IDENTIFYING THE DISADVANTAGED REGIONS FOR CONCENTRATED STATE SUPPORT USING THE DEA METHOD*

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The governmental approach to the selection of the Czech regions (NUTS 4) for the state support distribution is analyzed and the Data Envelopment Analysis (DEA) model is proposed. A set of used indicators, their dependence or independence, and their availability in the statistical databases of the Czech Statistical Office are examined. The results of the selection method used by the Czech government (Simple Additive Weighting method with the linear scale transformation procedure based on reference variant) and the results provided by the proposed DEA model (covering both the used indicators and a proposed set of indicators) are compared. All results indicate that the DEA method is a useful tool for the ranking of the regions and for the selection of the regions intended for the concentrated state support. Its advantage is that the weights of the indicators (inputs and outputs) should not be estimated subjectively before computation.

disadvantaged regions; regional disparities; multi-criteria decision making; Data Envelopment Analysis

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INTRODUCTION

One of the fundamental objectives of the European Community is 'economic and social cohesion' of different regions to reduce their disparities and to ensure their development. To achieve this, the EC and European countries spend considerable funds in supporting structural actions to promote the economic development and to reduce negative disparities among these regions (Standing, 1996). Keeping with the EU policy, the government of the Czech Republic (GCR) started to select the regions that are structurally disadvantaged, economically weak, and with a high above-average unemployment (NUTS 4) for concentrated state support. The characteristics of the regions are negative features of structural changes, lower economic level, and unemployment exceeding the state unemployment average. From a general point of view, they are less developed in many socio-economic indicators.

Regional disparities, advantages and disadvantages, have been intensively studied for many years. Standing (1996) describes the situation in Central and Eastern Europe lacking an exact method for regional evaluation. The process of assessment or evaluation of the disadvantaged regions involves various viewpoints and can be resolved using different exact (mathematical) methods. Abrhám (2007) deals with the development of the regions and development of their disparities in relation to the GDP, Vostrá Vydrová et al. (2011) use as important indicators structural measures of employment according to the Lisbon Strategy and multiple dimensional statistical methods. Viturka (2007, 2011) and Viturka et al. (2011) present microeconomic evaluation consisting of three main components: the quality of the business environment, use of human resources, and innovation potential of companies. Varivoda et al. (2010) evaluate regions according to their competitiveness. Kloudová (2009) and Kloudová, Chwaszcz (2012) assess the level of creative economy in the regions using multiple attribute approach. Recently, many authors have tried to evaluate the regions using the Data Envelopment

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Table 1. Indicators and their weights for the evaluation of regions after 2006

Tax revenue	Number of entrepreneurs	Purchasing power	Unemployment		
0.15	0.15	0.3	0.4		
			Long-term unemployment	Unemployment rate	Demand for job
			0.3	0.4	0.3
Global weights					
0.15	0.15	0.3	0.12	0.16	0.12
max	max	max	min	min	min

Table 2. Criteria weights for the evaluation of regions after 2010

Tax revenue	Number of entrepreneurs	Purchasing power	Unemployment	
0.2	0.2	0.2	0.4	
			Unemployment rate	Demand for job
			0.9	0.1
Global weights				
0.2	0.2	0.2	0.36	0.04
max	max	max	min	min

Analysis (DEA) (Nevima, Ramík, 2009, 2010; Klufová et al., 2010; Luptáčik, Böhm, 2010).

In this paper, the application of the DEA method on the designation of the regions to the state support is presented and the proposition of a new set of indicators discussed. The selection method used by the Czech government and the DEA method are compared.

MATERIAL AND METHODS

Designation of the regions to the state support

The first documents dealing with the regional development, economic and social development of territorial units, and defining the priorities for regional policy in the Czech Republic after the year 1989 appeared in 1998–1999. The methodology for the definition of problematic regions was selected according to the system of input parameters different for structurally disadvantaged regions (S) and economically weak regions (E). In 2003 the regions with highly above-average unemployment (U) were also selected.

During the year 2006, the procedure of selecting the regions with the concentrated state support was changed (SRR, 2000; DVS, 2009, 2010). The definition of structurally disadvantaged regions, economically weak regions, and regions with highly above-average unemployment remains unchanged, but the regions are assessed according to the integrated set of indicators and their weights (Table 1).

The last updating (2010) is based on the analysis of appropriate indicators available for a three-year period of 2006–2008. The main reason for this updating was the impact of the economic crisis that hit the Czech Republic which was accompanied by deterioration of the situation on the labour market manifested by a sharp rise in the unemployment rate.

Regions with a concentrated state aid for the years 2010–2013 were selected according to available statistical data on unemployment, number of entrepreneurs, and tax and data on purchasing power was obtained from the company Incoma GfK (Table 2).

Regional data

The data on all the 78 regions of the Czech Republic was used in the region position analysis. Basic data characteristics are shown in Table 3. Regions are evaluated according to the following indicators (criteria): Unemployment (Long-term unemployment, Unemployment rate, Demand for job), Tax revenue, Number of entrepreneurs, and Purchasing power.

Methods used

The process of selection of less-developed regions is a typical example of the multi-criteria decision making (MCDM) process. The regions are evaluated according to many socio-economic indicators which are measured in various units and at various scales. Therefore, an effective and unambiguous procedure how to calculate their global evaluation should be used.

Table 3. Overview of the regional data

		Unemployment rate	Long-term unemployment	Demand for job	Tax revenue	Number of entrepreneurs	Purchasing power	
CR	2002	9.81	3.65	9.03	9 755.50	178.12		
	2003	10.31	4.15	9.54	10 526.65	184.38		
	2004	9.41	3.82	8.52	11 360.71	184.14		
	2006	7.67	4.80		743.48	165.05	100.00	2005
	2007	5.98	2.50		698.94	165.64		
	2008	5.96	3.90		760.51	166.90	100.00	2009
Min	2002	2.75	0.45	1.43	6 149.21	121.59		
	2003	3.04	0.50	1.62	6 595.42	125.14		
	2004	2.94	0.48	1.63	7 026.97	126.89		
	2006	2.06	1.20		347.44	114.50	85.00	2005
	2007	1.64	0.40		247.39	116.40		
	2008	1.84	0.70		283.74	118.93	85.50	2009
Max	2002	21.71	12.54	21.34	24 284.29	242.79		
	2003	23.51	14.31	23.08	26 682.37	248.92		
	2004	22.71	14.63	22.28	28 493.83	246.28		
	2006	19.47	34.30		1 790.25	228.31	132.90	2005
	2007	15.46	16.10		1 732.91	225.10		
	2008	13.06	27.00		2 835.79	223.20	131.30	2009
Average	2002	9.94	3.58	9.17	7 564.15	171.79		
	2003	10.47	4.09	9.74	8 173.33	178.07		
	2004	9.75	3.85	8.97	8 834.72	177.95		
	2006	7.99	6.58		598.35	157.93	96.04	2005
	2007	6.29	3.90		563.96	158.48		
	2008	6.49	6.72		631.68	160.06	96.15	2009
Median	2002	9.19	2.83	8.17	6 830.46	167.20		
	2003	9.69	3.24	8.82	7 495.13	173.81		
	2004	8.87	3.22	8.01	8 174.47	174.75		
	2006	7.18	4.90		549.87	152.24	95.20	2005
	2007	5.89	2.90		509.78	152.67		
	2008	6.15	6.00		548.27	153.98	95.50	2009
Standard deviation	2002	4.15	2.40	4.34	2 636.76	23.90		
	2003	4.26	2.67	4.42	2 751.72	24.25		
	2004	3.95	2.47	4.14	2 954.49	23.96		
	2006	3.49	5.33		201.97	23.18	7.83	2005
	2007	2.75	3.18		205.52	22.27		
	2008	2.40	4.84		332.25	21.58	7.62	2009

The Czech government uses the Simple Additive Weighting method (SAW) with the linear scale transformation procedure based on the reference variant and with the weights set by the government. So the evaluation of the regions depends on the decision about these weights.

Therefore the selection of the regions by the Data Envelopment Analysis (DEA) method is suggested in this paper, because this method does not need the weights as its input.

Dependence or independence of the used indicators and relationships between the results of different methods are analyzed by the statistical method of correlation analysis.

Simple Additive Weighting (SAW) method with the linear scale transformation

This method is mathematically based on a simple form of criteria aggregation.

Firstly the ideal or reference point (a variant representing the best or desirable criteria values) has to be set. Then the criteria values of variants are related to the ideal (reference) values based on the principle: the better evaluation, the higher relative value (Hwang, Yoon, 1981).

If y_j^R is the reference value of criterion j and y_{ij} is the criterion value of variant i, then for benefit criteria the corresponding utility value (r_{ij}) is calculated as

$$r_{ij} = \frac{y_{ij}}{y_j^R} \quad (1)$$

and for cost criteria

$$r_{ij} = \frac{y_j^R}{y_{ij}} \quad (2)$$

Variants are then evaluated by weighted sum of utility values r_{ij} with criteria weights w_i

$$r_i = \sum_{j=1}^{k} w_j r_{ij} \quad (3)$$

The variant with the highest r_i is the best.

If we use the inverse ratio, the variant with the highest r_i is the worth.

Data Envelopment Analysis (DEA) method

Although the number of MCDM methodologies is available the DEA can be an alternative MCDM tool to achieve reasonable evaluation of the analyzed alternatives (Bouyssou, 1999; Zhao et al., 2006; Yilmaz, Yurdusev, 2011). The DEA results can be used as the preferences of the alternatives similarly as the results of the other MCDM techniques. The DEA application is based on defining the Decision Making Units (DMU) as the alternatives from the alternative set, the maximizing criteria as their outputs, and the minimizing criteria as their inputs.

If the desirable and undesirable factors/indicators are used in such evaluation, undesirable factors can be used as inputs and desirable factors as outputs (Lovell, Pastor, 1999; Seiford, Zhu, 2002).

The DEA superefficiency is used as the alternative evaluation according to which the alternatives can be ranked (Angulo-Meza, Pereire Estellita Lins, 2002), because it allows for the differentiation of efficient alternatives. The efficiency of efficient units is not always equal to 1 but it is greater than or equal to 1 and the efficiency of inefficient units is less than 1. Bouyssou (1999) pointed to the problems with the relationship between dominancy and ranking according to the DEA efficiency, even so the DEA results can be used as the quantitative support for the political decision like the selection of the regions for concentrated state support.

The BCC model (Banker et al., 1984) supposes variable returns to scale. Let y_{jk} be the amount of the j^{th} output from unit k, and x_{ik} be the amount of the i^{th} input to the k^{th} unit, and p the number of units. The input oriented BCC model with superefficiency uses the following linearization of the original DEA model for DMU_H :

$$\Phi_H = \sum_{j=1}^{n} u_{jH} y_{jH} + q_H \rightarrow MAX \quad (4)$$

subject to

$$\sum_{i=1}^{m} v_{iH} x_{iH} = 1$$

$$-\sum_{i=1}^{m} v_{iH} x_{ik} + \sum_{j=1}^{n} u_{jH} y_{jk} + q_H \leq 0$$

where:

H = identificator of evaluated DMU

k = identificators of other DMUs ($k = 1, 2, ...p$; $k \neq H$)

u_{jH} = weight given to output j ($u_{jH} \geq 0, j = 1, 2,..., n$)

v_{iH} = weight given to input i ($v_{iH} \geq 0$, $i = 1, 2,..., m$)

q_H = multiplier considering variable returns to scale (unrestricted)

All necessary calculations were made using the software Efficiency Measurement System (EMS, freeware for academic use) (Scheel, 2000).

RESULTS

Analysis of the regional indicators

The number of the factors/indicators characterizing the regions was reduced based on results of the correlation analysis. The correlation between regional indexes (criteria) was calculated for the whole set consisting of 78 regions and the above-described indexes. Tables 4 and 5 include correlation indexes for each of the three years of the analyzed periods (in three rows in each cell). The critical value at the level of 0.05% for 78 and/or 80 degrees of freedom equals 0.217. But only high coefficients show the strong relationship between the indicators.

Table 4 shows correlation coefficients describing the dependencies between all indicators used in the years 2002–2004. The values of correlation coefficients near to ±1 are highlighted in dark grey and the values of correlation coefficients near to 0 are highlighted in light grey.

All three indicators describing unemployment situation in the region show a high correlation, which means only one of them can be used for region evaluation. High correlation coefficients also show high dependence between Purchasing power and Tax revenue or Number of entrepreneurs. The indicator Tax revenue has no relationship to other indicators, because all correlation coefficients values are less than the critical value.

Table 4. Correlation of indicators (2002–2004)

2002 2003 2004	Unemployment rate	Long-term unemployment	Demand for job	Tax revenue per capita	Number of entrepreneurs per 1000 inhabitans	Purchasing power 2005
Unemployment rate	1					
Long-term unemployment	0.966 0.975 0.962	1				
Demand for job	0.997 0.997 0.996	0.962 0.970 0.955	1			
Tax revenue per capita	–0.021 –0.068 –0.097	0.057 0.008 –0.011	–0.025 –0.077 –0.133	1		
Number of entrepreneurs per 1000 inhabitans	–0.426 –0.433 –0.434	–0.443 –0.448 –0.459	–0.429 –0.439 –0.463	0.374 0.419 0.408	1	
Purchasing power 2005	–0.506 –0.500 –0.529	–0.396 –0.396 –0.410	–0.515 –0.514 –0.561	0.658 0.695 0.681	0.725 0.722 0.714	1

The values near to ±1 are highlighted in dark grey, the values near to 0 are highlighted in light grey.

Table 5. Correlation of indicators (2006–2008)

2006 2007 2008	Unemployment rate	Demand for job	Tax revenue per capita	Number of entrepreneurs per 1000 inhabitans	Purchasing power 2009
Unemployment rate	1				
Demand for job	0.856 0.843 0.727	1			
Tax revenue per capita	–0.435 –0.430 –0.327	–0.372 –0.352 –0.294	1		
Number of entrepreneurs per 1000 inhabitans	–0.404 –0.379 –0.378	–0.359 –0.267 –0.178	0.603 0.619 0.332	1	
Purchasing power 2005	–0.644 –0.643 –0.674	–0.534 –0.554 –0.512	0.812 0.825 0.498	0.761 0.742 0.721	1

The values near to ±1 are highlighted in dark grey.

Based on this analysis, it is advisable to keep the Unemployment rate, the indicator Tax revenue must remain and there is no reason for omitting the Number of entrepreneurs. Deleting the indicator Purchasing power can be recommended, especially because of the remaining indicators Tax revenue and also Number of entrepreneurs. So for the future analysis of regional situation, only these three indicators can be used.

Correlation coefficients given in Table 5 describe the dependences between all indicators used in the years 2006–2008. The values of correlation coefficients near to ±1 are highlighted in dark grey.

Table 6. Selected regions – DEA inputs and outputs (2006)

	DEA-I	DEA-II
Inputs	Long-term unemployment Unemployment rate Demand for job	Unemployment rate
Outputs	Tax revenue Number of entrepreneurs Purchasing power	Tax revenue Number of entrepreneurs

The indicators describing unemployment situation in the regions again show a high correlation. High correlation coefficients also point to a high dependence between Purchasing power and all other indicators. The dependence of the indicators Tax revenue and Number of entrepreneurs on other indicators is not very strong.

Again, keeping the indicator Unemployment rate and deleting the Purchasing power can be recommended, especially because of the possible use of the indicators Tax revenue and Number of entrepreneurs. For the future analysis of the regional situation, using the same three indicators given above is enough.

Comparison of the selection process based on the SAW and DEA methods

Based on the political decision of the Czech government, the regions are selected for the state support according to the results of the Simple Additive Weighting method (SAW) with the linear scale transformation based on national values of the afore-mentioned indicators (criteria). A new approach is suggested herein based on the DEA method. The DEA models were calculated with the original data used by the government. The indicators are divided into the set of minimization criteria (inputs) and maximization criteria (outputs) and the input oriented DEA model is calculated. The DEA super-efficiency is used for the region ranking.

Similarly as in the governmental procedure, the DEA evaluation of each region is calculated for three years and the regions are then ranked according to an average value. The average value removes partial changes of indicator values measured at three years. The Malmquist index is not used here, because the intertemporal comparison of the regions efficiency was not checked by the government and the suggested method is aimed at simplifying the procedure. The ranking is made on the following principle: the highest position means the worst economic situation or efficiency of a region. Calculations are performed for all regions except Prague, Prague-East, and Prague-West because these regions have a very high efficiency and it makes the results of other regions undistinguishable.

The DEA models are calculated with different sets of criteria/indicators as inputs and outputs. The first version DEA-I uses the same indicators as a governmental procedure, the second version DEA-II is calculated only for non-correlated and available indicators.

Comparison of the results of the selection method used by the Czech government and the DEA method is made for the periods 2002–2004 and 2006–2008.

Selected regions in 2006

The government selected three types of regions (S, E, U) for the state support based on six criteria using the SAW method. Criteria values are from the years 2002–2004, the criterion Purchasing power is evaluated only for the year 2005. Three criteria represent inputs and three criteria represent outputs in the DEA models (Table 6).

Table 7 contains the results yielded by all the models – SAW, DEA-I, and DEA-II. The last three columns in Table 7 show three groups of regions with the state support according to the government.

The 19 regions out of the 21 selected for the state support by the government are ranked on the first 19 positions according to the results yielded by all the three models. Only two regions, Ostrava-město (SAW evaluation 1.35, ordered by DEA as the 27th) and Jeseník (SAW evaluation 1.39, ordered by DEA as the 35th), are not ranked according to the DEA similarly as according to the SAW method used by the government.

Selected regions in 2010

In 2010, the government selected the regions of the three types (S, E, U) according to five criteria used also as inputs and outputs in the DEA models (Table 8). The data are from the years 2006–2008 and values of Purchasing power are from 2005 and 2009.

The ranking of regions according to the DEA-I and DEA-II and according to the SAW and the selected regions with the state support are shown in Table 9. The regions Jeseník and Blansko are on the 31st and 32nd positions according to the DEA results and only Jablonec n. Nisou (SAW evaluation 1.18, ordered by DEA as 62nd) is evaluated much efficient so it should not be included into the selected regions.

DISCUSSION

According to the analysis of the values in the correlation matrices and the analysis of the used criteria or indicators, we can suggest a new set of indicators/criteria with a weak direct or inverse proportionality which will be tested in the next calculations. Three indicators – Unemployment rate (undesirable), Number of entrepreneurs (desirable), and Tax revenue (desirable) – can be assumed as input and outputs for the DEA model.

Table 7. DEA-II ranking of the regions and regions selected by the government (2006)

Regions (rank, type, name)			DEA-I average efficiency	DEA-II average efficiency	SAW average SAW	Regions selected by government		
						type S	type E	type U
1	S	Most	0.204	0.204	1.771	Most	Znojmo	Děčín
2	S	Karviná	0.219	0.219	1.683	Karviná	Třebíč	Litoměřice
3	S	Teplice	0.235	0.235	1.526	Chomutov	Přerov	Ústí n. Labem
4	E	Bruntál	0.241	0.241	1.510	Teplice	Svitavy	
5	E	Louny	0.244	0.244	1.454	Ostrava-město	Šumperk	
6	S	Chomutov	0.272	0.272	1.457	Frýdek-Místek	Hodonín	
7	E	Hodonín	0.275	0.275	1.377	Nový Jičín	Jeseník	
8	U	Děčín	0.277	0.277	1.339	Sokolov	Bruntál	
9	S	Frýdek-Místek	0.289	0.289	1.363		Opava	
10	E	Znojmo	0.294	0.294	1.295		Louny	
11	E	Třebíč	0.306	0.306	1.315			
12	S	Nový Jičín	0.309	0.309	1.327			
13	U	Litoměřice	0.313	0.313	1.225			
14	E	Přerov	0.323	0.323	1.277			
15	U	Ústí n. Labem	0.324	0.324	1.274			
16	S	Sokolov	0.329	0.329	1.251			
17	E	Šumperk	0.331	0.331	1.257			
18	E	Svitavy	0.332	0.332	1.265			
19	E	Opava	0.361	0.361	1.213			
Min			0.204	0.204	0.516			
Max			2.490	1.496	1.771			
Average			0.520	0.507	1.081			
Median			0.467	0.462	1.032			
Standard deviation			0.324	0.235	0.228			

S = structurally disadvantaged regions (dark grey), E = economically weak regions (light grey), U = regions with far above-average unemployment; average values are calculated from results for the years 2002–2004

Table 8. Selected regions – DEA inputs and outputs (2010)

	DEA-I	DEA-II
Inputs	Unemployment Demand for job	Unemployment
Outputs	Tax revenue Number of entrepreneurs Purchasing power	Tax revenue Number of entrepreneurs

The criteria Demand for job, Long term unemployment, and Purchasing power are difficult to evaluate or are not surveyed. These criteria can be replaced or not included in the evaluation process. For example the criteria Demand for job and Long-term unemployment have high correlation with others, so these factors are included in Unemployment criteria. The evaluation of the criterion Purchasing power is much more complicated. The use of an external company Incoma GfK, which prepares and calculates these criteria, is very expensive From the correlation of the criterion Purchasing power it follows that it can be omitted. Another possibility is to find a new way of calculation of this criterion using data of the Czech Statistical Office.

However, the selection of regions for the concentrated state support is a political decision; the different quantitative methods for the selection of these regions are discussed in this article. The SAW model with the linear scale transformation based on national values of the indicators (criteria) is a model used by the government. The used criteria are Unemployment rate, Long-term unemployment, Demand for job, Tax revenue, Number of entrepreneurs, and Purchasing power, and their weights.

The Data Envelopment Analysis as a multi-criteria decision method is suggested and tested for this selection. The first model version DEA-I uses indicators identical with those of the governmental procedure, the second version model DEA-II is calculated only for non-

Table 9. DEA-II ranking of the regions and regions selected by the government (2010)

Regions (rank, type, name)			DEA-I average efficiency	DEA-II average efficiency	SAW average SAW	Regions selected by government		
						type S	type E	type U
1	S	Most	0.1695	0.1695	1.5	Sokolov	Tachov	Louny
2	S	Karviná	0.1945	0.1945	1.67	Chomutov	Děčín	Česká Lípa
3	S	Teplice	0.2136	0.2136	1.47	Most	Třebíč	Jablonec n. Nisou
4	E	Znojmo	0.2321	0.2232	1.36	Teplice	Blansko	Svitavy
5	E	Bruntál	0.2266	0.2266	1.56	Ústí n. Labem	Hodonín	Kroměříž
6	E	Hodonín	0.2283	0.2283	1.39	Karviná	Znojmo	Vsetín
7	S	Ústí n. Labem	0.2364	0.2364	1.29	Nový Jičín	Jeseník	Ostrava-město
8	E	Děčín	0.2406	0.2406	1.55		Přerov	
9	S	Chomutov	0.2514	0.2511	1.34		Šumperk	
10	U	Louny	0.2691	0.2691	1.24		Bruntál	
14	U	Ostrava-město	0.2929	0.2738	1.17			
11	S	Sokolov	0.2779	0.2779	1.3			
12	E	Třebíč	0.2875	0.2875	1.38			
13	U	Svitavy	0.2908	0.2893	1.25			
15	E	Přerov	0.2981	0.2981	1.36			
16	E	Šumperk	0.3051	0.3051	1.37			
17		Opava	0.3102	0.3102	1.23			
18		Litoměřice	0.3295	0.3295	1.16			
19		Břeclav	0.336	0.336	1.18			
20	E	Tachov	0.3405	0.3405	1.35			
23	U	Kroměříž	0.371	0.3426	1.22			
21		Frýdek-Místek	0.3454	0.3454	1.17			
22	U	Vsetín	0.3467	0.3467	1.22			
24	S	Nový Jičín	0.3721	0.3721	1.35			
25		Klatovy	0.3841	0.3841	0.97			
26	U	Česká Lípa	0.392	0.392	1.26			
27		Žďár n. Sázavou	0.3998	0.3998	1.14			
28		Kutná Hora	0.4033	0.4022	1.1			
29		Chrudim	0.4166	0.4067	1.18			
30		Český Krumlov	0.4151	0.4151	1.16			
31	E	Jeseník	0.4211	0.4211	1.45			
32	E	Blansko	0.4232	0.4232	1.3			
Min			0.143	0.143	0.579			
Max			1.504	1.389	1.670			
Average			0.459	0.446	1.134			
Median			0.415	0.413	1.135			
Standard deviation			0.235	0.230	0.208			

S = structurally disadvantaged regions (dark grey), E = economically weak regions (light grey), U = regions with far above-average unemployment; average values are calculated from results for the years 2006–2008

correlated and available indicators: Unemployment, Tax revenue, and Number of entrepreneurs.

The evaluation using DEA efficiency is similar to the evaluation using the SAW method and its great advantage is that it does not need the criteria weights. Fig. 1 shows the ranking of the regions for the year 2006.

Table 10 shows the correlation coefficients describing the strong relationship between the results of all the three models. Results provided by the three methods are very similar.

For the year 2010, the results for all the three methods are again very similar (Fig. 2), nine regions are ranked as disadvantageous by the models DEA-I and

Table 10. Correlation of results of the used models (2006)

	DEA-I	DEA-II	SAW
DEA-I	1		
DEA-II	0.956	1	
SAW	–0.668	–0.812	1

Table 11. Correlation of results of the used models (2010)

	DEA-I	DEA-II	SAW
DEA-I	1		
DEA-II	0.99619	1	
SAW	–0.75152	–0.73893	1

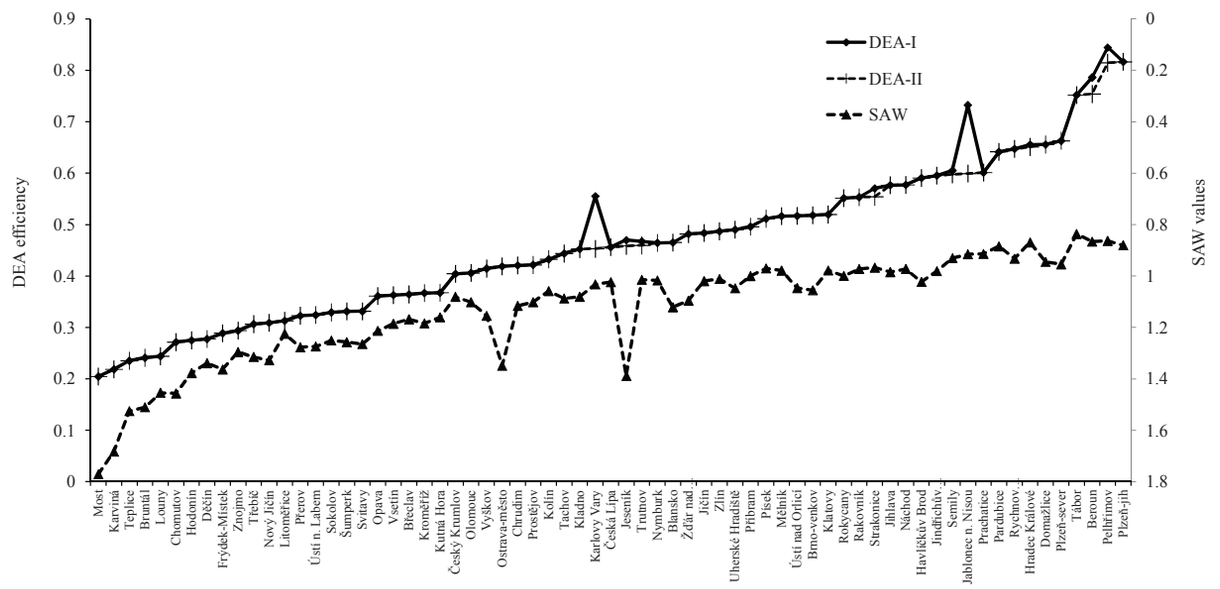

Fig. 1. DEA-II ranking of the regions and selected regions by the government (2006)

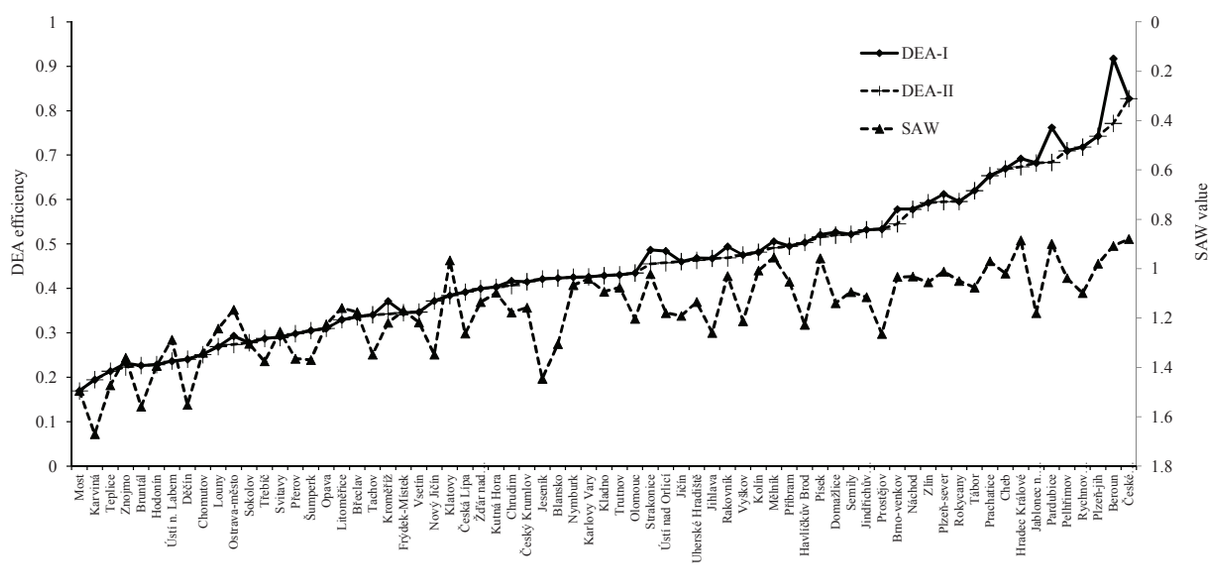

Fig. 2. DEA-II ranking of the regions and selected regions by the government (2010)

DEA-II, but they were not selected by the government into the regions intended for the concentrated state support. Table 11 presents the correlation coefficients showing the strong relationships between the results of the models.

The comparison of the results provided by the SAW, DEA-I, and DEA-II models shows a strong similarity. The correlation of the obtained results is very high.

CONCLUSION

We may conclude that the DEA method seems to be a useful tool for the multi-criteria analysis and the ranking of the regions according to DEA results can serve for selecting the regions intended for the concentrated state support. The advantage of this method consists in the fact that the weights of the indicators (inputs and outputs) should not be estimated subjectively before computation and are calculated individually for each region.

Results of the DEA-II model show the possibility to utilize only indicators available in the databases of the Czech Statistical Office. This fact is very important because some of the previously used indicators are very hard to obtain.

Future research will be oriented on the use of Malmquist index and on graphic comparison of the Malmquist index elements and DEA efficiency, which should allow for a deeper analysis of the situation of the individual regions.

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