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# The main achievements of the EU structural funds 2007–2013 in the EU member states: efficiency analysis of transport sector

**JEL Classification:** *C67; O11; O52; R11; R12*

**Keywords:** *DEA; efficiency; European Regional Development Fund, ex-post evaluation; Cohesion Fund*

**Abstract**
**Research background:** The European Union currently provides financial support to the Member States through various financial tools from European Structural and Investment Funds 2014–2020, and previously from the EU Structural Funds. In both terminologies, the funds represent the main instrument of EU Cohesion Policy to sustain territorial development, to increase competitiveness and to eliminate regional disparities. The overall impact of EU Funds depends on the structure of funding and absorption capacity of the country.
**Purpose of the article:** The efficiency of funding across the EU Member States is a fundamental issue for EU development as a whole. The Author considers deter-mining the efficiency of EU Funds as an issue of high importance, and therefore this paper provides a contribution to the debate on the role of EU Cohesion Policy in the Member States. The paper focuses on territorial effects of relevant EU Funds in programming period 2007–2013 in infrastructure through efficiency analysis.
**Methods:** Efficiency analysis is based on data at the country level, originating from ex-post evaluation of Cohesion Policy programmes 2007–2013 and representing the input and output variables to analyse whether the goal of fostering growth in the target countries have been achieved with the funds provided, and whether or not more resources generated stronger growth effects in transport accessibility. The paper deals with comparative cross-country analysis, descriptive analysis of dataset and multiple-criteria approach of Data Envelopment

Analysis (DEA) in the form of output-oriented BCC VRS model of efficiency and output-oriented APM VRS subsequently model of super-efficiency.
**Findings & Value added:** The paper aims to test the factors of two inputs and five outputs, trying to elucidate the differences obtained by the Member States in effective use of the European Regional Development Fund and the Cohesion Fund in the transport sector. The paper determines if the countries have been more efficient in increasing their levels of competitive advantages linked with transport. Preliminary results reveal that most countries with a lower amount of funding achieve higher efficiency, especially countries in a group of so-called "old EU Member States", i.e. group EU15.

## Introduction

The establishment of the EU market at the beginning of new area; the European Union (EU) Member States currently enjoy many benefits in this respect: a free market, effective trading, enhanced security, economic cohesion, sustainable development, protection of human rights, creation of jobs etc. The main goals of the EU are to boost economic and social progress and eliminate the existing differences between the standards of living of Member States and in their regions. The European Structural and Investment Funds (ESIF) are basic instruments of the EU Cohesion Policy to promote the overall harmonious development of the EU, to reduce disparities between the levels of development of the various regions, and to strengthen its economic, social and territorial cohesion. ESIF consist of the following five funds, i.e. European regional development fund (ERDF), European social fund (ESF), and Cohesion Fund (CF), European agricultural fund for rural development (EAFRD) and European maritime and fisheries fund (EMFF). The EU devotes an important part of its resources to financing regional development projects through ESIF, which provide subsidy aid to the Member States and their regions based on their economic situation, mainly based on the particular region's GDP. The EU defines subsidies as "any aid granted by the State or through State resources in any form whatsoever" based on Rubini's analysis (Rubini, 2010). How efficiently the Member States apply the European funds is a basic and pivotal topic for success and continuity of implementation of the EU Cohesion Policy, and especially so in the context of the economic crisis and the growing number of regions with low levels of development that the incorporation of so-called new countries into the EU has assumed. Such circumstances have forced the EU to make huge economic efforts to maintain and increase the resources for the funds, and so it is vital for the European authorities to know how effective the funds are being applied (Enguix *et al.*, 2012). The efficiency of the EU funds is an issue of high importance, and this paper provides a contribution to debate on the role of the EU Cohesion Policy in the EU Member States.

The paper focuses on the territorial effects of the EU Funds in programming period 2007–2013 in infrastructure through transport efficiency analysis. Efficiency analysis is based on national data originating from the ex-post evaluation of Cohesion Policy programmes 2007–2013 representing the input and output variables to analyse whether the goal of fostering growth in the evaluated countries have been achieved with the European funds provided and whether or not more sources created stronger growth effects and impacts in transport accessibility. By analysing the amounts granted to each Member State, the efficiency level of using funds is observed. The paper deals with comparative cross-country analysis, descriptive data analysis and multiple-criteria approach of Data Envelopment Analysis (DEA) in the form of output-oriented BCC VRS model. The paper aims to test several factors in the form of two inputs and five outputs, trying to elucidate the differences obtained by the EU Member States in effective use of ERDF and CF in the transport sector. The paper determines if the countries have been more efficient in increasing their levels of competitive advantages linked with transport. Additionally, development challenges are discussed for improvement of the efficiency effect of the EU Structural Funds on the national performance in the transport sector.

The paper is structured as follows. Section 2 briefly introduces the EU Cohesion Policy, reviews the methods for evaluation of the EU funds and highlights the importance of transport for development. Section 3 briefly introduces history and background of DEA methodology and proposes the efficiency and super-efficiency approaches. Section 3 describes the empirical background, i.e. inputs, output, evaluated units (DMUs), and data source. Section 4 presents and discusses the main and important empirical results. Section 5 compares the findings in the paper with the findings of other authors. Conclusions are summarised in the last section.

## Theoretical background

The goals of the EU Cohesion Policy lied in the perception of fact that a common market or internal market requires a certain degree of homogeneity in economic development of countries, which is not necessarily an automatic outcome of the European integration process but, eventually, has to be assisted by active policy interventions (both European or/and national interventions). Therefore, the EU Cohesion Policy aims at increasing competitiveness and the level of development and reducing economic and social disparities between the different regions involved. The means by which this goal can be supposedly reached are the EU Funds (formerly Structural Funds, and now ESI Funds or ESIF). Given their impressive amount, their impact has been analysed from several different perspectives. Theoretical approaches analysing the impact of economic integration and the EU Cohesion Policy can be classified as growth theories and trade theories, distinguishing between classical and new approaches. In part, these approaches have diametric political implications (Mohl & Hagen, 2010). It is not possible to identify the correct theory for the evaluation of the EU Cohesion Policy. It is striking that almost all empirical studies investigating the impact of the EU funds on regional economic growth are based on a neoclassical growth model, where funds mainly correspond to investments, which are endogenous in the neoclassical growth framework.

As the EU budget and financial perspective of each programming period become tighter and major recipients of European regional transfers struggle with financial and economic crises, questions and discussions about the proper utilization and effectiveness of financial transfers from the central EU budget to EU's poorest countries and subsequently regions are hot topics of policy debated. Spending the money allocated through funds was placed at the top of the list of most national governments. In order to boost the absorption rate, European institutions implemented a set of measures (Healy & Bristow, 2013; Katsarova, 2013). Investigating the impact of the EU funds on the economic growth and convergence process is thus a broad research topic (for a summary of the newest research see Table 1). Although studies on the efficiency of the EU Cohesion Policy through funds have not provided conclusive findings (see overview in Mohl & Hagen, 2010; Rogalska *et al.*, 2017), it is useful to determine whether the huge amounts of resources employed could have given better results.

Transport, resp. infrastructure as a whole can be seen as a baseline of European integration process from its beginning. This problem is one of the first and key-topicality issues to be listed to the EU common policy activities. The Treaty of Rome from 1957 (EUR-Lex, 1957) included the statement that transport or widely perceived infrastructure will have a big impact on securing three (free movement of goods, free movement of services and free movement of people) of four freedoms which internal market constitutes and ensures. Implementation of freedom could result in an effectively functioning transport network, i.e. one baseline of the whole infrastructure system. The key objectives: deeper common or internal market integration between the EU countries, the construction of efficient and big transport infrastructures, were seen as a needed assumption towards fulfilment of this goal. At the end of the 1990s, the EU has chosen a priority list of key investments in transport, so-called the Trans European Network (TEN) investments. The EU transport policy ensures two key objectives, i.e. to decrease trade costs (in line with the aim to build the EU internal market; and to promote the socio-economic development and structural adjustment of lagging regions and less-developed regions. Investments in infrastructure cause economic growth, supports both internal and external trade, higher employment rate and globally in the European context — increase the quality of life of European inhabitants and other favourable aspects. Therefore, the attractiveness of territory can be boosted by updating and upgrading the equipment in technical and social infrastructure, especially transport infrastructure — therefore it can get lower when distance, time and cost are taken into consideration. With respect to those facts, territories which can be characterized as those with highly developed transport infrastructure, are more attractive for investors, and in this can be seen as their competitive advantage too (see Górniak, 2016; Sucháček, 2013). The appropriate level in terms of the quality and the scope of transport infrastructure in the formed road, railway, air and water connections result in constant and better-increasing movement of people and goods and factually tend to improve the quality of life through the availability of transport services.

## Research methodology

The efficiency of the EU Cohesion Policy elements is an issue of high relevance, and it is the main aim of this paper which provides a contribution to the debate on the role of the EU Cohesion Policy in the EU Member States. The EU Cohesion Policy should be effective, as is the case for transport policy. The economic performance of transport infrastructure can be improved by investing in transport infrastructure, by selecting investments more carefully, and by using the existing infrastructure better. Whether interregional transport infrastructure is beneficial in terms of welfare and whether it generates economic growth at the macroeconomic level are two different issues. Assessing the benefits of transport investments ex-ante, but also ex-post is difficult. There is a number of potential problems with evaluations which mostly relate to the limited availability of sufficient data in the cross-sectional as well as the time dimensions, and to the methods applied. Currently, the trend in efficiency studies revolves around the application of non-parametric models, since they allow to consider a multiplicity of outputs and inputs in the analysis, and thus make less severe demands on the whole and the frontier of production. Efficiency measurement has been the challenge of many entities interested in improving their productivity. In 1957, Farrell in his study investigated the issue of measuring efficiency and supported the relevance of efficiency evaluation for economic policy-makers (Farrell, 1957). One of the reasons that all attempts to solve the problem have failed is the failure to combine the measurement of multiple inputs into any desirable outputs (Cook & Seiford, 2009; Caves *et al*., 1982). During subsequent years, methods, tools and techniques for efficiency measuring have become more frequent, popular and improved, as mentioned Melecký (2017).

Between the non-parametric techniques, Data Envelopment Analysis (DEA) is the most accepted method. DEA is the data-oriented approach for providing a relative efficiency assessment and evaluating the performance of a set of peer entities called Decision Making Units (DMUs). DEA provides a single measure and in a simple way deals with multiple inputs and multiple outputs, and its goal is to divide DMU into an efficient group or inefficient group, based on size and quantity of consumed inputs and produced outputs. In recent years, we have seen a great variety of applications of DEA for evaluating the performances of many different kinds of entities engaged in many different activities (such as banks, hospitals, universities, cities, courts, business firms, and others, including the performance of countries, regions, etc.), for more information see the latest examples of sectoral applications DEA methodology; e.g. Grmanová and Pukala (2018) or Balcerzak *et al.* (2017). Evaluation of territorial units is a topic of interest in this paper, for more DEA works about national or regional efficiency (see Staníčková, 2017, 2014); or previous works of the author, e.g. Meleck (2013); Melecký and Staníčková (2014). Further, DEA has proved especially valuable in cases where we have non-marketed inputs or outputs and/or cannot be derived or agreed upon between different DMUs. Various types of DEA models can be used, depending upon the problem at hand. Used DEA model can be distinguished by the scale and orientation of the model. With respect to the orientation of economic policy and decisions of policymakers to achieve better efficiency of activities, governments' priorities are to adjust their outputs rather than inputs, therefore an output-oriented (OO) DEA model, rather than an input-oriented (IO) one, is convenient and also used in the paper. From this point of view, here it is necessary to note that most of the studies mentioned above used only one common type of DEA model — an output-oriented model, which is considered suitable for measuring the efficiency of territories in the case of links between competitiveness and efficiency. The next step is Returns to Scale (RTS) estimation and based on RTS estimation and classifications of countries into RTS, then DEA model choice will is characterized, i.e. in most of the countries variable returns to scale (VRS) were estimated and thus used in this paper. For calculations of efficiency, it is used for output-oriented BCC Banker-Charnes-Cooper) model with VRS. The principle for calculating the efficiency scores can be explained briefly using the mathematical formula of the model (1) (Cook & Seiford, 2009):

$$\max \ g = \phi_q + \varepsilon(\mathbf{e}^{\mathbf{T}}\mathbf{s}^{+} + \mathbf{e}^{\mathbf{T}}\mathbf{s}^{-}), \tag{1}$$

subject to

$$\mathbf{X}\boldsymbol{\lambda} + \mathbf{s}^{-} = \mathbf{x}_q,$$
$$\mathbf{Y}\boldsymbol{\lambda} - \mathbf{s}^{+} = \phi_q \mathbf{y}_q,$$
$$\mathbf{e}^{\mathbf{T}}\boldsymbol{\lambda} = 1,$$
$$\boldsymbol{\lambda}, \mathbf{s}^{+}, \mathbf{s}^{-} \geq \mathbf{0},$$

where $g$ is the coefficient of efficiency of unit $U_q$; $\phi_q$ is radial variable indicates required rate of increase of output; $\varepsilon$ is infinitesimal constant; $e^T\lambda$ is convexity condition; $s^+$, and $s^-$ are vectors of slack variables for inputs and outputs; $\lambda$ represent vector of weights assigned to individual units; $x_q$ means vector of input of unit $U_q$; $y_q$ means vector of output of unit $U_q$; X is input matrix; Y is output matrix. In OO BCC model, the coefficient of efficient DMU equals 1, but the coefficient of inefficient DMU is greater than 1.

In BCC model, the coefficients of efficient units are equal to 1. With respect to the selected DEA model and the relationship between the number of units and the number of inputs and outputs in results — a number of efficient units can be relatively large. Due to the possibility of evaluated DMUs' classification, it is used in Andersen-Petersen's model (APM) of super-efficiency. Following OO VRS model is a dual version of APM (2) (Andersen & Petersen, 1993):

$$\max \ g = \phi_q + \varepsilon(\mathbf{e}^{\mathbf{T}}\mathbf{s}_i^{+} + \mathbf{e}^{\mathbf{T}}\mathbf{s}_i^{-}), \tag{2}$$

subject to

$$\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^{-} = x_{iq},$$
$$\sum_{j=1}^{n} y_{kj}\lambda_j - s_i^{+} = \phi_q y_{kq},$$
$$\mathbf{e}^{\mathbf{T}}\boldsymbol{\lambda} = 1,$$

$$\lambda_q = 0,$$
$$\lambda_j, s_k^+, s_i^- \geq 0,$$
$$j = 1, 2, \ldots, n, \ j \neq q; k = 1, 2, \ldots, r; i = 1, 2, \ldots, m.$$

where $x_{ij}$ and $y_{rj}$ are *i*-th inputs and *r*-th outputs of DMUj; $\phi_k$ is efficiency coefficient of observed $DMU_k$; $\lambda_j$ is the dual weight which shows $DMU_j$ significance in the definition of an input-output mix of the hypothetical composite unit, $DMU_k$ directly comparing with. The rate of the efficiency of inefficient units ($\phi_k > 1$) is identical to model (1); for units identified as efficient in the model (1), provides OO APM (2) rate of super-efficiency lower than 1, i.e. $\phi_k \leq 1$.

Based on the mentioned information, it is considered as appropriate to apply DEA mathematical technique, which allows calculating the technical efficiency and inefficiency of using the funds for enhancing transport accessibility and transport sector as a whole in the EU Member States. This paper covered 27 Member States of the EU drawing money from the EU during the programming period 2007–2013. With the aim to analyse and evaluate differences in terms of transport infrastructure, the paper utilized data from reports Evaluations of the 2007–2013 programming period: Ex Post Evaluation of the ERDF and CF: Key outcomes of Cohesion Policy in 2007–2013 (European Commission, 2016). The efficiency analysis is based on data at the country level originating from ex-post evaluation of the EU Cohesion Policy programmes 2007–2013, representing the input and output variables to analyse whether the goal of fostering growth in the target countries have been achieved with the funds provided, and whether or not more resources generated stronger growth effects in transport accessibility. Inputs represent two variables Road (in billion EUR, I1) and Rail (in billion EUR, I2); outputs represent five variables km of new roads (O1), km of new TEN roads (O2), km of reconstructed roads (O3), km of TEN railroads (O4) and km of reconstructed railroads (O5). In Table 2, data for 27 Member States (DMUs) with two inputs and five outputs are demonstrated in the numerical example. With respect to data availability and the need for relevancy of gained results, data for 23 Member States come into efficiency analysis through DEA method, i.e. without AT, DK and LU with zero values of indicators, and also without BE only with the one-known value of indicators. For other countries, the values are available for all of the indicators, or some indicators show missing data and therefore report zero values.

In the case when the number of inputs and outputs together is relatively high with respect to a number of evaluated units, as a result, most of the evaluated units will result efficiently, i.e. units behave efficiently. Thus, the getting results are not expressed as relevant. There is a rule of thumb expressing the relationship between a number of DMUs and number of efficiency measures, found by Toloo *et al.* (2015), that in nearly all of cases the number of inputs and outputs together does not exceed 6. Suppose there are *n* DMUs consuming *m* inputs to produce *s* outputs. A simple calculation expresses that when m ≤ 6 and s ≤ 6, then 3 (m + s) ≥ m × s. As a result, in this paper formula (3) is applied:

$$n \geq 3(m+s). \tag{3}$$

In the paper, DMUs number is three times higher than the sum of input and outputs together, i.e. 23 ≥ 3 (2 + 5), 23 ≥ 3 (7), 23 ≥ 21, thus the rule has been proved for the DEA application in the paper. DEA Frontier software tool for calculating issues of linear programming is applied in the paper.

## Results

In the first step, OO BCC VRS model of efficiency should be solved for the EU23 Member States. In this way, efficient and inefficient countries can be determined. In the second step, OO APM model of super-efficiency should be solved for all the EU23 Member States. Based on the results of Andersen-Petersen's model, efficient and inefficient countries can be determined and ranked. Complete results of efficiency analysis of the EU23 Member States are represented in Table 3. The paper reveals that only 12 countries are efficient in OO BCC VRS efficiency model, and all other 11 countries are inefficient. Output oriented BCC VRS model of efficiency and OO Andersen-Petersen's model of super-efficiency singled out productive units which are efficient; among the countries of this group there are: Bulgaria (BG), Spain (ES), France (FR), Italy (IT), Cyprus (CY), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romani (RO), Finland (FI) and Sweden (SE). Efficient countries are highlighted in bold in Table 3. In this case, the efficiency boundary is a straight line cutting through these DMUs. All other units are inefficient, i.e. they fall short of the efficiency curve. Inefficient countries are the Czech Republic (CZ), Germany (DE), Estonia (EE), Ireland (IE), Greece (EL), Latvia (LV), Lithuania (LT), Hungary (HU), Slovenia (SI), Slovakia (SK) and United Kingdom (UK). Inefficient countries are highlighted in italics in Table 3. In Table 3, the final results of OO APM model of super-efficiency are highlighted by the visual approach in the form of a colour method called traffic light. The range of colours can be different (based on author decision), traditionally can be used in two ranges of colours — colourful version (green-yellow-red) and black and white version (shadows of grey). The second black and white approach is applied in this paper, i.e. light, middle and dark shadows of grey colour. Based on this range, the results are as follows: better results in the form of lower OO APM values, the darker shadow of grey, and vice versa. The countries in the middle of results, i.e. between the lowest and highest OO APM values, are marked by middle grey colour.

The obtained results in the form of dividing countries into two groups — efficient and inefficient countries — can be seen as very simplistic. It is worthwhile to mention the concept of competitiveness and its effect on the differences between countries, which is linked to the level of development affecting the convergence trend of less developed countries to more developed ones. For this reason, we have to evaluate and compare initial variables, i.e. the numbers and values of inputs and outputs. It is also important to note that units are able to achieve the level of outputs with given level of inputs. Let us note that DEA allows for determining how DMU should change its behaviour to become efficient and rise to the efficiency curve. In the case of inefficient countries, optimal values of inputs and outputs are calculated, i.e. targets for inefficient countries as an instruction for improving their input-output ratio to become efficient (see Table 1 with initial values of indicators and Table 4 with efficient targets of indicators).

Efficient countries in the programming period 2007–2013, through the actions financing from ERDF and CF, managed to develop their infrastructures, increase their rates of investment and significantly raise their quality level of transport networks. Development of transport network is a very important element for the effective functioning of the EU Members States. Despite this fact and the well-known importance of this growth assumption, there are differences between the EU Member States in the range of transport networks, and therefore in the development of transport accessibility. Transport networks in the new EU countries are at the weaker level of technical development in comparison to the old EU countries. The tool for solving this inequality is the development of TEN in the new EU Member States, i.e. countries of Central and Eastern Europe and in Balkan countries through the EU funds, resp. ERDF and CF in the transport sector. New EU countries have good prospects for growth of transport infrastructure with regard to the number of allocations from the European funds and according to the theory of growth due to the effect of catching up of the less developed countries to more developed ones, and there are several reasons for it, as recognized by Staníčková and Melecký (2016):

- the new EU countries, i.e. countries which joined the EU in 2004, 2007 and 2013, with respect to the criterion of GDP per capita in PPS are classified into a group of — this is important for the inclusion in the appropriate categorization stage of development relevant for a statement of the EU funds allocation;
- belonging of a country to its appropriate category within classification the stage of development signifies relevant competitive advantages and disadvantages, the type of competitive advantage (quantitative or qualitative) and strengths as well as weaknesses. As Annoni and Dijkstra (2013) stated in their publication, relevant for economic entities primarily driven by basic factors are features like skilled labour and basic infrastructures, as well as good governance and quality of public health, i.e. medium stage of development. An intermediate stage of development is employed by factors like labour market efficiency, quality of higher education and market size. High stage of development recognizes the features such as innovation, business sophistication and technological readiness;
- the criterion for identifying national eligibility for drawing money via funds of the EU Cohesion Policy is a threshold in the forms of specified levels of GDP as a percentage of the EU average The EU funds are an important tool for reducing economic, social and territorial disparities between European countries. The topic of regional development and competitiveness are closely interconnected, minimizing disparities significantly impact the competitiveness of countries. Reducing disparities has a significant impact on competitiveness, and these two concepts are thus the EU's complementary objectives. A substantial part of the total EU financial perspective is allocated to the new EU Member States what boost their development;
- most of new EU Member States significantly depend on exports to the old EU Member States and, subsequently, on transactions for trade shift, thus freight transport needs adequate transportation network, which is important for these countries in terms of trade relations.

The factors mentioned above have a significant impact on convergence trend of new EU countries to the old EU countries. Based on the growth theory, more developed countries facilitate growth in less developed countries. Different growth rates and subsequent different levels quality of life can be explained by different competitive levels. Differences and variation in macroeconomic competitiveness should give rise to a debate on the extent to which these differences are harmful to their national competitiveness and the extent to which the internal variation can be remediated (Dijsktra *et al.*, 2011). These facts, i.e. variation and heterogeneity, are important reasons for measures which need to be taken into account. National economies, as well as regional focused on solving the main problematic issues of inhabitants, may thus orient not only on the improvement of the aggregate or average indicators of competitiveness but also on the minimizing of the differences in competitiveness and boost it. This is also partially solved via a drawing of funds of the EU Cohesion Policy. The overall impact of the EU funds and absorption depend on a national approach to the structure allocation of the EU funds. Effective implementation of topical policies in line with efficient using and realizing the public funds will address the aims and ensure required outcomes, which affects the effectiveness.

## Discussion

Not only this paper solves the topic of evaluation of the EU Structural Funds, but many other works exist which could help to extend the topic in future research. The studies mentioned below considered embracing both official evaluations undertaken by the EU institutions in cooperation with academic experts. It is worth noting, however, that this section does not provide a comprehensive literature survey of all evaluations of the EU Structural Funds.

One of the most relevant research work is the study 'Evaluation of the main achievements of Cohesion policy programmes and projects over the longer term in 15 selected regions'. This publication was submitted to the European institution of the European Commission (DG Regio) by two institutions, i.e. by the European Policies Research Centre (EPRC) of University of Strathclyde and London School of Economics (LSE) (Bachtler *et al.*, 2013). The study was focused in terms of its objectives on measurement and evaluation of the main achievements of programmes and projects implemented under the scope of the EU Cohesion policy (more specifically, co-financed by the ERDF and the Cohesion Fund) and finding out facts and information about their effectiveness and utility of achievements over the long-term period, i.e. from 1989 to 2012 in 15 chosen regions of the selected EU15 Member States. And what are the main results based on the qualitative evaluation? In the evaluated reference period, actions and interventions of the EU Cohesion policy are viewed as effective, but differences based on the evolution of the reference period from 1989 to 2012-variation are topical (with respect to the theme of programmes) and territorial (differences across evaluated regions). All in all, regions are considered to have (in most cases) improved their attainment of settled objectives in implemented programmes. With respect to territorial analysis, specific results across 15 evaluated regions are as follows: in the first programming period under evaluation, i.e. in period 1989–1993, only six regions were judged to have met or exceeded objectives, for other six regions it was impossible to make a judgement, and the last three regions underperformed. In comparison with the second programming period under evaluation, i.e. 2000–2006, most of the evaluated regions met or exceeded their objectives set in programmes. Results for thematic evaluation are as follows: in the case of evaluated regions it was recognized that short-term effectiveness appears to be higher for large-scale physical infrastructure, environmental improvements and local business and innovation infrastructure, i.e. for standard growth factor of medium or intermediate stages of development of economies. These factors can be considered as strengths of regions. But on the other hand, the weaknesses were recognized in areas such as structural adjustment, business support, innovation and community development. Overall thematically evaluation can be specified that most regions had good expertise in capital programmes and therefore, these regions were able to set realistic, relevant and reasonable objectives which were attainable and which were then delivered by appropriate tools in an effective way (Bachtler *et al.*, 2013).

The second most important publication is the study ‘Impact and effectiveness of the EU Structural Funds and EU policies aimed at SMEs in the regions’ requested by the European Parliament's Committee on Regional Development and created by the DG IP, Policy Department B: Structural and Cohesion Policies of the European Parliament (Tödtling–Schönhofer *et al.*, 2011). This study provides a description of the general nature of Small and Medium Size Enterprises (SMEs) and their development factors as well as the support that Cohesion Policy and other EU policies provide to SMEs. It then assesses practical aspects and effects of Cohesion Policy on enterprises and SMEs on the basis of a review of published materials and the eight case studies drawn from SME-relevant ERDF OPs from 2007–2013; where possible, also include the lessons learnt from 2000–2006. The conclusions and policy recommendations put forward clearly highlight the complex relationship between EU policies and SMEs as final beneficiaries of support in the EU multilevel governance system. Despite sizeable investments, there is not enough evidence to suggest that support has been effective. Better-targeted studies should be carried out — at EU, national and regional levels — on the impact that EU Structural Funds have on different types of SMEs and micro-firms, and on the results and impacts of support, both generally and with regard to the specific aims pursued (e.g. increased innovation, human capital etc.). In line with the need to strengthen the policy’s effectiveness (as far as the support of SMEs is concerned), project appraisals should pay more attention to the longer-term goals of support than to the capacity of a project to spend its budget within the timetable required to fulfil N+2. The complementarities and synergies between EU Structural Funds programmes and other (domestic) investment programmes should be strengthened. In particular, this should be pursued in Competitiveness and Employment Regions, where Cohesion Policy often covers only a small portion of the support in comparison with resources channelled through domestic funding streams. The synergies between Cohesion Policy and other EU instruments to effectively improve innovation and research funding in Europe need to be strengthened if the knowledge-based economy and innovation are really to be at the forefront of the EU2020 Strategy (Tödtling–Schönhofer *et al.*, 2011).

Besides these official sources of the EU, which were created under the auspices of the EU institutions (European Commission and European Parliament) and corresponding research centres, with the participation of academics, there are a number of scientific papers (e.g. mentioned in Table 1 in Section 2) dealing with the issue of the EU Structural Funds' efficiency or effectiveness. Relevant for all empirical studies and also for orientation of future research (as stated below) is topic of the effectiveness of public spending, i.e. in this case of using the EU Cohesion Policy not only efficiently, but moreover effectively through the implementation of operational programmes in EU countries.

## Conclusions

The paper has determined the efficiency analysis with which 23 Member States of the EU have managed the EU Structural Funds 2007–2013 received according to their levels of development. The Author has developed one efficiency model and, moreover, applied one super-efficiency model for obtaining the relevant results and classification of the evaluated sample. The paper reveals that only 12 countries are efficient in OO BCC VRS efficiency model, and all other 11 countries are inefficient. But these results can be seen as very simplistic, therefore an important part of the explanation to differences in efficiency between the Member States is related to differences in competitiveness. An economic entity in a country with low competitiveness, does not have the same or similar opportunities as an economic entity in the country with higher competitiveness. That is the fact remaining and also confirmed from the point of view of economic theory and through many empirical research works. Buts, what does this fact mean for efficiency in macroeconomic competitiveness? Comparison of efficiency and competitiveness, results will be definitely (more or less) different. Why or how is it possible? The concept of competitiveness is important not only for evaluation of the reasons of the growth rate of countries but also the level of efficiency dimension of competitiveness over time. This is totally linked with the level of development affecting the convergence trend of the new EU countries to the EU original Member states, and rate of growth of original members impact the growth in relatively new countries. The question arises from that finding: is a high level of competitiveness necessarily associated with a high level of efficiency, and vice versa? This is not the case of an evaluated sample of countries, as it is needed to measure and evaluate number and scores of initial variables (inputs and outputs).

Practically, efficient countries in the previous programming period 2007–2013 through the actions financing from ERDF and CF, managed to develop their infrastructures, increase their rates of investment and significantly raise their quality level of transport networks. Development of transport networks, i.e. technical infrastructure is an important and basic assumption for the efficient and effective functioning of the EU Members States. Nowadays, increasing demand for goods and services and as well as the movement of people is the reason for successful expansion and modernization of technical infrastructure in its complexity. Therefore, it is needed to interconnect all the EU Member States into a functioning system of transport networks. Existing infrastructure will support the movement of people and flow of goods and services (from the point of view that considers the distance between territories). Differences in the levels of accessibility are significant in the new EU countries. They have good prospects for growth of transport infrastructure with regard to the number of allocations from the European funds and according to the theory of growth due to the effect of catching up of the less developed countries to more developed ones, as discussed in the paper. The goal of transport availability can be achieved by creating a basic network of vital road and rail transport connections between the territories, completion of the missing cross-border road and rail transport connections and redevelopment of the intelligent transport systems.

The paper thus shows that those countries that have modified their technical infrastructures by developing this sector, moreover, have carried out deep transport reconstruction or transport construction, have obtained the best results both in terms of efficiency and super-efficiency models. The practicality or applicability of these results in terms of economic policy is, however, limited in view of the fact that the results only refer to relative efficiency. What does it mean? Relative efficiency of evaluated economic entity (unit) in comparison with others in the evaluated sample because of the production possibility frontier, i.e. technical efficiency or super-efficiency. This cannot be a positive fact, as it shows countries getting efficiency based on shifts in sources of competitiveness, i.e. quantitative type of competitive advantages. The character of technical efficiency thus contributes to the quantitative type of economic growth having limits in sources and their utilization. In the framework of the evaluation, it is necessary to move from efficiency to effectiveness, i.e. instead of conducting economic policy activities to their own setting and objectives, but this cannot be done by the DEA method. From the point of view of future research, it is necessary to rely on the evaluation of the relationship between output-outcome (effectiveness) and not input-output (efficiency), which the DEA method evaluates. Not only the reconstructed or newly built technical and transport infrastructure, i.e. its factual or physical existence but, above all, the possibilities of its proper use in activities generating added value for the economy, i.e. qualitative competitive advantage, is the key for the knowledge economy. This should be the topic of future research, i.e. how the factor endowment of the given economy contributes to its growth and how the economy can use not only its quantitative but especially qualitative competitive advantages. To this end, however, it is necessary to find suitable methods used in the evaluation of the effectiveness of the European Structural Funds or better European Structural and investment funds. It is necessary to place co-financed activities in a wider context, integrating European Structural and Investment Funds and domestic policies also with regards to evaluation. The quality and utility of evaluation could be improved further by developing a more integrated and on-going approach to evaluation

**References**

Aiello, F., & Pupo, V. (2012). Structural funds and the economic divide in Italy. *Journal of Policy Modeling*, *34*(3). doi: 10.1016/j.jpolmod.2011.10.006.

Andersen, P., & Petersen, N.C. (1993). A procedure for ranking efficient units in data envelopment analysis. *Management Science*, *39*(10). doi: 10.1287/mnsc.39.10.1261.

Annoni, P., & Dijkstra, L. (2013). *EU Regional Competitiveness Index 2013*. Luxembourg: Publication Office of the European Union.

Bachtler, J., Begg, I., Polverari, L., & Charles, D. (2013). Evaluation of the main achievements of Cohesion Policy programmes and projects over the longer term in 15 selected regions (from 1989-1993 programme period to the present). *Final Report to the European Commission (DG Regio) — (2011.CE.16.B.AT.015).* Glasgow: European Policies Research Centre, University of Strathclyde. London: London School of Economics

Balcerzak, A. P., Kliestik, T., Streimikiene, D., & Smrčka L. (2017). Non-parametric approach to measuring the efficiency of banking sectors in European Union Coun-tries. *Acta Polytechnica Hungarica, 14*(7). doi: 10.12700/APH.14.7.2017.7.

Becker, S. O., Egger, P. H., & von Ehrlich, M. (2010). Going NUTS: the effect of EU structural funds on regional performance. *Journal of Public Economics, 94*(9-10). doi: 10.1016/j.jpubeco.2010.06.006.

Becker, S. O., Egger, P. H., & von Ehrlich, M. (2012). Too much of a good thing? On the growth effects of the EU's regional policy. *European Economic Review, 56*(4). doi: 10.1016/j.euroecorev.2012.03.001.

Brzakova, K., & Pridalova, K. (2016). Comparison of investment costs for companies using EU structural funds and investment incentives. *Procedia Economics and Finance, 39*(2016). doi: 10.1016/S2212-5671(16)30283-0.

Cardenete, M. A., & Delgado, M.C. (2015). A simulation of impact of withdrawal European funds on Andalusian economy using a dynamic CGE model: 2014–20. *Economic Modelling, 45*(2015). doi: 10.1016/j.econmod.2014.09.021.

Caves, D. W., Christensen, L., & Diewert, E. W. (1982). The economic theory of index numbers and the measurement of input, output, and productivity. *Econometrica, 50*(6). doi: 10.2307/1913388.

Cook, W. D., & Seiford, L. M. (2009). Data envelopment analysis (DEA) — thirty years on. *European Journal of Operation Research, 192*(1). doi: 10.1016/j.ejor.2008.01.032.

Disjktra, L., Annoni, A., & Kozovska, K. (2011). A new regional competitiveness index: theory, methods and findings. *European Commission, Regional Policy Working Paper, 2/2011*.

Dragan, G. (2012). EU Structural Instruments key component in improving the Romanian macroeconomic stability? *Procedia Economics and Finance, 3*(2012). doi: 10.1016/S2212-5671(12)00294-8.

Enguix, M. R. M., García, J. G., & Gallego, J. C. G. (2012). An impact analysis of the European structural funds on the variation of the rate of employment and productivity in objective 1 regions. *European Planning Studies, 20*(4). doi: 10.1080/09654313.2012.665038.

EUR-Lex (1957). Treaty of Rome (EEC). Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3Axy0023 (23.02.2017).

European Commission (2016). Evaluations of the 2007–2013 programming period: ex post evaluation of the ERDF and CF: key outcomes of cohesion policy in 2007-2013. Retrieved from http://ec.europa.eu/regional_policy/en/information/publications/evaluations?title=Work+Package+1+&themeId=0&tObjectiveId=ALL&typeId=4&countryId=0&periodId=2&fundId=0&policyId=5&languageCode=en&search=1 (20.02.2017).

Farrell, M. J. (1957). The measurement of productivity efficiency. *Journal of the Royal Statistical Society, 120*(3). doi: 10.2307/2343100.

Gherman, M. G. (2014). An examination of the Romanian state budget regarding the European funds: co-financing provisions. *Procedia — Social and Behavioral Sciences, 116*(2014). doi: 10.1016/j.sbspro.2014.01.770.

Górniak, J. (2016). The spatial autocorrelation analysis for transport accessibility in selected regions of the European Union. *Comparative Economic Research*, *19*(5). doi: 10.1515/cer-2016-0036.

Grmanová, E., & Pukala, R. (2018). Efficiency of insurance companies in the Czech Republic and Poland. *Oeconomia Copernicana*, *9*(1). doi: 10.24136/oc.2018.004.

Hapenciuc, C. V., Morosan, A. A., & Arionesei, G. (2013). Absorption of structural funds international comparisons and correlations. *Procedia Economics and Finance*, *6*(2013). doi: 10.1016/S2212-5671(13)00139-1.

Healy, A., & Bristow, G. (2013). Economic crisis and the structural funds. Retrieved from http://www.espon.eu/export/sites/default/Documents/Press/PressReleases/2013-Article/OD-ECR2-article_Economic-Crisis-and-the-Structural-Funds.pdf (22.02.2017).

Katsarova, I. (2013). The (low) absorption of EU structural funds. *Library Briefing: Library of the European Parliament*, *130544REV1*.

Lucian, P. (2014). Absorption of European funds by Romania. *Procedia Economics and Finance*, *16*(2014). doi: 10.1016/S2212-5671(14)00838-7.

Melecký, L. (2017). Efficiency analysis of ERDF and CF co-financed programmes focusing on the transport in member states of the European Union. In A. P. Balcerzak, M. B. Pietrzak (Eds.). *Proceedings of the 9th international conference on applied economics contemporary issues in economy: quantitative methods.* Toruň: Institute of Economic Research & Polish Economic Society.

Melecký, L. (2013). Use of DEA approach to measuring efficiency trend in old EU member states. In A. Kocourek (Ed.). *Proceedings of the 11th international conference on Liberec Economic Forum*. Liberec: Technical University Liberec.

Melecký, L., & Staníčková, M. (2014). Regional efficiency evaluation by DEA approach: comparison of selected EU15 and EU13 countries. In I. Honová (Ed.). *Proceedings of the 2nd international conference on European integration*. Ostrava: VŠB-Technical University Ostrava.

Mohl, P., & Hagen, T. (2010). Do EU structural funds promote regional growth? New evidence from various panel data approaches. *Regional Science and Urban Economics*, *40*(5). doi: 10.1016/j.regsciurbeco.2010.03.005.

Rogalska, E. R., Pietrzak, M. B., & Balcerzak, A. P. (2017). Do European funds for sustainable growth policy support convergence process?. In T. Loster & T. Pavelka (Eds.). *The 11th international days of statistics and economics. Conference proceedings*. Prague: Melandrium.

Rubini, L. (2010). *The definition of subsidy and state aid: WTO and EC in comparative perspective*. Oxford: Oxford University Press.

Staníčková, M. (2017). Can the implementation of the Europe 2020 strategy goals be efficient? The challenge for achieving social equality in the European Union. *Equilibrium. Quarterly Journal of Economics and Economic Policy, 12*(3). doi: 10.24136/eq.v12i3.20.

Staníčková, M. (2014). Measuring the efficiency of EU13 NUTS 2 regions based on RCI approach. In V. Klímová & Žítek, V. (Eds.). In *17th international colloquium on regional sciences*. Brno: Masaryk University.

Staníčková, M., & Melecký, L. (2016). Malmquist index approach to efficiency analysis in selected old and new EU member states. *ER-CEREI*, *19*(2016). doi: 10.7327/cerei.2016.09.02.

Sucháček, J. (2013). Investment location from the perspective of urban and regional activities in the Czech Republic. In M. Čulík (Ed.). In *9th international scientific conference on financial management of firms and financial institutions location*. Ostrava: VŠB-TU Ostrava.

Štreimikienė, D. (2016). Review of financial support from EU structural funds to sustainable energy in Baltic States. *Renewable and Sustainable Energy Reviews*, *58*(2016). doi: 10.1016/j.rser.2015.12.306.

Tatulescu, A., & Patruti, A. (2014). Structural funds and economic crises: Romania's absorption paradox. *Procedia Economics and Finance*, *16*(2014). doi: 10.1016/S2212-5671(14)00775-8.

Tödtling–Schönhofer, H., Hamza, Ch., Resch, A., Polverari, L., & Bachtler, J. (2011). Impact and effectiveness of the structural funds and EU policies aimed at SMEs in the regions. *European Parliament, Working Study IP/B/REGI/FWC/2010-002/LOT1/C1/SC1*.

Toloo, M., Barat, M., & Masoumzadeh, A. (2015). Selective measures in data envelopment analysis. *Annals of Operations Research*, *226*(1). doi: 10.1007/s10479-014-1714-3.

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## Annex

**Table 1.** Literature review of the EU funds evaluation

| Title of the paper | Author(s) | Year |
|---|---|---|
| Comparison of investment costs for companies using EU Structural Funds and investment incentives | Brzakova, K. & Pridalova, K. | 2016 |
| Review of financial support from EU Structural Funds to sustainable energy in the Baltic States | Štreimikienė, D. | 2016 |
| Structural Funds And Economic Crises: Romania's Absorption Paradox | Tatulescu, A. & Patruti, A. | 2014 |
| A simulation of the impact of withdrawal European funds on Andalusian economy using a dynamic CGE model: 2014–20 | Cardenete, M.A. & Delgado, M.C. | 2014 |
| Absorption of European Funds by Romania | Lucian, P. | 2014 |
| An Examination of the Romanian State Budget Regarding the European Funds: Co-Financing Provisions | Gherman, M.G. | 2013 |
| Absorption of Structural Funds International Comparisons and Correlations | Hapenciuc, C.V., Morosan, A.A. & Arionesei, G. | 2013 |
| An Impact Analysis of the European Structural Funds on the Variation of the Rate of Employment and Productivity in Objective 1 Regions | Enguix, M.R.M., García, J.G. & Gallego, J.C.G. | 2012 |
| EU Structural Instruments key component in improving the Romanian macroeconomic stability? | Dragan, G. | 2012 |
| Too much of a good thing? On the growth effects of the EU's regional policy | Becker, S.O., Egger, P.H. & von Ehrlich, M. | 2012 |
| Structural funds and the economic divide in Italy | Aiello, F. & Pupo, V. | 2011 |
| Do EU structural funds promote regional growth? New evidence from various panel data approaches | Mohl, P., & Hagen, T. | 2010 |
| Going NUTS: The effect of EU Structural Funds on regional performance | Becker, S.O., Egger, P.H. & von Ehrlich, M. | 2010 |

**Table 2.** Numerical values of input (I) and output (O) indicators for DEA analysis: initial values

| Country | I1 | I2 | O1 | O2 | O3 | O4 | O5 |
|---|---|---|---|---|---|---|---|
| ~~BE~~ | ~~14.210~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ |
| BG | 1078.845 | 341.391 | 175.000 | 173.000 | 1040.480 | 234.000 | 234.000 |
| CZ | 3796.887 | 2900.935 | 311.770 | 110.750 | 2017.880 | 294.000 | 369.060 |
| ~~DK~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ |
| DE | 2082.771 | 766.349 | 293.520 | 100.700 | 769.900 | 158.800 | 248.600 |
| EE | 290.406 | 185.308 | 69.740 | 0.000 | 205.000 | 0.000 | 0.000 |
| IE | 63.500 | 16.750 | 0.000 | 0.000 | 33.000 | 0.000 | 0.000 |
| EL | 4602.952 | 530.576 | 144.400 | 144.400 | 2645.900 | 11.400 | 60.300 |
| ES | 2296.862 | 4139.081 | 509.750 | 124.720 | 2458.100 | 0.000 | 1.210 |
| FR | 171.837 | 202.326 | 28.000 | 0.000 | 0.000 | 57.000 | 549.870 |
| IT | 835.378 | 2185.181 | 94.270 | 0.000 | 188.070 | 733.190 | 1034.960 |
| CY | 33.209 | 0.000 | 2.900 | 3.000 | 3.420 | 0.000 | 0.000 |
| LV | 483.041 | 256.300 | 0.000 | 0.000 | 636.570 | 0.000 | 0.000 |
| LT | 681.253 | 580.370 | 0.000 | 0.000 | 1473.440 | 0.000 | 0.000 |
| ~~LU~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ |

**Table 2.** Continued

| Country | I1 | I2 | O1 | O2 | O3 | O4 | O5 |
|---|---|---|---|---|---|---|---|
| HU | 3276.672 | 1720.107 | 501.980 | 135.200 | 2521.170 | 20.000 | 216.000 |
| MT | 103.432 | 0.000 | 0.000 | 0.000 | 13.290 | 0.000 | 0.000 |
| NL | 8.450 | 0.424 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| ~~AT~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ | ~~0.000~~ |
| PL | 15910.620 | 5479.094 | 1886.270 | 1056.010 | 7216.230 | 123.650 | 482.060 |
| PT | 813.206 | 375.641 | 300.410 | 138.220 | 2996.660 | 47.550 | 385.500 |
| RO | 3377.417 | 1692.047 | 367.900 | 313.600 | 1892.820 | 21.800 | 122.260 |
| SI | 404.809 | 434.568 | 59.980 | 52.420 | 10.650 | 89.460 | 89.460 |
| SK | 1888.527 | 1028.793 | 79.500 | 40.570 | 1625.690 | 64.310 | 64.310 |
| FI | 14.776 | 10.198 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| SE | 9.272 | 11.605 | 36.000 | 0.000 | 14.000 | 0.000 | 81.000 |
| UK | 253.055 | 65.432 | 13.000 | 7.000 | 11.000 | 2.000 | 2.000 |

Note: I-1: Road (mld. EUR), I-2: Rail (mld. EUR), O-1: km of new roads, O-2: km of new TEN roads, O-3: km of reconstructed roads, O-4: km of TEN railroads, O-5: km of reconstructed railroads

Source: own elaboration based on European Commission (2016).

**Table 3.** Relative the EU countries' DEA efficiency

| DMU | Efficiency model | Super-efficiency model |
|---|---|---|
| **EU** | **OO BCC VRS** | **OO APM VRS** |
| BG | **1.000** | **0.347** |
| CZ | *1.267* | *1.267* |
| DE | *1.143* | *1.143* |
| EE | *1.842* | *1.842* |
| IE | *4.112* | *4.112* |
| EL | *1.159* | *1.159* |
| ES | **1.000** | **0.895** |
| FR | **1.000** | **0.335** |
| IT | **1.000** | **0.254** |
| CY | **1.000** | **0.214** |
| LV | *2.783* | *2.783* |
| LT | *1.702* | *1.702* |
| HU | *1.131* | *1.131* |
| MT | **1.000** | **0.257** |
| NL | **1.000** | **0.015** |
| PL | **1.000** | **0.223** |
| PT | **1.000** | **0.345** |
| RO | **1.000** | **0.988** |
| SI | *1.148* | *1.148* |
| SK | *1.860* | *1.860* |
| FI | **1.000** | **0.007** |
| SE | **1.000** | **0.008** |
| UK | *4.214* | *4.214* |

| Final order based on results of super-efficiency model | | |
|---|---|---|
| **Rank of countries** | | |
| **No.** | **EU** | **OO APM VRS** |
| 1 | FI | 0.007 |
| 2 | SE | 0.008 |
| 3 | NL | 0.015 |
| 4 | CY | 0.214 |
| 5 | PL | 0.223 |
| 6 | IT | 0.254 |
| 7 | MT | 0.257 |
| 8 | FR | 0.335 |
| 9 | PT | 0.345 |
| 10 | BG | 0.347 |
| 11 | ES | 0.895 |
| 12 | RO | 0.988 |
| 13 | HU | 1.131 |
| 14 | DE | 1.143 |
| 15 | SI | 1.148 |
| 16 | EL | 1.159 |
| 17 | CZ | 1.267 |
| 18 | LT | 1.702 |
| 19 | EE | 1.842 |
| 20 | SK | 1.860 |
| 21 | LV | 2.783 |
| 22 | IE | 4.112 |
| 23 | UK | 4.214 |

**Table 4.** Numerical values of input (I) and output (O) indicators for DEA analysis: efficient targets

| Country | I1 | I2 | O1 | O2 | O3 | O4 | O5 |
|---|---|---|---|---|---|---|---|
| BG | 1078.845 | 341.391 | 175.000 | 173.000 | 1040.480 | 234.000 | 234.000 |
| CZ | 3796.887 | 2199.226 | 519.539 | 256.480 | 2557.546 | 372.628 | 698.245 |
| DE | 2082.771 | 766.349 | 335.564 | 223.901 | 2049.805 | 181.547 | 313.335 |
| EE | 290.406 | 138.908 | 128.464 | 48.335 | 1057.030 | 16.628 | 187.483 |
| IE | 63.500 | 16.750 | 15.600 | 8.477 | 135.700 | 2.111 | 17.113 |
| EL | 1282.721 | 530.576 | 345.060 | 167.330 | 3066.051 | 55.554 | 383.837 |
| ES | 2296.862 | 4139.081 | 509.750 | 124.720 | 2458.100 | 0.000 | 1.210 |
| FR | 171.837 | 202.326 | 28.000 | 0.000 | 0.000 | 57.000 | 549.870 |
| IT | 835.378 | 2185.181 | 94.270 | 0.000 | 188.070 | 733.190 | 1034.960 |
| CY | 33.209 | 0.000 | 2.900 | 3.000 | 3.420 | 0.000 | 0.000 |
| LV | 483.041 | 226.137 | 191.820 | 81.455 | 1771.721 | 28.022 | 260.446 |
| LT | 681.253 | 315.890 | 257.011 | 115.533 | 2507.102 | 39.745 | 335.521 |
| HU | 3276.672 | 1720.107 | 567.569 | 271.710 | 3535.631 | 51.334 | 339.480 |
| MT | 103.432 | 0.000 | 0.000 | 0.000 | 13.290 | 0.000 | 0.000 |
| NL | 8.450 | 0.424 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PL | 15910.622 | 5479.094 | 1886.270 | 1056.010 | 7216.230 | 123.650 | 482.060 |
| PT | 813.206 | 375.641 | 300.410 | 138.220 | 2996.660 | 47.550 | 385.500 |
| RO | 3377.417 | 1692.047 | 367.900 | 313.600 | 1892.820 | 21.800 | 122.260 |
| SI | 404.809 | 184.079 | 68.835 | 60.159 | 369.320 | 102.668 | 123.229 |
| SK | 1888.527 | 914.309 | 393.099 | 190.023 | 3023.583 | 119.609 | 455.496 |
| FI | 9.169 | 10.198 | 31.469 | 0.000 | 12.238 | 0.000 | 70.806 |
| SE | 9.272 | 11.605 | 36.000 | 0.000 | 14.000 | 0.000 | 81.000 |
| UK | 192.377 | 65.432 | 54.778 | 29.496 | 185.078 | 39.334 | 95.493 |

Note: I-1: Road (mld. EUR), I-2: Rail (mld. EUR), O-1: km of new roads, O-2: km of new TEN roads, O-3: km of reconstructed roads, O-4: km of TEN railroads, O-5: km of reconstructed railroads

Source: own elaboration based on European Commission (2016).