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SPATIAL DATA ENVELOPMENT ANALYSIS METHOD FOR THE EVALUATION OF REGIONAL INFRASTRUCTURE DISPARITIES

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Abstract

Purpose—*to achieve a more detailed assessment of regional differences, exploring regional infrastructure and human capital usage efficiency and to display analysis capabilities of spatial data efficient frontier method.*

Design/methodology/approach—*the data envelopment analysis (DEA) is applied to find the efficient frontier, which extends the application of production function of the regions. This method of mathematical programming optimization allows assessing the effectiveness of the regional spatial aspects presented. In recent studies this method is applied for evaluating the European Union regional policy issues.*

Findings—*the application of DEA reveals its feasibility for regional input and output studies to evaluate more detailed and more reasonable fund allocation between Lithuanian regions. This analysis shows that in the comparatively efficient Lithuanian regions, such as Vilnius and Klaipėda, "the bottleneck" of usage of transport infrastructure and regional specific human capital is reached. It is stated that decision-making units could enhance region attractiveness for private investors by improving indirect factors in these regions. For practical*

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significance of the study the results are compared with German regional analysis, conducted by Schaffer and other researchers (2011).

Practical implications—*the practical value of this work is based on giving more accurate planning tools for fund allocation decisions in Lithuanian regions while planning infrastructure and human capital development. The regional indicators were analyzed for 2010.*

Keywords: *data analysis technologies, regional infrastructure development indicators, spatial data envelopment method of economic analysis.*

Research type—*case study.*

1. Introduction

Nowadays there are significant economic development disparities between European countries and also country internal regions, when we talk about income rates per capita and employment rates. Low per capita income and insufficient economic growth of developing regions remains one of the most significant economic policy issues (Ocubo, 2012). Hence, regional convergence has remained a key objective of EU regional policy.

According to recent EU convergence analysis (Butkus, Matuzeviciute, 2011), the disparities of the economic development have increased by 22.5 percent in the internal regions of the EU countries during the 1995–2010, including Lithuanian regions. It reveals the need for better regional development planning methods to achieve regional efficiency in attracting private investments and usage of available resources and funds.

There are several studies made to assign appropriate regional policy options in dependence on regions' income and efficiency level for German regions (Schaffer et al., 2011). These researches apply data envelopment methods to analyze indirect factors that foster regions' attractiveness for private investors in general—transport infrastructure and human capital factors. This paper follows this train of thought and aims to give more detail methods for the decision making in the field of regional transport infrastructure and human capital qualifications for Lithuania NUTS3 regions.

The purpose of this article is to achieve a more detailed assessment of Lithuanian regional differences, exploring regional infrastructure and human capital usage efficiency and to display capabilities of data envelopment analysis methods. We analyze non-parametric data envelopment methods which enable to evaluate the regions' efficient frontier, evaluate Lithuanian regions infrastructure and human capital efficiency disparities by applying data envelopment analysis model (for 2010) and compare results with German regions' efficiency frontier analysis, according to the results give advices for improvements of regional policy planning in Lithuania.

Application of spatial data envelopment analysis methods allowed us to find regions efficient frontier by usage of multiple-inputs of the region.

2. Related Works of Spatial Data Envelopment Analysis

Data Envelopment Analysis (DEA) is the mathematical programming optimization tool that measure technical efficiency of the multiple-input and/or multiple-output case by constructing a relative technical efficiency score. This method was introduced by Charnes, Cooper, Rhodes (1978) and was extended by Banker, Charnes, Cooper (1984) by including variable returns to scale. After these works the number of research papers based on data envelopment analysis is increasing.

There is no need for prior numerous assumptions for data envelopment analysis, as there is in the other approaches, such as statistical regression analysis. DEA is a nonparametric method and its results are determined exceptionally by the data without making a choice of a parametric model for the production function (Schaffer et. al., 2011). This option and also models practical functionality led this model to become widely used in analyzing governmental, non-profit or private sectors in the field of decision making and efficiency improvements.

According to that, data envelopment analysis is being used in various fields for decision making about optimizing inputs and outputs all over the world. Analysis of the countries' various sectors, regions' infrastructure and other fields are made in the macroeconomics level. For example, the recent sectors analysis are made for hospital sectors efficiency measures—Dastgiri et al. (2012) for evaluating public and private hospital services reform, relative performance evaluation of nurses at an intensive care unit (Berbary et al., 2011), technical efficiency of zone hospitals in Benin (Kirigia et al., 2010), for evaluating performance of employment offices in Tunisia (Boujelbene et al., 2011) and many others.

When we talk about data envelopment analysis in the field of regional development, the first studies were made in 1986–1987 for evaluation of economic performance of Chinese and Japanese cities. Also some studies made for evaluation efficiency of public investments (Athanassoloulos, 1996) and for rankings of the regions (Martic, Savic, 2001).

More recent regional studies are related with European Union regional policy issues, efficient distribution of funds between the regions and efficient frontier of the usage of social and infrastructure capital of the regions. There are some researches made in the fields of knowledge spillovers. For example, Autant-Bernard and LeSage (2009) estimated a knowledge production function in their research. Spatial spillovers of French regions, associated with private and also public expenditures, were examined by application of region- and industry-specific data.

Also there are studies made in the field of resources and fund allocation between regions. Castells and Sole-Olle (2005) analyse "efficiency-oriented" and "equity-oriented" distribution of public investments between the regions that reveals the elasticity of infrastructure investments to regions' income according to government insights. Li and Cui (2008) construct an algorithm by using data envelopment analysis tolls in various model forms and extensions, such as variable return to scale or inverse form of DEA model, extra resource allocation algorithm to suggest resource allocation

solution, which provide information for future resource allocation and gives alternatives for achieving effective-equality-efficient target.

Table 1. The related works of application of DEA methods for regional studies

The fields of the research	Researchers
The comparative studies on the economic performance and productivity growth of Chinese and Japanese cities.	Seifert, Zhu (1998), Hashimoto, Ishikawa (1993)
The efficiency of public investments, assessing spatial disadvantage of the regions.	Athanassopoulos (1996)
The rankings of the regions.	Martic, Savic, (2001)
Quantifying knowledge spillovers over the regions	Autant-Bernard, LeSage (2009)
Advanced DEA models including VRS, order-a-frontier models and other.	Daouia, Simar (2007), Simar, Wilson (2008)
Regional allocation of infrastructure investments, regions' efficiency in using human capital and infrastructure.	Castells, Sole-Olle (2005), Li, Cui (2008), Schaffer et al. (2011)

Shaffer and Siegele (2009), Shaffer (2011), Shaffer et al. (2011) focuses mostly on evaluation of regional transport infrastructure and human capital factors. Infrastructure capital in these studies is considered as an important condition to extend the potential level of regional production and income. These authors rely on the fact that the materialization of a region's higher production potential depends more on the regions' ability to use efficiently the existing and additional infrastructure capital. These thoughts of mind are applied to identify Australian and German regions' efficiency in the field of public transport infrastructure. Shaffer et al. (2011) study also involves evaluation of human capital factor.

It is important to mention that recent studies of data envelopment analysis are not only based on application of the model for solving some regional cases, but also to find and to suggest more advanced forms of the model by using variable returns to scale, order-α-frontier or order-m-frontier analysis, by analyzing smoothed spatial factors (Daouia, Simar, 2007, Simar, Wilson, 2008), that can increase significance of application of data envelopment analysis methods.

To sum up, the data envelopment analysis is considered to be the effective tool for measuring efficiency in various fields, such as fund allocation, the efficiency of various private and public sectors, the evaluation of spatial knowledge spillovers and the efficiency of different regional levels. This tendency is expanding by application of DEA in various fields of study and recent works on more advanced models. As application of DEA and its findings have practical background, DEA is considered as appropriate tool for supporting more evaluated and detailed decisions of policy makers, as well as, in the context of regional efficiency measures.

3. Model for Evaluation of Regions' Efficient Frontier

The analysis is carried out by using data envelopment analysis to find an efficient frontier of Lithuanian NUTS3 regions in terms of using infrastructure and human capital. NUTS3 means the level of regions according to the Nomenclature of territorial units for statistics. In the model the concept of the decision making unit (DMU) is used. DMU means all entities in the region that are able to convert inputs to the outputs. The decision making unit is considered as fully efficient on the basis of available evidence if the performance of the other DMU does not show that some of its inputs or outputs can be improved without worsening some of its other inputs or outputs (Cooper et al., 2006).

In the regional level efficiency could be achieved more likely by growing outputs rather than decreasing inputs (Schaffer et al., 2011). According to that, output-oriented version of model is used. It is considered that any region disposes of a set of inputs $x \in R_+^p$ to produce a set of outputs $y \in R_+^q$ that are positive numbers. Feasible combinations of *(x,y)* are defined as:

$$\psi = \{(x, y) \in R_+^{p+q} | x \; can \; produce \; y\} \tag{1}$$

The boundaries of ψ reflects maximum outputs that can be generated with given inputs. The regions' efficiency frontier is defined as:

$$Y^\delta = \{(x, y^\delta(x)) | y^\delta(x) \epsilon Y(x) : \; \lambda y^\delta(x) \notin Y(x), \forall \lambda > 1\} \tag{2}$$

Y(x) means the set of technology feasible outputs and $y^\delta(x)$ - the maximum achievable output of the unit with input level *x*. A unit's efficiency score is defined as:

$$\lambda(x, y) = sup\{\lambda | (x, \lambda y) \in \psi\} = sup\{\lambda | \lambda y \in Y(x)\} \tag{3}$$

In this formula $\lambda(x, y) \geq 1$ is the proportionate increase of output *y* of the region operating at output level *x* for region to be efficient (Schaffer et al., 2011). This form of data envelopment analysis defines an efficient boundary according the highest technically achievable output. Other forms of the DEA, such as order-m-frontier analysis and order-α-frontier analysis, allow extreme observations to lie above partial frontier while finding efficiency of DMU.

The identification of Lithuanian efficiency follows the mathematical model of data envelopment analysis. This model is used to find efficient frontier of Lithuanian regions. With regard to data available, the presented study is made on the country level that encloses 10 regions of NUTS3 level. The input and output system of regional frontier generally analyses variables that reflects social or economic regional processes. According to that, economic performance of territorial units is analyzed in this paper.

The gross regional product, trade volumes or employment rate is considered as regions' outputs (Athanassopoulos, 1996). Regions are different in terms of size and population, so intensive variables such as income per-capita or labor productivity might

reflect economic performance in a more appropriate way for comparative regional studies (LeSage, Fischer, 2008). This study defines the output as income per-capita for the year 2010.

According to Bronzini and Piseli (2009) regional production is determined by the regions endowment with immobile factors. The input side of the model is defined by region-specific human capital and transport infrastructure indicators. These input indicators are considered as indirect factors that make region more attractive to private investors in general (Schaffer et al., 2011). According to Bronzini and Piseli (2009) regional production is determined by the regions endowment with immobile factors. If these factors are used efficiently in the region, it is possible to foster regional growth by improving these factors. But if the bottleneck of the usage of internal factors is not reached, more emphases of regional policy should be made on direct programs that enhance activity of small and medium enterprises in the region, the level of innovation, clusters or other activities to foster regional growth.

With the terms of internal capital, two indicators are considered—internal transport infrastructure and external transport infrastructure. Internal transport infrastructure level of region *i* (I_i^{in}) is determined by the formula:

$$I_i^{in} = \frac{p_i}{r_{w,i}} + \frac{r_{w,i}}{a_i} \tag{4}$$

Where $r_{w,i}$—the length of road network (in km) is weighted by the differences of construction and maintenance cost, p_i is the population of region *i*, a_i is the area of region *i* (in sq. km).

The external infrastructure indicator (I_i^{ex}) reflects connectivity of region *i* with other regions and defines the road travel time between the considered regions, as follows:

$$I_i^{ex} = \sum_{j=1}^{m} GRP_j \cdot e^{\omega \cdot \min\, t_{road}(i,j)} \tag{5}$$

where *GRP* is gross region product of *j* region per-capita, $t_{road}(i,j)$ is travel time between region *i* and *j*, *m*—number of the regions and ω is a weighting factor that fulfils the following condition that $e^{\omega \cdot minT} = 0{,}5$ for T=90 min. GRP that can be reached with 90 minutes is weighted by 0,5. Smaller weights account for the GRP further away and higher—for the GRP that can be reached faster (Schaffer et al., 2011). 90 minutes is considered according to the size of Lithuania and often sited travel time for daily business trips (e.g. Schoch, 2004).

The formula of regions' human capital indicator (Q_i) is as follows:

$$Q_i = \frac{\sum_{j=1}^{3} \omega_j \cdot f_{ij}}{\sum_{j=1}^{3} f_{ij}} \tag{6}$$

The human capital factor involves both a quantitative side and a qualitative side. A quantitative side of an indicator is the number of regions' employees. The size effects are an interest in this case as they partly reflect the regions' differencies as rural or metropolitan areas. The qualification side reveals the education achievements of regional workforce by weighting this indicator to the educational level. By the International Standard Classification of Education (ISED) the workforce is divided in three groups. The group with lower secondary education belongs to the first group (ISED 1 and 2), with upper- and post-secondary education to the second group (ISED 3 and 4) and finally with the highest tertiary education—third group (ISED 5 and 6). In the next step educational achievements are weighted to 1, 1.8 and 2.6 respectively. These weights are considered according to the average time needed for students and teachers to obtain the qualification (Schaffer et al., 2011).

4. Regions' Efficiency Measure in Using Infrastructure and Human Capital: the Case of Lithuanian NUTS3 Regions

Lithuanian NUTS3 regions efficiency is evaluated by data envelopment analysis. According to this method the most efficient regions are Vilnius, Klaipėda and Utena regions that get maximum efficiency score—1 (Fig. 1). Even though Utena region has comparatively low income per capita indicator—lower than Lithuanian average, this region with worse level of inputs generates comparatively higher level of output than other Lithuanian regions.

In data envelopment analysis a region is considered comparatively inefficient if one or more other regions equipped with a similar or worse level of inputs generates higher levels of output (Shaffer, 2011). These regions are considered as achieved the bottleneck by using indirect factors—transport infrastructure and human capital. According to that, more emphasis on allocating resources for indirect factors should be considered in these regions to attract more private investments and to foster regional growth.

The most inefficient regions are Tauragė, Kaunas and Panevėžys regions. According to the model, these regions could enhance the gross regional product per capita by 27.1, 23.5 and 20.5 percent respectively with current infrastructure and specific-human capital of the region. This percent indicates that more direct programs should be made to prosper private investments to the regions and to increase productivity of regional entities. It is not argued that funds for transport infrastructure or human capital qualifications should be banned, but it is suggested that more emphasis should be made on the other programs to enhance regional economic growth with current resources.

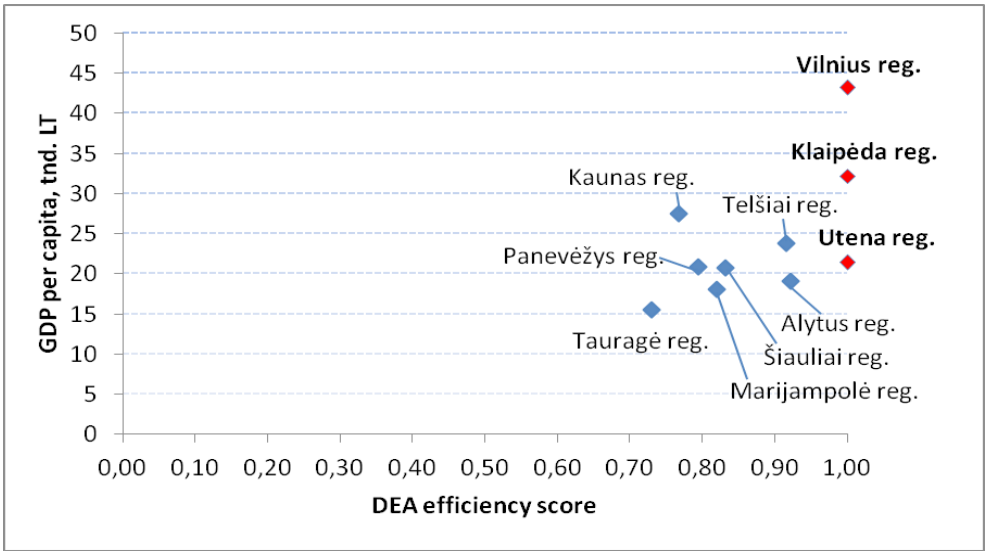

Fig. 1. Efficiency scores of Lithuania NUTS3 regions, 2010.
(Compiled by the authors according to the data of the Department of Statistics of the Republic of Lithuania)

Other regions, such as Šiauliai and Marijampolė, got 0.831 and 0.821 efficiency scores, Alytus and Telšiai—0.921 and 0.916 respectively. These regions are more effective than Kaunas or Tauragė regions in using infrastructure and human capital, but still not enough. The policy implications are very similar to least efficient regions that more direct emphasis should be made to foster regions' entities economic activities and greater efficiency.

If we look at spatial distribution of efficiency scores (Fig. 2) the least efficient regions of using internal and external transport infrastructure and specific-regional human capital and its qualifications is in the middle of Lithuania. It could be explained that travel time between these regions and other regions are comparatively low that should make more advantage for these regions to reach other regions' economies. Also in the field of human capital qualifications this resource is not used so efficiently in Kaunas as in Vilnius and Klaipėda districts.

The data envelopment analysis of German NUTS3 regions was made by Schaffer et al. (2011). German regions' efficiency in using transport infrastructure and human capital was analysed. The differences of the German analysis and Lithuanian region analysis in this paper is order-α-frontier form used in which effective scores are calculated in the way that some extreme values could lie above the efficient frontier, because of that efficiency scores varies between 0,33 and 2.32. Even though we cannot compare German and Lithuanian efficiency scores directly, we compare the tendencies in these countries' NUTS3 level regions explained by the application of data envelopment analysis.

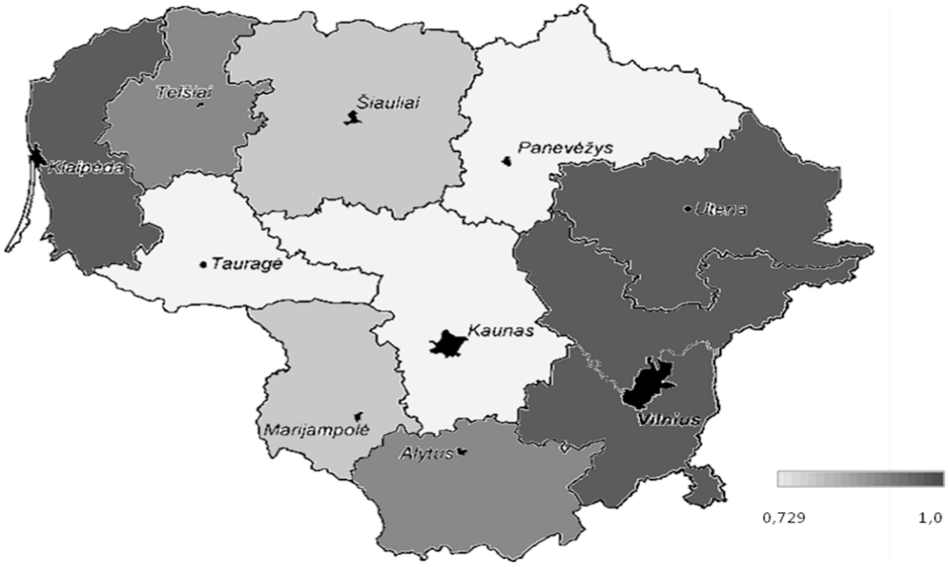

Fig. 2. Spatial distribution of efficiency score of Lithuania NUTS3 regions, 2010. (Compiled by the authors according to the data of the Department of Statistics of the Republic of Lithuania)

Differently from German NUTS3 regions analysis (Schaffer et al, 2011) German regions analysis showed that efficiency is dependant of neighbouring regions. For example, regions surrounded by not efficient regions tend to be ineffective according to the other regions. In Lithuanian regions this tendency is not seen so obviously.

This could be explained by the fact that Lithuania is smaller in size, having 10 NUTS3 regions while Germany—439 regions and also because of the fact that Germany was divided in East and West parts. Till now there are obvious disparities between the regions in different Germany parts. If we talk about policy implications, more direct programs are suggested for inefficient German regions to fester regional growth.

Table 2. Efficient peers of Lithuanian regions, 2010. (Compiled by the authors according to the data of the Department of Statistics of the Republic of Lithuania)

Regions	**Regions' peers weights**		
	Utena reg.	**Klaipėda reg.**	**Vilnius reg.**
Alytus reg.	**0.572**	–	0.196
Kaunas reg.	0.092	**0.634**	**0.314**
Marijampolė reg.	**0.804**	0.151	–
Panevėžys reg.	0.477	0.469	0.023
Šiauliai reg.	**0.713**	0.142	0.120
Tauragė reg.	**0.770**	0.149	–
Telšiai reg.	0.472	0.493	–

The application of data envelopment analysis for Lithuanian regions also let to find coordinates of inefficient regions on efficient frontier. These coordinates is named as regions' peers weights. These weights reveal inefficient regions similarities with efficient regions in the way of available efficiency improvements and possible technology usage by decision making units. All inefficient regions have similarities with Utena region and could base their efficiency by the example of Utena region's technology (table 2).

The highest level of similarity with Utena region has Marijampolė, Šiauliai and Tauragė regions, the coefficients are 0.804, 0.713 and 0.770 respectively. With Klaipėda production technology is similar Kaunas district, the peer weight is 0.634. Finally, only Kaunas, Alytus, Šiauliai and Panevėžys districts have similarities with Vilnius region's technology of creating output. Regions with comparatively big cities, as regional centers, could improve their efficiency according to Vilnius region. This could also be explained by the input of specific-human capital qualifications that is the highest in Vilnius region.

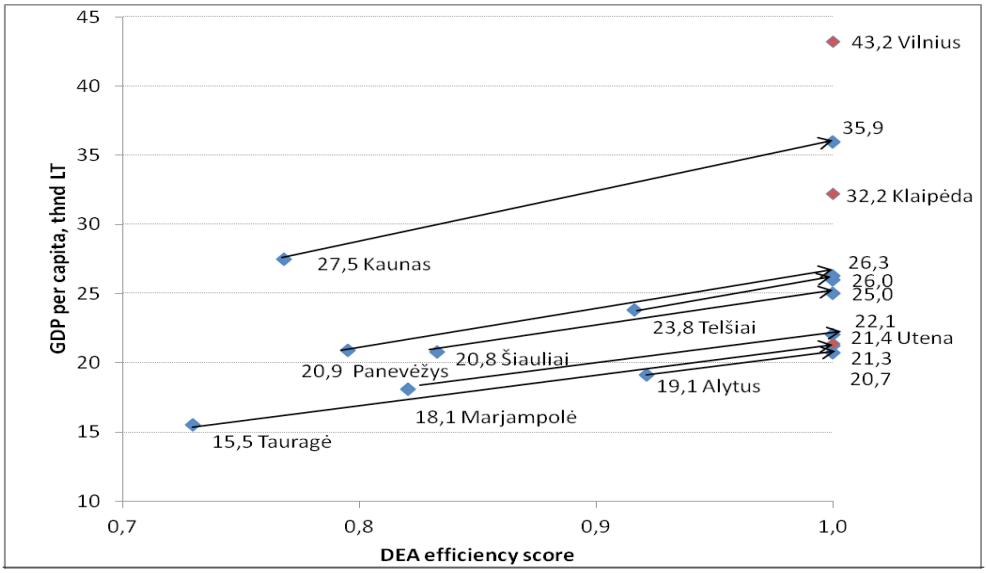

Fig. 3. Projected values of Lithuanian regions' efficient outputs. (Compiled by the authors according to the data of the Department of Statistics of the Republic of Lithuania)

According to the Lithuanian regions' efficient scores and efficient peers, the level of possible output of each inefficient region is calculated. With the current internal and external transport infrastructure and specific-capital level in the region, the highest improvements are available in Kaunas and Tauragė districts (fig. 3). Also improvement are calculated for the other inefficient regions as Panevėžys, Šiauliai, Marijampolė, Alytus and Telšiai for a situation if these regions are using infrastructure capital in comparatively effective way. As it was discussed above in this paper, there should be made more significant emphasis on direct programs in these regions that help to improve economic activity of the current entities in the region or/and make program, legislative

changes to attract more private capital through innovation enhancement, by stimulating the activity of small and medium enterprises.

5. Conclusions

This paper analyses data envelopment analysis and its applications for regional disparities measures. Data envelopment analysis, as method of mathematical programming, extends the application of production function by usage of efficient frontier. In this type of analysis there is no need for huge number of prior assumptions, as model has a nonparametric form and results are evaluated by the data. Also this type of analysis gives a key for practical applications of the results. Because of these factors data envelopment analysis is used in various fields of social and economic studies to evaluate comparative efficiency of decision making units by usage of inputs to generate the outputs.

Most recent works that apply data envelopment analysis is made on the basis of European Union issues. For example, some studies are made to quantify knowledge spillovers between the regions, to evaluate regions' efficiency usage of the invested capital in the region to find more accurate solutions for fund allocation decisions and to find more advanced models to improve the level of significance for more reliable results.

In this paper spatial data envelopment analysis allowed us to measure spatial efficiency of regions' DMU in the field of regions' infrastructure and human capital usage. This model was adapted to Lithuanian NUTS3 level regions. It revealed the comparatively efficient regions of Lithuania in terms of usage the human capital and its qualifications and internal and external transport infrastructure.

In empirical part of this paper regions' efficiency scores were calculated, spatial distribution of efficiency between Lithuanian regions was projected and compared with the results of Germany regions analysis (Schaffer et al., 2011), and finally values of Lithuanian regions' efficient outputs were projected on the bases of current resources. The application of this method revealed its feasibility for regional input and output studies to evaluate appropriate tools for more detailed and more reasonable fund allocation between Lithuanian regions. This method is applied practically, as helps to give insights how to solve regional disparities problems, to enhance regional development and to attract more private capital into it.

According to the results, there should be made more emphasis on direct factors to attract private capital to the comparatively inefficient regions and to enhance their regional development. This analysis shows that in the comparatively efficient regions "the bottleneck" of usage of transport infrastructure and region specific human capital is reached. It reveals that regions DMU could improve regions attractiveness for private investors by improving indirect factors in these regions. According to this though of mind, it is suggested to include evaluation of regional efficiency score into the planning of the regional funds' allocation and in this way to achieve more effective results of regional policy.

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ERDVINĖS DUOMENŲ APSUPTIES ANALIZĖS METODO TAIKYMAS VERTINANT REGIONŲ INFRASTRUKTŪROS VYSTYMO NETOLYGUMUS

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Santrauka. *Šiuo metu pastebima regionų ekonominio vystymosi diferenciacija reikalauja visapusiškesnio regionų ekonominio augimo netolygumų tyrimo. Regionai, nepasiekę reikiamo išsivystymo lygio, neleidžia tinkamai suklestėti visos valstybės nacionalinei ekonomikai. Mažos pajamos vienam gyventojui ir nepakankamas neišsivysčiusių šalies regionų*

ekonomikos augimas yra vienos didžiausių regioninės politikos problemų (Okubo, 2012).

Remiantis ES konvergencijos analize (M. Butkus, K. Matuzevičiūtė, 2011), šalių vidinių teritorinių vienetų ekonomikos augimo diferenciacija per 1995–2010 m. laikotarpį išaugo apie 22,6 proc. Tai rodo poreikį tirti smulkesnių teritorinių vienetų ekonominės plėtros netolygumų priežastis bei numatyti privačių investicijų pritraukimo į prasčiau besivystančius regionus priemones.

***Tyrimo tikslas** – detaliau įvertinti regionų netolygumus, tiriant regionų infrastruktūros ir žmogiškojo kapitalo išnaudojimo efektyvumą ir pagrindžiant erdvinės duomenų apsupties analizės metodo taikymo galimybes.*

***Metodologija**. Tyrimui pritaikyta išplėstinė duomenų apsupties analizė, vadinama efektyvios ribos nustatymo analize, kuri praplečia ekonomikos augimo lygties taikymo galimybes ekonominiuose tyrimuose. Tai – matematinio programavimo optimizavimo metodas, kuris matuoja subjektų techninį efektyvumą, esant keliems sąnaudų ir produkcijos matams. Pritaikius šį metodą yra apskaičiuojami tiriamųjų subjektų reliatyvūs techninio efektyvumo įverčiai, kuriais remiantis yra įvertinami tiriamųjų subjektų technologiniai netolygumai. Šis metodas leidžia nustatyti regionų efektyvumą erdviniu požiūriu. Naujausiuose regionų moksliniuose tyrimuose duomenų apsupties metodas yra taikomas Europos Sąjungos regioninės politikos problemų nagrinėjimui ir galimų priemonių sprendimui.*

***Rezultatai**. Tyrime taikant erdvinį duomenų apsupties metodą analizuoti Lietuvos NUTS3 lygmens regionai. Tirti netiesioginiai, bendri veiksniai, didinantys regionų patrauklumą privatiems investuotojams – regionų transporto infrastruktūra ir žmogiškasis kapitalas. Regionų transporto infrastruktūra analizuota dviem aspektais. Vertinta vidinė regionų transporto infrastruktūra pagal kelių intensyvumą regione ir išlaidas kelių renovacijai bei konstrukcijai ir išorinė transporto infrastruktūra susisiekimo su kitais regionais greičio požiūriu. Regiono žmogiškojo kapitalo veiksnys apima tiek regiono darbo jėgos dydžio, tiek ir darbo jėgos išsilavinimo lygio įvertinimą. Darbe apskaičiuoti regionų efektyvumo įverčiai leido identifikuoti neefektyviausius šalies regionus, kuriuose turi būti daugiau dėmesio skiriama tiesioginėms ekonomikos, verslo skatinimo priemonėms. Tyrime įvertinti panašūs regionai technologiniu požiūriu bei numatytos neefektyvių regionų BVP, efektyviai išnaudojant turimus išteklius.*

***Praktinė reikšmė**. Tyrimo rezultatai buvo lyginti su Vokietijos NUTS3 regionų analize, atlikta Schaffer ir kitų mokslininkų (2011). Remiantis gautais rezultatais identifikuotos galimos Lietuvos regionų plėtros kryptys infrastruktūriniu ir žmogiškojo kapitalo plėtros požiūriu. Duomenys analizuoti pagal 2010 m. regionų vystymosi rodiklius.*

***Originalumas/vertingumas**. Šiame tyrime analizuojamas erdvinis duomenų apsupties analizės metodas pirmą kartą pritaikytas Lietuvos NUTS3 regionų kelių infrastruktūros ir žmogiškojo kapitalo išnaudojimo efektyvumo vertinimui. Darbe siekiama atskleisti metodo taikymo galimybes, kaip efektyvios priemonės finansinių išteklių paskirstymo tarp regionų sprendimų pagrindimui.*

***Raktažodžiai**: duomenų analizės technologijos, regionų infrastruktūra, vystymosi rodikliai, erdvinis duomenų apsupties metodas, ekonominė analizė.*

***Straipsnio tipas**: atvejo analizė.*