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DEA Method for Evaluation of EU Performance

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Abstract**—**The paper deals with an application of quantitative analysis – the Data Envelopment Analysis (DEA) method to performance evaluation of the European Union Member States, in the reference years 2000 and 2011. The main aim of the paper is to measure efficiency changes over the reference years and to analyze a level of productivity in individual countries based on DEA method and to classify the EU Member States to homogeneous units (clusters) according to efficiency results. The theoretical part is devoted to the fundamental basis of performance theory and the methodology of DEA. The empirical part is aimed at measuring degree of productivity and level of efficiency changes of evaluated countries by basic DEA model – CCR CRS model, and specialized DEA approach – the Malmquist Index measuring the change of technical efficiency and the movement of production possibility frontier. Here, DEA method becomes a suitable tool for setting a competitive/uncompetitive position of each country because there is not only one factor evaluated, but a set of different factors that determine the degree of economic development.

Keywords**—**CCR CRS model, cluster analysis, DEA method, efficiency, EU, Malmquist index, performance.

I. Introduction

IN the European Union (EU), the process of achieving an increasing trend of performance and a higher level of competitiveness is significantly difficult by the heterogeneity of countries and regions in many areas. Although the EU is one of the most developed parts of the world with high living standards, there exist significant and huge economic, social and territorial disparities having a negative impact on the balanced development across Member States and their regions, and thus weaken EU's performance and competitiveness in a global context. The European integration process is thus guided by striving for two different objectives: *to foster economic competitiveness* and *to reduce differences* [10], [15]. The support of cohesion and balanced development together with increasing level of competitiveness belong to the temporary *EU's key development objectives*. In relation to competitiveness, performance and efficiency are *complementary objectives*, which determine the long-term development of countries in a globalized economy [3], [7].

II. Theoretical Basis of Efficiency and Effectiveness Analysis in the Context of Performance

In recent years, the topics about measuring and evaluating of competitiveness and efficiency have enjoyed economic interest. Although there is *no uniform definition* and understanding of these terms, these multidimensional concepts remain ones of the basic standards of performance evaluation and it is also seen as a reflection of success of area (country/region) in a wider (international/interregional) comparison. Performance, efficiency and competitiveness are *complementary objectives*, which determine the long-term development of an organization (e.g. companies, states, regions). *Increasing productivity* is generally considered to be the *only sustainable way of improving living standards in the long-term period*. However, performance, efficiency and competitiveness are not stable over time. Variability in performance, efficiency and competitiveness over time reflect (1) learning processes and other long-term changes and (2) temporary changes in performance; see e.g. [16], [17].

A. Relationship between Concepts of Efficiency and Effectiveness

Performance management is one of the major sources of sustainable national efficiency and effectiveness (Fig. 1). A systematic understanding of the factors that affect productivity, and subsequently also competitiveness, is very important. Performance is also highly important for many economic subjects (e.g. companies, states and regions) as a whole and for the individuals involving in it. Performance comprises both a behavioral and an outcome aspect. It is a multidimensional concept as well as competitiveness.

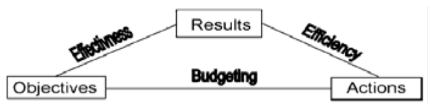

Fig. 1 The triangle of the performance [13, p. 8]

Reference [9] indicates that the *efficiency and effectiveness analysis is based on the relationship between the inputs* (entries), the *outputs* (results) and the *outcomes* (effects). As it can be seen in Fig. 2, *the efficiency is given by the ratio of inputs to outputs*, but there is difference between *the technical efficiency* and *the allocative efficiency*. The technical efficiency implies a relation between inputs and outputs on the frontier production curve, but not any form of technical efficiency makes sense in economic terms, and this deficiency is captured through the allocative efficiency that requires a cost/benefit ratio. *The effectiveness* implies a *relationship between outputs and outcomes*.

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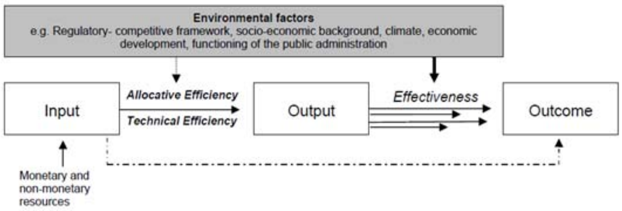

Fig. 2 The relationship between the efficiency and the effectiveness [9, p. 3]

B. *Problematic of Efficiency and Effectiveness Evaluation*

The analysis of efficiency and effectiveness is about the relationships between inputs, outputs and outcomes. Techniques to measure efficiency are improved and investigations of efficiency become more frequent. Nevertheless, the measurement of efficiency and effectiveness of countries and regions, resp. their factors, *remains a conceptual challenge*, because there are *difficulties in measuring* efficiency and effectiveness. Measurement of efficiency and effectiveness is highly sensitive to the data sets being used. Good quality data are needed because the techniques available to measure efficiency are sensitive to outliers and may be influenced by exogenous factors. The *data used for international comparisons* require a minimum level of homogeneity.

The primary problem in creating an effective evaluation system is establishing clear performance and efficiency standards and priorities at the beginning of the performance cycle. The early research on this problem focused on separate measures for productivity and there was a failure to combine the measurements of multiple inputs into any satisfactory measure of efficiency. These inadequate approaches included forming an average productivity for a single input (ignoring all other inputs), and *constructing an efficiency index* in which a weighted average of inputs is compared with output. Responding to these inadequacies of separate indices of labor productivity, capital productivity, etc., Farrell [6], proposed an activity analysis approach that could more adequately deal with the problem. His measures were intended to be applicable to any productive organization; in other words, *from a workshop to a whole economy* [14]. Farrell confined his numerical examples and discussion to single output situations, although he was able to formulate a multiple output case. Twenty years after *Farrell's model*, and building on those ideas, *A. Charnes*, *W. W. Cooper* and *E. Rhodes* in 1978 [4], responding to the need for satisfactory procedures to assess the relative efficiencies of multi-input/multi-output production units, introduced a powerful methodology which has been titled *Data Envelopment Analysis* (DEA) in the form of CCR model assuming constant returns to scale (CRS).

Measurement and evaluation of performance, efficiency and productivity is an *important issue for at least two reasons*. One is that in a group of units where only limited number of candidates can be selected, the performance of each must be evaluated in a fair and consistent manner. The other is that as time progresses, better performance is expected. Hence, the units with declining performance must be identified in order to make the necessary improvements [8]. The performance of countries can be evaluated in either a cross-sectional or a time-series manner, and the DEA is a useful method for both types of efficiency evaluation [14].

III. DEA Approach for Efficiency Analysis

The most common quantitative methods convenient for a high number of multivariate measured variables can be identified as *multivariate statistical methods*. Multivariate analysis is an ever-expanding set of techniques for data analysis that encompasses a wide range of possible research situation. One of the multivariate statistical methods is *DEA method*, which is used in the paper. Measuring the efficiency level of evaluated countries is based on procedure in Table I.

TABLE I
Basic Scheme of Efficiency Measuring and Evaluation

Pre-processing phase »
Data collection » Analysis of indicators » Groups of input/output indicators
DEA modeling »
CCR CRS model » Malmquist index » Efficiency evaluation

Source: Own elaboration, 2013

A. *DEA Background for Measuring National Efficiency and Productivity*

DEA 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. DEA is thus a multi-criteria decision making method for evaluating effectiveness, efficiency and productivity of a homogenous group (DMUs). The aim of DEA method is to examine DMU if they are *effective* or *not effective* by the size and quantity of consumed resources by the produced outputs. In DEA approach, DMUs usually use a set of resources as inputs and transform them into a set of outcomes as outputs. The efficiency score of DMUs in the presence of multiple input and output factors is defined as follows (1):

$$Efficiency\ of\ \ DMU = \frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}}. \qquad (1)$$

DEA can successfully separate DMUs into two categories which called efficient DMUs and inefficient DMUs [2]. Efficient DMUs have equivalent efficiency score. However, they don't have necessarily the same performance. DMU is efficient if the observed data correspond to testing whether the DMU is on the imaginary 'production possibility frontier'. All other DMU are simply inefficient. For every inefficient DMU, DEA identifies a set of corresponding efficient units that can be utilized as benchmarks for improvement.

B. *Fundamental Characteristics of Empirical Analysis*

The performance analysis, based on application of *Factor Analysis* (FA) and *DEA* approach, is used for evaluating national development quality and potential (with respect to the national factors endowment). Based on the above facts, it is possible to determine the *initial hypothesis* of the analysis, which is based on the assumption that more advanced EU countries achieving best results in efficiency (old EU Member States (EU15)) are countries best at converting inputs into outputs and therefore having greater performance and productive potential than new EU Member States (EU12); see e.g. [11], [12].

The efficiency analysis starts from building database of indicators that are part of a common approach of WEF and EU in the form of *Country Competitiveness Index* (CCI). Eleven pillars of CCI are grouped according to the different dimensions (*input versus output aspects*) of national competitiveness they describe. The terms '*inputs*' and '*outputs*' are meant to classify pillars into those which describe driving forces of competitiveness, also in terms of long-term potentiality, and those which are direct or indirect outcomes of a competitive society and economy. From this point of view, *methodology of CCI is suitable for measuring national competitiveness by DEA method* [1]. Set of CCI data file consists of *66 CCI indicators* – 38 of them are inputs and 28 outputs. In this paper, all CCI indicators are not used because all indicators were not available for the whole period for each country, but for some indicators were found comparable indicators. The pillars and 62 used indicators are listed in Appendix – in Table IV.

Empirical analysis is based on a *frontier non-parametric approach* and aims to study productivity growth and performance effectiveness. This is based on CCR CRS model and MI for measuring the change of technical efficiency and the movement of the frontier in terms of individual countries [5], in the *reference years 2000* (beginning of growth period) and *2011*(last year of complete data-base for all evaluated countries; post-crisis year) in CCR CRS model and in comparing these years by MI.

CCR CRS input oriented model is obtained by solving (2):

$$\min \ z = \theta_{\mathbf{q}} - \varepsilon(\mathbf{e}^{\mathbf{T}}\mathbf{s}^{+} + \mathbf{e}^{\mathbf{T}}\mathbf{s}^{-}), \qquad (2)$$

on conditions:

$$\mathbf{X}\lambda + \mathbf{s}^{-} = \theta_{\mathbf{q}}\mathbf{x}_{\mathbf{q}},$$
$$\mathbf{Y}\lambda - \mathbf{s}^{+} = \mathbf{y}_{\mathbf{q}},$$
$$\lambda, \mathbf{s}^{+}, \mathbf{s}^{-} \geq 0,$$

where z i is the efficiency coefficient of unit U_q; θ_q is radial variable indicates required level of reduction in input; is infinitesimal constant; s+, and s– are vectors of additional variables for inputs and outputs; λ represent vector of weights assigned to individual units; $e^T\lambda$ is convexity condition, $e^T = (1, 1, \ldots, 1)$; x_q is vector of input of unit U_q; y_q is vector of output of unit U_q; X is input matrix; Y is output matrix. The coefficient of efficiency takes values in the interval [0,1]. In DEA models aimed at inputs the efficiency coefficient of efficient DMU equals 1, while the efficiency coefficient of inefficient DMU is less than 1.

For calculations of economic efficiency of EU Member States basic DEA model (CCR model) and advanced DEA approach to performance evaluation known as the *Malmquist Index* are used. Suppose we have a production function in time period *t* as well as period *t+1*. MI calculation requires two single period and two mixed period measures. The two single period measures can be obtained by using the *CCR model with Constant Returns to Scale* (CRS). For simplicity of the Malmquist index calculation, it is presented basic DEA models based on assumption of a single input and output.

Suppose each DMU_j *(j=1, 2… n)* produces a vector of output $y_j^t = \left(y_{1j}^t, \ldots, y_{sj}^t\right)$ by using a vector of inputs $x_j^t = \left(x_{1j}^t, \ldots, x_{mj}^t\right)$ at each time period *t, t=1... T*. From time *t* to time *t+1*, DMU_0's efficiency may change or (and) the frontier may shift. MI is calculated via (3) comparing x_0^t to the frontier at time *t*, i.e., calculating $\theta_0^t\left(x_0^t, y_0^t\right)$ in the following input-oriented CCR CRS model (3):

$$\theta_0^t\left(x_0^t, y_0^t\right) = \min \theta_0, \qquad (3)$$

subject to

$$\sum_{j=1}^{n} \lambda_j x_j^t \leq \theta_0 x_0^t,$$
$$\sum_{j=1}^{n} \lambda_j y_j^t \geq y_0^t,$$
$$\lambda_j \geq 0, \ j = 1, \ldots, n,$$

$x_0^t = \left(x_{10}^t, \ldots, x_{m0}^t\right)$ and $y_0^t = \left(y_{10}^t, \ldots, y_{s0}^t\right)$ are input and output vectors of DMU_0 among others.

MI is further calculated via (4) comparing x_0^{t+1} to the frontier at time *t+1*, i.e., calculating $\theta_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)$ in the following input-oriented CCR CRS model (4) for $\lambda_j \geq 0, \ j = 1, \ldots, n$:

$$\theta_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right) = \min \theta_0, \qquad (4)$$

subject to

$$\sum_{j=1}^{n} \lambda_j x_j^{t+1} \leq \theta_0 x_0^{t+1},$$
$$\sum_{j=1}^{n} \lambda_j y_j^{t+1} \geq y_0^{t+1}.$$

MI is further calculated via (5) comparing x_0^t to the frontier at time *t+1*, i.e., calculating $\theta_0^{t+1}\left(x_0^t, y_0^t\right)$ via the following linear program (5) for $\lambda_j \geq 0, \ j = 1, \ldots, n$:

$$\theta_0^{t+1}\left(x_0^t, y_0^t\right) = \min \theta_0 , \quad (5)$$

subject to

$$\sum_{j=1}^{n} \lambda_j x_j^{t+1} \le \theta_0 x_0^t ,$$

$$\sum_{j=1}^{n} \lambda_j x_j^{t+1} \ge y_0^{t+1}$$

MI is further calculated via (6) comparing x_0^{t+1} to the frontier at time *t,* i.e., calculating $\theta_0^t\left(x_0^{t+1}, y_0^{t+1}\right)$ via the following linear program (6) for $\lambda_j \ge 0,\ j = 1,\dots, n$:

$$\theta_0^t\left(x_0^{t+1}, y_0^{t+1}\right) = \min \theta_0 , \quad (6)$$

subject to

$$\sum_{j=1}^{n} \lambda_j x_j^t \le \theta_0 x_0^{t+1} ,$$

$$\sum_{j=1}^{n} \lambda_j x_j^t \ge y_0^{t+1} .$$

MI measuring the efficiency change of production units between successive periods *t* and *t+1*, is formulated via (7):

$$M_0\,(x^{t+1}, y^{t+1}, x^t, y^t) = E_0 \cdot P_0 \quad (7)$$

where E_0 is change in the relative efficiency of DMU_0 in relation to other units (i.e. due to the production possibility frontier) between time periods *t* and *t+1; P_0* describes the change in the production possibility frontier as a result of the technology development between time periods *t* and *t+1*. The following modification of M_0 (8) makes it possible to measure the change of technical efficiency and the movement of the frontier in terms of a specific $DMU_{0,}$

$$M_0 = \frac{\theta_0^t\left(x_0^t, y_0^t\right)}{\theta_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)} \left[\frac{\theta_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)}{\theta_0^t\left(x_0^{t+1}, y_0^{t+1}\right)} \cdot \frac{\theta_0^{t+1}\left(x_0^t, y_0^t\right)}{\theta_0^t\left(x_0^t, y_0^t\right)} \right]^{1/2} \quad (8)$$

The first component E_0 on the right hand side measures the magnitude of *technical efficiency change* (TEC) between time periods *t* and *t+1*. Obviously, $E_0 <=> 1$ indicating that technical efficiency improves remains or declines. The second terms P_0 measures the shift in the possibility frontier, i.e. *technology frontier shift* (FS), between time periods *t* and $t+1$. Productivity declines if $P_0 > 1$, remains unchanged if $P_0 = 1$ and improves if $P_0 < 1$. In Table II, characteristics and trends of Malmquist index are shown.

TABLE II
CHARACTERISTICS AND TRENDS OF THE MALMQUIST INDEX

Malmquist Index	Productivity
> 1	Declining
= 1	Unchanging
< 1	Improving
Efficiency Change	**Technical Efficiency**
< 1	Improving
= 1	Unchanging
> 1	Declining

Source: Own elaboration, 2013

If the MI on the basis of minimization of production factors was less than one, it indicates productivity improvement, on the other hand, if on the basis of maximization of production factors, the MI or any of its elements were less than one, it signifies productivity getting better, while if the MI is bigger than one, indicates productivity decrease.

For solution of DEA method software tools based on solving linear programming problems are used in the paper, e.g. Solver in MS Excel 2010, such as *the DEA Frontier*.

IV. APPLICATION OF DEA METHOD TO EFFICIENCY ANALYSIS OF EU MEMBER STATES

The *initial hypothesis* was confirmed through analysis by *CCR CRS model*, as it is illustrated in following evaluation. Apparently the best results are traditionally achieved by economically powerful countries which were 'efficient' or 'highly efficient' during the both reference years. In Table III *'efficient' countries* are colored by dark grey color; also rank of individual countries in the context of their competitive/uncompetitive position based on efficiency results is recorded. These are Scandinavian countries, thus *Denmark, Finland* and *Sweden*, and *Luxembourg*. These countries belong to old EU Member States (EU15), they have placed the *first position* and in the frame of paper hypothesis, could be countries with the best competitive potential and perspective to further development. Efficiency coefficients of these countries were equal to 1 in both reference years and record no efficiency change.

The efficient countries are followed by a group of countries which are also *'highly efficient'*. These countries do not achieved efficiency equal to 1 in CCR CRS model, but their efficiency index reached consistently high values close to 1 during the reference years (colored by light grey color in Table III). These countries are *Germany, United Kingdom, Austria, Netherlands, France* and *Belgium*. Their efficiency coefficients were greater than 0.7 in both reference years. All these countries also belong to old EU Member States (EU15) and have placed from the *third position to the seventh position.* All these countries have recorded decreasing trend in their efficiency coefficients, only United Kingdom have recorded increasing trend in their efficiency coefficients. These countries show high level of competitive potential.

Countries with efficiency index less than 1 (but greater than 0,5 in both reference years) in CCR CRS model are classified as *'slightly efficient' countries*, i.e. these countries are considered as countries with lower competitive potential. Most of new EU Member States (EU12) belongs to the group of slightly efficient countries with lower competitive position and potential than old EU Member States (EU15). These 'new' EU countries are *Czech Republic, Slovenia, Slovakia, Poland, Cyprus, Malta, Estonia* and *Latvia.* 'Old' EU countries belonging to the group of slightly efficient countries are *Ireland, Italy, Spain, Greece* and *Portugal.*

In Table III, the most 'inefficient' countries are highlighted by italics. *Hungary, Lithuania, Bulgaria*, and *Romania*, are countries with the lowest development potential, but their trends show increasing level of convergence. Efficiency coefficients of these countries were lower than 0.5 in both reference years.

TABLE III
APPLICATION OF DEA FOR EU MEMBER STATES

Code	Country/Time	IO CCR CRS model			IO CCR CRS MI**	
		2000	2011	Rank*	2000-2011	Trend
BE	Belgium	0,795	0,751	7	1,059	↓
BG	*Bulgaria*	*0,291*	*0,479*	*23*	0,608	↑
CZ	Czech Republic	0,682	0,719	8	0,949	↑
DK	**Denmark**	**1,000**	**1,000**	**1**	1,000	—
DE	Germany	0,994	0,958	2	1,038	↓
EE	Estonia	0,365	0,574	19	0,636	↑
IE	Ireland	0,819	0,538	9	1,522	↓
GR	Greece	0,683	0,315	17	2,168	↓
ES	Spain	0,680	0,428	14	1,589	↓
FR	France	0,806	0,756	6	1,066	↓
IT	Italy	0,739	0,561	11	1,317	↓
CY	Cyprus	0,590	0,489	15	1,207	↓
LV	Latvia	0,342	0,588	20	0,582	↑
LT	*Lithuania*	*0,338*	*0,552*	*22*	0,612	↑
LU	**Luxembourg**	**1,000**	**1,000**	**1**	1,000	—
HU	*Hungary*	*0,450*	*0,456*	*21*	0,987	↑
MT	Malta	0,530	0,496	16	1,069	↓
NL	Netherlands	0,790	0,789	5	1,001	↓
AT	Austria	0,850	0,806	4	1,055	↓
PL	Poland	0,455	0,673	13	0,676	↑
PT	Portugal	0,530	0,464	18	1,142	↓
RO	*Romania*	*0,236*	*0,429*	*24*	0,550	↑
SI	Slovenia	0,556	0,759	10	0,733	↑
SK	Slovakia	0,562	0,669	12	0,840	↑
FI	**Finland**	**1,000**	**1,000**	**1**	1,000	—
SE	**Sweden**	**1,000**	**1,000**	**1**	1,000	—
UK	United Kingdom	0,873	0,881	3	0,991	↑

Note: * Rank is based on average of efficiency coefficients level in both years.
** IO CCR CRS MI = MI based on input oriented CCR CRS model.
Source: Own calculation and elaboration, 2013.

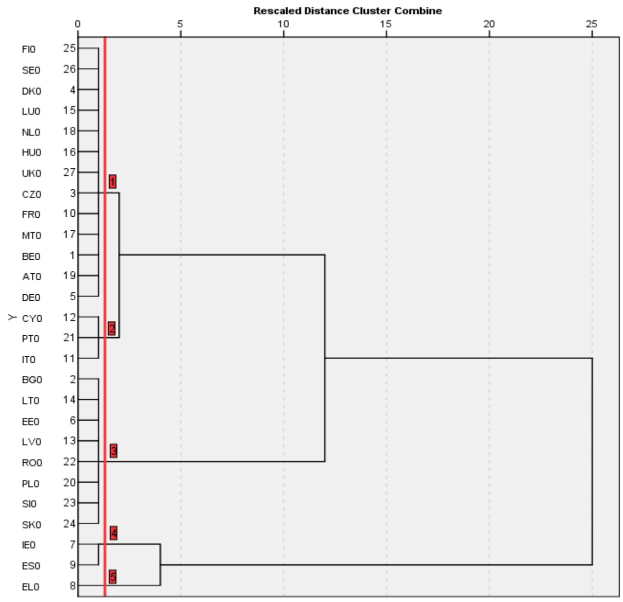

Fig. 3 Dendogram of outputs clusters using Ward linkage Source: Own calculation and elaboration, 2013

CA is used for defining clusters of countries based on the results of efficiency analysis by Malmquist index. The best interpretation of data ensures *five-cluster solution* in the context of comparison years 2000 and 2011 by MI. *Cluster I* is created by economic powerful countries as Finland, Sweden, Denmark, Luxembourg, Netherlands, United Kingdom, France, Belgium, Germany and Austria. This cluster is also characterized by new EU Member States as Hungary, Czech Republic and Malta. These countries have *lower economic efficiency and performance* than EU15 countries in Cluster I. *Cluster II* is characterized by countries as Cyprus, Portugal and Italy having worse economic prosperity, ones of the worst levels of competitiveness indicators and thus belong to *the worst economic efficiency and performance* of all countries. *Cluster III* represents Bulgaria, Latvia, Lithuania, Estonia, Romania, Poland, Slovakia and Slovenia, which are characterized with lower level of macroeconomic indicators and lower level of performance. *Cluster IV* is created by countries as Spain and Ireland having also not very good economic prosperity and level of performance. *Cluster V* represents only Greece, which is characterized with the lowest level of macroeconomic indicators and the lowest level of performance.

The initial hypothesis of efficiency being a mirror of competitive potential *was confirmed* also through analysis by *Malmquist index*. Considering the information of Table III, some of countries have reached the best results and recorded predominantly *total productivity increase* through the time period (*Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, Slovakia* and *United Kingdom*) and countries have reached predominantly *total productivity decrease* in reference years (*Belgium, Estonia, Ireland, Greece, Spain, France, Italy, Cyprus, Malta, Netherlands, Austria* and *Portugal*). According to trends of efficiency change in reference years based on MI, most of countries recording productivity increase are new EU Member States. On the other side, most of countries recording productivity decrease are EU15. These facts confirms convergence trend of EU12 countries to EU15 countries.

V. Conclusion

Based on factor analysis and DEA method has been found out that in evaluated countries is a *distinct gap between economic and social standards*, so differences still remain. Measuring the Malmquist index on the basis of the DEA method is an important method which has many applications. This index has been used in this paper to analyze and evaluate performance of EU Member States in reference years 2000 and 2011. Regarding the findings and the analysis each country can decide whether it had a productivity increase during the time period, or not. By having this information and dividing productivity into its elements, the basic trend in productivity whether it be increase or decrease is observed. Based on input oriented CCR CRS model and Malmquist results, the most advanced countries are Scandinavian countries and Luxembourg, which have recorded best results in level of efficiency and no trend in productivity changes. According to MI results, in old EU countries was mostly achieved noticeable productivity decreases and performance deteriorating during reference years. Development in new EU countries has a trend towards advanced EU15 countries. Most countries experienced decline in their performance as a result of economic crisis. The economic crisis has threatened the achievement of sustainable development in the field of competitiveness. The crisis has underscored importance of competitiveness-supporting economic environment to enable economies better absorb shocks and ensure solid economic performance going in future.

Appendix

TABLE IV
Indicators of Inputs and Outputs in Years 2000 and 2011 Relevant to DEA Modeling

Dimension	Pillar	Indicator of input*
Inputs	Institution	Political Stability, Voice and Accountability, Government Effectiveness, Regulatory Quality, Rule of Law, Control of Corruption
	Macroeconomic Stability	Harmonized Index of Consumer Prices, Gross Fixed Capital Formation; Income, Saving and Net Lending/Net Borrowing, Total Intramural Research & Development Expenditure, Labor Productivity per Person Employed; ~~General Government Gross Debt~~
	Infrastructure	Railway transport - Length of Tracks, Air Transport of Passengers, Volume of Passenger Transport, Volume of Freight Transport; Motorway Transport -Length of Motorways, Air Transport of Freight
	Health	Healthy Life Expectancy, Infant Mortality Rate, Cancer Disease Death Rate, Heart Disease Death Rate, Suicide Death Rate; Hospital Beds, Road Fatalities
	Primary, Secondary and Tertiary Education; Training and Lifelong Learning	Mathematics-Science-Technology Enrolments and Graduates, Pupils to Teachers Ratio, Financial Aid to Students, Total Public Expenditure at Primary Level of Education, Total Public Expenditure at Secondary Level of Education, Total Public Expenditure at Tertiary Level of Education, Participants in Early Education, Participation in Higher Education, Early Leavers from Education and Training, Accessibility to Universities; Lifelong Learning
	Indicators for Technological Readiness	Level of Internet Access; E-government Availability
Dimension	**Pillar**	**Indicator of output***
Outputs	Labor Market Efficiency	Labor productivity, Male employment, Female employment, Male unemployment, Female unemployment, Public expenditure on Labor Market Policies; Employment rate, Long-term unemployment, Unemployment rate
	Market Size	Gross Domestic Product; Compensation of employees, Disposable income
	Business Sophistication	Gross Value Added in sophisticated sectors, Employment in sophisticated sectors, ~~Venture capital (investments early stage), Venture capital (expansion- replacement)~~
	Innovation	Human resources in Science and Technology, Total patent applications, Employment in technology and knowledge-intensive sectors, Employment in technology and knowledge-intensive sectors-by gender, Employment in technology and knowledge-intensive sectors-by type of occupation, Human resources in Science and Technology – Core, Patent applications to the EPO, Total intramural R&D expenditure, High-tech patent applications to the EPO, ICT patent applications to the EPO, Biotechnology patent applications to the EPO; ~~Employment in technology and knowledge-intensive sectors-by level of education~~

Note: * Number of indicators for inputs was decreased from 38 to 37; Number of indicators for outputs was decreased from 28 to 25
Source: Own elaboration, 2013

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