Evaluation of the EU Member States Efficiency by Data Envelopment Analysis Method

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***Abstract*—**Efficiency of the European Union (EU) Member States is the source of national competitiveness. The aim of the paper is to analyze a competitive potential of the EU Member States with the help of quantitative analysis – Data Envelopment Analysis (DEA). The main purpose of this approach is to evaluate numerical grades of efficiency of economical processes within all the 27 EU Member States. Using of DEA method for national competitiveness evaluation is convenient because there is not only one factor evaluated, but a set of different factors that determine the degree of economic development. The DEA method is based on the inputs and outputs of used indicators and evaluates the efficiency how the EU Member States are able to transform their inputs into outputs. Therefore, efficiency of the EU Member States can be considered as a 'mirror' of the competitiveness. Here, the DEA method becomes a suitable tool for setting a competitive/uncompetitive position of each Member State and for the comparison of the level of competitive potential of 27 EU Member States.

***Keywords*—**Evaluation, efficiency, Data Envelopment Analysis, efficiency index, super efficiency index.

I. Introduction

THE history of European integration in the past five decades was and is guided by striving for two different objectives: *to foster economic competitiveness* and *to reduce regional differences*. The economy may be competitive but if the society and the environment suffer too much the country will face major difficulties. The same would happen vice versa when the economy is too weak. Therefore governments in the long run cannot focus alone on the economic competitiveness of their country; instead they need an integrated approach to govern the country. Although the European Union is not one state with one nation, one government and a common territory, the Union developed an institutional setting which is in many respects similar to that of a state. European institutions as the European Council, the European Parliament and the European Commission take decisions which affect the lives of all citizens of the Union. Competitiveness of the economy and its enterprises matters a lot but it is at the same time in competition with other policy objectives of the EU. Economic competitiveness is a high ranking policy objective of the EU and therefore has to be mainstreamed into other policies.

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II. Theoretical Background of Competitiveness

In recent years, the topics about measuring and evaluating competitiveness acquire economic interest. Competitiveness belongs to one of the most used words. In spite of high frequency of usage this expression, hardly anybody can exactly explain the right meaning of the word competitiveness.

A. Concept of Competitiveness

The definition of competitiveness is difficult because of the *lack of mainstream view* for understanding this term. Competitiveness remains a concept that is not well understood and that can be understood in different ways and levels despite widespread acceptance of its importance. The concept of competitiveness is distinguished at different levels - *microeconomic, macroeconomic and regional*. Anyway, there are some differences between these three approaches; see e.g. [12].

In original meaning the concept of competitiveness was applied only to companies and corporate strategies. Competitiveness of companies is understood as *the ability to provide products and services as well as or more effectively than their main competitors*. Competitiveness of companies is derived from the main sources of competitiveness – the competitive advantage which companies gained through their methods of organization, production and effect on the markets in comparison to their rivals, and covers the company's ability to maintain its market position.

Nowadays competitiveness is one of the *fundamental criteria for evaluating economic performance* and reflects the success in the broader comparison. Competitiveness is monitored characteristic of national economies which is increasingly appearing in evaluating their prosperity, welfare and living standards. The need for a theoretical *definition of competitiveness* at macroeconomic level emerged with the development of globalization process in the world economy as a result of increased competition between countries. Despite

that, growth competitiveness of the territory belongs to the main priorities of countries' economic policies. There is not a standardized definition and understanding of national competitiveness (compared with the competitiveness at the microeconomic level). The concept of competitiveness in the EU is specific regarding the inclusion of *elements of European integration* that goes beyond the purely economic parameters. One of the most common interpretations of this term understood national competitiveness *as the ability to produce goods and services in the country that are able to successfully face international competition, and people can enjoy a growing and sustainable living standards* [11]. *The Organization for Economic Cooperation and Development* defines the national competitiveness as *the degree or extent to which the country, in terms of open and fair trade, produce goods and services which meet the test of international markets while maintaining and increasing the real incomes of its citizens in the long run* [6]. Michael Porter suggests that the best way to understanding competitiveness is through the sources of a nation's prosperity. "*A nation's standard of living is determined by the productivity of its economy, which is measured by the value of its goods and services produced per unit of the nation's human, capital and natural resources. True competitiveness, then, is measured by productivity. Productivity allows a nation to support high wages, a strong currency and attractive returns to capital and with them a high standard of living*" [18]. The European Commission offers similar definition of this term in The Sixth Periodic Report on the Social and Economic Situation of Regions in the EU: "*...the ability to produce goods and services which meet the test of international markets, while at the same time maintaining high and sustainable levels of income or more generally, the ability of (regions) to generate, while being exposed to external competition, relatively high income and employment levels"* [4]. European Commission presented that *the economy is competitive if its population enjoy a high and constantly rising living standards and permanently high employment*.

In last few years the topic about *regional competitiveness* stands in the front of economic interest. The concept of competitiveness has quickly spread into the regional level, but the notion of regional competitiveness is also contentious. Macroeconomic concept of national competitiveness cannot be fully applied at the regional level because the regional competitiveness is much worse and less clear defined, between these two concepts is a big difference [12]. In the global economy regions are increasingly becoming the drivers of the economy and generally one of the most striking features of regional economies is the presence of clusters, or geographic concentrations of linked industries [18]. Current economic fundamentals are threatened by the shifting of production activities to places with better conditions. The regional competitiveness is also affected by the regionalization of public policy because of the shifting of decision-making and coordination of activities at the regional level. Within governmental circles, interest has grown in the *regional foundations of national competitiveness*, and with developing new forms of regionally based policy interventions to help improve the competitiveness of every region and major city, and hence the national economy as a whole. *Regions play an increasingly important role in the economic development of states.*

B. Evaluation of Competitiveness

Evaluating competitiveness is also the main issue of economic research, which also lacks a mainstream approach, so there is a space for alternative approaches. Evaluation of competitiveness in terms of differences between countries and regions should be measured through complex of economic, social and environmental criteria that can identify imbalance areas that cause main disparities. Currently not only quantitative but also qualitative development at the national level, and especially at the regional level, increase socio-economic attraction and create new opportunities that are fundamentals for subsequent overcoming disparities and increasing the competitiveness of the territory.

Competitiveness is most commonly evaluated by *decomposition of aggregate macroeconomic indicators.* Competitiveness of countries is monitored in many institutions, however, two well known international institutes publish most reputable competitiveness reports. To compare a level of competitiveness of countries we can use the databases performed by *Institute for Management Development* (IMD) and *World Economic Forum* (WEF). WEF publishes the *Global Competitiveness Report* (GCR) that produces annul competitiveness indices that rank national economies. Global Competitiveness Reports use two main aggregate indexes for measuring the level of competitiveness – the *Global Competitiveness Index* (GCI) and the *Business Competitiveness Index* (BCI). IMD ranking on competitiveness is realized in the *World Competitiveness Yearbook* (WCY) which provides a comprehensive report on the competitiveness of countries, assesses and analyzes the national conditions for business competitiveness.

EU competitiveness can be measured also by indicators of *EU' growth strategies* (Lisbon strategy – Structural (Lisbon) indicators, Strategy Europe 2020 – Indicators of Europe 2020) or by *macro-econometric modelling* with creation of an econometric panel data model; see e.g. [8], [9], [10]. Another approach is the evaluation by the method of *Data Envelopment Analysis* (DEA), which measures national efficiency and subsequent national competitive potential; see e.g. [16].

Regional competitiveness and its evaluation are issues constantly in the forefront of economic sciences, which lacks a mainstream method of regional competitiveness monitoring and evaluation. *Decomposition of aggregate macroeconomic indicators* of international organizations (WEF, IMD) is most commonly used approach at the regional level, as well as *comprehensive* (mostly descriptive) *analysis* aimed at identifying the key factors of regional development, productivity and economic growth; see e.g. [1], [13]. Another

approach is an evaluation by indicators of *EU' growth strategies* or by *macro econometric model* with creation of a regional econometric panel data model; see e.g. [15]. Alternative approach is the evaluation using the DEA method measuring regional efficiency and subsequent regional competitive potential; see e.g. [14].

Evaluation of regional competitiveness is determined by the chosen territorial level, especially in terms of the European Union the *Nomenclature of Territorial Units Statistics* (NUTS) is applied. No less importance is the reference period, availability and periodicity of data, and selection of convenient specific factors. Factors affecting regional competitiveness are therefore becoming the subjects of evaluation at qualitative or quantitative level. Selection of appropriate criteria for evaluating regional competitiveness is the key issue as these need to be universally acceptable. For evaluation of regional competitiveness it is necessary to note that the data availability decreases in direct proportion to the lower territorial unit (NUTS). For evaluating regional competitiveness in the terms of the EU, the most appropriate territorial unit is NUTS 2 level which is in the centre of the interest of the European Commission in terms of fulfilling the objectives of EU Cohesion Policy.

Comparing the instruments for measuring and evaluation of competitiveness in terms of the EU is no simply matter. There are linkages among instruments for measuring the EU competitiveness on both national and regional levels. There are different time period series on both levels, overlap of indicators of the EU's Growth Strategies on national and regional levels. Furthermore there is continuity between the approach of the WEF and approach of the EU to measuring and evaluation of the EU competitiveness. Between the EU Competitiveness and Cohesion policies a link exists in terms of the Cohesion reports – 4th and 5th reports articulated a special indices for measuring and evaluation of competitiveness of the European regions. Indicators and indices cover a broad area of economic, social and environmental interests, but coverage and reference period decrease in direct proportion to the lower territorial unit (NUTS). Because of these not always clear and close links among the instruments (indicators and indices) for measuring of competitiveness it is difficult to choose just the best approach to evaluation. Possibilities of measuring both national and regional levels of the EU competitiveness are characterized by high coverage in the monitored areas, which can indicate the similar informative ability of the indicators and indices.

III. Measuring EU Efficiency by DEA Method

Although the EU is one of the most developed parts of the world with high living standards, there exist huge economic, social and territorial disparities between Member States. These disparities have a negative impact on the balanced development across the Union and weaken its competitiveness in the global context. Globalization, rapid technological change, an ageing population and new knowledge economies are external factors which are becoming a growing threat. The EU needs to transform its economy and society. Europe's economic challenge is to secure its position in global markets facing intense challenges from its competitors. The European Union makes an effort to restore the foundations of its competitiveness and economic performance through increasing its growth potential and its productivity. The performance analysis provided by DEA method can be used for evaluating national development efficiency with respect to the national factor endowment.

A. Theoretical Background of DEA

Since DEA was first introduced in 1978, researchers in a number of fields have quickly recognized that it is an excellent and easily used methodology for modelling operational processes for performance evaluations. This has been accompanied by other developments. DEA's empirical orientation and the absence of a need for the numerous *a priori* assumptions that accompany other approaches (such as standard forms of statistical regression analysis) have resulted in its use in a number of studies involving efficient frontier estimation in the governmental and non-profit sector, in the regulated sector, and in the private sector.

DEA is based on *Farrel model* for measuring the effectiveness of units with one input and one output, which expanded *Charnes*, *Cooper* and *Rhodes* (CCR model) and *Banker*, *Charnes* and *Cooper* (BCC model); see e.g. [2], [3]. In the original study DEA is described as a 'mathematical programming model applied to observational data (that) provides a new way of obtaining empirical estimates of relations - such as the production functions and/or efficient production possibility surfaces – that are cornerstones of modern economics; see e.g. [3]. The Data Envelopment Analysis is a relatively new 'data oriented' approach for providing a relative efficiency assessment (*DEA efficient*) and evaluating the performance of a set of peer entities called *Decision Making Units* (DMUs) which convert multiple inputs into multiple outputs; see e.g. [17]. DEA is thus a *multi-criteria decision making method* for evaluating effectiveness, efficiency and productivity of homogenous group (DMUs). The definition of a DMU is generic and flexible. DEA is convenient to determine efficiency of DMU which are mutually comparable – using same inputs, producing same outputs, but their performances are different. Homogenous production unit is a set of units producing identical or equivalent effects, which will be referred as the outputs of these units. To create such effects, each unit uses inputs that are in contrary with their nature minimization, i.e. lower value of these inputs leads to higher performance of these units. An efficiency analysis compares the actual output of a DMU with the maximal output estimated by a production function. The best-practice units of a comparison group are used as a reference for the evaluation of the other group units. For every inefficient DMU, DEA identifies a set of corresponding efficient units that can be utilized as benchmarks for

improvement. A test DMU is inefficient if a composite DMU (linear combination of units in the set) can be identified which utilizes less input than the test DMU while maintaining at least the same output levels. The units involved in the construction of the composite DMU can be utilized as benchmarks for improving the inefficient test DMU. DEA also allows for computing the necessary improvements required in the inefficient unit's inputs and outputs to make it efficient. It should be noted that DEA is primarily a diagnostic tool and does not prescribe any reengineering strategies to make inefficient units efficient. The aim of this method is to examine DMU if they are *effective* or *not effective* by the size and quantity of consumed resources by the produced output or other type of output [3]. Determining whether a DMU is efficient from the observed data is equivalent to testing whether the DMU is on the "frontier" of the production possibility set. The concept of the production frontier is extended from the production function to the case of multiple outputs. The methods and models of DEA can be used to describe the structure of the production frontier. Therefore, DEA is recognized as a non-parametric statistical estimation method; see e.g. [2], [3].

Formally, DEA is a methodology directed to frontiers rather than central tendencies. Instead of trying to fit a regression plane through the *centre* of the data as in statistical regression, for example, one 'floats' a piecewise linear surface to rest on top of the observations. Because of this perspective, DEA proves particularly adept at uncovering relationships that remain hidden from other methodologies. For instance, consider what one wants to mean by "efficiency", or more generally, what one wants to mean by saying that one DMU is more efficient than another DMU. This is accomplished in a straightforward manner by DEA without requiring explicitly formulated assumptions and variations with various types of models such as in linear and nonlinear regression models.

In recent years, we have seen a great variety of applications of DEA for evaluating the performances of many different kinds of entities engaged in many different activities (such as banks, hospitals, universities, cities, courts, business firms, and others, including the performance of countries, regions, etc.). Because of low assumption requirements DEA has also opened up possibilities for use in cases which have been resistant to other approaches because of the complex (often unknown) nature of the relations between the multiple inputs and multiple outputs involved in DMUs [2]. *DEA method is thus a convenient method for comparing national efficiency as an assumption for the competitiveness of countries.*

Using DEA method as a quantitative analysis for national competitiveness evaluation is suitable because it does not evaluate only one factor, but a set of different factors that determine the degree of economic development. The DEA method used for our evaluation is based on a particular set of input and output indicators. The inputs and outputs form the key elements of the system evaluated for every member state in the sense of their effective/ineffective economic position. For this purpose, the DEA method can identify a competitive/uncompetitive position of each EU27 Member State. *Efficiency* of each EU Member State is thus the *source of national competitiveness* [7].

B. Fundamental Basis of Empirical Analysis

Based on the facts above, it is possible to determine the initial *hypothesis of the analysis*. The hypothesis is based on the assumption that the EU Member States achieving best results in efficiency are countries with the best using of their competitive advantages and therefore having the greatest competitive potential and perspective to further effectively development.

DEA is applied to 27 EU Member States. The efficiency analysis starts from a database of indicators monitored by Eurostat – EU Policy indicators, EU Structural (Lisbon) indicators and indicators of Strategy Europe 2020 [5]. Database analysis consists of *six indicators* – four of them are inputs and two outputs. The *reference period* is determined by an early adoption and the current start of the Lisbon strategy in 2000 and the availability of selected indicators at national level which ends in 2010.

It is necessary to note criteria for selecting used inputs and outputs. The first input is *Gross domestic expenditure on research and development* (GERD) which measures the key R&D investments that supports future competitiveness and results in a higher Gross domestic product (GDP). GERD represents one of the major drivers of economic growth in a knowledge-based economy. Trends in the GERD indicator provide key indications of the future competitiveness and wealth of the EU. It is quite obvious that the overall performance of the economy affects the number of people employed in various sectors of the economy, their skills and their working age (20-64 years) that is why we selected the criterion of *Employment rate*, so this is the second input. The third input is *Gross fixed capital formation* (GFCF), which includes generally investment activity of domestic companies and fixed assets of foreign companies, in addition to the GFCF is the 'engine' of the innovation competitiveness. The GFCF is largely influenced by the inflow of foreign investment, especially foreign direct investment. Efficiency will demonstrate the ability of member state to transform its own or profitable capital for its further development. The fourth included input is a *Number of students by tertiary education* that presents a new indicator targeted in Strategy Europe 2020.

There are two outputs in the case of the presented DEA model. Reflected outputs are measured by *Gross domestic product* in purchasing power standards (PPS) and *Labour productivity per person employed*. The Gross domestic product is the most important macroeconomic aggregate. Similarly, it can deal with the labour productivity as it shows how much production economically active people have created, or employed persons in the national economy.

For calculations of economic efficiency and super efficiency of 27 EU Member States we use *primary CCR input oriented model* (with multiple inputs and outputs), assuming constant returns to scale (CRS) and *BCC input oriented model* (with multiple inputs and outputs), assuming *variable returns to scale* (VRS). In 1984, Banker, Charnes and Cooper suggested a modification of CCR model, which considers VRS (decreasing, increasing or constant). VRS enable identify more efficient units (in our case regions). The assumption of VRS provides a more realistic expression of economic reality and factual relations, events and activities existing in the countries and regions [14].

CCR and BCC models evaluate the efficiency and super efficiency of units (in our case countries) for any number of inputs and outputs. The coefficient of efficiency is the ratio between the weighted sum of outputs and the weighted sum of inputs. Each country selects input and output weights that *maximize its efficiency score*. The coefficient of efficiency takes values in the interval <0,1>. In *DEA models aimed at inputs* the efficiency coefficient of efficient countries (located on the efficient frontier package) always equals 1, while the efficiency coefficient of inefficient countries is less than 1. DEA also allows for computing the necessary improvements required in the inefficient country's inputs and outputs to make it efficient.

In the primary DEA models, efficient countries depend on the unit rate of effectiveness. According to the chosen model and the relationship between number of countries and number of inputs and outputs, the number of effective countries can be relatively large. Because there were many efficient countries in the classification we have designed *model of super efficiency*. The original efficiency coefficient equals 1, however it has a value greater than one (for models oriented at inputs) in the super efficiency model. Score of no effective countries does not change because they are not evaluated in models of super efficiency.

Assuming that there are 27 EU Member States, each with *m* inputs and *s* outputs, the relatively efficiency score of a test country *p* is obtained by solving the following equation for CCR (CRS) model (1) [2]:

$$\max \frac{\sum_{k=1}^{s} v_k y_{kp}}{\sum_{j=1}^{m} u_j x_{jp}},$$

$$\text{on conditions: } \frac{\sum_{k=1}^{s} v_k y_{ki}}{\sum_{j=1}^{m} u_j x_{ji}} \le 1; i = 1,2,...,n,$$

$$v_k \ge 0;\ k = 1,2,\ldots s,$$

$$u_j \ge 0;\ j = 1,2,\ldots,m, \qquad (1)$$

where:

y_{ki} = amount of output *k* produced by country *i*;
x_{ji} = amount of input *k* utilized by country *i*;
v_k = weight given to output *k*;
u_j = weight given to input *j*.

Mathematical formulation of primary BCC input oriented model with VRS show the equation (2) [2]:

$$\max\ z = \sum_{i}^{r} u_i y_{iq} + \mu,$$

$$\text{on conditions: } \sum_{i}^{r} u_i y_{iq} + \mu \le \sum_{j}^{m} v_j x_{jk}, k = 1,2,...n,$$

$$\sum_{j}^{m} v_j x_{jq} = 1,$$

$$u_i \ge \varepsilon;\ i = 1,2,\ldots,r,$$

$$v_j \ge \varepsilon;\ j = 1,2,\ldots m,$$

$$\mu - \text{arbitrary}, \qquad (2)$$

where:

z = optimal efficiency score;
y_{iq} = amount of output *i* produced by country *q*;
x_{jq} = amount of input *j* utilized by country *q*;
u_i = weight given to output *i*;
v_j = weight given to intput *j*;
ε = infinitezimal constant;
μ = dual variable.

IV. Efficiency and Super Efficiency Analysis of 27 EU Member States by CCR Input Oriented Models – CCR with CRS and BCC with VRS

The initial hypothesis was partly confirmed through analysis as illustrated in following evaluation. Apparently the best results are traditionally achieved by economically powerful countries which were 'efficient' or 'highly efficient' during the whole referred period compared to EU27; see Table 1 and Table 2 for CCR model with CRS, and Table 3 and Table 4 for BCC model with VRS . It means that the outputs achieved were greater than incurred inputs. Ratio of inputs and outputs is in an optimum and there is no requirement to change them. The resulting efficiency index achieved by DEA is equal to 1 for an 'efficient' country within the whole period 2000 to 2010. In Table 1 and Table 3, 'efficient' countries are coloured by dark grey colour. These are *Luxembourg* and *Malta*. *Cyprus* could also be included in the category of 'efficient' countries as up to 2 years (in CCR model) and 1 year (in BCC model) reached full effectiveness. These EU Member States, in the frame of our hypothesis, could be countries with the best competitive potential and perspective to further development. It is primarily confirmed by Luxembourg because it is a country with the best results in economic growth and performance.

In the case of Malta and Cyprus, the DEA method faced *anomalies* in the final efficiency classification of 27 EU Member States. These countries were evaluated as highly competitive. Anyway in this case it is not possible to confirm the initial hypothesis of efficiency being a mirror of competitive potential. The DEA method evaluates the volume of inputs for given outputs, which in case of these two countries seems to be effective, although these countries are generally belong to the less/average developed countries within EU27. In the case of other countries, we can also not confirm the initial hypothesis of efficiency being a mirror of

competitive potential, e.g. Czech Republic, Denmark, Sweden and Hungary. Denmark and Sweden are countries with very good ranking in the field of competitiveness according to WEF or IMD. In our analysis, these two countries were ranking in the middle or lower position compared to other EU Member States, as show Table 1 and Table 3. Czech Republic gets one of the worst positions in the overall evaluation. According to WEF or IMD, Czech Republic is evaluated in the middle ranks of the charts. Contrary in our analysis, Hungary was ranking in the middle or lower position compared to other EU Member States, as show Table 1 and Table 3. According to WEF or IMD, Hungary is evaluated in the last ranks of the charts.

The efficient countries are followed by a group of countries which are also 'highly efficient'. These countries do not achieved efficiency equal to 1, but their efficiency index reached consistently high values close to 1 during the referred period (coloured by light grey colour in Table 1 and Table 3). These countries are *Ireland* and *Greece*, and moreover Spain in BCC model. *Italy* reached high efficiency scores at the beginning of the period, but the trend is decreasing. Italy shows the largest decline in performance of all EU Member States, especially in CCR model. *On the other hand Slovakia has* the greatest growth of efficiency index of all EU Member States during the referred period (in both models). These countries show high level of competitive potential. Greece evinces an obviously decreasing trend reflecting current Greek crisis.

Other countries with efficiency index less than 1 are classified as 'inefficient' compared to EU27, i.e. these countries are considered non-competitive. In Table 1 and Table 3, the most 'inefficient' countries are highlighted by italics. *Bulgaria*, *Romania*, *Lithuania* and *Estonia* are countries with the lowest development potential, but their trends show increasing level of convergence.

Table 2 and Table 4 present comparison of countries evaluated as effective, because 'efficiency index' was equal to 1 and subsequent 'super efficiency' index was greater than 1, thus *Luxembourg*, *Malta* and *Cyprus*. Super efficiency index allows comparing development of efficient countries among themselves. All countries recorded a comparable increasing trend meaning effectively utilizing competitive advantages, but the best development potential reaches Luxembourg with the highest increasing trend.

It is necessary to note that 'old' EU Member States reached comparable and balanced values for the referred period. Development in 'new' EU Member States has a convergence trend towards 'old' ones. There was a growth in their performance, increasing trend in effective use of their advantages and improve in competitive position. Most countries experienced also a decline in their performance (outputs decline as a result of declines in inputs) as a result of economic crisis. This is proved by a decrease in the efficiency index and also in the super efficiency index (only in efficient countries).

V. Conclusion

Applying DEA method presents a possible and convenient way of comparing competitiveness on national level, even though the mainstream approach of competitiveness evaluation is absent. The above presented approach is only one specific example of DEA methods. It is possible to evaluate competitiveness through other DEA methods; see e.g. [2], [3]. We should emphasize that using different approaches to measuring and evaluating competitiveness generates different results. However, this is logical and predictable. Generally, we cannot expect that different approaches lead to the same results about the level of competitiveness. Many methods to evaluating competitiveness are to a certain extent, incomparable, so their results must be taken into account individually.

Based on the analysis performed by primary CCR input oriented model with CRS and BCC input oriented model with VRS was found out that in 27 EU Member States, there were only 2, resp. 3 'efficient' countries within the whole referred time period. Moreover, 4, resp. 5 other countries were 'highly efficient', because resulting efficiency index reached consistently high values close to 1 during the referred period. The rest of countries belong to the category of 'inefficient' countries and thus with less competitive potential. But 4 countries are the most inefficient, because reached the lowest level of efficiency index. Results of the analysis (with a high degree) correspond to the actual situation in each Member State and therefore within the EU.

The level of EU development reflects the degree of economic, social and territorial disparities at both national and regional level, which have a negative impact on the balanced development across the Union and weaken the EU competitiveness and its position as a global player in the global economy. Relatively fast economic growth, increasing employment and enhancing competitiveness have recently caused a significant convergence of the EU Member States. These facts are confirmed by the efficiency evaluation in Table 1 and Table 2. Pace of convergence however vary according to EU Member States. There is a distinct gap between economic and social standards in terms of the EU, so *differences still remain.*

The recent economic crisis has seriously threatened the achievement of sustainable development in the field of competitiveness, and revealed the structural weaknesses in the European economy. The crisis has underscored the importance of a competitiveness-supporting economic environment to enable national economies to better absorb shocks and ensure solid economic performance going into the future. From this point of view, there is a challenge ahead of the EU Member States to develop and promote convergence process in all areas.

APPENDIX

Table I Application of DEA for EU 27 Member States – Efficiency CCR (CRS) Model

Code	*Country/Time*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*EI**	*Rank*
EU27	**European Union**	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	/
BE	**Belgium**	0,795	0,857	0,875	0,836	0,802	0,795	0,747	0,729	0,714	0,773	0,751	0,789	6.
BG	***Bulgaria***	*0,291*	*0,334*	*0,340*	*0,337*	*0,405*	*0,437*	*0,449*	*0,455*	*0,439*	*0,437*	*0,479*	*0,400*	*26.*
CZ	***Czech Republic***	*0,382*	*0,424*	*0,419*	*0,431*	*0,455*	*0,426*	*0,401*	*0,402*	*0,407*	*0,451*	*0,419*	*0,420*	*24.*
DK	**Denmark**	0,543	0,573	0,583	0,552	0,559	0,557	0,519	0,512	0,503	0,548	0,571	0,547	17.
DE	**Germany**	0,594	0,638	0,640	0,630	0,621	0,629	0,585	0,572	0,554	0,573	0,558	0,599	13.
EE	***Estonia***	*0,365*	*0,405*	*0,398*	*0,413*	*0,464*	*0,467*	*0,434*	*0,459*	*0,421*	*0,505*	*0,574*	*0,446*	*23.*
IE	**Ireland**	0,819	0,891	0,927	0,909	0,916	0,892	0,894	0,864	0,728	0,813	0,838	0,863	4.
GR	**Greece**	0,783	0,883	0,885	0,886	0,891	0,895	0,899	0,896	0,884	0,867	0,815	0,871	3.
ES	**Spain**	0,780	0,828	0,810	0,762	0,770	0,733	0,705	0,668	0,634	0,753	0,728	0,473	7.
FR	**France**	0,706	0,760	0,760	0,698	0,689	0,713	0,672	0,672	0,655	0,712	0,690	0,702	9.
IT	**Italy**	0,939	0,989	0,904	0,867	0,855	0,849	0,814	0,778	0,742	0,814	0,761	0,847	5.
CY	**Cyprus**	1,000	1,000	0,952	0,843	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,981	2.
LV	**Latvia**	0,342	0,382	0,384	0,416	0,535	0,493	0,457	0,520	0,488	0,622	0,588	0,475	21.
LT	**Lithuania**	0,338	0,399	0,391	0,412	0,460	0,474	0,495	0,501	0,516	0,489	0,552	0,457	22.
LU	**Luxembourg**	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1.
HU	**Hungary**	0,450	0,501	0,508	0,513	0,575	0,554	0,541	0,544	0,547	0,560	0,556	0,532	18.
MT	**Malta**	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1.
NL	**Netherlands**	0,590	0,630	0,640	0,592	0,598	0,618	0,577	0,570	0,559	0,586	0,589	0,595	15.
AT	**Austria**	0,650	0,678	0,687	0,665	0,668	0,658	0,617	0,600	0,588	0,626	0,606	0,640	10.
PL	**Poland**	0,455	0,514	0,560	0,578	0,654	0,664	0,657	0,659	0,618	0,618	0,673	0,605	12.
PT	**Portugal**	0,530	0,545	0,547	0,545	0,592	0,620	0,546	0,494	0,404	0,445	0,464	0,521	19.
RO	***Romania***	*0,236*	*0,276*	*0,293*	*0,310*	*0,432*	*0,460*	*0,482*	*0,483*	*0,496*	*0,565*	*0,529*	*0,415*	*25.*
SI	**Slovenia**	0,456	0,477	0,490	0,517	0,513	0,507	0,480	0,485	0,443	0,466	0,459	0,481	20.
SK	**Slovakia**	0,462	0,527	0,548	0,546	0,707	0,765	0,839	0,918	0,892	0,926	0,969	0,736	8.
FI	**Finland**	0,614	0,646	0,642	0,609	0,625	0,617	0,577	0,588	0,572	0,618	0,618	0,611	11.
SE	**Sweden**	0,563	0,576	0,578	0,574	0,592	0,581	0,552	0,555	0,543	0,579	0,572	0,570	16.
UK	**United Kingdom**	0,573	0,627	0,630	0,617	0,630	0,608	0,588	0,566	0,559	0,595	0,581	0,598	14.

Note: * Overall Efficiency Index = average of time period 2000 – 2010
Source: Own calculation and elaboration, 2011

Table II Evaluation of Efficient EU Member States – Super Efficiency CCR (CRS) Model

Code	*Country/Time*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*EI**	*Rank*
CY	**Cyprus**	1,091	1,244	0,952	0,843	1,600	1,504	1,482	1,409	1,471	1,383	1,397	1,307	3.
LU	**Luxembourg**	7,566	8,768	7,210	8,900	8,541	10,244	11,601	12,664	12,631	12,473	12,201	10,254	1.
MT	**Malta**	2,526	2,162	3,061	2,659	2,986	2,772	2,887	3,087	4,006	3,987	3,159	3,027	2.

Note: * Overall Efficiency Index = average of time period 2000 – 2010
Source: Own calculation and elaboration, 2011

Table III Application of DEA for EU 27 Member States – Efficiency BCC (VRS) Model

Code	*Country/Time*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*EI**	*Rank*
EU27	**European Union**	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	/
BE	**Belgium**	0,736	0,765	0,782	0,773	0,760	0,753	0,782	0,804	0,817	0,851	0,844	0,788	18.
BG	***Bulgaria***	*0,502*	*0,506*	*0,515*	*0,523*	*0,528*	*0,534*	*0,545*	*0,546*	*0,549*	*0,538*	*0,524*	*0,258*	*26.*
CZ	**Czech Republic**	0,770	0,772	0,782	0,780	0,781	0,779	0,761	0,772	0,768	0,786	0,817	0,779	19.
DK	**Denmark**	0,797	0,797	0,800	0,816	0,825	0,819	0,809	0,816	0,818	0,829	0,851	0,816	14.
DE	**Germany**	0,836	0,845	0,866	0,874	0,873	0,862	0,838	0,829	0,818	0,813	0,825	0,844	10.
EE	***Estonia***	*0,544*	*0,538*	*0,528*	*0,525*	*0,582*	*0,504*	*0,576*	*0,562*	*0,568*	*0,574*	*0,598*	*0,554*	*24.*
IE	**Ireland**	0,865	0,909	0,982	0,931	0,921	0,893	0,895	0,874	0,876	0,969	0,954	0,915	6.
GR	**Greece**	0,922	0,937	0,934	0,925	0,911	0,936	0,902	0,883	0,875	0,854	0,825	0,900	7.
ES	**Spain**	0,940	0,930	0,938	0,923	0,910	0,884	0,863	0,868	0,889	0,965	0,984	0,918	5.
FR	**France**	0,847	0,855	0,885	0,872	0,885	0,896	0,888	0,893	0,886	0,905	0,906	0,883	8.
IT	**Italy**	0,966	0,969	0,975	0,981	0,985	0,985	0,964	0,974	0,976	0,974	0,943	0,972	3.
CY	**Cyprus**	1,000	1,000	1,000	0,956	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,996	2.
LV	**Latvia**	0,592	0,566	0,585	0,539	0,594	0,588	0,512	0,561	0,551	0,572	0,563	0,566	22.
LT	***Lithuania***	*0,561*	*0,574*	*0,544*	*0,538*	*0,539*	*0,520*	*0,504*	*0,502*	*0,521*	*0,574*	*0,553*	*0,539*	*25.*
LU	**Luxembourg**	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1.
HU	**Hungary**	0,618	0,617	0,628	0,624	0,631	0,631	0,620	0,635	0,655	0,647	0,632	0,631	21.
MT	**Malta**	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1.
NL	**Netherlands**	0,806	0,804	0,805	0,805	0,811	0,815	0,797	0,792	0,783	0,784	0,815	0,802	16.
AT	**Austria**	0,840	0,845	0,853	0,848	0,866	0,856	0,835	0,830	0,823	0,830	0,835	0,842	11.
PL	**Poland**	0,816	0,839	0,886	0,889	0,891	0,893	0,897	0,867	0,828	0,804	0,827	0,858	9.
PT	**Portugal**	0,775	0,774	0,783	0,793	0,797	0,802	0,794	0,808	0,808	0,824	0,850	0,801	17.
RO	***Romania***	0,522	0,528	0,535	0,544	0,575	0,564	0,576	0,585	0,588	0,560	0,555	*0,557*	*23.*
SI	**Slovenia**	0,832	0,825	0,838	0,852	0,830	0,822	0,815	0,818	0,818	0,822	0,854	0,830	12.
SK	**Slovakia**	0,887	0,882	0,892	0,891	0,952	0,962	0,972	0,978	0,964	0,961	0,955	0,936	4.
FI	**Finland**	0,825	0,827	0,830	0,829	0,840	0,831	0,815	0,822	0,812	0,837	0,855	0,829	13.
SE	**Sweden**	0,768	0,762	0,769	0,774	0,787	0,778	0,768	0,770	0,767	0,786	0,793	0,775	20.
UK	**United Kingdom**	0,800	0,791	0,806	0,806	0,810	0,810	0,804	0,812	0,814	0,826	0,838	0,811	15.

Note: * Overall Efficiency Index = average of time period 2000 – 2010
Source: Own calculation and elaboration, 2011

Table IV Evaluation of Efficient EU Member States – Super Efficiency BCC (VRS) Model

Code	*Country/Time*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*EI**	*Rank*
CY	**Cyprus**	1,188	1,504	1,100	0,956	1,627	1,579	1,582	1,491	1,544	1,403	1,441	1,401	3.
LU	**Luxembourg**	7,851	8,858	7,432	9,125	8,785	10,433	11,712	12,846	12,741	12,743	12,346	10,443	1.
MT	**Malta**	2,737	2,283	3,296	2,659	3,085	2,848	2,890	3,098	4,007	4,046	3,168	3,102	2.

Note: * Overall Efficiency Index = average of time period 2000 – 2010
Source: Own calculation and elaboration, 2011

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