs in capitals or large cities. Finally, in Northern Europe there is a linear trend without major fluctuations. A common element for the entire continent is that the maximum efficiency values are recorded in almost all capitals: this is true for Bucharest, in Romania, which falls into the category of inefficient nations; it applies to Brussels, Belgium, which is one of the major European economies; it also applies to Île-de-France belonging to Mediterranean Europe. Indeed, the 2019 competitiveness report also offers a similar trend in the competitive arena.

Finally, it is possible to note how northern and Mediterranean Europe find themselves in opposition given that the southern regions, although they have lower RCI values, still manage to efficiently transform competitiveness into human development; while in northern Europe, despite significantly higher data, lower performances are recorded.

Finally, there has been an evaluation of the efficiency of European regions using a linear projection frontier: through slack analysis it has been made a projection of the outputs for the groups of countries to emphasize the potential outputs obtainable given the current inputs. The results showed that the greatest improvements can be achieved for inefficient regions, which means that by adopting the right policies you can improve the quality of life of your citizens. Eg. Romania which showed a $DEA = 0$ (apart from the capital) with the right interventions manages to bring 5 regions out of 8 to maximum efficiency levels. It can then be noted that greater increases are recorded in regions with relatively low results to the detriment of cities with average values. The results show how the Northern Europe is

achieving lower increases than the Mediterranean, projecting itself to levels slightly higher than the current situation. This data confirms how these regions are already achieving the maximum efficiency obtainable with the current inputs / outputs.

The methodology proposed in this study could be used to analyze the performance over several years to be able to identify a trend of the results and could be further improved by analyzing which are the variables that have the greatest influence in the definition of the results.

Appendix - Table with data on competitiveness and human development

Region	Life expectation	Schooling	GDP per capita	Innovation	Efficiency	Base
Bruxelles (Brussel)	81.60	139.4	63700.00	83.22	85.92	74.30
Oost-Vlaanderen	82.60	169.39	33500.00	75.31	66.72	71.31
Antwerp	83.00	126.05	43500.00	77.40	85.92	76.55
Hainaut	79.60	110.57	22900.00	57.74	67.35	66.72
Luxembourg (BE)	80.60	111.04	22600.00	58.06	69.57	66.72
Liège	80.60	103.97	26100.00	61.59	67.35	66.72
Namur	80.30	111.88	24600.00	61.60	71.54	66.72
West-Vlaanderen	83.20	134.48	35800.00	68.76	83.55	69.91
Limburg	83.30	131.42	29800.00	72.08	83.55	71.31
Yugozapaden	76.00	95.51	28000.00	31.02	67.19	27.23
Yuzhen tsentralen	75.60	48.52	11700.00	7.16	46.28	27.23
Severoiztochen	75.00	83.02	12900.00	9.72	39.68	18.25
Severen tsentralen	74.60	90.73	11100.00	2.77	46.28	15.74
Yugoiztochen	74.50	83.17	12600.00	3.04	39.68	13.74
Severozapaden	73.70	92.82	10200.00	2.56	28.85	5.98
Jihovychod	79.90	82.54	26300.00	57.77	70.77	57.77
Jihozapad	79.50	81.57	24500.00	53.31	65.76	51.78
Moravskoslezsko	77.90	79.39	22800.00	54.08	66.16	53.48
Prague	81.00	139.2	64600.00	62.75	82.56	62.75
Severovychod	79.70	80.21	23800.00	54.08	66.70	54.08
Severozapad	77.70	73.78	20100.00	53.31	57.55	48.33
Střední Morava	79.30	86.33	23600.00	53.31	65.84	53.31
Hovedstaden	81.50	78.46	51400.00	90.18	84.45	99.54
Midtjylland	82.00	85.11	36500.00	72.02	82.24	90.78
Nordjylland	81.30	84.09	33200.00	61.02	71.89	84.45
Sjælland	80.80	82.9	28000.00	65.47	78.03	90.78
Syddanmark	81.50	84.8	35600.00	64.13	76.10	87.18
Thüringen	80.70	52.8	27000.00	64.86	79.11	71.21
Schleswig-Holstein	80.90	98.34	31100.00	66.25	80.54	74.94
Sachsen-Anhalt	80.00	51.96	26600.00	60.04	71.36	74.50
Saarland	80.20	74.73	32600.00	63.62	76.44	74.98
Rheinhausen-Pfalz	81.30	58.96	34800.00	70.13	84.83	82.49
Düsseldorf	80.70	72.54	38800.00	68.14	84.92	82.31

Hamburg	81.50	71.9	61000.00	84.09	90.72	84.51
Bremen	80.70	73.13	44600.00	74.54	78.79	75.43
Berlin	81.50	60.41	38900.00	77.97	81.26	83.52
Estonia	79.00	73.83	25800.00	57.14	57.14	62.62
Eastern and Midland (Dublin)	83.00	69.48	62900.00	74.54	76.58	74.54
Southern (South-West)	82.40	76.27	75100.00	69.22	76.58	65.38
Northern and Western (Mid-West)	82.90	75.09	20900.00	56.28	55.29	58.56
Anatoliki Macedonia, Tracia	81.10	64.57	14100.00	15.88	21.03	7.37
Attiki	81.20	64.83	28200.00	49.15	59.57	25.47
Dytiki Ellada	81.50	63.25	15000.00	20.87	19.80	8.55
Dytiki Makedonia	82.50	78.51	17200.00	16.68	20.74	8.20
Ionia Nisia	81.40	78.11	19600.00	12.96	25.35	15.27
Ipeiros	84.00	67.78	14600.00	19.41	28.09	9.91
Kentriki Macedonia	81.70	66.94	16200.00	26.66	36.59	14.82
Kriti	82.10	68.01	17600.00	27.28	25.96	12.02
Notio Aigaio	82.30	66.24	22300.00	12.96	24.72	12.76
Peloponnese	82.10	65.44	17500.00	12.96	23.76	13.74
Stereia Ellada	81.80	58.77	18700.00	12.96	26.65	13.98
Thessalia	82.30	68.94	15800.00	15.88	27.44	12.35
Voreio Aigaio	82.70	59.01	13700.00	16.60	6.75	16.57
Andalusia	82.60	70.35	21000.00	39.49	25.10	49.67
Aragon	84.40	77.6	30900.00	46.00	43.72	57.21
Canary Islands	83.50	75.86	23000.00	32.45	28.44	49.50
Cantabria	83.90	85.24	26200.00	42.46	54.18	56.12
Castilla y León	84.70	84.34	26800.00	38.12	41.67	53.04
Castilla-La Mancha	83.90	73.51	22400.00	31.65	27.86	59.34
Catalonia	84.30	69.02	33500.00	55.32	56.01	68.32
Ciudad Autónoma de Ceuta	81.40	77.93	22500.00	25.51	17.75	43.89
Comunidad de Madrid	85.80	73.38	38700.00	67.32	74.95	68.32
Comunidad Foral de Navarra	85.00	80.26	34400.00	47.18	60.83	54.56
Comunidad Valenciana	83.50	74.93	24800.00	43.35	46.05	54.42
Extremadura	83.10	77.21	20700.00	28.77	15.75	50.05

Ciudad Autónoma de Melilla	81.40	69.45	20600.00	24.79	15.75	44.98
Galicia	84.00	90.53	25600.00	40.31	46.42	49.49
La Rioja	84.20	76.95	30200.00	37.94	48.20	53.10
Pais Vasco	84.50	88.89	36500.00	56.17	73.36	57.67
Principado de Asturias	83.20	81.89	25000.00	41.79	49.75	51.42
Región de Murcia	82.90	73.46	23200.00	37.94	31.18	54.45
Illes Balears	84.20	67.05	30600.00	40.42	41.98	50.58
Auvergne	82.50	64.2	26200.00	57.45	69.42	51.82
Basse-Normandie	82.50	68.4	25600.00	50.97	66.20	51.34
Bourgogne	82.40	65.61	26800.00	49.50	67.47	55.51
Centre-Val de Loire	82.70	66.75	26900.00	56.43	72.21	59.90
Champagne-Ardenne	81.80	64.5	27200.00	47.63	56.64	61.56
Corse	84.00	64.56	25200.00	49.72	48.31	47.14
Martinique	82.10	74.11	23100.00	44.98	47.49	33.70
Franche-Comté	82.80	65.69	24900.00	55.72	69.11	50.99
Guadeloupe	81.80	73.66	21500.00	31.05	38.39	34.12
Haute-Normandie	81.80	64.82	27400.00	53.42	70.87	60.24
Île-de-France	84.60	64.15	56700.00	84.79	94.45	77.25
Languedoc-Roussillon	83.10	64.83	24600.00	59.44	61.39	55.37
Limousin	82.30	64.46	23900.00	44.64	69.99	50.61
Lorraine	82.00	65.34	23700.00	55.86	70.04	55.12
Mayotte	75.90	59.63	8900.00	36.95	2.21	29.87
Midi-Pyrénées	83.80	63.73	30100.00	65.63	75.54	58.18
Pays de la Loire	83.40	104.13	29200.00	59.15	76.16	57.53
Picardie	81.40	64.47	24300.00	51.20	66.81	61.48
Poitou-Charentes	82.80	65.93	26500.00	53.03	64.59	51.32
Provence-Alpes-Côte Azur	83.40	69	30800.00	84.79	70.16	60.88
La Réunion	81.30	70.02	20800.00	38.69	39.14	40.96
Rhône-Alpes	84.10	65.02	33400.00	84.79	81.70	63.04
Bretagne	82.50	67.2	27900.00	57.34	75.76	52.30
Jadranska Hrvatska	79.90	75.21	20100.00	28.72	46.93	29.34
Abruzzo	83.70	97.07	25600.00	36.84	44.24	36.43
Basilicata	83.00	105.21	23200.00	28.27	36.31	32.27
Calabria	82.80	99.22	17700.00	25.09	23.61	35.45
Campania	82.10	98.87	19500.00	30.49	30.80	40.99

Emilia-Romagna	84.00	100.49	36600.00	47.09	65.95	45.42
Friuli-Venezia Giulia	83.90	101.57	32700.00	46.12	60.89	43.44
Lazio	83.80	100.77	35100.00	54.23	61.24	46.49
Liguria	83.50	99.97	32900.00	47.24	57.70	47.62
Lombardia	84.20	96.15	39800.00	51.82	68.04	49.32
Marche	84.40	99.46	28400.00	38.56	54.14	39.98
Molise	83.60	99.48	21800.00	31.40	45.79	35.87
Piemonte	83.30	101.03	32000.00	47.62	61.12	47.37
Provincia Autonoma di Bolzano	84.50	121.57	48600.00	36.27	65.12	35.34
Provincia Autonoma di Trento	84.90	99.91	39500.00	52.24	67.64	37.68
Puglia	83.70	98.4	19500.00	28.65	26.53	40.72
Sardegna	83.60	104.52	22000.00	36.46	27.59	36.28
Sicilia	82.30	98.53	18400.00	27.68	21.45	39.84
Toscana	84.10	102.7	33100.00	44.91	59.47	42.89
Umbria	84.50	101.17	26600.00	42.45	56.20	37.58
Valle d'Aosta	83.60	97.09	38900.00	32.51	55.04	36.93
Veneto	84.30	98.03	34100.00	43.60	62.66	46.41
Kypros	82.30	56.54	27528.00	56.96	56.96	48.93
Latvija	75.70	68.07	21436.00	38.48	39.46	39.46
Vidurio ir vakarų Lietuvos	76.40	46.37	21300.00	32.71	59.71	31.00
Sostinės regionas (Vilnius County)	76.90	46.41	38200.00	44.71	72.52	53.85
Luxembourg	82.70	78.51	52877.00	84.09	90.21	84.09
Del-Alfold	76.20	86.85	16600.00	22.80	51.63	20.26
Del-Dunantul	76.00	78.72	15500.00	24.20	46.08	18.13
Eszak-Alfold	75.50	84.29	14700.00	21.12	45.69	17.17
Eszak-Magyarország	74.50	74.51	15200.00	21.81	46.83	19.42
Kozep-Dunantul	76.20	83.56	21100.00	29.21	62.24	26.65
Kozep-Magyarország (Budapest)	77.90	175.2	47300.00	55.91	75.50	34.12
Nyugat-Dunantul	77.30	85.83	22100.00	28.49	61.59	27.91
Drenthe	81.90	83.95	27300.00	66.84	75.97	86.10
Friesland	82.00	84.1	28000.00	61.67	72.85	89.54
Gheldria	82.10	80.79	33800.00	74.77	85.50	96.32
Groningen	81.30	78.26	36400.00	75.63	78.91	85.27

Limburg	81.80	77	35400.00	70.73	83.87	93.94
Noord-Brabant	82.30	75.3	40700.00	74.69	86.54	96.41
Noord-Holland	82.40	82.11	53600.00	84.31	91.48	97.30
Overijssel	81.90	80.4	33800.00	69.81	81.77	92.98
Zeeland	82.60	77.95	31800.00	60.43	80.27	88.52
Zuid-Holland	82.20	75.79	38800.00	78.80	87.34	98.26
Utrecht	82.70	77.63	50200.00	90.16	96.62	99.52
Wien	80.50	82.24	46400.00	72.75	86.34	81.09
Oberösterreich	81.40	80.96	40400.00	61.06	83.23	74.87
Vorarlberg	83.30	78.48	42200.00	59.63	81.91	81.13
Steiermark	82.20	80.72	36100.00	65.38	80.40	71.78
Salzburg	82.80	90.51	47100.00	61.57	81.67	74.05
Burgenland	81.90	75.7	27800.00	59.50	80.14	76.22
Tirol	83.00	84.5	42200.00	59.75	81.25	73.53
Kärnten	82.20	82.92	33800.00	60.87	77.43	68.83
Dolnoslaskie	77.50	67.81	24900.00	33.81	64.75	28.25
Śląskie	77.50	70.69	23300.00	28.83	72.81	32.70
Lodzkie	76.90	28.91	21400.00	23.64	64.47	28.37
Lubuskie	78.20	67.14	18500.00	19.81	57.06	23.53
Malopolskie	79.20	69.99	20800.00	31.23	69.40	32.54
Mazowieckie	77.00	68.2	19600.00	34.21	63.01	28.72
Opolskie	78.20	71.16	18000.00	19.28	62.04	29.10
Podkarpackie	79.40	69.74	16100.00	21.45	54.40	28.47
Pomorskie	78.50	70.51	22200.00	33.71	61.99	34.43
Swietokrzyskie	78.00	71.77	16200.00	16.19	58.11	23.27
Warminsko-Mazurskie	77.20	66.18	15600.00	20.94	45.18	26.93
Wielkopolskie	78.10	42.24	24700.00	24.73	63.15	29.38
Zachodniopomorskie	77.50	64.91	18800.00	27.14	54.40	28.37
Kujawsko-pomorskie	77.50	71.04	18100.00	23.24	55.40	25.64
Lubelskie	78.20	70.03	15500.00	23.22	55.72	24.46
Alentejo	80.70	69.27	22400.00	25.68	40.33	39.65
Algarve	80.70	68.59	27600.00	23.89	39.76	46.91
Lisbon Metropolitan Area	82.20	77.58	32000.00	64.75	68.26	57.32
Centru	82.00	71.95	21300.00	35.96	48.53	47.26
Norte	82.40	70.39	21000.00	34.99	43.61	50.90

Região Autónoma da Madeira	78.80	68.43	23800.00	26.04	26.05	42.98
Região Autónoma dos Açores	78.80	63.32	21800.00	27.62	8.62	39.92
Bucureşti-Ilfov	77.20	92.54	50100.00	44.28	80.94	18.12
Centru	76.00	64.76	20400.00	8.40	38.26	2.31
Nord-Est	74.60	64.27	13600.00	1.03	34.00	1.86
Nord-Gilet	75.70	68.84	20200.00	12.69	44.37	0.73
Sud-Muntenia	75.50	63.17	16500.00	3.56	40.03	8.46
Sud-Est	74.40	68.63	17300.00	0.00	29.40	0.00
Sud-Vest Oltenia	76.20	74.81	16900.00	5.86	34.94	2.02
Veste	75.60	73.65	22400.00	15.61	47.63	3.10
Zahodna Slovenija (Osrednjeslovenska)	82.80	104.06	33000.00	65.67	74.16	61.29
Vzhodna Slovenija (Jugovzhodna Slovenia)	80.70	90.69	22900.00	44.66	64.20	56.00
Bratislavský kraj	79.30	104.03	50200.00	68.76	86.39	56.04
Stredne Slovensko	77.20	70.15	17600.00	30.54	54.58	38.68
Vychodne Slovensko	77.60	58.61	15300.00	30.27	45.08	35.39
Zapadne Slovensko	78.00	70.08	20200.00	29.32	62.38	42.50
Aland	83.90	72.31	36000.00	48.68	60.25	80.47
Etela-Suomi	81.70	107.28	30300.00	67.16	69.57	83.35
Helsinki-Uusimaa	82.60	117.6	44800.00	89.32	88.91	91.57
Lansi-Suomi	82.30	109.66	30100.00	66.33	66.23	77.05
Pohjois-ja Ita-Suomi	81.50	110.42	28400.00	60.90	53.58	73.78
Mellersta Norrland	82.10	101.88	31800.00	50.70	55.75	85.61
Norra Mellansverige	82.70	98.6	29700.00	52.80	62.65	82.63
Ostra Mellansverige	83.00	95.69	31800.00	75.26	79.57	91.13
Ovre Norrland	82.20	99.04	36200.00	63.03	55.25	82.48
Smaland med oarna	83.60	95.19	31400.00	52.21	71.35	85.20
Stockholm	83.90	56.61	51300.00	92.07	96.97	100.00
Sydsverige	83.10	94.02	31800.00	74.52	83.70	94.70
Vastsverige	83.10	95.25	36000.00	70.70	82.65	90.66

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