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APPLICATION OF TAXONOMIC METHOD FOR THE ANALYSIS OF ECONOMIC COHESION IN THE EUROPEAN UNION IN 2007

1. Introduction

It was agreed in the Treaty of Rome establishing the European Economic Community that the integration process should bring about diminishing regional disparities among member states. At that time it was believed that market mechanism itself would help achieve the goal of inner cohesion, so no special policies or actions were implemented [Pelkmans 2006].

Gradual development of the European Communities, however, resulted in a growing gap between the rich and the poor member economies. That is why Structural Funds and – later – Cohesion Fund were introduced [Nowak, Milczarek (eds.) 2006].

Eastern enlargement of the European Union has resulted in a further, quite considerable rise of inner diversification of the EU. Thus the number one objective of the EU policy for the period 2007-2013 is to promote socio-economic cohesion of the block. It is reflected in the current financial framework of the European Union, where a huge amount of money is eligible for poor regions (characterized by *per capita* GDP lower than 75% of the average for the EU) and poor countries (characterized by *per capita* GDP under 90% of the average for the EU) as well as the so called "statistical effect" regions [Nugent 2006].

The processes of globalisation and internationalisation get more and more intense in contemporary world economy. Thus it is necessary to stimulate the competitive growth of an economy in order to meet global challenges. If the European Union is to fulfil the requirements and objectives of the Lisbon Strategy and become the most competitive subject in the world economy (or at least one of the most competitive ones) it has to overcome the obstacles of insufficient cohesion [Runiewicz-Wardyn M. (ed.) 2008].

An attempt has been made to examine and evaluate the level and degree of economic cohesion of 27 EU Member States. The methods of multidimensional comparative analysis have been applied. Major Statistical Office and Eurostat served as sources of statistical data. Research was done for 2007, because it was impossible to collect a complete set of data for the later period of time.

2. Methodology of research

One of taxonomic methods have been used for the analysis. Multidimensional methods of comparative analysis seem to be quite useful here due to the fact that as many as 27 economies are subject to comparisons and in addition to that one has to apply a great number of indices. The research was based on Z. Hellwig's taxonomic measure of development [Malina, Zeliaś 1996; Nowak 1990; Pluta 1977; 1986].

The research included the following operations:

- determining the set of diagnostic variables: $\{x_1, x_2, ..., x_m\}$,
- determining the character of each of variables (stimulus, destimulus),
- standardizing the j variable in i unit:

$$z_j = \frac{x_{ij} - \bar{x}_j}{S_{x_j}}, \qquad i=1, 2, ..., n; \quad j=1, 2, ..., m,$$

where: x_{ij} – empirical value of j variable in i unit,

$\bar{x}_j$ – arithmetic mean of x_j diagnostic variable,

S_{x_j} – standard deviation in x_j diagnostic variable distribution;

- constructing development model – a model unit where values of diagnostic variables are determined according to the rule:

$$z_{0j} = \max_i (z_{ij}) \text{ for stimuli,}$$

or

$$z_{0j} = \min_i (z_{ij}) \text{ for destimuli;}$$

- using Euclid's measure to calculate the distance of i-unit from the development model:

$$d_{oi} = \sqrt{\sum_{j=1}^{m} (z_{ij} - z_{oj})^2};$$

- calculating taxonomic measure of development (TMD) according to the formula:

$$\text{TMD}_i = 1 - \frac{d_{oi}}{d_o}, \qquad I = 1, 2, ..., n,$$

where: $d_0 = \bar{d}_o + 2S_0$,

and:

$$\bar{d}_0 = \frac{1}{n}\sum_{i=1}^{n} d_{oi}\,, \qquad S_0 = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(d_{oi} - \bar{d}_o)^2}\,,$$

while: $TMR_i \in [0; 1]$, for i=1, 2, ..., n;

- arranging the analysed subjects in order according to the level of development expressed by taxonomic measure of development (TMD).

The achieved results were compared with the competitive position of EU member economies in the world competitiveness report 2008.

3. Results of the analysis

The comparison of 27 EU member economies with the usage of Z. Hellwig's method of taxonomic analysis was made for the year 2007. The following set of economic data was used:

X_1 – per capita GDP,
X_2 – GDP growth,
X_3 – rate of inflation,
X_4 – harmonized unemployment rate,
X_5 – activity rate,
X_6 – budget deficit/surplus in relation to GDP,
X_7 – general government debt in relation to GDP,
X_8 – index of industrial production,
X_9 – share of services in gross value added,
X_{10} – exports *per capita*,
X_{11} – broadband penetration rate,
X_{12} – e-government on-line availability.

The majority of variables are considered to be stimuli, while three of them, namely: rate of inflation, harmonized unemployment rate and general government debt in relation to GDP are treated as destimuli. Budget surplus has been treated as a stimulus.

The application of the chosen method of multidimensional comparative analysis has let me find the best and worst economies as well as determine Poland's position among the 27 EU member economies. Data used for the analysis have been presented in Table 1.

The initial analysis of the data has led to the following conclusions:

- EU economies are very differentiated with respect to the level of *per capita* GDP. Luxembourg is the richest country with *per capita* GDP over 75 000 EUR, while Bulgaria is the poorest one – *per capita* GDP below 4000 EUR;
- The average GDP growth for EU-27 in 2007 was 4.6%; the highest level of GDP growth was observed in Latvia – 10.1%;

Table 1. Input data

Economy	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
Austria	32796	103.4	102.2	4.4	74.7	–0.5	59.1	104.9	66.9	14299.5	18.4	100.0
Belgium	31131	102.8	101.8	7.5	67.1	–0.2	84.9	102.7	75.0	29578.4	23.9	60.0
Bulgaria	3773	106.2	107.6	6.9	66.3	3.4	18.2	109.1	61.5	1762.4	5.7	15.0
Cyprus	19822	104.4	102.2	3.9	73.9	3.3	59.8	103.1	78.6	1270.6	11.1	45.0
Denmark	41703	101.8	101.7	3.8	80.2	4.4	26.0	100.4	73.0	13827.8	37.2	63.0
Estonia	11550	107.1	106.7	4.7	72.9	2.8	3.4	106.7	68.5	5961.3	20.0	70.0
Finland	33806	104.4	101.6	6.9	75.6	5.3	35.4	104.4	64.6	12384.2	28.8	67.0
France	29764	102.2	101.6	8.3	70.2	–2.7	64.2	101.5	77.2	6351.8	22.3	70.0
Greece	20450	104.0	103.0	8.3	67.0	–2.8	94.5	102.2	73.3	1536.7	6.8	45.0
Spain	23392	103.8	102.8	8.3	71.6	2.2	36.2	101.9	66.9	3919.4	16.8	70.0
Ireland	42510	105.3	102.9	4.6	72.4	0.3	25.4	107.2	63.4	20270.3	15.5	50.0
Lithuania	8294	108.8	105.8	4.3	67.9	–1.2	17.3	104.0	61.4	3702.6	12.7	35.0
Luxembourg	75208	104.5	102.7	4.7	66.3	2.9	6.8	100.3	85.2	34166.7	24.6	40.0
Latvia	8743	110.3	110.1	6.0	72.8	0.0	9.7	100.5	74.7	2680.1	11.6	30.0
Malta	13203	103.8	100.7	6.4	59.5	–1.8	62.6	104.4	75.9	5134.5	13.9	95.0
Netherlands	34155	103.5	101.6	3.2	78.5	0.4	45.4	103.1	73.7	24534.5	33.1	63.0
Germany	29462	102.5	102.3	8.4	76.0	0.0	65.0	106.1	69.0	11764.0	21.1	74.0
Poland	8095	106.6	102.6	9.6	63.2	–2.0	45.2	109.5	64.6	2670.4	6.8	25.0
Portugal	15347	101.8	102.4	8.0	74.1	–2.6	63.6	101.8	72.9	3525.6	14.8	90.0
Czech Republic	12396	106.5	103.0	5.3	69.9	–1.6	28.7	108.8	59.3	8641.4	12.2	55.0
Romania	5634	106.0	104.9	6.4	63.0	–2.5	13.0	105.0	55.3	1364.5	6.6	35.0
Slovakia	10154	110.4	101.9	11.1	68.3	–2.2	29.4	112.8	60.1	7874.7	6.9	35.0
Slovenia	16601	106.1	103.8	4.8	71.3	–0.1	24.1	106.2	63.5	10852.3	15.3	90.0
Sweden	36292	102.7	101.7	6.1	79.1	3.5	40.6	104.1	69.8	13489.3	28.3	75.0
Hungary	10054	101.3	107.9	7.4	61.9	–5.5	66.0	108.3	66.4	6861.6	11.6	50.0
United Kingdom	33095	103.1	102.3	5.2	75.3	–2.9	43.8	100.2	77.4	5237.6	23.8	89.0
Italy	25861	101.5	102.0	6.1	62.5	–1.9	104.0	99.8	70.9	6039.6	15.9	70.0

Source: Eurostat data and Central Statistical Office data, cited after: [*Polska w Unii*... 2008; *Mały rocznik*... 2008; *European Innovation Scoreboard 2007*... 2008; *European Innovation Scoreboard 2008*... 2009].

- The biggest problem of inflation was noted in Latvia – prices grew by more than 10% in 2007, while the lowest inflation was characteristic for Malta (0.7%) and the average rate of inflation for EU-27 equalled 3.3%;
- In 2007 unemployment rate in the Netherlands was just 3.2%, while in Slovakia it exceeded 11%. The average rate of unemployment for EU-27 amounted to 6.3%;
- The level of activity in EU member economies also varied to a great extent, reaching the maximum of 80.2% in Denmark and the minimum of 59.5% in Malta. The average level of activity for EU-27 equalled 70.4%;
- The problem of budget deficit close to 3% GDP was observed in the UK and Greece. Hungary noted budget deficit of 5.5% GDP. At the same time Finland and Denmark achieved budget surplus of 5.3 and 4.4% GDP respectively;

- General government debt in relation to GDP amounted to as much as 104% in Italy and only 3.4% in Estonia. Luxembourg and Latvia noted general government debt below 10% GDP;
- It is believed that there is a strong correlation between the level of economic development and the importance of service sector in the economy. With respect to EU economies the highest share of service sector in GDP creation is characteristic for Luxembourg (over 80%), in the UK it is close to 80%. On the other hand for countries like Bulgaria, Slovakia and the Czech Republic it is about 60% and in case of Romania even less than that;
- For the creation and evolution of knowledge economy, a well developed ICT sector is needed. The analysis of indices connected with ICT sector (namely broadband penetration rate and e-government on-line availability) let me conclude that the most favourable situation is observed in Scandinavian countries and the UK.
- Poland, Romania, Bulgaria, Cyprus, Latvia and Greece constitute the group of economies with the smallest exports *per capita*.

The results of the analysis with the application of Z. Hellwig's taxonomic measure of development (TMD) have been presented in Table 2, while the ranking list of EU economies according to TMD has been shown both in Table 3 and Figure 1. It stems from the data that the Netherlands, Luxembourg, Sweden, Denmark, Finland and Ireland constitute the group of economies with the highest TMD. In 2007 they all achieved TMD higher than 0.4. In case of Hungary, Romania, Greece, Poland and Bulgaria TMD is below 0.1. They are the least developed EU economies. Estonia and Slovenia are fairly well developed. In their case TMD is the highest of all new EU members. Greece and Italy are the least developed economies among old EU members (as far as TMD is concerned).

Table 2. Taxonomic measure of development (TMD) for EU economies in 2007

Economy	TMD	Economy	TMD
Austria	0.365	Malta	0.195
Belgium	0.304	Netherlands	0.456
Bulgaria	0.098	Germany	0.313
Cyprus	0.269	Poland	0.097
Denmark	0.407	Portugal	0.177
Estonia	0.332	Czech Republic	0.248
Finland	0.402	Romania	0.060
France	0.231	Slovakia	0.132
Greece	0.094	Slovenia	0.328
Spain	0.248	Sweden	0.423
Ireland	0.405	Hungary	0.043
Lithuania	0.173	United Kingdom	0.301
Luxembourg	0.446	Italy	0.115
Latvia	0.135		

Source: own calculations.

Table 3. Ranking list of EU-27 economies according to TMD in 2007

Economy	TMD	Economy	TMD
Netherlands	0.456	Czech Republic	0.248
Luxembourg	0.446	France	0.231
Sweden	0.423	Malta	0.195
Denmark	0.407	Portugal	0.177
Ireland	0.405	Lithuania	0.173
Finland	0.402	Latvia	0.135
Austria	0.365	Slovakia	0.132
Estonia	0.332	Italy	0.115
Slovenia	0.328	Bulgaria	0.098
Germany	0.313	Poland	0.097
Belgium	0.304	Greece	0.094
United Kingdom	0.301	Romania	0.060
Cyprus	0.269	Hungary	0.043
Spain	0.248		

Source: own calculations.

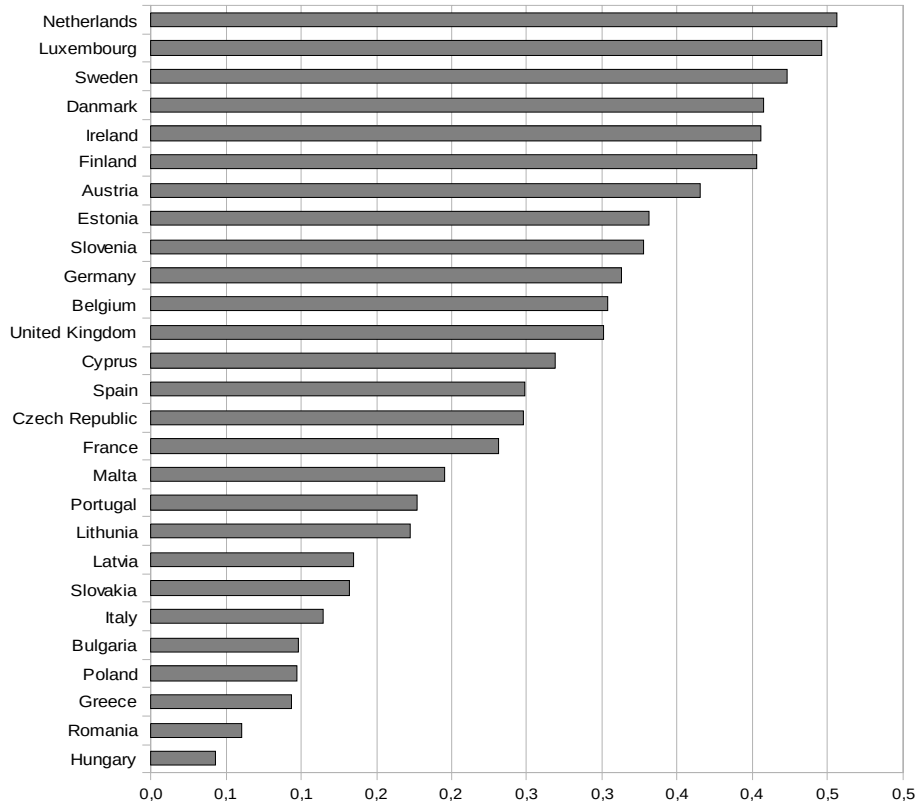

Figure 1. Graphical presentation of economic development of EU economies according to Z. Hellwig's TMD

Source: own presentation.

One should however remember that the analysis was made for a given set of variables and a certain period of time.

The achieved results were compared with the evaluation of EU economies by the World Economic Forum experts. Table 4 presents Global Competitiveness Index 2008-2009 for 27 EU economies. Although the methodology adopted by the World Economic Forum differs considerably from the one applied in the paper, again Bulgaria, Romania, Greece, Hungary, Poland were classified as the least competitive economies of all 27 EU member countries. Denmark, Sweden, Finland, the Netherlands and Germany took the leading positions.

Table 4. Global Competitiveness Index 2008-2009 for 27-EU economies

Economy	GCI rank	GCI score	Economy	GCI rank	GCI score
Denmark	3	5.58	Cyprus	40	4.53
Sweden	4	5.53	Slovenia	42	4.50
Finland	6	5.50	Portugal	43	4.47
Germany	7	5.46	Lithuania	44	4.45
Netherlands	8	5.41	Slovakia	46	4.40
United Kingdom	12	5.30	Italy	49	4.35
Austria	14	5.23	Malta	52	4.31
France	16	5.22	Poland	53	4.28
Belgium	19	5.14	Latvia	54	4.26
Ireland	22	4.99	Hungary	62	4.22
Luxembourg	25	4.85	Greece	67	4.11
Spain	29	4.72	Romania	68	4.10
Estonia	32	4.67	Bulgaria	76	4.03
Czech Republic	33	4.62			

Source: [*The Global Competitiveness*... 2008].

4. Conclusions

The importance of economic and social cohesion has been stressed by EU officials for a long time. A couple of decisions made by the EU required increased cohesion. Economic and Monetary Union creation was connected with the necessity of nominal and real cohesion. If the EU is to reach a higher level of international competitiveness which would fall in line with Lisbon Strategy recommendations and objectives, again stronger cohesion is necessary.

Almost all stages of EU enlargement, however, have resulted in increased disparities among member economies and regions. That is why the EU implements special financial instruments designed for poor regions and poor member states; structural funds and Cohesion Fund are a good example here.

The application of Z. Hellwig's taxonomic measure of development for the analysis of economic cohesion of EU in 2007 has proven the existence of considerable differences among EU member economies. An outstanding position of six economies,

namely the Netherlands, Luxembourg, Sweden, Denmark, Finland and Ireland ought to be underlined. Among the least developed EU member economies in 2007 (according to TMD) one should list: Hungary, Romania, Greece, Poland and Bulgaria.

The years 2008 and 2009 brought about financial and economic crisis in the world economy. The crisis may result in broadening the gap between the poor and the rich. The overall effects of the crisis will largely depend on actions undertaken by the EU as well as by individual member states.

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