National Efficiency Evaluation of Visegrad Countries in Comparison with Austria and Germany by Selected DEA Models

Lukáš Melecký[1], Michaela Staníčková[2]

Abstract. The paper deals with an application of Data Envelopment Analysis (DEA) method to multi-criteria efficiency evaluation of the Visegrad Four countries (V4) in comparison with selected advanced European Union's (EU) countries – Austria and Germany. The aim of the paper is to analyse a degree of efficiency achieved in individual countries which is perceived as a reflection of the level of competitive potential in the reference years 2000 and 2010. The theoretical part of the paper is devoted to the fundamental bases of competitiveness and the methodology of factor analysis and DEA method. The empirical part is aimed at measuring the effectiveness of selected countries by selected DEA models. When applying factor analysis and DEA method, we used indicators, which are part of the Country Competitiveness Index (CCI) created by World Economic Forum (WEF) and EU. Indicators included in CCI are interrelated, therefore we use factor analysis for assessment of internal relations between indicators and for reduction of their high number to a smaller number of variables, but at a minimum loss of information contained in the original variables. Factor analysis allows to use a structure of common factors of all variables and create factors including the most important and convenient indicators for national efficiency evaluation. Results of factor analysis are used for calculations of selected DEA models – basic CCR and BCC models and additive SDM, FDH and FRH models. The DEA method evaluates the efficiency how countries are able to transform their inputs into outputs. Therefore, efficiency of countries can be considered as a 'mirror' of national competitiveness. The final part of the paper offers a comprehensive comparison of results obtained by using of all calculated DEA models.

Keywords: Competitiveness, DEA method, efficiency, factor analysis, model BCC/CCR/FDH/FRH/SBM, Visegrad Four countries.

JEL Classification: C61, C67, O11, P51, Y10
AMS Classification: 62H20, 62H25, 90C05, 93B15, 93D25

1 Introduction

European Union is a heterogeneous unit with significant economic and social disparities between its Member States and their regions. The support of cohesion and balanced regional development together with increasing level of EU competitiveness belong to the temporary *key development objectives* of the EU. In relation to *competitiveness, performance* and *efficiency* are *complementary objectives*, which determine the long-term development of states and regions. The *measurement, analysis and evaluation of productivity changes, efficiency and level of competitiveness are controversial topics* and have enjoyed great interest among researchers.

1.1 Concept of Competitiveness

The *definition of competitiveness* faces to the *lack of mainstream view* for understanding this term. Competitiveness remains a concept that can be understood in different ways and levels despite widespread acceptance of its importance. Although there is *no uniform definition and understanding* of this concept, competitiveness remains one of the *fundamental criteria of economic performance evaluation* and it is also seen as a reflection of area (country/region) success in a wider (international/interregional) comparison. 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. [8]. In original meaning the concept of competitiveness was applied only to companies and corporate strategies. *Competitiveness of companies* is understood as the ability to

[1] VŠB-Technical University of Ostrava, Faculty of Economics, Department of European Integration, Sokolská třída 33, 701 21 Ostrava, lukas.melecky@vsb.cz.
[2] VŠB – Technical University Ostrava, Faculty of Economics, Department of European Integration, Sokolská třída 33, 701 21 Ostrava, michaela.stanickova@vsb.cz.

provide products and services as well as or more effectively than their main competitors; see e.g. [9]. There is not such a standardized definition and understanding of *national competitiveness* in comparison with the competitiveness at the microeconomic level. One of the most common interpretations 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 [7]. 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; see e.g. [8]. *Regional competitiveness* can be understood as the result of joint efforts on the most productive use of internal resources development in the interaction with the use of external resources and development opportunities focused on sustainable increases in production potential.

1.2 Evaluation of Competitiveness

Competitiveness is most commonly evaluated by *decomposition of aggregate macroeconomic indicators.* To compare a level of national competitiveness we can use the databases performed by *Institute for Management Development* (IMD) – the *World Competitiveness Yearbook* (WCY), and *World Economic Forum* (WEF) – the *Global Competitiveness Report* (GCR). Decomposition of aggregate macroeconomic indicators of international organizations is the most commonly used approach mainly at regional level, as well as *comprehensive analysis* aimed at identifying the *key factors* of regional development, productivity and economic growth; see e.g. [11]. *EU competitiveness* can be measured also by indicators of *EU' growth strategies* (Lisbon strategy – Structural indicators, Strategy Europe 2020 – Indicators of Europe 2020) or by *macro-econometric modelling* with creation of an econometric panel data model; see e.g. [7]. There is continuity between approach of EU and WEF in *EU Country/Regional Competitiveness Index*; see e.g. [1]. Another approach is evaluation by *DEA method*, which measures national/regional efficiency and subsequent national/regional competitive potential; see e.g. [10].

2 Multivariate Methods of Competitive Potential Measurement

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 [6]. Between collection of multivariate statistical methods we can include e.g. Factor analysis, Cluster analyses or DEA method.

2.1 Theoretical Basis of Factor Analysis

Factor analysis is a collection of methods used to examine how underlying constructs influence the responses on a number of measured variables. Factor analysis is a method for investigating whether a number of variables of interest $Y_1, Y_2, \dots Y_n$, are *linearly related* to a smaller number of unobservable factors $F_1, F_2, \dots F_k$. If we suggest that one measured variable Y_1, is function of two underlying factors, F_1 and F_2, then it is assumed that Y variable is linearly related to the two factors F, as follows in equation (1):

$$Y_1 = \beta_{10} + \beta_{11}F_1 + \beta_{12}F_2 + e_1. \quad (1)$$

The error terms e_1, serves to indicate that the hypothesized relationships are not exact. In the special vocabulary of factor analysis, the parameters $\beta_{i,j}$ are referred to as *loadings.* For example, β_{12} is called the loading of variable Y_1 on factor F_2. There is generally a wide range of literature based on factor analysis. For example, a hands-on how-to approach can be found in Stevens [11]; more detailed technical descriptions are provided in Hair and Black [6]. De Coster [4] posted, that there are basically *two types of factor analysis*: exploratory and confirmatory. *Exploratory factor analysis* (EFA), which is applied in this paper, attempts to discover the nature of the constructs influencing a set of responses. *Confirmatory factor analysis* (CFA) tests whether a specified set of constructs is influencing responses in a predicted way.

The main *applications* of factor analytic techniques are (1) to *reduce* the number of variables and (2) to *detect structure* in the relationships between variables that is to *classify variables*. Therefore, factor analysis is applied as a *data reduction* or *structure detection method*. Factor analyses are performed by examining the pattern of *correlations* between the observed measures. Measures that are highly correlated (either positively or negatively) are likely influenced by the same factors, while those that are relatively uncorrelated are likely influenced by different factors. The primary objectives of an *EFA* are to determine (1) The number of common factors influencing a set of measures and (2) The strength of the relationship between each factor and each observed measure. There are *seven usual basic steps* to performing *EFA*, used in the empirical analysis of the paper: (1) Collection of measurement variables; (2) Obtain the correlation matrix between each of variables; (3) Selection of the number of factors for inclusion; (4) Extraction of initial set of factors; (5) Rotation of factors to a final solution; (6) Interpretation of factor structure; (7) Construction of factor scores for further analysis.

2.2 Fundamental Background of DEA Method

The performance analysis provided by *Data Envelopment Analysis* (DEA) method can be used for evaluating territorial development efficiency with respect to the territorial factor endowment. DEA was first proposed by Charnes, Cooper and Rhodes [2] in 1978. Since that time, 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. DEA is based on *Farrel model* for measuring the effectiveness of units with one input and one output, which expanded *Charnes, Cooper, Rhodes* (CCR model) and *Banker, Charnes, Cooper* (BCC model), in advanced *Slack-Based Model* (SBM), *Free Disposal Hull* (FDH) and *Free Replicability Hull* (FRH) models [3].

DEA is gaining importance as a tool for evaluating and improving the performance of a set of peer entities called *Decision Making Units* (DMUs)) which convert multiple inputs into multiple outputs. DEA is a *multi-criteria* productivity analysis model for measuring relative efficiency and providing comparison of a homogenous set of DMUs. The DMUs are usually characterized by several inputs that are utilized for producing several outputs, but their performances are different. 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*. The best-practice units are used as a reference for evaluation of other group units. The *aim of DEA method* is to examine DMU if they are *effective* or *not effective* by size and quantity of consumed resources by produced output [3].

3 Application of Multivariate Methods to Efficiency Analysis

3.1 Efficiency Analysis Background

Based on the facts above, it is possible to determine the initial *hypothesis of the analysis*. The hypothesis is based on the assumption that *countries achieving best results in efficiency are countries best at converting inputs into outputs (best using of competitive advantages) and therefore having the greatest performance and productive potential*. DEA is applied to 4 countries within the V4 Group– Czech Republic (CZ), Hungary (HU), Poland (PL) and Slovakia (SK), and to 2 selected advanced EU countries – Austria (AT) and Germany (DE). The efficiency analysis starts from building database of measurable indicators that are part of a common approach of WEF and EU in the form of *Country Competitiveness Index* (CCI). The aim of this approach is to develop a rigorous method to benchmark national competitiveness and to identify key factors which drive competitiveness performance of countries. The reference to CCI is the well-established *Global Competitiveness Index* (GCI) by WEF. Eleven pillars of GCI are used for CCI constructing and may be grouped according to the different dimensions (*input versus output aspects*) of national competitiveness they describe. *Methodology of CCI is thus suitable for national competitiveness evaluation by Factor analysis and DEA method* [1]. The *68 indicators* selected for the CCI framework are all of quantitative type (hard data) and consist of several database sources. In this paper, database analysis consists of *66 selected indicators* – 38 of them are inputs and 28 outputs. The reference period is set across years 2000 and 2010. We do not use all indicators included in CCI because not all indicators were available for the whole period for each explored country, but for some indicators we have found comparable indicators. The pillars and used indicators are listed in Annex – Table 1.

For calculations of economic efficiency of evaluated countries, we have used *10 selected DEA models* with multiple inputs and outputs: *1. CCR input oriented model assuming constant returns to scale (CRS), 2. CCR output oriented model assuming CRS, 3. BCC input oriented model assuming variable returns to scale (VRS), 4.BCC output oriented model assuming VRS, 5. SBM additive model not-focusing on input and output assuming CRS, 6. SBM additive model not-focusing on input and output assuming VRS, 7. FDH input oriented model, 8.FDH output oriented model, 9. FRH input oriented model, 10. FRH output oriented model.* For solution of DEA models, we have used software tools based on solving linear programming problems, e.g. Solver in MS Excel, such as the *DEA Frontier*. Assuming *6 countries*, each with *m* inputs and *r* outputs, efficiency of a test country *q* is obtained by solving equations (2) [5]. Given the extensive equations of each model, only basic CCR model is shown for illustrative purposes, for *CCR input oriented model* with CRS the following equation (2) [5]:

$$\max\ z = \sum_{i}^{r} u_i y_{iq}, \qquad (2)$$

on conditions:

$$\sum_{i}^{r} u_i y_{ik} \le \sum_{j}^{m} v_j x_{jk}, k = 1,2,\ldots,n,$$

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

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

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

Where:

z	the coefficient of efficiency of unit U_q;
ε	infinitesimal constant;
v_j	weights assigned to j-th input;
u_i	weights assigned to the i-th output;
x_{jk}	value of j-th input of unit U_k;
x_{jq}	value of j-th input of unit U_q;
y_{ik}	value of i-th output of unit U_k;
y_{iq}	value of i-th output of unit U_q;
m	inputs;
r	outputs.

Basic DEA models, *primary CCR input/output oriented models*, assume CRS. *BCC input/output oriented models* consider VRS (decreasing, increasing or constant). VRS enable better identify more efficient units, because VRS provides a more realistic expression of economic reality and factual relations and activities existing in countries. CCR and BCC models evaluate efficiency of countries for any number of inputs and outputs. The *coefficient of efficiency* (CE) is 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 CE takes values in interval <0,1>. In *DEA models aimed at inputs* the CE of efficient countries equals 1, while the CE of inefficient countries is less than 1. In *DEA models aimed at outputs* the CE of efficient countries equals 1, but the CE of inefficient countries is greater than 1. In formulation of *SBM additive models is not necessary to distinguish between a focus on inputs and outputs*. In SBM models, the CE of efficient units equals 0, because it is the sum of additional variables for inputs and outputs (s^+ and s^-), which express the distance from the efficient frontier. The sum of additional variables for inputs and outputs is lower, evaluated countries is closer to the efficient frontier package and thus has a higher degree of efficiency, and otherwise [3]. The basic idea of *FDH model* is unconvexity of set of production possibilities. This means that evaluated unit can be only relatively compared towards really existing units. For comparison with CCR and BCC models, it should be added that limits of efficiency rate is similar to these models, and it depends on model orientation on inputs or outputs. Rate of efficiency, obtained by FDH models, is generally higher than in CCR and BCC models. This is due to the possibility that a production unit is dominated not only by specific production units of set of units (in the case of CCR and BCC models), as well as convex combinations of these units. A simple extension of FDH model is *FRH model*, which unlike FDH model, allows evaluated unit compares with multiplied combinations of other units [5].

3.2 Competitiveness Factors Measurement by Factor Analysis

For utilization of above mentioned sources, set of *66 variables* was compiled. In order to ensure comparability between different countries, all variables have to be relativized, and these variables thus entered into analysis. In process of data preprocessing is necessary to make their *standardization* (normalization), thus to unify their standards. The most commonly used method of standardization is to transform data into *Z-scores*. Based on used data standardization method, Pearson's correlation coefficient was chosen as a measure of correlation. The ideal would be case in which correlation degree of variables do not fall below 0.3. Like would not fall below 0.3, correlation coefficients should appropriate variables or vice versa exceed 0.9. On basis of defined conditions, *15 variables* for inputs and *13 variables* for outputs were excluded. Relevant new database consists now of *38 indicators – 23 input* and *15 output indicators*, illustrated in Table 1 in Annex also with excluded variables in crossed font.

After a relatively complex process of variables selection, the core of factor analysis follows. Statistical package SPSS (in our case *IBM SPSS Statistics – Version 20*) provides a wide range of methods for factors extraction. In this paper we have chosen specifically modified *method of principal components* because of higher number of variables. By its application to input set of variables, an estimate of *factor/component matrix* (often called also as matrix of factor loads) has been provided. Number of factors has been predefined in input parameters by determining the value of own number to a value greater than 1.0. Own number of a particular factor indicates the amount of total variability explained by just this factor. Very frequently criterion for finding the *optimal number of factors*, the percentage of total variance explained collectively by selected factors, is used. For an imaginary boundary of quality solution is widely accepted 70 % of explained variability. In our case, *five dominating factors for inputs* explained *100 %* of total variability in years 2000 and 2010, which can be considered as very satisfactory result. In the case of *outputs – four dominating factors* explained *95.168 %* of total variability in year 2000 and *94.188 %* of total variability in year 2010, which can be considered also as very satisfactory results.

The *optimal number of factors* is already known (*5 factors for inputs* in years 2000 and 2010, and *4 factors for outputs* in years 2000 and 2010), their interpretation still proceed not. One of yet unnamed conditions is that each factor has influence the most of variables, while each of variables, if it is possible, and should depend on the fewest number of factors. Further step is to rotate of factors or factorial axes, which task is just to maximize the load of each variable in one of the extracted factors, while her loads under other factors are substantially minimized. The *Varimax method* of rotation, which rotates the coordinate axes in the direction of maximum variance, has been used. Results clearly show that target of rotation was almost completely fulfilled. Only a few variables are now characterized by high loads in more than one factor and total structure of factor matrix is considerably simplified. For interpretation, those variables were identified as relevant, factor loadings exceeded the 0.4. This frontier was marked as convenient by *Stevens* [11]. Based on results of correlation and factor analysis, we could proceed to DEA method. Indicators for inputs and outputs, depending on their level of significance for competitiveness of evaluated countries, were divided by results of factor analysis in 2000 and 2010.

3.3 Evaluation of National Efficiency by DEA Models

The initial hypothesis of efficiency being a mirror of competitive potential *was confirmed* through analysis as illustrated in following Tables 1 and 2 in years 2000 and 2010. In the case of national efficiency evaluation was found out that in used DEA models were comparable results in all V4 countries, but also in Austria and Germany. *At national level, it is evident that levels of efficiency of individual V4 countries are lower in CCR models than in BCC, FDH and FRH models* (except Austria and Germany, which were evaluated to be efficient in all models during referred period). *This fact confirms theory that in BCC models with VRS, the CE reach higher values and higher number of evaluated countries is classified as efficient. This has been also confirmed in SBM models with VRS by higher number of evaluated countries identified as highly efficient compared to SBM models with CRS. This fact is also confirmed in FDH and FRH models*, because these models relatively compare inputs and outputs of evaluated countries towards really existing countries, and not to virtual country.

The overall evaluation of efficiency of V4 countries, Austria and Germany shows that the best results achieved 2 of 6 countries in years 2000 and 2010. The best results are predictably achieved by economically powerful countries which were *efficient in all used DEA models* during the whole referred period. Therefore, according to hypothesis, these countries should have the *greatest competitive potential*. Efficient countries – *Austria* and *Germany,* are highlighted by dark grey colour in Tables. The efficient countries are followed by a group of countries which are *slightly inefficient*. These countries do not achieved efficiency equal to 1 in *CCR*, *BCC, FDH* and *FRH models* or low sum of values of additional variables in *SBM* models, but their efficiency indices reached consistently highly effective values close during referred period (coloured by light grey colour in Tables). These countries are *Czech Republic*, *Slovakia* and *Poland in all used DEA models*. Only Hungary *was classified as inefficient in all used DEA models,* so it shows low competitive potential and development perspective (coloured by ultra-light grey colour and italics in Tables 1 and 2).

Tables also show position of individual V4 countries and Austria and Germany within selected DEA models in terms of the order of achieved values of efficiency coefficients in CCR, BCC, FDH and FRH models or sum of values of additional variables in SBM models in years 2000 and 2010. The overall evaluation of individual countries shows that best results, in terms of efficiency in all used DEA models, *Austria* and *Germany* have reached and are ranked in *first place*. These countries thus effectively utilize their competitive advantages. In *second place*, there is *Czech Republic*, which was evaluated as slightly inefficient with high level of competitive potential. *Slovakia* and *Poland* are ranked in *third* and *fourth place* because they have reached the lower values of the CE in CCR, BCC, FDH and FRH models, and higher sum of values of additional variables in SBM models. *Hungary* was ranked in *last – fifth place*, because it was classified as *inefficient* with the lowest values of the CE in CCR, BCC FDH and FRH models, and the highest sum of values of additional variables in SBM models.

Country 2000	**CCR IO**	**CCR OO**	**BCC IO**	**BCC OO**	**SBM CRS**	**SBM VRS**	**FDH IO**	**FDH OO**	**FRH IO**	**FRH OO**	**Absolute Rank of Country**
AT	1	1	1	1	0	0	1	1	1	1	**1.**
DE	1	1	1	1	0	0	1	1	1	1	**1.**
CZ	0,969	1,089	0,975	1,056	3 750	850	0,986	1,032	0,991	1,026	**2.**
HU	*0,901*	*1,123*	*0,915*	*1,109*	*1 456 003*	*404 589*	*0,926*	*1,087*	*0,945*	*1,071*	**5.**
PL	0,934	1,107	0,942	1,089	65 893	35 025	0,961	1,072	0,972	1,054	**4.**
SK	0,944	1,097	0,958	1,072	51 236	28 567	0,978	1,059	0,983	1,048	**3.**

Note: * IO = input oriented model, OO = output oriented model

Table 1 Results of Selected DEA Models in Year 2000 According to Coefficients of Efficiency

Source: Own calculation and elaboration, 2012

Country 2010	**CCR IO**	**CCR OO**	**BCC IO**	**BCC OO**	**SBM CRS**	**SBM VRS**	**FDH IO**	**FDH OO**	**FRH IO**	**FRH OO**	**Absolute Rank of Country**
AT	1	1	1	1	0	0	1	1	1	1	**1.**
DE	1	1	1	1	0	0	1	1	1	1	**1.**
CZ	0,985	1,041	0,993	1,029	1 126	252	0,995	1,015	0,998	1,004	**2.**
HU	*0,927*	*1,101*	*0,937*	*1,095*	*901 969*	*226 946*	*0,949*	*1,071*	*0,967*	*1,062*	**5.**
PL	0,952	1,089	0,961	1,078	51 256	19 925	0,978	1,062	0,985	1,041	**4.**
SK	0,966	1,079	0,975	1,059	37 595	17 261	0,986	1,041	0,991	1,028	**3.**

Note: * IO = input oriented model, OO = output oriented model

Table 2 Results of Selected DEA Models in Year 2010 According to Coefficients of Efficiency

Source: Own calculation and elaboration, 2012

4 Conclusion

Based on DEA analysis has been found out that in evaluated countries is a *distinct gap* between economic and social standards, so *differences still remain*. Development in V4 countries has a trend towards advanced countries, such as Austria and Germany. There was a growth in their performance, increasing trend in effective use of their advantages and improve in competitive position. But most countries experienced also a decline in their performance (outputs decline as a result of declines in inputs) as a result of economic crisis. The recent economic crisis has seriously threatened the achievement of sustainable development in the field of competitiveness. The crisis has underscored importance of competitiveness – supporting economic environment to enable national economies to better absorb shocks and ensure solid economic performance going into the future.

Acknowledgements

This paper was created under SGS project (SP2012/153) of Faculty of Economics, VŠB-TU of Ostrava.

References

[1] Annoni, P., and Kozovska, K.: *EU Regional Competitiveness Index 2010*, Publication Office of the European Union, 2010.
[2] Charnes, A., Cooper, W., Rhodes, E.: Measuring the efficiency of decision making units. *European Journal of Operational Research* **2** (1978), 429-444.
[3] Cook, W. D., and Zhu, J.: *Data Envelopment Analysis: Modelling Operational Processes and Measuring productivity*. Kluwer Academic Publishers, Boston, 2008.
[4] DeCoster, J.: *Overview of Factor Analysis* [online]. 1998. <http://www.stat-help.com/notes.html>.
[5] Fiala, P.: *Operační výzkum: Nové trendy*. Professional Publishing, Praha, 2010.
[6] Hair, J. F., and Black, W.C. et al.: *Multivariate Data Analysis*. Prentice Hall, 2009.
[7] Hančlová, J. et al.: *Makroekonometrické modelování české ekonomiky a vybraných ekonomik EU*. VŠB-Technical University, Ostrava, 2010.
[8] Krugman, P.: Competitiveness: A Dangerous Obsession. *Foreign Affairs* **2** (1994), 28-44.
[9] Porter, M. E.: The Economic Performance of Regions. *Regional Studies* **6/7** (2003), 549-578.
[10] Staníčková, M., and Skokan, K.: Evaluation of the EU Member States Efficiency by Data Envelopment Analysis Method. *International Journal of Mathematical Models and Methods in Applied Sciences* **2** (2012), 349-357.
[11] Stevens, J.: *Applied multivariate statistics for the social sciences.* Hillsdale, NJ: Lawrence Erlbaum Associates, 1986.

Annex

Dimension	Pillar	Indicator*
Inputs	**1. Institution**	In: **Political Stability** Out: ~~Voice and Accountability~~, ~~Government Effectiveness, Regulatory Quality, Rule of Law, Control of Corruption~~
	2. Macroeconomic Stability	In: **Harmonized Index of Consumer Prices, Gross Fixed Capital Formation** Out: ~~Income, Saving and Net Lending/Net Borrowing~~, ~~General Government Gross Debt, Total Intramural Research & Development Expenditure, Labour Productivity per Person Employed~~
	3. Infrastructure	In: **Railway transport - Length of Tracks, Air Transport of Passengers, Volume of Passenger Transport, Volume of Freight Transport** Out: ~~Motorway Transport -Length of Motorways, Air Transport of Freight~~
	4. Health	In: **Healthy Life Expectancy, Infant Mortality Rate, Cancer Disease Death Rate, Heart Disease Death Rate, Suicide Death Rate** Out: ~~Hospital Beds, Road Fatalities~~
	5. + 6. Primary, Secondary and Tertiary Education, Training and Lifelong Learning	In: **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** Out: ~~Lifelong Learning~~
	9. Indicators for Technological Readiness	In: **Level of Internet Access** Out: ~~E-government Availability~~
Outputs	**7. Labour Market Efficiency**	In: **Labour productivity, Male employment, Female employment, Male unemployment, Female unemployment, Public expenditure on Labour Market Policies** Out: ~~Employment rate, Long-term unemployment, Unemployment rate~~
	8. Market Size	In: **Gross Domestic Product** Out: ~~Compensation of employees, Disposable income~~
	10. Business Sophistication	In: **Gross Value Added in sophisticated sectors, Venture capital (expansion- replacement)** Out: ~~Employment in sophisticated sectors, Venture capital (investments early stage)~~
	11. Innovation	In: **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, Employment in technology and knowledge-intensive sectors-by level of education** Out: ~~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~~

Table 1 Indicators of Inputs/Outputs in Period 2000-2005-2010 Relevant to Factor Analysis
Note: * Number of indicators was decreased after correlation in inputs from 38 to 23, in outputs from 28 to 15
Source: [1]; own calculation and elaboration, 2012