Eva Poledníková

VŠB-Technical University of Ostrava, Faculty of Economics, Department of European Integration, Sokolská třída 33, 701 21 Ostrava, Czech Republic
email: eva.polednikova@vsb.cz

Usage of AHP and Topsis Method for Regional Disparities Evaluation in Visegrad Countries

Abstract

The socio-economic disparities in the level of the regional performance are a major obstacle to the balanced and harmonious development of the regions, but also of the territory as a whole. At supranational level, it is European Union (EU) that supports the elimination of differences between less and most developed Member States and regions to strengthen the cohesion and competitiveness of European territory. The effort to reduce the economic, social and territorial disparities has especially increased since the EU biggest enlargement. The accession of new Member States has been associated with an increase in regional disparities that have negatively affected the EU competitiveness in global scale. The strengthening of competitiveness and convergence of economic performance with an average level of the EU have become the basic objectives for new Member States. The Czech Republic, Hungary, Poland and Slovakia, called Visegrad Four countries (V4), belong to new Member States whose economic development of the last 10 years has been strongly influenced by EU accession. Although the regional disparities have been reduced in V4 with contribution of EU Cohesion policy, negative disparities have still persisted. This paper is aimed to evaluate the regional disparities of socio-economic development in V4 in the period 2000-2010 using analytic hierarchic process (AHP) and TOPSIS method. Theoretical background of the paper outlines the concept of regional disparities in the EU and focuses on AHP and TOPSIS methodology. TOPSIS is one of the multicriteria decision-making methods that can present an alternative way of regional disparities and its evaluation. The empirical part of the paper deals with multi-criteria evaluation and comparison of differences between NUTS 2 regions in V4 based on selected economic, social and territorial indicators. At first, the weights of indicators for disparities evaluation are computed based on method of pairwise comparison in the context of AHP. Through TOPSIS method the ranking of regions is determined in year 2000, 2005 and 2010.

Key Words

AHP, multicriteria decision-making method, pairwise comparison, regional disparity, TOPSIS, Visegrad Four

JEL Classification: C49, R11, Y10

Introduction

The measurement of socio-economic disparities between regions is the main topic of many regional economic researches. Disparities negatively affect the internal coherent and balanced development of the EU as well as the level of global EU performance and competitiveness, which is highly related to the imbalanced development in economic, social and territorial cohesion [6]. On one hand the quality analysis of disparities brings

important information about the key issues in the region, on the other hand it is also dealing with development potential. Nevertheless, regional disparities evaluation is impaired by a lack of integrated approaches and methodologies in the EU [9].

The aim of the paper is to evaluate the regional disparities of socio-economic development in Visegrad Four (V4) countries in the period 2000 – 2010 using AHP and TOPSIS method. The paper should contribute to accept or reject the hypothesis that the main regional disparities exist between NUTS 2[1] regions with capital city (Praha, Bratislavský kraj, Mazowieckie, Közép-Magyarország) and other regions in V4. In the absence of the mainstream to regional disparities evaluation, this paper can be understood as a contribution to discussion about quantitative measurement of disparities between regions.

1. Approaches to regional disparities evaluation in the EU

Within European approach we recognize three types of disparities which characteristic provides following table 1.

Tab. 1 Basic classification of regional disparities in the EU

Type of disparities	**Definition**
Economic disparities	They are related to regional output in wider context of economic performance, structure, development and manpower. Economic disparities are measures of economic cohesion that increases when the weakest regions are able to catch up with advanced ones.
Social disparities	They are related to how people perceive spatially differentiated quality of life, standard of living, social inequality, etc. Social disparities are primarily considered in relation to unemployment.
Territorial disparities	They reflect strong inequalities of economic performance, physical-geographical potential and transport and technical infrastructure, etc. These differences are most important between centres and peripheries.

Source: [5], [7]; own modification

The evaluation of regional disparities is related to the problem of the lack of uniform methods or an aggregate index. The level of regional disparities within EU is evaluated by the Cohesion Reports published by the European Commission every 3 years [1], [2]. Most of the existing approaches to regional disparities evaluation use several indicators that are processed by different mathematical and statistical methods. The aim is usually to obtain one comprehensive index (or more indices in the case of thematic evaluations) that represents each of the territories analysed [9]. Most of the economic inequalities

[1] The NUTS classification (Nomenclature of territorial units for statistics) is a hierarchical system for dividing up the economic territory of the EU for the purpose of the collection, development and harmonisation of EU regional statistics. The level NUTS 2 presents basic regions for the application of regional policies.

are measured by a variety of indices based on the indicator of gross domestic product, e.g. coefficient of variation, the Geographic concentration index, the Theil index, see e.g. [13]. A highly innovative approach to disparities analysis in regional development is presented by Viturka [15]. From the point of view of simple calculation, high informative level and applicability of the results in practice, the following mathematical and statistical methods are often used to measure disparities [5]: point method, traffic light method (scaling), method of average (standard) deviation, method of standardized variable and method of distance from the imaginary point. More sophisticated methods that are very useful in the process of regional disparities evaluation are multivariate statistical methods, especially cluster analysis and factor analysis, see [11].

Alternative and not broadly extended approach to regional disparities represents multicriteria decision-making methods, see e.g. [4]. One of the most popular techniques dealing with multi-criteria decision making (MCDM) problems in the real world is the Technique for Order Preferences by Similarity to an Ideal Solution (TOPSIS). It helps decision maker organize the problems to be solved, and carry out analysis, comparisons and rankings of the alternatives. TOPSIS has been successfully applied to the areas of human resources management, transportation, product design, manufacturing, water management, quality control, and location analysis [12]. The high flexibility of this concept is able to accommodate further extension to make better choices in various situations. e.g. in the field of regional analysis. MCDM problems involve criteria of varying importance to decision-makers. Consequently, information about the relative importance (weight) of the criteria is required. A number of criteria weighting procedures have been proposed in the MCDM literature. One of the most popular procedure is the pairwise comparison within analytic hierarchic process (AHP) [8]. In the absence of the mainstream in regional disparities evaluation, used of multicriteria decision-making methods can contribute to discussion about quantitative measurement of disparities.

2. Methodology

Analytic hierarchy process (AHP) and TOPSIS method is applied to the evaluation of disparities between NUTS 2 regions in V4. AHP is used to derive the weights of criteria that are subsequently inserted to weighted decision matrix in TOPSIS method. In using the AHP to model the problem, hierarchy representing the problem is needed, as well as pairwise comparisons to establish relation within the structure [10]. Distances of regions to ideal solution and their final ranking can be obtained from the method TOPSIS.

2.1 Determination of criteria weights by AHP

In this paper, AHP is used to derive the scales from paired comparison in four level hierarchic structures. The decision hierarchy structure is created; the goal of the decision is at the top level, subcriteria (group of criteria) at second level followed by the level of criteria (criteria on which subsequent elements depend). The lowest level

represents a set of alternatives. Having the hierarchic structure, we compare the comparative weight between the attributes of the decision elements in form of pairwise comparison matrices. The comparisons are taken from fundamental scale that reflects the relative strength of preferences. Table 2 exhibits Saaty´s fundamental scale which indicates how many times more important one element is over another element with respect to property to which they are compared to. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.

Tab. 2 Fundamental scale for pairwise comparison

Intensity of importance	Definition
1	equal importance
3	moderate importance
5	strong importance
7	very strong importance
9	extreme importance

Source: [10]; own modification

2.2 TOPSIS method

TOPSIS method is based on the determination of the best alternative that comes from the concept of the compromise solution. The compromise solution can be regarded as choosing the best alternative nearest to the ideal solution (with the shortest Euclidean distance) and farthest from the negative ideal solution [14]. TOPSIS is always used for multi-attribute decision making, by ranking the alternatives according to the closeness between the alternative and the ideal alternative. The main advantage of this approach is that its user could directly input judgment data without any previous mathematical calculations and locate both the ideal solution and the negative ideal solution easily [4].

The procedure of TOPSIS method includes the following steps. The first step is to construct the decision matrix. Given a set of alternatives, $A = \{A_i \mid i = 1,..., n\}$, and a set of criteria (attributes), $C = \{C_j \mid j = 1,..., m\}$, where $Y = \{y_{ij} \mid i = 1,..., n; j = 1,..., m\}$ denotes the set of performance ratings and $w = \{w_j \mid j = 1,..., m\}$ is the set of weights for criteria, the decision matrix can be represented as shown in table 3. Procedure that converts all the criteria so that all of them were either minimization or maximization is often implemented before the execution of TOPSIS method.

Tab. 3 Information table of TOPSIS

	Criteria			
Alternatives	C_1	C_2	....	C_m
A_1	y_{11}	y_{12}	....	y_{1m}
A_2	y_{21}	y_{22}	....	y_{2m}
⋮	⋮	⋮	⋮	⋮
A_n	y_{n1}	y_{n2}	....	y_{mn}
W	w_1	w_2	....	w_m

Source: [14]; own modification

Second step is to calculate the normalized decision matrix according to formula:

$$r_{ij} = \frac{y_{ij}}{\sqrt{\sum_{i=1}^{n} y_{ij}^2}}, \quad (1)$$

where $i = 1,...,n$; $j = 1,...,m$. With regard to the defined weight of criteria, the third step of TOPSIS method is to calculate weighted normalized decision matrix expressed as $v_{ij} = w_j \cdot r_{ij}$, where $i= 1,...,n$; $j = 1,...,m$. The following step includes the determination of the positive ideal solution (H_j) and the negative ideal solution that are derived as H_j = max (v_{ij}) and D_j= min (v_{ij}).

Subsequently, the separation from the ideal (d_i^+) and the negative ideal solutions (d_i^-) between alternatives is calculated. The separation values can be measured using the Euclidean distance, which is given as:

$$d_i^+ = \sqrt{\sum_{j=1}^{k} (v_{ij} - H_j)^2}, \quad (2)$$

$$d_i^- = \sqrt{\sum_{j=1}^{k} (v_{ij} - D_j)^2}. \quad (3)$$

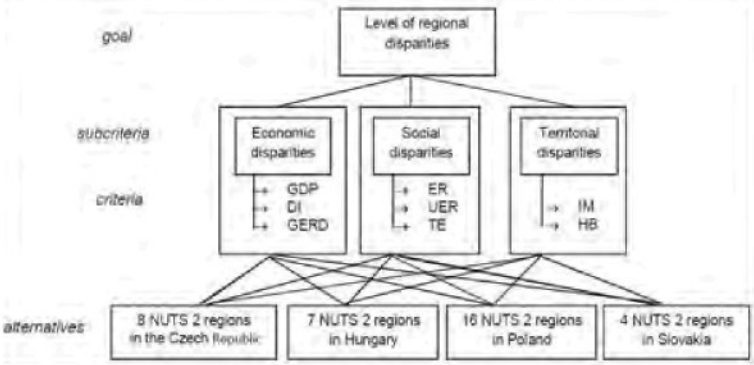
Last step include the calculation of the relative closeness to the ideal solution and rank the alternatives in descending order. The relative closeness of the i-th alternative A_i is expressed as:

$$c_i = \frac{d_i^-}{d_i^- + d_i^+}. \quad (4)$$

3. Application of AHP and TOPSIS method for V4 regional disparities evaluation

In this case, the goal is to assess the level of regional disparities in Visegrad Four countries. As shown in figure 1, the alternatives are 35 NUTS 2 regions (8 Czech NUTS 2 regions, 7 Hungarian NUTS 2 regions, 16 Polish NUTS 2 regions, 4 Slovak NUTS regions).

Fig. 1 Hierarchic structure of evaluation system



Source: own elaboration

These alternatives are evaluated by three types of subcriteria (economic, social and territorial disparities) and eight criteria shown in table 4. These indicators are most frequently used indicators of regional disparities monitored within Cohesion reports (see European Commission, 2007, 2010) and available in Eurostat database.

Tab. 4 Selected criteria (indicators) for disparities evaluation in V4 regions

Criteria	Abbreviation
GDP per capita (PPS)	**GDP**
Disposable income of households (PPS)	**DI**
Gross domestic expenditure on R&D (GERD) (% of GDP)	**GERD**
Employment rate (%)	**ER**
Unemployment rate (%)	**UER**
Persons aged 30-34 with tertiary education attainment (%)	**TE**
Infant mortality rate (%)	**IM**
Hospital beds (Number/100 000 inhabitants)	**HB**

Source: [1], [2], [3]; own modification

To determine the final weights of criteria, pairwise comparison in the context of AHP is applied to calculate weights of subcriteria with respect to the goal. After that criteria are pairwise compared against the subcriteria importance. The pairwise comparison matrices are shown in Annex, table 1 – 4. According to final calculated weights of criteria shown in table 5, indicators GDP per capita, disposable income and unemployment rate have the highest importance in evaluation of regional disparities and the level of region´s development.

Tab. 5 Weights of criteria

Subcriteria	Weight	Criteria	Weight	Final weight of criteria
Ecomic disparities	0.7306	GDP	0.6370	0.4654
		DI	0.2583	0.1887
		GERD	0.1047	0.0765
Social disparities	0.1884	ER	0.2790	0.0526
		UER	0.6491	0.1223
		TE	0.0719	0.0136
Territorial disparities	0.0810	IM	0.7500	0.0607
		HB	0.2500	0.0202

Source: own elaboration

According to TOPSIS method described above, combing with determined weight of criteria, the TOPSIS method is applied to evaluate and compare the regional disparities in economic, social and territorial development of 35 regions in V4 in the year 2000, 2005 and 2010.Table 6 shows and compares the scores of relative closeness to ideal solution (ci) and the ranks of regions of those three year, which could reveal the trends of regional disparities. On the basis of wide range value of relative closeness that regions achieved (interval between 0.9 – 0.05), the significant socioeconomic differences between region can be identified. The shortest relative closeness to ideal solution is achieved by regions with capital city – Praha, Bratislavský kraj, Közép-Magyarország and Mazowieckie. These regions are ranked on the top four positions and their ranking has not changed for whole reference period. For the rest of regions the greater or lesser

changes in disparities trends are observed during the examined period. The strong positive trend in reducing disparities is recorded by Czech region Moravskoslezsko, Jihovýchod and Polish region Lubuskie and Dolnośląskie when they have achieved better ranking each year. On the contrary two Czech regions Severozápad, Střední Morava and two Hungarian regions Nyugat-Dunántúl, Dél-Alföld recorded visible weakening of development and increase in disparities since their ranking is getting worse in each examined year. The situation and the ranking of other regions were only slightly changed both in positive or negative sense. For example 13 Polish regions, 4 Hungarian regions and 2 Slovak regions have largest distance (disparity) to ideal situation and they are mostly ordered in the second half of overall ranking. Moreover, in comparison with the year 2000 their positions were not positively, significantly changed in the year 2005 and 2010 which indicates the persistence of regional disparities. In positive sense, regions as Střední Čechy, Jihozápad, Severovýchod,Közép-Dunántúl, Małopolskie, Wielkopolskie and Západné Slovensko kept their position in top twenty for most of evaluated period.

Tab. 6 Comparison of region´s ranking by TOPSIS (2000, 2005, 2010)

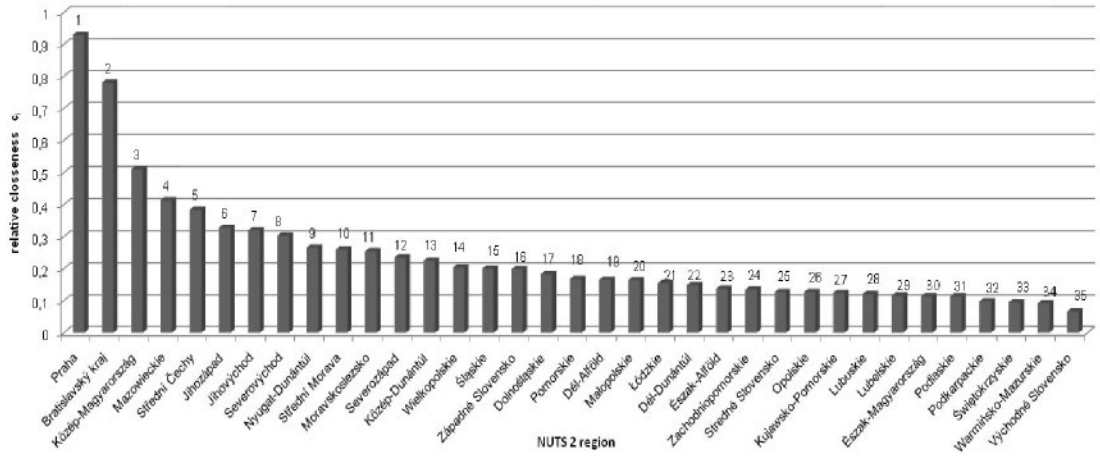
Code	Year	2000		2005		2010	
	Region	c_i	Rank	c_i	Rank	c_i	Rank
CZ01	Praha	0.8928	1	0.9496	1	0.9455	1
CZ02	Střední Čechy	0.4285	4	0.3877	4	0.3334	5
CZ03	Jihozápad	0.3520	6	0.3456	6	0.2847	7
CZ04	Severozápad	0.2652	11	0.2404	13	0.1974	16
CZ05	Severovýchod	0.3401	7	0.3101	8	0.2595	8
CZ06	Jihovýchod	0.3384	8	0.3238	7	0.2961	6
CZ07	Střední Morava	0.2789	10	0.2662	11	0.2334	12
CZ08	Moravskoslezsko	0.2494	13	0.2721	9	0.2412	9
HU10	Közép-Magyarország	0.4894	3	0.5400	3	0.4986	3
HU21	Közép-Dunántúl	0.2498	12	0.2502	12	0.1732	20
HU22	Nyugat-Dunántúl	0.3072	9	0.2674	10	0.2219	15
HU23	Dél-Dunántúl	0.1740	17	0.1698	16	0.1008	32
HU31	Észak-Magyarország	0.1427	25	0.1390	23	0.0578	35
HU32	Észak-Alföld	0.1494	23	0.1600	19	0.1029	31
HU33	Dél-Alföld	0.1974	15	0.1683	18	0.1293	27
PL11	Łódzkie	0.1471	24	0.1288	24	0.1865	18
PL12	Mazowieckie	0.4090	5	0.3624	5	0.4686	4
PL21	Małopolskie	0.1727	18	0.1412	21	0.1764	19
PL22	Śląskie	0.1912	16	0.1690	17	0.2391	11
PL31	Lubelskie	0.1218	28	0.1014	30	0.1241	28
PL32	Podkarpackie	0.1154	30	0.0776	32	0.0993	33
PL33	Świętokrzyskie	0.0972	33	0.0738	33	0.1107	30
PL34	Podlaskie	0.1081	32	0.1076	26	0.1228	29
PL41	Wielkopolskie	0.2071	14	0.1739	15	0.2279	13
PL42	Zachodniopomorskie	0.1557	22	0.1048	28	0.1424	25
PL43	Lubuskie	0.1093	31	0.1058	27	0.1449	23
PL51	Dolnośląskie	0.1628	21	0.1441	20	0.2396	10
PL52	Opolskie	0.1332	26	0.1037	29	0.1424	24
PL61	Kujawsko-Pomorskie	0.1296	27	0.0967	31	0.1455	22
PL62	Warmińsko-Mazurskie	0.0781	34	0.0662	34	0.1305	26
PL63	Pomorskie	0.1656	20	0.1392	22	0.1969	17
SK01	Bratislavský kraj	0.6881	2	0.7915	2	0.8613	2
SK02	Západné Slovensko	0.1664	19	0.2049	14	0.2233	14
SK03	Stredné Slovensko	0.1164	29	0.1112	25	0.1522	21
SK04	Východné Slovensko	0.0529	35	0.0651	35	0.0785	34

Source: own elaboration, 2013

Figure 2 shows the average region´s ranking according to average relative closeness with respect to ideal solution. According to table 5 and figure 2, we could divide the NUTS 2 regions into four levels. First level includes regions of capital city Praha, Bratislavský kraj, Közép-Magyarország and Mazowieckie that are treated as the developed regions with strong economy. The average relatives closeness is in interval 0.9 – 0.4 and therefore these regions are evaluated as the best. The ranking of these

regions implies the visible differences among regions of capital cities and the rest of V4 regions. The group of regions with average relative closeness between 0.3 – 0.2 and with average ranking from 5th to 14th position can be considered as a second level. There are Czech regions Střední Čechy, Jihozápad, Jihovýchod Severovýchod, Střední Morava, Severozápad, Moravskolezsko, two Hungarian regions Közép-Dunántúl and Nyugat-Dunántúl and Polish region Wielkopolskie. These regions rather converge to ideal point and have development potential. The third level can be defined by the regions from 15th to 31th average ranking and includes Hungarian regions Dél-Alföld, Észak-Magyarország, Észak-Alföld, Dél-Dunántúl, Polish regions Małopolskie, Śląskie, Pomorskie, Dolnośląskie, Łódzkie, Zachodniopomorskie, Kujawsko-Pomorskie, Lubuskie, Lubelskie, Podlaskie, Opolskie and finally Slovak regions Západné Slovensko and Stredné Slovensko. These regions represent the middle situation, regional disparities have rather moderate decrease and their economy is still not strong enough. Polish regions Podkarpackie, Świętokrzyskie, Warmińsko-Mazurskie and Slovak region Východné Slovensko represents last level. These regions can be considered as less developed compared to others, their positions to ideal solution are the farthest and they are ranked in last position.

Fig. 2 Average rank of regions (2000 – 2010)



Source: own elaboration

Conclusion

The evaluation of disparities between NUTS 2 regions in V4 has been presented on the basis of eight selected economic, social and territorial disparities and their importance determined by AHP. The highest impact to the rate of disparities and final ranking of regions has economic and social indicators GDP per capita, disposable income and unemployment rate. Applying the TOPSIS method we get the final ranking of regions according to region´s distances (disparity) to ideal solution. Comparison of the region´s ranking indicates the trends of regional disparities in year 2000, 2005 and 2010. It is necessary to take into account that each technique is specific and the results can be influenced by the characteristic of the data file, by the selected number and type of the indicators, as well as by selected method. Presented multicriteria decision making

methods can be considered as suitable and interesting alternative for quantitative regional disparities evaluation.

With regard to the shortest relative closeness to ideal solution, the most developed regions with capital city – Praha, Bratislavský kraj, Közép-Magyarország and Mazowieckie are ranked on the first four positions. These regions didn´t indicate any changes in ranking during evaluated period. On the contrary Polish regions Podkarpackie, Świętokrzyskie, Warmińsko-Mazurskie and Slovak region Východné Slovensko recorded the farthest distance to ideal solution and they are average ranked in last position. These regions did not indicate any significant positive changes in ranking during evaluated period and therefore can be considered as less developed compared to others. For the rest of regions we can observe visible positive, negative or small changes in development of regional disparities during the examined period. Reducing of disparities is recorded by Czech region Moravskoslezsko, Jihovýchod and Polish region Lubuskie, Dolnośląskie. The increasing of disparities can be seen by Czech regions Severozápad, Střední Morava and Hungarian regions Nyugat-Dunántúl, Dél-Alföld. Regions Střední Čechy, Jihozápad, Severovýchod, Közép-Dunántúl, Małopolskie, Wielkopolskie and Západné Slovensko oscillate around similar ranking during whole evaluated period. The final region´s ranking also indicates the substantial differences between Czech regions and other regions. All Czech regions are ranked among the top twenty regions for all three years and region Praha is ranked on the first place among all regions as well as among regions with capital city.

The results partially confirm the hypothesis; main regional disparities in V4 have persisted between regions with capital cities and other regions since year 2000. The dominance of capital cities results from more intensive integration into the world economy, which is reflected in different structures in comparison with other regions. Capital cities are main administrative centres, where the great mass of public institutions and the private sector is concentrated (corporate headquarters, central administrative authorities, universities, etc.). On the other hand, it is necessary to take into account the statistical effect that can overvalue some indicators of economic performance. The approach to regional disparities reduction in V4 should be based on the support of convergence between capital cities and other regions, not from the limitation of capital cities development. Due to diffusion effects, the support of economically successful capital cities and their competitiveness results later in higher performance of whole state, including the lagging regions. The main source for growth of less developed regions is considered an effective use of strengths and opportunities, stimulation of the endogenous potential (particularly innovation potential) and effective using of subsidies from European funds. The specific measures of NUTS 2 regions determined at the second and third level should focus on the use of development opportunities (especially human resources) in combination with continuous activation of strengths and elimination of the weaknesses of each region. The border regions (regions Severovýchod, Severozápad, Nyugat-Dunántúl Dolnośląskie, Zachodniopomorskie, Lubuskie, Západné Slovensko) should boost the cross-border cooperation with more developed regions in Germany and Austria that are to certain extent the impulse for further development of less developed regions. The group of least developed regions defined at fourth level (e.g. Podkarpackie, Świętokrzyskie, Warmińsko-Mazurskie, Východné Slovensko) should focus on higher expenditure on

research and development which are major drivers of economic growth and it also supports future competitiveness that results in higher GDP. The public investments in infrastructure (transport, communication, energy), spending on education and active labour market play the key roles for development of these regions. An important measure is to increase integration of these regions into the European and world economy. The main benefit of integration is the increase in demand for goods and services produced in each region. On the contrary, the public interventions in regions of capital cities are primarily needed for the elimination of the negative environmental and social impacts generated by the strong economic development of the life quality.

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References

[1] *Growing Regions, Growing Europe. Forth Report on Economic and Social Cohesion.* Luxembourg: Office for Official Publications of the European Communities, 2007. ISBN 92-79-05704-5222.

[2] *Fifth Report on Economic, Social and Territorial Cohesion. Investing in Europe's future.* Luxembourg: Publications Office of the European Union, 2010. ISBN 978-92-79-16978.

[3] *EuroStat Database – Regional Statistics* [online]. [cit. 2013-03-29]. Available from WWW: <http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/regional_statistics/data/database>.

[4] DAI, X., ZHANG, J. The TOPSIS Analysis on Regional Disparity of Economic Development in Zhejiang Province. *Canadian Social Science,* 2011, **7**(5): 135 – 139. ISSN 1712-8056.

[5] KUTSCHERAUER, A. et al. *Regional disparities. Disparities in the Regional Development, their Concept, Identification and Assessment.* Ostrava: VŠB-Technical University of Ostrava, 2010. ISBN 978-80-248-2380-5.

[6] MELECKÝ, L., SKOKAN, K. EU Cohesion and Its Evaluation in the Case of Visegrad Four Countries. In KOCOUREK, A. (ed.) *Proceedings of the 10th International Conference Liberec Economic Forum 2011.* Liberec: Technical University of Liberec, 2011, pp. 314 – 326. ISBN 978-80-7372-755-0.

[7] MOLLE, W. *European Cohesion Policy.* London: Routledge, 2007, 342 pgs. ISBN 978-0-415-43812-4.

[8] OZTURK, D., BATUK, F. *Technique for order preference by similarity to ideal solution (TOPSIS) for spatial decision problems.* [online]. 2011 [cit. 2013-03-29]. Available from WWW: <http://www.isprs.org/proceedings/2011/Gi4DM/PDF/PP12.pdf>.

[9] POLEDNÍKOVÁ, E. Evaluation of Visegrad Four convergence in the context of EU cohesion. *Ekonomická revue,* 2013, **16**(1): 19 – 28. ISSN 1212-3951.

[10] SAATY, T., VARGAS, G. L. *Models, Methods, Concepts and Applications of the Analytic Hierarchy Process.* New York: Springer Science+Business Media, 2012. ISBN 978-1-4614-3596-9.
[11] SOARES, O. J., MARGUES, M. M. L., MONTEIRO, C. M. F. A multivariate methodology to uncover regional disparities: A contribution to improve European Union and governmental decision. *European Journal of Operational Research*, 2003, **145**(1): 121 – 135. ISSN 0377-2217.
[12] SHIHA, H. S., SHYURB, H. J., LEE, E. S. An extension of TOPSIS for group decision making. *Mathematical and Computer Modelling*, 2007, **45**(7 - 8): 801 – 813. ISSN 0895-7177.
[13] TVRDOŇ, M. Cohesion, convergence and regional disparities: The case of European Union. *WSEAS Transactions on Business and Economics*, 2012, **9**(2): 89 – 99. ISSN 2224-2899.
[14] TZENG, G. H., HUANG, J. J. *Multiple attribute decision making: methods and applications*. Boca Raton: CRC Press, 2011. ISBN 978-1-4398-6158-5.
[15] VITURKA, M. Regionální disparity a jejich hodnocení v kontextu regionální politiky. *Geografie*, 2010, **115**(2): 131 – 143. ISSN 1212-0014.

Annex

Tab. 1 Pairwise comparison matrix of subcriteria with respect to the goal

	Economic disparities	Social disparities	Territorial disparities
Economic disparities	1	5	7
Social disparities	1/5	1	3
Territorial disparities	1/7	1/3	1

Source: own elaboration

Tab. 2 Pairwise comparison matrix for criteria with respect to economic disparities

	GDP	DI	GERD
GDP	1	3	5
DI	1/3	1	3
GERD	1/5	1/3	1

Source: own elaboration

Tab. 3 Pairwise comparison matrix for criteria with respect to social disparities

	ER	UER	TE
ER	1	1/3	5
UER	3	1	7
TE	1/5	1/7	1

Source: own elaboration

Tab. 4 Pairwise comparison matrix for criteria with respect to territorial disparities

	IM	HB
IM	1	3
HB	1/3	1

Source: own elaboration