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THE ANALYSIS OF ECONOMIC ACTIVITIES OF TURKEY AND MEMBER COUNTRIES OF EUROPEAN UNION

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Countries try to get the most for their nations' welfare by using the various inputs they have as much as they can. The aim of this study is to measure the effectiveness and the total factorial productivity of the member countries of EU by using some of their economic indicators. As the results of the study, the economic effectiveness of the countries mentioned was defined one by one. The scores of the ineffective countries were also defined and it was mentioned that how much they should decrease their inputs or increase their outputs according to their scores. Additionally it was found out that how often the effective countries are the reference for the ineffective countries. İn this study Data Envelopment Analysis (DEA) and Total Factor Productivity (TFP) Methods were used. Data Envelopment Analysis (DEA) is an effectiveness measurement method which is used especially in the economic decision-making units and it has a wide area in literature as a nonparametric effectiveness measurement method. This method both provides reference clusters for the ineffective decision-making units and shows the necessary potential conditionings for them to be effective. The method has the ideal capability to measure the effectiveness both for the profit-based production systems and for the nonprofit based organizations. The total factor productivity between the countries was calculated by using Malmquist İndex approach. The study in which the economic effectiveness of the member countries of EU and Turkey has two sections. İn the first section performance analysis a notion of effectiveness were mentioned and also some information was given about DEA and Malmquist İndex. In the second section of the study, the economic effectiveness and productivity of the countries were measured. Additionally the changes in the economic productivity of these countries throughout years were introduced. At the end, some policies were suggested according to the results.

Keywords: Data Envelopment Analysis (DEA), Economic activities, Total Factor Productivity (TFP), European Union, Turkey.

Introduction

European Union (EU), in 1993, ratified the Copenhagen Criteria, which contained the requirements of "having an efficient market economy in the European Union that could resist also to competing pressures and market forces". By having powerful sectors of countries contained in the EU, to circulate with employment and capital in the union, aims of attaining a more efficient utilization and reaching a state of having an economy which is efficient and have a high global competing power were taken as the bases.

United States of America (USA), Canada and Japan, are global business actors who have a total import which is twice of the import of EU alone. There is a joint integrated business policy that provides the foundations for this success. The main factor behind the international marketing power of EU is the domestic trade rules, the decision processes institutionalized and the structure of the institution (Meunier, 2005:4). At one side of this structure, there are the economies of scale and at the other side, the variability, verity. A balance is attained, in an environment where there are conflicting forces. The production results, attained by full and efficient use of all of the resources, are providing sufficient externality to the system, through the creation of verities (Alesina, et al., 2005:275). Factors of production (capital, labor, land and raw materials) have different characteristics, in each country and countries are engaged in production, in the direction of meeting their requirements in a state of facing increasing opportunity costs of producing. In each of the countries of the European Union, the business behavior is changed, in such a way to be compatible with the EU business policy and thus, it is expected to have maximum benefit, from the economies of scale. Accordingly, when the domestic trade is liberalized and the protective business polices are enforced towards the non- member countries, the result will be to have competition superiority in EU in filed of World Trade (Hanson, 1998: 60). During the post-Planned Business Integration, each of the countries, by moving towards the framework of Production Factors in which they are specialized in, is making attainment of a decrease in Opportunity Costs possible.

Countries, desiring to have competitive advantages, have to develop different strategies, to be the best, among their competitors. Each country, desiring to secure this advantage, takes an orientation related to economic performance source concerned. Therefore, efficiency and productivity which are components of performance, must be correctly defined, measured and kept under control. Within this scope, the efficiency and productivity indictors have great importance. The increase in productivity and efficiency will bring the economic growth along with it. Attainment of the productivity and efficiency increase mean optimum use (utilization) of the resources of the country. In the long run, there is no possibility of decreasing poverty without having economic growth. Economic growth or productivity increase is among the objectives towards which economic policies have a close interest in. Becauseof this, analyzing the economic performance of regions, countries and the world as a whole, formed subject for innumerable studies (Deliktaş and Balcılar, 2005: 6-7).

There are three basic approaches in literature, focusing on the Economic Performance Analysis of countries included in a study (Rao, et.al, 1998). First and most widely used of these approaches, is focused on, the per capita growth of GDP (GSYİH). This indicator can be considered as being the representative variable of life standard realized in a country. The second approach is concerned about measuring the inequalities in global income distribution. The studies about the dimension of converging which are accomplished by undeveloped countries are also seen. The last approach is about the Productivity Performance And Multi-Factor Productivity Measurements within the framework of making assessments (Kök and Deliktaş, 2004: 2).

Since, the concept of performance is rather wide, it became a requirement to benefit from the various method of measurement of efficiency or productivity, during the performance measurements. To accept a decision-making unit as efficient, it must create maximum output by using certain inputs as components or must produce certain output by using minimum inputs as components. The methods used in performance measurement, are possible to be divided into two, as Rate Analysis and Frontier Efficiency Approaches. In Rate Analysis, a determination is made in the form of one input-output rate and it is monitored during the process of applications. Whereas in Frontier Efficiency Approach, first the most effective bound is determined, the deviations from the frontier (border-limit) because of various reasons, are termed as inefficiencies (Stavarek, 2003:129).

The study focuses on the measurement of Efficiency and Productivity. Efficiency will be determined in the study, by using the Data Enveloping Analysis Approach. Furthermore, Total Factor Productivity and Technical Efficiency and Technological Change which is its components will be computed by benefiting from Malmquist Total Factor Productively Index. With the assistance of socio-economic data determined for the EU member countries and Turkey, the relative efficient about them, in the years

20006 and 2013 are seen and the status of other countries, according to the reference countries are interpreted. By making explanations, about each of the Decision Making Units which are determined to be inefficient, the required measures to put them into a state of being efficient and the countries to be shown as reference, are determined.

Literature Search

It is possible to come across with many studies in literature focusing on the measurement of Efficiency and Performance of countries with respect to Resource Utilization. Some of these studies may be summarized, as indicated below.

The empirical studies made by Maddison, in years 1987,1989 and 1995, with respect to International Economic Performance Evaluation And Analysis, provided a wide accumulation of knowledge for persons. In analyzing the growth and its components, in Total Factor Productivity (TFP) of countries Fare et.al. (1994) pioneered the use of Data Enveloping Analysis. In the study, Total Factor Productivity Changes And Its Components of 17 OECD countries, during the 1979-1988 periods, were analyzed with the assistance of Malmquist TFV index. Following this study, Lovell (1995), studied the Macro Economic Performance of 10 Asian countries in 1970-1988 period; Taşkın and Zaim (1997), studied Total Factor Productivity And Its Components for 23 countries in 1975-1990 period; Osiewalski et.al. (1997), studies Changes In Efficiency of 20 countries containing Poland and Western Economies in 1980-1990 period; Golany and Thore (1997a),studied Economic And Social Performances of 72 developed and developing countries in 19701985 period; Golany and Thore (1997b),studied Efficiency of 74 countries in 1970-1985 period; Rao and Coelli (1998), studied Changes In Total Factor Productivity of 60 countries in 1965-1990 period; Krüger et.al. (2000), Studied Changes In Total Factor Productivity of 87 countries in 19601990 period; Koop et.al.(2000), studied Changes In Efficiency And Productivity of 20 countries including Poland, Yugoslavia and Western economies in 1980-1990 period; Güran and Cingi (2002), studied Effectiveness Of State Interventions in 55 countries as of year 1995; Emrouznejad (2003), studied Dynamic Efficiency of 17 industrialized countries; Pires and Garcia (2004), studied Total Factor Productivities of 75 countries in 1950-2000 period; Kök and Deliktaş (2004), studied Changes In Efficiency of total of 47 countries containing 25 transition (emerging market) countries and 22 OECD countries, in 1991-2002 period; Deliktaş and Balcılar (2005), studied Macro Economic Performances (Economic Efficiency And Total Factor Productivity) of 25 transition (emerging market) countries in 1991-2000 period; Güran and Tosun (2005), studied the Macro Economic Performance Of Turkish Economy With The Assistance Of Economic Growth, Rate Of Inflation, Rate Of Unemployment And Deficit (Gap) In Current Transactions Which Are Characterized As “Big Diamond” by OECD, in 1951-2003 period; Ramanathan (2006), studied Economic Efficiency of 18 Middle East and North Africa countries in 1997-1999 period; Tan and Hooy (2007), studied Economic Efficiency of 9 Eastern Asia Countries as of the year 2001; Karabulut et.al. (2008), studied Economic Performance of European Union Countries and Turkey in 2001-2005 period; Hsu et.al. (2008), studied Economic Performances exhibited by 50 countries who were or not members in the European Union in year 2004; Kodak and Çilingirtürk (2011), studied Relative Efficiency And Super Efficiencies of 30 countries, in relation to the economic input-output structures for the years 2002 and 2006; Pires and Garcia (2012), studied Total Factor Productivity (TFP)of 75 countries in 1950-2000 period; Demireli and Özdemir (2013), studied Macro Economic Performances of 13 European Economies in 2005-2011 period; Demir and Bakırcı (2014), studied Economic Efficiency of 34 OECD member countries in 2006-2010 period; Daştan and Çalmaşur(2014), studied Total Factor Productivity Change Indexes of 34 countries in 1995-2012 period, of the members or candidate countries of the European Union, by making computations and entering into analysis of values of Technical Efficiency And Scale Efficiency, based on the CCR and BCC models.

Method of Application

Analysis dimension of the study contains two phases. First by making a start with the Data Enveloping Analysis (DEA) the levels of efficiency of decision-making units are computed. In the second phase of the analysis, the changes in the productivity of the decision untie are shown. The methods used in the study can be indicated as follows:

Efficiency shows the success of producing maximum output with inputs used. By using the mixture of inputs relating to the system in the best way possible, the success in producing the possible maximum output that can be attained is defined as "Technical Efficiency" and the success in having production attained in suitable scale is defined as "Scale Efficiency". The efficiency computed by multiplying technical efficiency with scale efficiency is called Total Efficiency. The institutional developments relating to the concept of efficiency brought along he efforts directed to the measurement of efficiency as well.

In literature, especially during the post-Second World War period, efforts in the direction of developing a method to correctly measure the production efficiency, in restructuring of economies continued and the study of Farrell (1957) created a point of turn in this filed. The bases of efficiency measurement in the study of Farrell are provided by the studies entered into by Debreu (1951) and Koopmans (1951). In his study, Debreu (1951), states that each production unit operates in an economic system with a set of production sources and limited physical resources and studies optimum state of the system. Following the study of Farrell (1957), by the end of the 1970s, the interest is shown to the measurement of efficiency rapidly increased and methods developed were started to be put into wide use. Methods used in measuring an effectiveness of systems can be grouped under three main headings. These are the rate analysis, parametric methods and nonparametric methods. Rate analysis is a method that proportionate single output value, with a value of the single input. Whereas parametric methods containing such approaches as Stochastic frontier (border-limit)//Stokastik Sınır (SFA), Undistributed frontier (border-limit) //Dağıtımsız Sınır (DFA) and Bold frontier (border-limit) //Kalın Sınır (TFA) bases on multiple regression analysis. These methods are directed to determine relationship structure of dependent variable and the independent variable known to have a cause-effect relationship among them. In parametric methods, if the efficiency, value of any system, is above the regression line which shops the average efficiency in general, that system is called effect otherwise it can be said not to be efficient. Non-parametric methods containing Data Envelopment Analysis-DEA Free Usage Envelope Analysis // Serbest Kullanım Zarfı Analizini (FDH) uses more than one output and input as variable and is used in cases when they are measured with different units of measurement. These methods are techniques that measure the distance of the production systems to the production frontier (border-limit) (Ozden, 2008: 168).

Since the Data Enveloping Analysis (DEA) is forming the theoretical fundamentals of this study, only DEA among the method of measuring efficiency will be explained. Data Enveloping Analysis (DEA) makes it possible to measure the level of efficiency of inefficiency depended directly to a frontier (border-limit). Data Enveloping Analysis (DEA), rather than central tendencies, contains extreme data as well and as a methodology aims at forming the optimum production frontier (border-limit) (production curve) without imposing any restriction on the production technology. In other words, instead of regression plane that fits the data center best, contains partial linear surface formation that will include extreme data of observations (Arnade, 1994: 31). The level of efficiency of each of the Decision Making Units is determined by using the surface so formed. The degree of a Decision Making Unit to be below the production frontier (border-limit), is the relative inefficiency measure of it.

Data Enveloping Analysis, is a collection of concepts and methods and is being formulated in form of four different model as CCR Model (1978), BCC Model (1984), Model With Multipliers//Çarpanlı Model// (1982-1983) and Additive Model//Eklemeli Model (1985-1987). Within the limitation of the study only, the CCR and BCC models will be studied.

a. CCR Model

The initial form of Data Enveloping Analysis (DEA) is called 'CCR Model" which reflects the first letters of the names of Charnes, Cooper and Rhodes who developed the model. In the foundation of all of the models that are developed at a later time, there is the CCR model. The CCR model and its assumptions are indicated as follows:

The CCR model, bases on the production process of Decision Making Unit that uses m different inputs in making s different outputs. The mathematical expression of input/output rate that is to be maximized is as follows (Charnes, A. et. al. 1978: 429-444).

$$\max h_k = \frac{\sum_{r=1}^{s} u_{rk} y_{rj}}{\sum_{i=1}^{m} v_{ik} x_{ij}}$$

In this expression:

$x_{ij} \geq 0$ parameter shows the i amount of inputs used by j decision making unit,

$y_{rj} > 0$ parameter shows the r amount of outputs attained by j decision making unit.

Variables in this decision making unit are the weights that will be assigned for i amount of inputs and r amount of outputs to be assigned to them by the k decision-making unit. These weights are shown as v_{ik} and u_{rk} respectively.

When the weights of k decision making unit are used by other decision making units as well, the following expression attains a state in form of limits, that the efficiencies do not exceed 100%.

$$\frac{\sum_{r=1}^{s} u_{rk} y_{rj}}{\sum_{i=1}^{m} v_{ik} x_{ij}} \leq 1; \qquad j = 1,2,.....,n.$$

The restriction that makes it possible not to have negative values for input and output weights used are indicated below:

$$u_{rk} \geq 0; \qquad r = 1,2,.....,n.$$

$$v_{ik} \geq 0; \qquad i = 1,2,.....,n.$$

To transform this set of inequalities into a linear programming model and to reach at a solution; it is sufficient that the denominator of the objective function, for reaching at maximization, be equaled to 1 and put in form of a restriction. This transformation is known as "Charnes-Cooper transformation" and the model so formed is as shown below:

$$Max h_k = \sum_{r=1}^{s} u_{rk} y_{rk}$$

$$\sum_{r=1}^{s} u_{rk} y_{rj} - \sum_{r=1}^{m} v_{ik} x_{ij} \leq 0; \qquad j = 1,2,.....,n.$$

$$\sum_{r=1}^{m} v_{ik} x_{ik} = 1$$

$$u_{rk} \geq 0; \qquad r = 1,2,.....,s.$$

$$v_{ik} \geq 0; \qquad i = 1,2,.....,m.$$

The above model must be prepared with parameters of n decision making unit with their own parameters and solved for n times. Especially, in determining the efficient reference sets, the model which provides a support, is remembered with the name "enveloping problem" and it is expressed as follows:

$$\min\ v_k = q_k$$

$$\sum_{r=1}^{n} \lambda_{kj} \geq y_{rk}; \qquad r = 1,2,.....,s.$$

$$-\sum_{i=1}^{n} \lambda_{kj} x_{ij} + q_k X_{ik} \geq 0; \qquad i = 1,2,.....,m.$$

$$\lambda_{kj} \geq 0; \qquad j = 1,2,.....,n.$$

$$-\omega \leq q_k \leq +\omega$$

The λ variable in the Dual model, is used in determining efficient reference sets. The decision making units which corresponds to all of λ_{kj} dual variables producing positive values, in the primal model of k decision making unit, are termed as efficient. To the set made of this efficient decision making units is called the reference set of the k decision making unit. If k is efficient, than the only decision making unit in the reference set will be itself and the value of λ_{kj} in dual variable, will be equal to 1. Whereas for decision making units which are not efficient, the reference set will be guiding, in the direction of reaching at efficiency.

b. BCC Model

The BCC model was developed in 1984 by Banker, Charnes and Cooper (Banker, R.D., vd. 1984: 1078-1092) and separates technical and measurement efficiencies. Therefore it computes pure technical efficiency for an operation. On the other hand, in order to have it used in future applications, it determines if there are fixed, increasing or decreasing return or not according to scale. The mathematical expression of the output/input rate to be maximized is as follows:

$$Max h_k = \sum_{r=1}^{s} u_{rk} y_{rk} - u_0$$

$$\sum_{r=1}^{s} u_{rk} y_{rj} - \sum_{r=1}^{m} v_{ik} x_{ij} - u_0 \leq 0; \qquad j = 1,2,.....,n.$$

$$\sum_{r=1}^{m} v_{ik} x_{ik} = 1$$

$$u_{rk} \geq 0; \qquad r = 1,2,.....,s.$$

$$v_{ik} \geq 0; \qquad i = 1,2,.....,m.$$

y_{rk}= Amount of r^{th} output produced by decision making unit k (r = 1,2,…,s).

x_{ik} = Amount of i^{th} input used by decision making unit k (i = 1,2,…,m).

u_{rk} = Weight assigned to r^{th} output by decision making unit k (r = 1,2,…,s).

v_{ik} = Weight assigned to i^{th} input by decision making unit k (i = 1,2,…,m).

y_{rj} = Amount of r^{th} output produced by decision making unit j when the decision making unit k is made subject of study (r = 1,2,…,s) and (j = 1,2,…,n)

x_{ij} = Amount of i^{th} input used by decision making unit j when the decision making unit k is made subject of study (i = 1,2,…,m) and (j = 1,2,…,n).

CCR model uses fixed return method according to scale in studying the total efficiency but the more flexible as compare to itself, the BCC model, in study of variable return according to scale bases on measurement of efficiency in determining the technical efficiency. The restrictions in the model, show that restrictions in each of the Decision Making Units, relating to the rate of artificial output to artificial input not to exceed 1 is a requirement and the maximum value of the best objective function could be 1 at most [1].

By starting from the relative inefficiency values generated from the CCR and BCC models, putting into sequence of decision making units can be done, by commencing from the ones that has the least ineffectiveness (1-efficiency) in the direction of ones that have most . However, since the value of efficiency of decision making units that are efficient is equal to 1, it is not possible to make such a sequencing. To make this sequence possible, the super efficiency model which was developed in 1993 by Andersen and Petersen is being used. Along with the super efficiency model of Andersen and Petersen, there is the Cross Efficiency Matrix developed by Sexton et.al. and the Multi Purpose Data Enveloping Analysis (DEA) model of Li and Reeves which are proposed[2].

Data Enveloping Analysis (DEA) models oriented to input and output are basically very similar to each other. Despite this, the DEA models oriented to input, looks into what should be the optimum input mixture to be used, with the purpose of producing certain amount of output mixture in most efficient manner whereas the Data Enveloping Analysis (DEA) models oriented to output, studies, how much output mixture could be realized at the maximum by using certain amount of input mixtures.

Efficiency appraisal by using Data Enveloping Analysis (DEA) is a process that contains three phases (Golany, Roll, 1989);

1. Defining and selecting Decision Making Units to be analyzed,
2. Determination of suitable input and output factor variables to make relative efficiency assessments of the selected Decision Making Units,
3. Application of the Data Enveloping Analysis (DEA) models and analyzing the results

There are very important advantages in the application of the DEA but, it has weak points as well (Ayhan and Bakırcı: 2014, 114). For example, for all of the input and outputs of each of the DEAs, it is possible to determine most suitable(optimum) weights without facing any restriction. This brings in an advantage for DEA, but such weights that are freely determined sometimes do not reflect the reality. Certain strength and weaknesses of DEA are indicated below:

Data Enveloping Analysis (DEA) which is supported with economic theory and methods, focusing not on absolute but relative efficiency, capability of including multiple input and outputs in coordination into computations and has the ability of defining the optimum case as target, has possibility of being widely used and instead of average of the population, makes performance approval according to optimum

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[1] For detailed information about Data Enveloping Analysis (DEA) please look at Kök and Deliktaş, ibid, pp 210-243; Farrell, ibid.; Debreu, ibid. pp. 273-292; Charnes, Cooper, Lewin and Seiford, ibid.; Coelli and others, **An Introduction To Efficiency and Productivity Analysis,** Springer, Second Edition, USA, (2005); Şimşek, NeDEAt., Analysis of Foreign Trade of Turkey in Industry//Türkiye'nin Endüstri-İçi Dış Ticaretinin Analizi, Beta Yayınları, İstanbul, 2008; Kara, ibid. pp. 316-318; Aydın, Üzeyir, Comparative Organizational Efficiency in the Turkish Finance Industry : Turkish Case //Türk Finans Endüstrisinde Karşılaştırmalı Organizasyonel Etkinlik: Türkiye Örneği//, İzmir, Ninth September University(DEÜ=Institute of Social Sciences, 2010, (Unpublished PhD. Dissertation).

[2] Super efficiency models, moves an efficient Decision Making Unit out of the efficiency bound and measures the distance of this Decision Making Unit to the efficiency frontier (border-limit). Among such values to be generated from the super efficiency model, the Decision Making Unit having the highest value will be termed as the most efficient unit. The super efficiency values computed in relation to the units which are efficient are put into sequence starting from the decision making units having the largest efficiency value and by moving towards the units having smallest efficiency value and thus a sequence of efficiency can be generated. Whereas since the efficiency values of Decision Making Units which are not efficient will be equal to each other as compared to their relative efficiency values, their sequence number in relation to efficiency will not change. For more information please look at Tavares (2002).

(best) and for each Decision Making Unit, optimum (bet) sample is defined by forming a frontier (border-limit) and to the coordinate values present in the direction of this frontier (border-limit) in deciding as effective or ineffective. In applications of Data Enveloping Analysis (DEA) which does not require certain functional structure of behavioral prerequisites, the technological infrastructure between the Decision Making Units could be completely uncertain or variable and in such a linear unity, making the activities as subject of analysis is natural. Another advantage e of DEA is its characteristics of determining the potential points of growth for inefficient Decision Making Units and by means of this method, through making comparison between the Decision Making units included into the envelope according to the efficiency frontier (border-limit) and the ones that are Decision Making Units located on the frontier (border-limit), level of efficiency could be determined for each of the input and outputs that are related to the resource utilization. In the end, one of the most important advantages of Data Enveloping Analysis (DEA) is its ability to reach at a set of conclusions based on a small number of observations. Furthermore, with respect to unit of measure, the inputs and outputs are independent of measures and in Data Enveloping Analysis (DEA) applications in which measurements are made by using very different unit of measure, there is no need to use various assumptions for making these measures in the same manner or to transform them.

A conclusion that a Decision Making Unit determined to have a relative score of efficiency of 1, according to the results reached by using Data Enveloping Analysis (DEA) and the data of the production units in set, can not increase efficiency more, is extremely misleading. Furthermore, the deterministic structure of the method defining deviations from the efficiency frontier as inefficiency is criticized and at the same time, the method is sensitive to measurement errors in data gathering and the errors done at the time of building a model.

c. Malmquist Productivity Index

In efficiency analysis, by taking into consideration certain past periods of the production process, the changes of productivity, in time, in some or all of the factors can be computed by benefiting from the Total Factor Productivity Indexes(TFPI).

To measure the Total Factor Productivity (TFP)with Malmquist productivity index, there must be at least two periods. The result to be generated from difference functions for both periods explains the deviations from the maximum average output. The Malmquist total factor productivity index (m_0) is the most used approach in estimating the required distance function. This index, computes the relative distance of each data point according to joint technology and measures the change of Total Factor Productivity (TFP) between the two data points (technical advancement and technological change that forms it) and is expressed with the following notation:

$$m_0(y^t,x^t,y^{t+1},x^{t+1}) = \left[\left(\frac{d_0^t(y^{t+1},x^{t+1})}{d_0^t(y^t,x^t)}\right)x\left(\frac{d_0^{t+1}(y^{t+1},x^{t+1})}{d_0^t(y^t,x^t)}\right)\right]^{\frac{1}{2}}$$

The base year is t in this index, the following year is shown as t+1 period. In this equation, the notation of $d_0^t(y^{t+1},x^{t+1})$ represent the distance to the technology of (t) period, in (t+1) observations in the (t) period. This equation can be shown with the following form:

$$\frac{d_0^{t+1}(y^{t+1},x^{t+1})}{d_0^t(y^t,x^t)}\left[\left(\frac{d_0^t(y^{t+1},x^{t+1})}{d_0^{t+1}(y^{t+1},x^{t+1})}\right)x\left(\frac{d_0^t(y^t,x^t)}{d_0^{t+1}(y^t,x^t)}\right)\right]^{\frac{1}{2}}$$

In the equation given above, the proportional part staying outside of the main bracket, is the part that measures the change in the output focused technical advancement between the years (t) and (t+1). In other words, the change of efficiency is equal to the Technical Efficiency rate studied by Farrell (Farrell 1957), in period (t+1) and to the Technical Efficiency rate determined in period (t). Whereas the part contained in the main bracket, is the geometric average of the two rate and explains the change occurred in the technology in the two periods (x^{t+1} and x^t).

When the value of m_0 is greater than 1 it means that the Total Factor Productivity (TFP) in period (t) moved to the (t+1) period with increase; when the value is smaller than 1, it means that the Total Factor Productivity (TFP) in period (t) moved to (t+1) with decrease (Kök and Deliktaş 2003: 241; Kara, 2011). When a change in TFP is separated into two parts, the technological change and change in efficiency can be separately indicated.

$$Teknik\ Etkinlikteki\ Değişme = \frac{d_0^{t+1}(y^{t+1}, x^{t+1})}{d_0^t(y^t, x^t)}$$

Technical Efficiency Change=

$$Teknolojik\ Değişme = \left[\left(\frac{d_0^t(y^{t+1}, x^{t+1})}{d_0^{t+1}(y^{t+1}, x^{t+1})}\right) x \left(\frac{d_0^{t+1}(y^t, x^t)}{d_0^{t+1}(y^t, x^t)}\right)\right]^{\frac{1}{2}}$$

Technologic Change=

Separation of Malmquist productivity index makes it possible to determine the advancements of the Technical Efficiency in the total factor productivity and its contribution to the technological change(TD). While this state is termed as the catching-up effect of TE of the production frontier, the shifting of TD production frontier, is called frontier-shift. TE and TD form the main factors of change in Total Factor Productivity (TFP). In other words, multiplying TE with TD indicates a change in Total Factor Productivity.

There are two changes as sub-components named as Change in Total Factor Productivity and Technologic Change. Change in Technical Efficiency (TED), shows the performance exerted by the Decision Making Units, in getting converged with the best production frontier or catch it up. When this index takes a value greater than 1, it is taken as an indicator that the Decision Making Units by adapting to global technology has included the requirements in the structure. On the other hand, change in the Technical Efficiency index is separated into two sub-components as a change in the pure efficiency and in scale efficiency. That is, TED = PED x ÖED. The first one of these indexes, means that the existing factors of productions are used better while the second one, shows whether the Decision Making Units are realizing production at optimal scale or not. The value of both indexes being grater than 1 means improvement while it is less than 1 it means worsening.

Technological change index (TD) means the change at the best production frontier-shift. When this index is greeter than 1, it means that the production curve moves (slides)upward. The change in the Total Factor Productivity index also changes according to the two indexes. In other words, TFVD = TED x TD (Deliktaş, 2006: 17).

Change in the total factor productivity index being greater than 1, means the increase in the total factor productivity, when the index is smaller than 1, it means that there is a decrease in the total factor productivity. Change in the Technical Efficiency separates all of the efficiencies changes in it, in two, as a change of efficiency and scale efficiency changes. Whereas the change in scale efficiency shows the Decision Making Unit as having success in engaging in production activities at a suitable scale (Deliktaş, 2002: 263).

Under the assumption of return changing according to scale, because of difficulty in computing he distance functions, the Malmquist Total Factor Productivity index, could not at all time measure correctly the changes in the total factor productivity and thus, the indexes determined by doing so, could not properly reflect the gains and losses of total factor productivity originating from the scale efficiency. Because of this, to estimate the distance functions used in Malmquist total factor productivity index computations, it is assumed tat the technology is generating fixed return according to the scale (Coelli vd., 2005: 224). For this reason, while comparing the economic performances of the countries, the Efficiency and Total Factor productivity indexes determined under the assumption that countries have fixed return according to the scale, was preferred.

In the study, the Data Enveloping Analysis and Malmquist Total Factor Productivity Index Methods are applied for each period separately, the change in Technical Efficiency, Technological Change And Total Factor Productivity Change Indexes are computed. In these computations, the licensed, SAITECH DEA-Solver Pro 4.1f package program was used.

Gathering Data in the Direction of Applications

By using some of the economic indicators of EU member countries and of Turkey in the study, the aim is determined to be measuring their efficiencies separately. It is possible to secure ample date relating to 28 member countries of the EU and Turkey for the period of 2006-2012. However, by taking into consideration that, in case of using excessive data, the efficiency of the analysis will be weakened, the number of inputs and outputs were kept limited.

For this purpose, with priority to use in the study, the data sets were formed. The data important in relation to the determination of the economic efficiency of the countries were seen through the help of literature and gathered from World Bank, OECD, Eurostat and TUİK.

One of the factors that were taken into consideration in gathering data was to the collection of data that could represent different sectors. Here, instead of taking a few data from a sector, efforts were shown to gather one data from each of the sectors. In selecting the data, for the purpose of putting the efficiency of the country in real terms, at open, data secured from each of the sectors are included and used in the analysis. Furthermore, especially by gathering index data, the ability of representation of data included in the analysis and their being oriented to more sectors are attained. However, no effort was exerted to find an output data that corresponds, one to one, to each of the inputs.

For each of the data to be used in the analysis, it is required that it be gathered for all of the Decision Making Units. However, some of the lackings, in the tables were completed by determinations made with he method of the simple regression equation, in making an estimation.

Furthermore, for data having negative values, simple adding operation was done to have data having lowest value to move towards a very small acceptable positive value and all of the data of the year were added with same value and thus negative values were put into a state of being positive.

In the study, among quite large number of data in form of economic indicators of 29 countries, there were 6 input and 6 output data that did not have correlation among them and they were used for the purpose of performance measurement. These data are : "Rate of Unemployment (%)" (I1), "Annual Average Working Period (hour)" (I2), "Direct Foreign Investments (million dollars)" (I3), "Food Production Index (1999-2001=100)" (I4), "Total Imports Index (2000=100)" (I5) and "Tax Revenue (% of National Income)" (I6) that are taken as **input data**. Along with these data, "Per Capita Gross National Product (GNP) (dollar)" (O1), "Purchasing power parity (dollar)" (O2), "Comparative Price Index(AB=100)" (O3), "Income Index" (O4), "total Exports (2000=100)" (O5) and "Per capital CO2 Emission (tons)" (O6) were taken as **output data** and included in the analysis. Table 1 shows the correlation coefficients determined between the economic data.

Table 1. Correlation Coefficients Determined With Respect to Economic Inputs and Outputs

	1	2	3	4	5	6	1	2	3	4	5	6
1	1,00	0,38	0,01	0,08	0,24	-0,34	-0,46	0,18	-0,41	-0,37	0,28	-0,32
2	0,38	1,00	-0,26	0,21	0,34	-0,32	-0,46	0,18	-0,48	-0,48	0,38	-0,16
3	0,01	-0,26	1,00	0,04	-0,34	-0,04	0,30	-0,13	0,35	-0,11	-0,32	0,09
4	0,08	0,21	0,04	1,00	-0,02	0,04	0,06	-0,15	0,05	-0,04	0,07	0,14
5	0,24	0,34	-0,34	-0,02	1,00	-0,44	-0,58	0,31	-0,76	-0,60	0,84	-0,23
6	-0,34	-0,32	-0,04	0,04	-0,44	1,00	0,14	-0,26	0,20	0,15	-0,51	0,02
1	-0,46	-0,46	0,30	0,06	-0,58	0,14	1,00	-0,15	0,87	0,82	-0,41	0,70

2	0,18	0,18	-0,13	-0,15	0,31	-0,26	-0,15	1,00	-0,18	-0,13	0,42	-0,05
3	-0,41	-0,48	0,35	0,05	-0,76	0,20	0,87	-0,18	1,00	0,75	-0,69	0,43
4	-0,37	-0,48	-0,11	-0,04	-0,60	0,15	0,82	-0,13	0,75	1,00	-0,41	0,61
5	0,28	0,38	-0,32	0,07	0,84	-0,51	-0,41	0,42	-0,69	-0,41	1,00	-0,02
6	-0,32	-0,16	0,09	0,14	-0,23	0,02	0,70	-0,05	0,43	0,61	-0,02	1,00

Application: Analysis and Findings

In measuring the economic efficiency of EU member countries and Turkey, the SAITECH DEA-Solver Pro 4.1f version package program was used and efficiency scores for both the CCR which measures based on fixed returns according to scale and for the BCC Model which measures, based on variable returns according to scale were computed. The CRR economic efficiency rates determined at the end of analysis was done and the level of returns according to the scale of the economic efficiency levels of BCC are presented in Table 2.

Table 2. Economic Efficiency Results

	2006		2007		2008		2009		2010		2011		2012		2013		2006-2013
DMU	TE	RS	TE	RS	TE	RS	TE	RS	TE	RS	TE	RS	TE	RS	TE	RS	AVRG
Austria	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Belgium	0,973	Inc	0,924	Inc	1	Const	1	Const	1	Const	0,988	Inc.	1	Const	1	Const	0,986
Bulgaria	0,861	Const	0,808	Const	0,923	Inc	0,85	Const	1	Const	0,941	Inc	0,884	Const	0,857	Inc.	0,891
Croatia	0,984	Decr	0,869	Const	0,915	Const	0,773	Const	0,837	Const	0,877	Const	1	Const	0,998	Decr	0,907
Cyprus	1	Const	0,961	Inc	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	0,995
Czech Rep.	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Denmark	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Estonia	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Finland	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
France	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Germany	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Greece	1	Const	0,973	Inc	0,987	Inc	0,989	Inc	1	Const	1	Const	1	Const	1	Const	0,994
Hungary	1	Const	1	Const	0,961	Inc	1	Const	1	Const	1	Const	1	Const	1	Const	0,995
Ireland	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Italy	0,988	Inc	0,975	Inc	1	Const	0,991	Const	1	Const	0,972	Decr	1	Const	1	Const	0,991
Latvia	1	Const	1	Const	0,961	Const	1	Const	1	Const	1	Const	1	Const	1	Const	0,995
Lithuania	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Luxembourg	1	Const	1	Inc	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Malta	1	Const	1	Const	1	Const	1	Const	0,947	Inc.	1	Const	0,94	Inc	1	Const	0,986
Netheriands	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Poland	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Portugal	1	Const	0,986	Inc	0,949	Inc	1	Const	0,934	Const	0,973	Inc	1	Const	1	Inc	0,980
Romania	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Slovakia	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Slovenia	1	Const	0,96	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	0,995
Spain	1	Const	0,943	Inc	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	0,993
Sweden	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1	Const	1,000
Turkey	1	Const	1	Const	1	Const	1	Const	0,994	Dec.	0,977	Const	1	Const	0,978	Inc	0,994
United King	0,861	Const	0,941	Decr	0,902	Inc	0,906	Inc	0,899	Inc.	0,904	Inc.	0,889	Inc.	0,939	Const	0,905
AVRG	0,988		0,977		0,986		0,983		0,986		0,987		0,990		0,992		0,986

DMU: Decision Making Unit TE: Technical Efficiency , RS: Return According to Scale; AVRG: Average; Inc: Return Increased; Decr: Return Decreased; Const: Constant Return

Data Enveloping Analysis is a static method in essence. By departing from the current state, it discovers the measures that should be taken in future. However, in the research study, by taking data for activities extending over years, a dynamic dimension is included into the analysis. The results are shown according to the years and interpretations in detail were made only for the results indicated for the year 2013 and the recommendations are stated. Furthermore, for countries that were not efficient in the year 2013 to become efficient, the potential improvements that should be done are also included in the study.

According to the results of analysis generated by using he CCR method for the period of 2006-2013 based on the economic data, in relation to fixed return based on scale; along the entire years, such countries as Austria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Lithuania, Luxembourg, Netherlands, Poland, Romania, Slovakia and Sweden were determined to be among the efficient countries. When the analyzes are renewed with BCC method, by using the return changing based on scale, it is observed that all of these countries, could attain efficiency below the returns according to scale. Belgium was inefficient in years 2006, 2007 and 2011 in sequence with rates of 2.7 percent, 7.6 percent and 1.2 percent and is in a state of using resources with increasing returns. In other years, it continued resource utilization as fully efficient and reached at an average efficiency of 98.6 per cent.

United Kingdom, in all of the years taken as the bases for the analysis, Bulgaria in all of the years excluding year 201 and Croatia in all of the years excluding year 2012 could reach, respectively, at an average efficiency of 90,5, 89,1 and 90,7.

Greece, in years, 2007, 2008, 2009 for a period of 3 years, Italy, excluding the year 2008; Portugal excluding the year 2009 for a period of 2 years were faced with inefficiency scores. By taking into consideration that the subject years were times when global crises occurred, one can conclude that the three countries were badly affected from the crises, with respect to resource utilization. These countries have respectively an average efficiency of 99,4, 99,1 and 98,0.

Spain, was able to efficiently use their resources in the year 2007 at the rate of 94,1 per cent used them ineffectively at the rate of 5.9 percent. Spain, fully efficient in other years, have an average efficiency of 99,3. Turkey having similar resource utilization with Spain, has stayed a little below the full efficiency in years 2010, 2011 and 2013.

As a result of analysis made by using data of year 2006, according to the CCR method, there are 24 countries who are efficient; 5 countries that could not reach the full efficiency score and had an average efficiency of 98.8. While all of the inefficient countries are below the average there are increasing returns in Belgium, decreasing returns in Croatia and increasing returns in Italy.

When an assessment is made according to the years, as a result of analysis done by using date of the year 2007, according to CCR method, there are 19 countries who are effect, 10 countries that could not reach at fully efficient score and the average efficiency is realized at the rate of 97.7. Of the inefficient countries, while Portugal was above the average, others stayed below the average line. There is increasing return in Belgium and Spain; fixed returns in Bulgaria, Slovenia and Croatia increasing returns in Cyprus, Greece, Portugal and Italy and decreasing returns in the United Kingdom.

As a result of analysis done by using data of the year 2013, according to he CCR method, there are 25 countries who are efficient, 4 countries as Bulgaria, Croatia, Turkey and the United Kingdom not able to reach the full efficiency score and the average efficiency is determined to be accrued at 99,2. Of the ineffective countries, Croatia was above the average line while others stayed below the average. Bulgaria and Turkey are being operated with increasing return, Croatia decreasing returns and the United Kingdom with fixed returns[3] In Table 3 the potential improvements that should be made, by the countries that were not fully efficient in the year 2013, are listed for countries, to be fully efficient.

[3] Other years could be interpreted in similar manner.

Table 3. Potential Improvement Table for the Year 2013

DMU	1/Score				DMU	1/Score				DMU	1/Score				DMU	1/Score			
I/O	Data	Projection	Difference	%	I/O	Data	Projection	Difference	%	I/O	Data	Projection	Difference	%	I/O	Data	Projection	Difference	%
United Kingdom	**1,065**				**Bulgaria**	**1,167**				**Croatia**	**1,002**				**Turkey**	**1,022**			
Unemployment Rate (%) (I1)	7,10	7,10	0,00	0,00	1,00	12,90	9,06	-3,84	-0,30	1,00	17,00	8,37	-8,63	-0,51	1,00	9,10	9,10	0,00	0,00
Annual Average Working Time (hour) (I2)	1669,00	1335,14	-333,86	-0,20	2,00	1913,00	1913,00	0,00	0,00	2,00	1883,00	1571,97	-311,03	-0,17	2,00	1832,00	1832,00	0,00	0,00
Direct Foreign Investments (million Dollars)" (I3)	48314,45	18691,52	-29622,94	-0,61	3,00	1887,67	1887,67	0,00	0,00	3,00	588,38	-3929,23	-4517,61	-7,68	3,00	12918,00	4025,02	-8892,98	-0,69
Food Production Index (I4)	99,50	87,00	-12,50	-0,13	4,00	94,20	94,20	0,00	0,00	4,00	89,30	89,30	0,00	0,00	4,00	93,80	93,78	-0,02	0,00
Total Import Index (I5)	96,70	96,70	0,00	0,00	5,00	251,60	248,88	-2,72	-0,01	5,00	152,50	152,50	0,00	0,00	5,00	247,10	247,10	0,00	0,00
Tax Revenues (% of National Income)	25,20	21,76	-3,44	-0,14	6,00	17,90	17,90	0,00	0,00	6,00	20,60	16,83	-3,77	-0,18	6,00	20,60	16,49	-4,11	-0,20
Per Capita Net Gross National Income (dollar) (O1)	41787,50	51502,39	9714,89	0,23	1,00	7498,80	18584,87	11086,07	1,48	1,00	13607,50	35222,23	21614,73	1,59	1,00	10971,70	19277,98	8306,28	0,76
Purchasing Power Parity (dollar) (O2)	0,93	1,00	0,07	0,08	2,00	0,93	1,73	0,79	0,85	2,00	1,81	1,81	0,00	0,00	2,00	1,47	2,02	0,54	0,37
Comparative Price Index (O3)	108,00	115,05	7,05	0,07	3,00	41,00	59,36	18,36	0,45	3,00	65,00	83,27	18,27	0,28	3,00	57,00	58,27	1,27	0,02
Income Index (O4)	0,75	0,80	0,05	0,07	4,00	0,76	0,89	0,13	0,17	4,00	0,79	0,79	0,00	0,00	4,00	0,79	0,87	0,08	0,10
Total Export Index (O5)	95,40	105,01	9,61	0,10	5,00	272,90	320,92	48,02	0,18	5,00	157,30	200,54	43,24	0,27	5,00	323,50	330,72	7,22	0,02
CO2 Emission Per Person (ton) (O6)	9,10	9,69	0,59	0,07	6,00	6,00	9,03	3,03	0,51	6,00	5,30	5,99	0,69	0,13	6,00	3,30	8,95	5,65	1,71

According to Table 3, for United Kingdom which is determined to be inefficient, at the rent of 6.5 per cent, in assessments made, based on output, it is necessary that the per capita net national income must increase at the rate of 23 percent, purchasing power parity at the rate of 8 percent, comparative price index at the rate of 7 percent, income index at the rate of 7 per cent, total export index at the rate of 10 per cent and the per capita CO_2 emission at the rate of 7 percent, to be efficient.

For Bulgaria found to be inefficient at the rate of 16.7 per cent, it is necessary that the per capita net national income must increase at the rate of 148 percent, purchasing power parity at the rate of 85 percent, comparative price index at the rate of 45 percent, income index at the rate of 17 per cent, total export index at the rate of 18 per cent and the per capita CO_2 emission at the rate of 51 percent, to be efficient.

For Croatia found to be inefficient at the rate of 2 per thousand, it is necessary that the per capita net national income must increase at the rate of 159 percent, purchasing power parity should not be changed, comparative price index at the rate of 28 percent, should not change income index, total export index at the rate of 27 per cent and the per capita CO_2 emission at the rate of 13 percent, to be efficient.

For Turkey found to be inefficient at the rate of 2.2 per cent, it is necessary that the per capita net national income must increase at the rate of 76 percent, purchasing power parity at the rate of 37 percent, comparative price index at the rate of 2 percent, income index at the rate of 10 per cent, total export index at the rate of 2 per cent and the per capita CO_2 emission at the rate of 171 percent, to be efficient.

One of the important characteristics of DEA is its ability to determine fully efficient countries as potential improvement points for the inefficient countries. The reference set frequency distribution of countries is shown in Table 4. As a result of analysis made, in 2006, Denmark and Luxembourg are termed as countries possessing characteristics to be the mot referred countries by 4 inefficient countries. Luxembourg became a reference for 9 countries in year 2007, Lithuana became a reference for 6 countries in year 2008. In year 2013, Lithuania was referred at by 3 countries again. During the time period of 2006-2013 Luxembourg was referred by total of 24 countries; Lithuania referred by 19 countries and Ireland referred by 16 countries. They were included among the countries which were most frequently referred at.

Table 4. Frequency with Which the Countries Are Referenced

	2006	2007	2008	2009	2010	2011	2012	2013	TOTAL
Austria	1	0	2	2	4	0	1	0	10
Belgium	0	0	0	0	0	0	2	0	2
Bulgaria	0	0	0	0	0	0	0	0	0
Cyprus	0	0	0	2	1	2	0	0	5
Czech Republic	1	3	2	2	0	0	0	2	10
Denmark	4	2	1	2	2	2	1	1	15
Estonia	0	0	0	0	0	1	2	0	3
Finland	0	0	0	2	0	1	0	0	3
France	2	2	0	2	2	4	1	0	13
Germany	1	4	2	0	1	2	0	2	12
Greece	0	0	0	0	2	1	0	0	3
Hungary	0	2	0	1	2	4	0	1	10
Ireland	2	6	2	2	2	0	1	1	16
Italy	0	0	4	0	0	3	1	0	8
Latvia	0	0	1	0	0	0	0	1	2
Lithuania	2	2	6	1	3	2	0	3	19
Luxembourg	4	9	0	3	3	4	0	1	24
Malta	0	0	1	3	0	0	2	0	6
Netheriands	0	0	2	0	2	0	0	0	4
Poland	1	2	0	0	1	1	0	2	7

Portugal	0	3	0	0	0	0	0	0	3
Romania	0	1	1	0	0	0	0	0	2
Slovakia	0	1	2	1	2	1	1	0	8
Slovenia	0	0	0	3	0	2	0	0	5
Spain	0	0	0	2	0	2	0	0	4
Sweden	1	0	1	2	0	2	0	1	7
Turkey	0	0	1	0	0	0	0	0	1

In Table 5, changes in Technical Efficiency, technological change and in total factor productivity index computed for countries by using the Malmquist Total Factor Productivity Index Method and the sources of these changes are shown.

Table 5. Changes of Total Factor Productivities and Sources of Changes

Malmquist	Catch-up	Frontier	2006=>2007	2007=>2008	2008=>2009	2009=>2010	2010=>2011	2011=>2012	2012=>2013	Average
Germany	1,0081	1,0137	1,0208	1,0320	0,9736	1,0146	1,0172	1,0353	1,0577	1,0216
Austria	1,0006	0,9948	0,9602	1,0296	0,9893	0,9912	1,0019	1,1048	0,8887	0,9951
Belgium	1,0694	0,9880	0,8949	1,3204	0,9294	1,1313	0,9508	1,0075	0,9821	1,0309
United King	1,0854	0,9926	1,5456	0,9915	1,0155	0,8360	0,9981	1,0013	1,1446	1,0761
Bulgaria	1,6056	1,1248	1,1101	2,0256	0,4040	2,8925	0,6736	1,0271	0,6311	1,2520
Czech Rep	0,9966	1,0068	0,9684	1,0841	0,9888	0,9779	1,1410	0,8673	0,9983	1,0037
Denmark	0,9742	1,0117	0,8823	1,0681	0,8801	0,9540	1,0011	1,0382	1,0521	0,9823
Estonia	0,9963	1,0062	1,0039	1,0085	0,9620	1,0051	1,0525	0,9489	1,0284	1,0013
Finland	0,9930	1,0002	0,9498	1,0025	1,0040	1,0233	0,9700	1,0233	0,9774	0,9929
France	1,0006	1,0173	1,0028	1,0011	1,0233	0,9840	0,9934	1,0012	1,1209	1,0181
Croatia	1,0915	1,1208	0,5829	1,5026	0,8160	1,0651	0,9898	2,0438	1,3630	1,1947
Netheriands	0,9974	0,9998	1,0001	1,0472	0,9230	1,0289	0,9966	1,0229	0,9642	0,9976
Ireland	1,0046	1,0025	0,9783	1,0316	0,9879	1,0202	1,0310	0,9894	1,0114	1,0071
Spain	1,0314	1,0161	0,8040	1,3935	1,1490	0,7680	1,1169	1,1634	0,8480	1,0347
Sweden	1,0052	1,0064	1,0490	0,9418	1,1194	0,9927	0,9701	1,0034	1,0069	1,0119
Italy	1,0100	1,0053	0,9983	0,9959	0,9367	1,0645	0,7973	1,3252	0,9885	1,0152
Cyprus	1,0054	0,9946	1,0034	1,0316	0,9184	1,0313	0,9711	1,0411	1,0029	1,0000
Latvia	1,0021	1,0010	0,9949	1,0421	0,9811	1,0441	0,9342	1,0235	1,0012	1,0030
Lithuania	0,9859	1,0221	1,0107	0,9649	1,1137	0,9224	0,9896	1,0984	0,9514	1,0073
Luxembourg	0,9940	1,0060	1,0145	0,9807	0,8800	1,0628	1,1556	1,0166	0,8911	1,0002
Hungary	1,1181	1,0154	1,0300	0,5019	1,5554	1,0321	0,9843	1,2237	0,9887	1,0451
Malta	0,9963	1,0083	1,0596	1,0083	1,1301	0,8663	1,0068	0,9995	0,9627	1,0047
Poland	1,0004	1,0042	0,9980	1,0150	1,0075	0,9849	0,9915	1,0170	1,0174	1,0045
Portugal	1,0209	1,0365	1,0017	0,9330	1,2336	0,7482	1,2102	1,1615	1,0111	1,0428
Romania	1,0063	1,0012	1,0625	0,9237	1,0013	0,9901	0,9943	1,0483	1,0332	1,0076
Slovakia	1,0021	1,0217	1,0482	0,9955	1,0314	1,0374	0,9772	1,1766	0,9066	1,0247
Slovenia	0,9614	1,0201	0,8727	1,0552	0,8942	1,0081	1,0058	1,0010	0,9797	0,9738
Turkey	1,0311	1,2613	1,0061	1,0116	1,0100	0,9922	1,0710	2,3840	0,7247	1,1714
Greece	1,0131	1,0344	1,0336	0,9249	1,1665	1,2096	1,0181	0,9882	0,9987	1,0485
Average	1,0347	1,0253	0,9961	1,0643	1,0009	1,0579	1,0004	1,1304	0,9839	1,0334
Max	1,6056	1,2613	1,5456	2,0256	1,5554	2,8925	1,2102	2,3840	1,3630	1,2520
Min	0,9614	0,9880	0,5829	0,5019	0,4040	0,7482	0,6736	0,8673	0,6311	0,9738
SD	0,1152	0,0552	0,1444	0,2489	0,1805	0,3653	0,0981	0,3164	0,1258	0,0643

According to Table 5 when the average value of countries are taken, while here was a decrease of 1 percent at the beginning of the period with respect to Total Factor Productivity(TFV) of the countries, during the years 2007-2008 it is changed in the direction of increase of 6.4 percent. This change of direction in the way of increase was 13 percent during years 2011-2012 and reached at the highest level. Whereas in the following year, the productivity decreased by 1, 2 percent, When the average of the period is examined, it is observed that there is an increase of 3.3 per cent in the period with respect to productivity. Accordingly, of the change in the direction of increase at the rate of 3.3 percent, 3.4 percent is originated from the increase of countries reaching at a level of catching up the technical efficiency or approaching to the frontier of the reference efficiency; the 2.5 percent from technological changes crated by sliding up of the production frontier function upwards. On the other hand, the Standard Deviation (SD) showing the distribution of performance indicators of Decision Making Units, is an important indicator with respect to change of productivity of countries whether they have converged or not converged with each other. Accordingly, when Standard Deviation(SD) is examined, it can be seen that during the years 2007-2008, the standard deviation increased as compared to years 2006-2007. This indicates the increase of productivity difference prevailing between the countries. By looking at SDs in the following years, it is possible to say that there are important differences of change in productivity. Accordingly, when taken into consideration from the angle of objective of the study, it can be stated that the phenomena of capability of competing between the Decision Making Units(Countries) are gradually becoming different. When an appraisal is made that the becoming different coincided with a period in which effects of the global crises are felt, it can be concluded that countries such as Germany, Belgium, United Kingdom, Bulgaria, Czech Republic, Estonia, France, Croatia, Ireland, Spain, Sweden, Italy, Latvia, Lithuania, Luxembourg, Hungary, Malta, Poland, Portugal, Romania, Slovakia, Turkey and Greece moved out of crises with increase of productivity and this can be monitored by using the average productivity values. As compared to this, countries such as Austria, Denmark, Finland, Netheriands and Slovenia experienced decrease of productivity in the global crises period.

Furthermore, from the angle of countries which are a Decision Making Unit by herself, the changes in productivity can be monitored with a dynamic process in Figure 1.

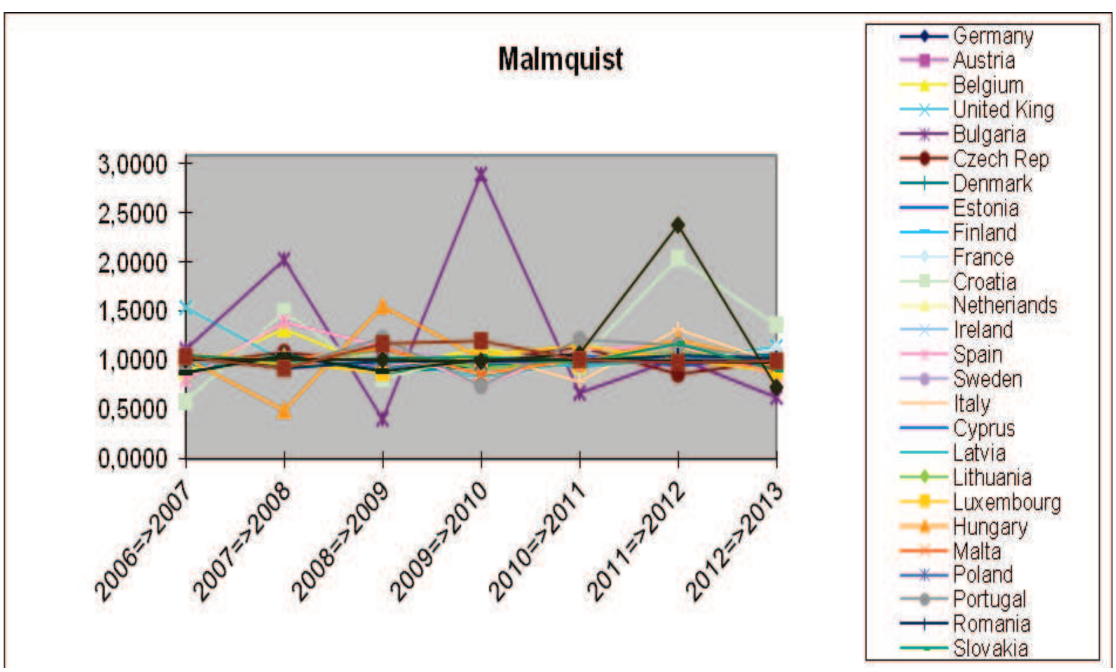

Figure 1. Graph of Changes in Total Factor Productivities

Conclusion

The sources of efficiency, productivity or inefficiency and unproductive production activities engaged in by countries and of the changes observed, in time, with respect to efficiency, productivity or unproductive activities are concerned with, not only by the country involved, but also by other countries with which the country has close relations, along with the policy makers and the researchers. The question of weather the subject countries are realizing production efficiently or not, if they know the sources of their being efficient or unproductive and if they could increase productivity in production by taking these into consideration in formulation of new strategies that will lead to increase in efficiency and at the same time increase in their competing power as country and the effects to be created in a positive direction, for other countries interacted with, is looked into.

In this study, the objective is determined to make analysis of Efficiency And Total Factor Productivity in European Union (EU) member countries and of Turkey, with a view to determine the efficiency of member countries, based on CCR and BCC models, during the 2006-2013 period. Furthermore, during the related time period, the Total Factor Productivity and their components according to the countries, are analyzed in detail.

Through the assistance of the Output Focused Data Enveloping Analysis (Çıktı Odaklı Veri Zarflama Analizi) and according to the original commend (CCR) accepting fixed return according to scale, the Average Technical Efficiency Value is computed to be 98,6. In the subject time period, there were 14 countries who were not using their resources efficiently while there were 15 countries realizing production activities efficiently, by using resources effectively.

During the same time period, it was observed that there was 3.3 percent productivity increase in member countries of European Union and in Turkey, with respect to Total Factor Productivity. The source of this increase, is determined to be the Technological Change which took the form of Technical Efficiency (Catch-up) and resulted in a sliding up of the Production Frontier (border-limit) Function.

Belgium, United Kingdom, Bulgaria, Croatia, Greece, Italy, Portugal, Spain and Turkey have lower Technical Efficiency scores. These countries, were not able to manage, the existing factors of production, in this time period, properly. Therefore, in order for these countries to be able to continue production activities in a efficient manner, in future periods, they must reorganize their existing production factors and manage them better.

The conclusions generated in the study, are bounded with the data collected from countries, in relation to the period of the study, about the input-output variables and method of analysis used. In case of having different time period, different variables and different methods used in a study, there may be the case of having changes, in the results of analysis, indicated here. The changes in Efficiency And Total Factor Productivity are indicated according to the countries and the sources of such changes are analyzed, in this study, through Data Enveloping Analyses and Malmquist Total Factor Productivity Index Method. Change of Efficiency And Productivity, can be determined by using different input-output, different time period and different methods.

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