EVALUATION OF REGIONAL DISPARITIES IN VISEGRAD FOUR BASED ON SELECTED MCDM METHODS

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Abstract

In the European Union (EU) there is a general belief that differences between states and regions are major obstacles to the balanced and harmonious development of European territory and these inequalities should be reduced or kept in the sustainable limits. The EU Cohesion Policy is a main instrument for pursuing growth, prosperity and harmonious development across the EU. Although, the EU Cohesion Policy has contributed to reduction of economic, social and territorial disparities over the past decade, overall a wide gap remains between the less developed and the highly developed EU regions. Visegrad Four countries (V4; the Czech Republic, Hungary, Poland, Slovakia) belong to states that have joined the EU in the year 2004 and their regional development of the last 10 years has been strongly linked to the EU Cohesion Policy funding. The aim of the paper is to evaluate and compare the development of regional disparities in Visegrad Four over the period from 2004 to 2012 (period before economic crisis and after it) by utilizing selected multicriteria decision making (MCDM) methods (namely entropy, TOPSIS and VIKOR methods). The information entropy is used to derive the objective weights of the regional indicators and the TOPSIS and VIKOR methods are employed to rank the NUTS 2 regions in V4 according to their socio-economic development in the context of EU cohesion. Applying MCDM methods, the paper solves the problem of an alternative approach to quantitative evaluation of the regional disparities.

Key words: evaluation, MCDM methods, NUTS 2, regional disparities, Visegrad Four

JEL Code: C02, O18, R11

Introduction

Through the EU Cohesion Policy, the European Union aims to reduce the regional inequalities and support lagging states and their regions to catch up with the rest of the EU members. Till 2007 the EU enjoyed a sustained period of economic prosperity and shrinking of socio-economic differences among regions. The situation has been changed since the economic crisis hit the EU states and regions in the year 2008.The unemployment rate, poverty and social exclusion have rapidly increased in most of parts of the EU and the positive tendencies in the narrowing of regional disparities have stopped.

The quantitative evaluation of the regional disparities in the EU in order to adopt the effective measure for regional disparities elimination is actual and important topics of many discussions and research studies. However, the attitude of the researches to the measurement and evaluation of the regional disparities is not uniformed. Most existing approaches use several disparities indicators that are processed by less or more sophisticated mathematical and statistical methods, see e.g. Campo, Monteiro and Soares (2008), Ginevičius, Podvezko and Mikelis (2004), Poledníková (2014).Alternative and not broadly extended approach in the field of regional economics represents the multicriteria decision-making methods (e.g. AHP, Entropy, TOPSIS, VIKOR, DEA), see e.g. Tzeng and Huang (2011), Ishizaka and Nemery (2013), Kashi and Franek (2014), Melecký and Staníčková (2014).MCDM methods help to decision maker organize the problems to be solved, and carry out analysis, comparisons and rankings of the alternatives.

The aim of the paper is to evaluate and compare the development of regional disparities in Visegrad Four based on the rank of NUTS 2 regions reflecting their socio-economic development over the period 2004-2012 by utilizing the selected MCDM methods. In the absence of the mainstream in methodological approach to regional disparities evaluation, MCDM methods can be considered as a suitable alternative tool.

1 Methodology and data description

Following sections discuss the theoretical background of MCDM methods and describe the data base. In this paper, Entropy is used to derive the weights of the regional indicators. Subsequently, TOPSIS and VIKOR method ranks the NUTS 2 regions according to their socio-economic development in the context of the EU cohesion over the period 2004-2012.

1.1 Entropy

In information theory, entropy is a general measure of the uncertainty. It is represented by a discreet probability distribution, in which broad distribution represents more uncertainty. When the difference of the value among the evaluating objects on the same indicator is high, while the entropy is small, it illustrates that this indicators provides more useful information, and the relative weight of this indicator would be higher and vice versa (Zou, Yun and Sun, 2006). The procedure of entropy includes the following steps. *The first step* of entropy is to get the normalized decision matrix $R = (r_{ij})_{m\times n}$, where r_{ij} is the data of the i-th evaluating object on the indicator, and $r_{ij} \in [0,1]$. If there are benefit indicators then r_{ij} is calculated as (Zou, Yun and Sun, 2006):

$$r_{ij} = \frac{x_{ij} - \min_i\{x_{ij}\}}{\max_i\{x_{ij}\} - \min_i\{x_{ij}\}}, \text{ if there are cost indicators then } r_{ij} = \frac{\max_i\{x_{ij}\} - x_{ij}}{\max_i\{x_{ij}\} - \min_i\{x_{ij}\}}, \qquad (1), (2)$$

The second step is to calculate entropy value H_j. In the n indicators, m evaluating objects evaluation problem, the entropy of j-th indicator is defined as:

$$H_j = -k\sum_{i=1}^{m} f_{ij} \ln f_{ij}, j = 1,2,...,n, \qquad (3)$$

in which $f_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}}$, $k = \frac{1}{\ln m}$, and suppose when $f_{ij} = 0, f_{ij} \ln f_{ij} = 0,$ (4)

The third step is to determine the weight of entropy of j-th indicator as:

$$w_j = \frac{1 - H_j}{n - \sum_{j=1}^{n} H_j}, \; 0 \le w_j \le 1, \sum_{j=1}^{n} w_j = 1. \qquad (5)$$

1.2 TOPSIS method

TOPSIS method (the Technique for Order Preferences by Similarity to an Ideal Solution)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 (Tzeng, Huang, 2011). 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| i= 1…..n}, and a set of criteria (attributes), C= {C_j| j= 1….. m}, where Y= {y_{ij}| i= 1….. n; j= 1….. m} denotes the set of performance ratings and w= {w_j| j= 1….. m} is the set of weights for criteria. *The second step* is to calculate the normalized decision matrix according to formula:

$$r_{ij} = \frac{y_{ij}}{\sqrt{\sum_{i=1}^{n} y_{ij}^2}}, \; i = 1...n; j = 1...m, \qquad (6)$$

The third step is to calculate the weighted normalized decision matrix expressed as $v_{ij} = w_j \cdot r_{ij}$, where i= 1.....n; j= 1.....m. *The fourth step* includes the determination of the positive ideal solution $H_j = \max(v_{ij})$and the negative ideal solution $D_j = \min(v_{ij})$.*The fifth step* is to calculate the separation from the ideal d_i^+ and the negative ideal solutions d_i^- between alternatives. The separation values can be measured using the Euclidean distance which is given as:

$$d_i^+ = \sqrt{\sum_{j=1}^{k} \left(v_{ij} - H_j\right)^2}, \; d_i^- = \sqrt{\sum_{j=1}^{k} \left(v_{ij} - D_j\right)^2}, \tag{7), (8}$$

The last step includes the calculation of the relative closeness from the ideal solution and ranking the alternatives in descending order. The relative closeness of the *i*-th alternative A_i is expressed as:

$$c_i = \frac{d_i^-}{d_i^- + d_i^+}. \tag{9}$$

1.3 VIKOR method

VIKOR method (VlseKriterijumskaOptimizacija I KompromisnoResenje) focuses on ranking and selecting from a set of alternatives in the presence of conflicting criteria. It introduces the multicriteria ranking index based on the particular measure of *closeness to the ideal solution* (Tzeng and Huang, 2011, p. 71). Assuming that each alternative is evaluated according to each criterion function, the compromise ranking could be performed by comparing the measure of closeness to the ideal alternative. The multicriteria measure for compromise ranking is developed from the *Lp-metric* used as an aggregating function in a compromise programming method. The various *i*alternatives are denoted as a_1; a_2; . . . ; a_n. For alternative a_i, the rating of the *j*-th aspect is denoted by f_{ij}, i.e. f_{ij} is the value of *j*-th criterion function for the alternative a_i; *m* is the number of criteria. Development of the VIKOR method started with the following form of *Lp-metric*:

$$L_{pi} = \left\{ \sum_{j=1}^{n} \left[w_j (f_j^* - f_{ij})/(f_j^* - f_j^-) \right]^p \right\}^{1/p}, 1 \le p \le \infty, i = 1, 2, ..., n, \tag{10}$$

Within VIKOR method, $L_{1,i}$ and $L_{\infty,i}$ are used to formulate ranking measure. The solution obtained by $min_i S_i$ is with a maximum group utility (“majority” rule), and the solution obtained by $min_i R_i$ is with a minimum individual regret of the “opponent”. The compromise solution F^c is a feasible solution that is the “closest” to the ideal F^*, and compromise means an agreement established by mutual concessions. The compromise ranking algorithm VIKOR has the following steps (Tzeng and Huang, 2011, p. 72-74). The first step is to determine the best f_j^* and the worst f_j^- values of all criterion functions, j= 1, 2,

.. , m, that is known as positive and negative ideal solution. If the *j*-th function represents a benefit then (Opricovic and Tzeng, 2004, p. 447-448):

$$f_j^* = \max_i f_{ij},\ f_j^- = \min_i f_{ij}, \qquad (11)$$

Second step is to compute the values S_i and R_i, j=1, 2,..., m, by formula:

$$S_i = \sum_{j=1}^{m} w_j (f_j^* - f_{ij})/(f_j^* - f_j^-),\ R_i = \max_j \left[w_j (f_j^* - f_{ij})/(f_j^* - f_j^-) \right] \qquad (12), (13)$$

In the VIKOR method $S_i = L_{1,i}$ and $R_i = L_{\infty,i}$ are introduced as "boundary measures". S_i is a_i with respect to all criteria calculated by the sum of the distance for best value, R_i is a_i with respect to the *j-th* criterion, calculated by the maximum distance from the worst value. Third step is to calculate the values Q_i, i= 1, 2, . . . , n, by relation:

$$Q_i = v(S_i - S^*)/(S^- - S^*) + (1-v)(R_i - R^*)/(R^- - R^*), \qquad (14)$$

where $S^* = \min_i Si,\ S^- = \max_i S_i,\ R^* = \min_i R_i,\ R^- = \max_i R_i.$ (15), (16)

and v is introduced as weight of the strategy of "the majority of criteria" (or "the maximum group utility"), here $v=0.5$. Index Q_i is obtained and based on the consideration of both the group utility and the individual regret of the opponent. Fourth step is to propose as the compromise solution the alternative *(a')* which is ranked the best by the measure *Q* if the two conditions, acceptance advantage and acceptance stability in decision making, are satisfied, see Opricovic and Tzeng (2004). The last step is to rank the alternatives, sorting by the values S, R and Q, in decreasing order. The best alternative *Q(a')* is the best solution with the minimum of Q_i.

1.4 Data description

Visegrad Four countries are divided into 35 NUTS 2 regions (8 Czech NUTS 2 regions, 7 Hungarian NUTS 2 regions, 16 Polish NUTS 2 regions, 4 Slovak NUTS 2 regions). These NUTS 2 regions (alternatives) are evaluated by 16 selected indicators (criteria) of economic, social and territorial disparities shown in table 1. These indicators are most frequently used indicators of regional disparities monitored within Cohesion reports, see e.g. European Commission (2010). These indicators are available in the Eurostat database, the last available regional data are for the year 2012.

Tab. 1: Selected indicators (criteria) for disparities evaluation in V4 regions

Type of disparity	Indicator	Abbreviation
Economic disparity	Gross domestic product per inhabitant (PPS/inhabitant)	GDP
	Gross fixed capital formation (mil. EUR)	GFCF
	Total intramural R&D expenditure (% GDP)	GERD
	Patent applications to the European Patent Office (number/mil. inhabitant)	EPO
	Employment in technology and knowledge-intensive sectors (%)	ETKS
Social disparity	Employment rate from 15 to 64 years (%)	ER15-64
	Employment rate of older workers from 55 to 64 years (%)	ER55-64
	Unemployment rate from 15 and more (%)	UR15+
	Persons aged 30-34 with tertiary education attainment (%)	TE30-34
	Early leavers from education and training, persons aged 18–24 (%)	EL
Territorial disparity	Density of railway (km/1000 km^2)	DR
	Density of motorway (km/1000 km^2)	DM
	Life expectancy at age less than 1 year (mean number of years)	LE
	Infant mortality rate (%)	IMR
	Hospital beds (number/100000 inhabitant)	HB
	Victims in road accidents (number/mil. inhabitant)	VRA

Source: Eurostat, 2015; author's processing, 2015

2 Application of MCDM methods and empirical results

The final values of indicators' weights (criteria) based on entropy in the years 2004 and 2012 are shown in Table 2. In both years, indicators density of railway, GDP per inhabitant and Gross fixed capital formation had the biggest importance in the evaluation.

Tab. 2: Weights of indicators

Indicator	2004	2012	Indicator	2004	2012
GDP	0.0915	0.0980	TE30-34	0.0464	0.0409
GFCF	0.0784	0.0832	EL	0.0284	0.0180
GERD	0.0749	0.0638	DR	0.1247	0.1519
EPO	0.1227	0.0666	DM	0.0779	0.0807
ETKS	0.0671	0.0736	LE	0.0421	0.0355
ER15-64	0.0499	0.0528	IMR	0.0477	0.0560
ER55-64	0.0727	0.0674	HB	0.0164	0.0538
UER15+	0.0403	0.0394	VRA	0.0189	0.0185

Source: author's calculation, 2015

Table 3 shows and compares the final value of the ranking index c_i within TOPSIS method and Q_i within VIKOR method in the years2004 and 2012. The highest ranked region is the closest to ideal point. The wide range of the index c_i (an interval 0.6-0.07) and Q_i (0.05-0.9) indicates the significant socioeconomic differences between NUTS 2 regions.

In the year 2004, when the V4joined the EU and European economy prospered, the shortest distance to ideal solution according to TOPSIS method was achieved by three regions with capital cities - Praha, Közép-Magyarország and Bratislavský kraj followed by Czech regions Střední Čechy and Jihovýchod. These regions were ranked on the top five positions and in comparison with other regions their best ranking has predominated in year 2012. On the other hand, Polish regions Warmińsko-Mazurskie, Zachodniopomorskie, Kujawsko-Pomorskie and Slovak regions Východné Slovensko, Stredné Slovensko had the farthest distance to ideal solution and they were ranked in the last five positions. Based on *index* Q_i the shortest distance to the ideal solution was achieved also by regions Praha, Közép-Magyarország, Bratislavskýkraj, Střední Čechy and Jihovýchod. Also region with capital city Mazowieckie was ranked on the same, sixth position by both methods. It can be said that there was a consistence between the ranking of regions with the farthest distances to ideal solution based on index c_i and index Q_i.

Tab. 3: Comparison of V4 regions' ranking

Year		2004				2012			
Method		TOPSIS		VIKOR		TOPSIS		VIKOR	
Code	Region	c_i	Rank	Q_i	Rank	c_i	Rank	Q_i	Rank
CZ01	Praha	0.6613	1	0.0500	1	0.6282	2	0.1473	2
CZ02	Střední Čechy	0.3538	4	0.6565	4	0.3332	5	0.5035	5
CZ03	Jihozápad	0.2036	9	0.6725	8	0.2137	17	0.7431	14
CZ04	Severozápad	0.1593	20	0.9033	13	0.2044	19	0.8011	24
CZ05	Severovýchod	0.2836	7	0.7900	11	0.2396	12	0.8103	25
CZ06	Jihovýchod	0.3011	5	0.5731	5	0.3539	4	0.4968	4
CZ07	Střední Morava	0.1868	13	0.8247	19	0.2296	13	0.7471	15
CZ08	Moravskoslezsko	0.1910	11	0.8689	22	0.2399	11	0.6897	10
HU10	Közép-Magyarország	0.6308	2	0.4630	2	0.6011	3	0.1682	3
HU21	Közép-Dunántúl	0.2563	8	0.7262	7	0.3281	6	0.5059	6
HU22	Nyugat-Dunántúl	0.1913	10	0.8088	10	0.2497	10	0.6570	9
HU23	Dél-Dunántúl	0.1287	27	0.8911	23	0.2793	9	0.6038	7
HU31	Észak-Magyarország	0.1897	12	0.9579	16	0.2185	16	0.7575	18
HU32	Észak-Alföld	0.1765	16	0.9438	24	0.1806	23	0.8404	27
HU33	Dél-Alföld	0.1632	19	0.8474	14	0.2034	20	0.7666	20
PL11	Łódzkie	0.1129	28	0.9120	26	0.1950	21	0.7516	17
PL12	Mazowieckie	0.2949	6	0.7961	6	0.2969	7	0.7653	19
PL21	Małopolskie	0.1827	14	0.7623	9	0.2224	15	0.7236	12
PL22	Śląskie	0.1773	15	0.8980	18	0.2920	8	0.6442	8
PL31	Lubelskie	0.1299	25	0.9104	25	0.1532	28	0.7952	22
PL32	Podkarpackie	0.1293	26	0.9049	21	0.1612	26	0.7876	21
PL33	Świętokrzyskie	0.1424	23	0.9271	30	0.1734	24	0.7486	16
PL34	Podlaskie	0.1074	29	0.9243	28	0.1228	34	0.8475	30
PL41	Wielkopolskie	0.1427	22	0.8877	15	0.1844	22	0.7968	23
PL42	Zachodniopomorskie	0.0855	34	0.9126	31	0.1290	33	0.9162	34
PL43	Lubuskie	0.1749	17	0.9690	17	0.1423	30	0.8656	31
PL51	Dolnośląskie	0.1509	21	0.9404	20	0.2278	14	0.7063	11
PL52	Opolskie	0.1385	24	0.9365	27	0.1519	29	0.8136	26
PL61	Kujawsko-Pomorskie	0.0892	33	0.9346	33	0.1341	32	0.8440	29
PL62	Warmińsko-Mazurskie	0.0790	35	1.0000	35	0.0823	35	1.0000	35
PL63	Pomorskie	0.1040	30	0.9343	34	0.1690	25	0.8426	28
SK01	Bratislavský kraj	0.5548	3	0.4823	3	0.6556	1	0.0889	1
SK02	Západné Slovensko	0.1660	18	0.8224	12	0.2126	18	0.7254	13
SK03	Stredné Slovensko	0.1029	31	0.9255	29	0.1355	31	0.8887	33
SK04	Východné Slovensko	0.0917	32	0.9343	32	0.1593	27	0.8676	32

Source: author's calculation, 2015

In the year 2012, after time of economic crises and in time of economic recession, the regions with capital city remained at the leading five positions according to *TOPSIS results*.

However, the rank of regions was changed. The region Bratislavský kraj was ranked at first position and region Közép-Magyarország dropped to third position. The Polish regions Warmińsko-Mazurskie, Zachodniopomorskie, Kujawsko-Pomorskie were again regions with farthest distances to ideal solution together with regions Podlaskie which dropped to 34th position. Contrary, region Východné Slovensko recorded the improvement in the development and got the better position. Overall, in the year 2012, 15 Czech, Hungarian and Polish regions had the worse positions in comparison with the year 2004, 8 regions were at the same level of development and 12 regions got better positions (six of them was in Poland). The VIKOR results showed the same ranking of regions with the shortest distances to ideal solutions as in the case of TOPSIS results. Small changes can be observed by ranking of regions at the last positions. The Polish regions Warmińsko-Mazurskie and Zachodniopomorskie were ranked at the last two positions. Slovak regions Stredné Slovensko got the worse 33rd position and region Lubuskie dropped to 31st position. Compared to TOPSIS ranking, in the year 2012 15 regions had the worse positions in comparison with the year 2004, 5 regions recorded the same positions and 15 regions got better positions (eight of them was in Poland).

Conclusion

The results of TOPSIS and VIKOR methods confirmed the ranking of most and less developed regions. Although the rank of regions Praha, Közép-Magyarországand Bratislavský kraj was changed and the rank differed according to TOPSIS or VIKOR method they can be considered as most developed in the period 2004-2012 regardless of the crisis. Small changes could be observed also by regions on the last positions. Regardless of economic prosperity or crisis, Polish regions Warmińsko-Mazurskie, Zachodniopomorskie, Kujawsko-Pomorskie together with region Podlaskie and Slovak region Východné Slovensko showed overall the farthest distance to ideal point and these regions can be considered as less developed. In the year 2012, 15 regions in V4got the worse positions in comparison with the year 2004. The rest of regions recorded the same level of development or better positions, most of these regions were Polish. The TOPSIS and VIKOR showed that disparities among regions with capital cities (with exception of region Mazowieckie which was ranked on lower position) and the rest of V4 regions have still persisted.

Different VIKOR and TOPSIS ranking of the rest of regions can be caused by own means of calculation of both methods. The VIKOR and TOPSIS are based on an aggregating function representing closeness to the reference point. The basic principle of the VIKOR method is that the best ranked alternative has the shortest distance from the ideal solution. The ranking index Q_i is an aggregation of all criteria, the relative importance of the criteria and a balance between total and individual satisfaction. The TOPSIS method ranks the alternatives according to the shortest distance from the ideal solution and the farthest distance from the negative solution. The highest ranked alternative by TOPSIS is the best in terms of the ranking index, which does not mean that it is always the closest to the ideal solution. The VIKOR method uses linear normalisation to eliminate the units of criterion functions and TOPSIS method uses vector normalization. The normalized value in the TOPSIS method depends on the evaluation unit of a criterion function. The advantage of VIKOR and TOPSIS methods is that they are simple, easy to use and understand. Due to the importance of the indicators we are able to determine the distance to the ideal solution in a more realistic way. The regional development can be characterized by various types of parameters. Multicriteria approach enables to evaluate the actual level of regional development in complex way. However, it is necessary to take into account the disadvantages of MCDM methods. The informative level of the VIKOR and TOPSIS methods can be influenced by the selected type of the indicators, weights of indicators and reference year. The author also takes into consideration that the value of the index Q_i depends on the value of the v. For these reasons it seems an interesting task to conduct a sensitivity analysis to compare the impact of different indicators' weights (calculated by different method, e.g. AHP) or v on final ranking of regions.

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References

[1] Campo, C., Monteiro, C.M.F. and Soares, O.J. (2008). The European regional policy and the socio-economic diversity of European regions: A multivariate analysis. *European Journal of Operational Research*, vol. 187(2), pp. 600–612.

[2] European Commission (2010). *Fifth Report on Economic, Social and Territorial Cohesion.*Luxembourg: Publications Office of the European Union.

[3] Eurostat (2015). *Regional Statistics* [online]. 2015 [cit. 2015-02-14].Available at: http://ec.europa.eu/eurostat/data/database

[4] Ginevičius, R., Podvezko, V. and Mikelis, D. (2004). Quantitative evaluation of economic and social development of Lithuanian regions.*EKONOMIKA,* vol. 65, 1-15.

[5] Ishizaka, A. and Nemery, P. (2013). *Multi-criteria Decision Analysis: Methods and Software*. United Kingdom: Wiley and Sons, Ltd.

[6] Kashi, K. and Franek, J. (2014). MADM Methods: ApplyingPracticalDecisionMaking in Business Processes. In *Proceedingsofthe 13th EuropeanConference on ResearchMethodologyfor Business and Management Studies (ECRM 2014)*. London, Jun 16-17, 2014, pp. 416-424 .

[7] Melecký, L. and Staničková, M. (2014). RegionalEfficiencyEvaluation by DEA Approach: ComparisonofSelected EU15 and EU13 Countries. In *Proceedingsofthe 2nd International Conference on EuropeanIntegration 2014 (ICEI 2014)*. Ostrava, May 15-16, 2014, pp. 465-475.

[8] Opricovic, S. and Tzeng, G.H. (2004). Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. *European Journal of Operational Research*,156, pp. 445–455.

[9] Poledníková, E. (2014). MulticriteriaEvaluation of Regional Disparities in Visegrad Four.In *The 8th International Days of Statistics and Economics Conference Proceedings September 11–13, 2014, Prague, Czech Republic*, pp. 1197-1207.

[10] Tzeng, G.H. and Huang, J.J. (2011). *Multiple attribute decision making: methods and applications*. Boca Raton: CRC Press.

[11] Zou, Z., Yun, Y. and Sun, J. (2006). Entropy method for determination of weight of evaluating indicators in fuzzy synthetic evaluation for water quality assessment.*Journal of Environmental Sciences*, Vol. 18, No. 5, pp. 1020-1023.

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