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ALEKSANDRA ŁUCZAK, FELIKS WYSOCKI

Poznań University of Life Sciences, Poland

SOCIAL AND ECONOMIC DEVELOPMENT STATUS OF EUROPEAN UNION COUNTRIES

Key words: socio-economic development, development status, positional TOPSIS, bilinear ordering

ABSTRACT. The purpose of this paper is to compare the social and economic development statuses of European Union countries in 2005 and 2016. The study relied on bilinear ordering with the use of positional TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) approach. By applying these methods, it was possible to determine the development levels in social and economic fields, and in socio-economic development levels (six levels: from very low to very high). Furthermore, four main types of development status were identified: socially and economically beneficial; economically beneficial; socially beneficial; and socially and economically less beneficial. Central and Eastern European countries (including Poland in particular) witnessed a clear improvement in their development statuses in 2016 compared to 2005. In turn, countries experiencing clear deterioration primarily include Greece. In both years under consideration, Denmark and Luxembourg were the only countries to maintain a very high level of socio-economic development accompanied by a socially and economically beneficial development status. Eurostat data provided the empirical basis for this study.

INTRODUCTION

Irrespective of the political and economic system, socio-economic development is the key challenge facing central and local authorities around the world [Kacprzyk 2001]. Because of its complexity, it is difficult to clarify and measure the essence of development [Domański 2006, Hausner 2012]. In general terms, development is defined as a long-term process of positive qualitative and quantitative changes which includes economic, social and territorial processes spanning over countries and regions [Korenik 2007, Brol 2008]. At a regional level, development primarily means an improvement in the population's living standards due to growth of regional economic potential. At the same time, regional development contributes to regional competitiveness which, in turn, drives socio-economic development at a national level [Kozak et al. 2000]. Socio-economic development can be defined as "making improvements to the economic potential, and creating and maintaining working conditions and a quality of life at a level satisfactory to the population" [Wysocki 2010]. In this sense, development could mean a specific inherent process supported by the activity of public authorities [cf. Cowen, Shenton 1996]. In a competitive environment, social and economic changes taking place in European Union countries provide a good

reason to investigate changes in both development levels and socio-economic development statuses. The development level specifies the degree (condition, characteristics) of development of a country in social and economic terms in a defined period [Wysocki 2010]. The development status shows the socio-economic situation of different European Union countries against a background of other Union members, and specifies whether a country has or does not have a competitive advantage.

Due to the complexity and relevance of this problem, a comprehensive and methodological approach needs to be adopted. The main purpose of this paper is to compare European Union countries by social and economic development statuses in 2005 and 2016. The study relied on the TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) approach [Hwang, Yoon 1981] in its positional variant [Lira et al. 2002, Młodak 2009, Łuczak, Wysocki 2013b]. This allowed to identify the level and status of social and economic development of different countries. Eurostat data provided the empirical basis for this study [GUS 2017, Eurostat 2018].

RESEARCH METHODS

The TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) approach [Hwang and Yoon 1981] together with the Weber spatial median [Lira et al. 2002] were proposed to assess the level of social and economic development of European Union countries. The procedure of TOPSIS in positional formulation comprises the following seven steps:

1. Selecting social and economic variables.
2. Identifying the nature of variables.
3. Normalizing the values of variables.
4. Calculating the distance of each object from the positive ideal solution (PIS) and negative ideal solution (NIS).
5. Calculating the two synthetic sub-measures (for the levels of social and economic development, respectively) and the general synthetic measure of the level of socio-economic development.
6. Linear ordering and determining the levels of socio-economic development.
7. Bilinear ordering and identifying the types of development status.

In the first step, two independent sets of variables are used to describe social and economic aspects (sub-criteria) in European Union countries. When choosing the variables, a decisive role should be played by substantive grounds supported by a statistical analysis [Wysocki 2010]. The next step consists of determining the way in which each variable affects the sub-criterion considered. Hence, the variables selected are classified as stimulants, destimulants and nominants (step 2). In step 3, the variables are normalized for each sub-criterion in order to make them mutually comparable. The normalization procedure consists of rescaling the variables and unifying their orders of magnitude. Source literature provides a multitude of methods for the normalization of variables [see Walesiak 2014]. Variables considered to be destimulants may be converted into stimulants with the use of a negative coefficient transformation [see eg. Łuczak, Wysocki 2013b]:

$x_{ik} := a - b \cdot x_{ik}$, ($i = 1, 2, ..., N$; $k = 1, 2,..., K$)

where: x_{ik} – the value of the k-th variable for the i-th European Union country, a and b – constants set arbitrarily (usually, $a = 0$, $b = 1$); the substitution symbol (:=) means that the value of a variable was substituted with a converted value.

When assessing the levels of social and economic development of European Union countries, variables with atypical values (outliers) are a common occurrence, and affect the quality of defined synthetic measures. This can be solved by using the Weber spatial median which is robust to outliers [Lira et al. 2002, Młodak 2009, Łuczak, Wysocki 2013b]:

$$z_{ik} = \frac{x_{ik} - \widetilde{med}_k}{1.4826 \cdot \widetilde{mad}_k}, \ (i = 1, 2, ..., N; k = 1, 2,..., K)$$

where: x_{ik} – the value of the k-th variable for the i-*th* European Union country, $\widetilde{med}_k$ – the component of the Weber median vector Θ for the k-th variable, $\widetilde{mad}_k = med_i \left| x_k - \widetilde{med}_k \right|$ – the absolute median deviation, i.e. the median of absolute deviations of the variable from the Weber median corresponding to the k-th variable; 1.4826 is the constant scaling coefficient [see Młodak 2006, 2009].

The fourth step consists of calculating the coordinates of the positive ideal solution (PIS):

$$A^+ = \left(\max_i (z_{i1}), \max_i (z_{i2}), ..., \max_i (z_{iK}) \right) = \left(z_1^+, z_2^+, ..., z_K^+ \right)$$

and of the negative ideal solution (NIS):

$$A^- = \left(\min_i (z_{i1}), \min_i (z_{i2}), ..., \min_i (z_{iK}) \right) = \left(z_1^-, z_2^-, ..., z_K^- \right)$$

The coordinates are then used as a basis for calculating the absolute median deviation from the PIS (A^+) and from the NIS (A^-) [Wysocki 2010]:

$$d_i^+ = med_k \left(\left| z_{ik} - z_k^+ \right| \right), \ d_i^- = med_k \left(\left| z_{ik} - z_k^- \right| \right), \ (i = 1, 2, \ldots, N)$$

where: $med_k(\cdot)$ – the marginal median for the k-th variable.

The next (fifth) step is the construction of synthetic sub-measures based on the TOPSIS aggregation formula [Hwang, Yoon 1981, Wysocki 2010]:

$$S_i^{(\bullet)} = \frac{d_i^-}{d_i^+ + d_i^-} \ (i = 1, 2, \ldots, N), \ 0 \le S_i^{(\bullet)} \le 1$$

where (•) means S for the social field and E for the economic field.

Then, the general measure of the level of socio-economic development is calculated as:

$$S_i = \frac{S_i^S + S_i^E}{2}, \ (i = 1, 2, \ldots, N)$$

The values of synthetic measure S_i range from 0 to 1. The higher the synthetic measure of development, the higher the development level of the European Union country concerned.

Once linearly ordered, the values of the synthetic measure S_i provide a basis for the creation of typological classes (step 6). These can be created using statistical methods or defined arbitrarily [see Wysocki 2010]. This paper used the arbitral approach with the following numeric intervals for S_i values: class 1 (very high level of development): $0.8 \leq S_i \leq 1$; class 2 (high level): $0.6 \leq S_i < 0.8$; class 3 (medium-high level): $0.5 \leq S_i < 0.6$; class 4 (medium-low level): $0.4 \leq S_i < 0.5$; class 5 (low level): $0.2 \leq S_i < 0.4$; class 6 (very low level): $0 \leq S_i < 0.2$.

Based on the values of synthetic measures S_i^S and S_i^E, European Union countries can be bilinearly ordered to represent them in two-dimensional Euclidean space. The method proposed for bilinear ordering allows to determine the development status of European Union countries in relation to other Union members, and to identify their socio-economic development types. In this approach, the coordinates of a location relative to social and economic fields can be calculated as follows:

$$WS_i = S_i^S - IS\,,\ WE_i = S_i^E - IE$$

where: *IS* and *IE* are the reference values for social and economic fields, respectively, which can be calculated as the mean (median) of sub-measures for both fields.

Four main types of socio-economic development status can be identified depending on which of the values of synthetic measures prevail; (*S*+*E*+): socially and economically beneficial (above-average development of social and economic fields); (*S*+*E*-): socially beneficial (above-average development of the social field); (*S*-*E*+): economically beneficial (above-average development of the economic field); (*S*-*E*-): socially and economically less beneficial (below-average development of social and economic fields).

RESULTS OF RESEARCH

Research on the socio-economic development level of European Union countries relied on 2005 and 2016 Eurostat statistical data[1]. The variables, which provide a description of European Union countries in social and economic terms, were selected in the first step of this study. The social field is described with variables related to demographic changes, the labour market, education, poverty, living conditions and public health, i.e.: the share of people in households (other than working people aged 18-59) (%) (x_1); the long-term unemployment rate (%) (x_2); the share of adults participating in education and training in the total population of the same age group (%) (x_3); the share of young people not in further education in the total population of the same age group (%) (x_4); the people at risk of poverty or social exclusion – the percent of persons at risk of poverty and/or suffering from severe material deprivation and/or living in households with low work intensity

[1] The study was carried out for both years under consideration in a countries × years layout, making it possible to perform comparative analyses. $N = 56$, i.e. 28 countries × two years covered by this study. The variables used in the study were expressed in current prices.

in the total population (%) (x_5); inequality of income distribution[2] (x_6); the Euro Health Consumer Index (EHCI)[3] (score) (x_7); the Human Development Index (HDI) (x_8).

The economic field was represented by variables relating to innovativeness, economic development, and production and employment patterns, i.e.: human resources in science and technology as a share of the active population in the age group 25-64 (x_9); the ratio of expenditures on R&D in relation to the GDP (%) (x_{10}); gross domestic product per capita in PPP[4] (x_{11}); the ratio of general government gross debt to GDP (%) (x_{12}); the average monthly income of the population (EUR) (x_{13}); the rate of total economic activity (%) (x_{14}); the socio-economic inactivity rate for young people aged 15-24 (%) (x_{15}).

The second step assumed that seven variables are destimulants ($x_1, x_2, x_4, x_5, x_6, x_{12}, x_{15}$) while others are stimulants. The variables with a destimulating effect were converted into stimulants with the use of a negative coefficient transformation. The set of variables retained for the study includes variables which demonstrate a strong asymmetry and outliers. This is especially true for variables x_2-x_5 and x_{11}. Therefore, the positional method was used as it is robust to outliers and to values of the positive ideal solution and negative ideal solution defined for the set of all European Union countries in 2005 and 2016. The variables were normalized with the use of Weber median[5] standardization (step 4). Following this, absolute median deviations from the positive ideal solution and negative ideal solution were used to calculate the synthetic sub-measures of social and economic development (step 5).

The values of synthetic sub-measures of social and economic development levels of selected European Union countries are shown in Table 1. The synthetic measure of socio-economic development of European Union countries was calculated as the mean of sub-measures (Table 1), and varied in the range of 0.183 to 0.844 in 2005 and 0.213 to 0.875 in 2016. This allowed to identify six development types for European Union countries in 2005 (from very low to very high) and five types in 2016 (from low to very high) (Table 1 and 2).

The method proposed is also suitable for determining the development status of European Union countries in relation to each other. This allowed to identify the relevant statuses of socio-economic development by calculating the coordinates of the countries' location in relation to social and economic fields. The deviations of values of synthetic sub-measures from the mean value (expressed as the median) were used to determine the development statuses of countries in relation to the fields considered.

Four main types of socio-economic status were identified based on the prevalence of the social or economic development level. In 2005, ten European Union countries enjoyed

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[2] This is calculated as the ratio of total income of 20% of highest earners (top quintile) to total incomes of 20% of the lowest earners (bottom quintile) [GUS 2017].

[3] The ratio is defined as the total rating of indicators defined for the following fields (sub-categories) related to healthcare: patients' rights and information, availability (waiting times for treatment), treatment outcomes, scope and coverage of services provided, pharmaceuticals [GUS 2017].

[4] Gross domestic product per capita in Poland, calculated using Purchasing Power Parity (PPP) and expressed in PPS (Purchasing Power Standard, an artificial common currency unit) in relation to the European Union average which is set to be 100 (UE-28 = 100) [GUS 2017].

[5] The calculations were performed in R using the robustX package [Stahel, Maechler 2012].

Table 1. Values of the synthetic measure, sub-measures of socio-economic development and coordinates of the location of selected European Union countries in 2005 and 2016

Country	Year	S_i^S	S_i^E	S_i	WS_i	WE_i	Level of development		
							social	economic	socio-economic
Denmark	2005	0.911	0.777	0.844	0.252	0.278	very high	high	very high
Luxembourg	2005	0.891	0.773	0.832	0.232	0.273	very high	high	very high
Sweden	2005	0.844	0.734	0.789	0.185	0.234	very high	high	high
…	…	…	…	…	…	…	…	…	…
Belgium	2005	0.661	0.484	0.573	0.002	-0.016	high	medium-low	medium-high
The Czech Republic	2005	0.788	0.341	0.564	0.129	-0.159	high	low	medium-high
Spain	2005	0.616	0.455	0.535	-0.043	-0.045	high	medium-low	medium-high
…	…	…	…	…	…	…	…	…	…
Poland	2005	0.391	0.121	0.256	-0.268	-0.379	medium-low	very low	low
Bulgaria	2005	0.364	0.034	0.199	-0.295	-0.466	medium-low	very low	very low
Romania	2005	0.329	0.036	0.183	-0.330	-0.464	medium-low	very low	very low
Sweden	2016	0.875	0.874	0.875	0.216	0.375	very high	very high	very high
Luxembourg	2016	0.808	0.933	0.871	0.149	0.434	very high	very high	very high
Denmark	2016	0.866	0.873	0.870	0.207	0.373	very high	very high	very high
…	…	…	…	…	…	…	…	…	…
Ireland	2016	0.659	0.589	0.624	0.000	0.089	medium-high	medium-high	medium-high
The United Kingdom	2016	0.629	0.576	0.602	-0.030	0.076	medium-high	medium-high	medium-high
Malta	2016	0.685	0.471	0.578	0.026	-0.029	medium-high	medium-low	medium-high
…	…	…	…	…	…	…	…	…	…
Greece	2016	0.317	0.205	0.261	-0.342	-0.295	low	low	low
Bulgaria	2016	0.171	0.345	0.258	-0.488	-0.155	very low	low	low
Romania	2016	0.254	0.171	0.213	-0.405	-0.329	low	very low	low
Mean	2005	0.654	0.440	0.547	IS = 0.659	IE = 0.500	×	×	×
Mean	2016	0.618	0.535	0.577					
min	2005	0.329	0.034	0.183					
min	2016	0.171	0.171	0.213					
max	2005	0.911	0.777	0.844					
max	2016	0.875	0.933	0.875					

Source: own calculations based on Eurostat statistical data

Table 2. Typological classification of European Union countries by socio-economic development level in 2005 and 2016

Typological class	Value of the synthetic measure	Level of development											
		social				economic				socio-economic			
		2005		2016		2005		2016		2005		2016	
		N_c	%	N_c	%	N_c	%	N_c	%	N_c	%	N_c	%
I (very high)	<0.80, 1.00>	7	25.0	7	25.0	0	0.0	3	10.7	2	7.1	3	10.7
II (high)	<0.60, 0.80)	12	42.9	4	14.3	6	21.4	3	10.7	9	32.1	4	14.3
III (medium-high)	<0.40, 0.50)	3	10.7	8	28.6	5	17.9	11	39.3	5	17.9	12	42.9
IV (medium-low)	<0.50, 0.60)	6	21.4	5	17.9	5	17.9	2	7.1	6	21.4	6	21.4
V (low)	<0.20, 0.40)	0	0.0	3	10.7	8	28.6	8	28.6	4	14.3	3	10.7
VI (very low)	<0.00, 0.20)	0	0.0	1	3.6	4	14.3	1	3.6	2	7.1	0	0.0

N_c – the number of the object in the c-th class (c =1, ..., 6)
Source: own calculations based on Eurostat statistical data

a socially and economically beneficial type (*S*+*E*+) (Table 3). There were two countries at a very high level of socio-economic development (Denmark and Luxembourg) and eight countries at a high development level. In 2016, that status was attained by eleven European Union countries which, however, were more heterogeneous in terms of the socio-economic development level (ranging from medium-high to very high) (Table 4). The socially beneficial type (*S*+*E*-) was recorded in five European Union countries in 2005, and in only two countries in 2016.

Table 3. Statuses and levels of socio-economic development of European Union countries in 2005

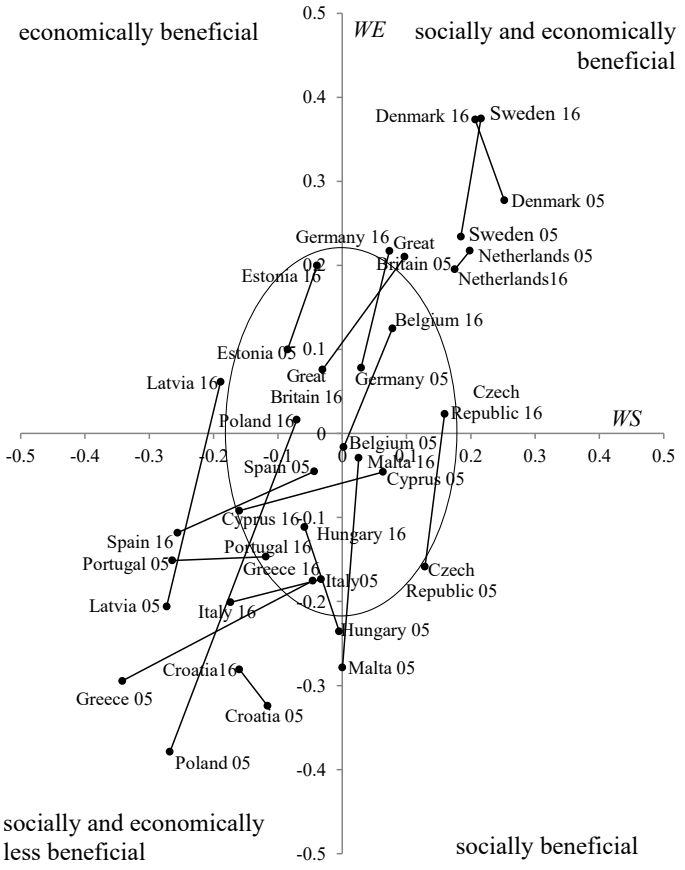
Socio-economic status of development	Socio-economic level of development	Countries
Socially and economically beneficial (*S*+*E*+)	very high	Denmark, Luxembourg
	high	Sweden, the Netherlands, Finland, Great Britain, Austria, Ireland, France, Germany
Socially beneficial (*S*+*E*-)	high	Slovenia
	medium-high	Cyprus, Belgium, the Czech Republic
	medium-low	Malta
Economically beneficial (*S*-*E*+)	medium-high	Estonia
Socially and economically less beneficial (*S*-*E*-)	medium-high	Spain
	medium-low	Greece, Hungary, Lithuania, Slovakia, Italy
	low	Portugal, Croatia, Latvia, Poland
	very low	Bulgaria, Romania

Source: own calculations based on Eurostat statistical data

Table 4. Statuses and levels of socio-economic development of European Union countries in 2016

Socio-economic position of development	Socio-economic level of development	Countries
Socially and economically beneficial (*S*+*E*+)	very high	Sweden, Luxembourg, Denmark
	high	Finland, Austria, the Netherlands, Germany
	medium-high	Belgium, the Czech Republic, Slovenia, France
Socially beneficial (*S*+*E*-)	medium-high	Malta, Slovakia
Economically beneficial (*S*-*E*+)	medium-high	Estonia, Ireland, Great Britain, Poland, Lithuania, Latvia
Socially and economically less beneficial (*S*-*E*-)	medium-low	Hungary, Cyprus, Portugal, Spain, Italy, Croatia
	low	Greece, Bulgaria, Romania

Source: own calculations based on Eurostat statistical data



s_{WS}, s_{WE} – standard deviations of location coordinates of EU countries relative to social and economic fields, respectively, with $s_{WS} = 0.182$ and $s_{WE} = 0.216$

The area bounded by ellipse constitutes countries with an average status

Figure 1. Changes in development statuses of selected EU countries between 2005 and 2016
Source: own elaborations based on [Łuczak, Wysocki 2009, 2013a, Łuczak 2016] and Eurostat statistical data

The next type, economically beneficial (*S-E+*), was composed of countries at a medium-high level of socio-economic development. In 2005, Estonia was the sole representative, whereas in 2016 six representatives were identified. Conversely, in 2005, the largest group (as many as twelve) were representatives of the socially and economically less beneficial type (*S-E-*), compared to nine in 2016.

Figure 1 shows changes in the development statuses of selected European Union countries in 2005 and 2016. Note the clear positive transformation experienced in Poland which represented the socially and economically less beneficial type in 2005 but moved to the economically beneficial type by 2016. Between 2005 and 2016, Belgium, the Czech Republic, Germany, Estonia, Latvia, Sweden, Slovakia, Portugal and Malta witnessed an improvement in both their development statuses and social and economic development levels. In turn, countries which experienced a clear deterioration primarily include Greece (Figure 1). Cyprus, Spain, the Netherlands, Italy and Great Britain saw a deterioration in their social and economic condition with a simultaneous decline in their development status. In all of these countries, the economic situation was largely affected by a decrease in GDP per capita, a reduction in the employment rate for the population aged 20-64 and an increase in the socio-economic inactivity rate for young people aged 15-24. In turn, social decline was driven by the percentage of young people not in further education and by an increased risk of poverty or social exclusion. Note also that some European Union countries recorded an average development status (Figure 1). It should be noted that statuses of countries depend primarily on the set of variables selected. This confirms the thesis put forward by Stanisława Bartosiewicz [2011] that, in research of complex phenomena, the ranking of objects mainly depends on subjectively selected variables.

SUMMARY

This paper proposed an approach to the multidimensional analysis of socio-economic development levels based on positional TOPSIS and bilinear ordering. With these methods, it was possible to determine development levels in social and economic fields, and socio-economic development levels (6 grades: from very low to very high). The above provided the basis for identifying four types of development statuses of European Union countries, i.e.: socially and economically beneficial; economically beneficial; socially beneficial; and socially and economically less beneficial. This study allowed to assess and compare European Union countries by social and economic development status in 2005 and 2016. Central and Eastern European countries (including Poland in particular) witnessed a clear improvement in their development statuses in 2005–2016. In turn, countries which experienced clear deterioration primarily include Greece, severely affected by an economic and political crisis at the time. In both years under consideration, Denmark and Luxembourg were the only countries to maintain a very high level of socio-economic development accompanied by a socially and economically beneficial development status.

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SPOŁECZNA I GOSPODARCZA POZYCJA ROZWOJOWA KRAJÓW UNII EUROPEJSKIEJ

Słowa kluczowe: rozwój społeczno-gospodarczy, pozycja rozwojowa, pozycyjna metoda TOPSIS, porządkowanie biliniowe

ABSTRAKT

Celem pracy jest ocena i porównanie pozycji rozwojowej krajów Unii Europejskiej w latach 2005 i 2016 w aspekcie sytuacji społecznej i gospodarczej. W badaniach zastosowano porządkowanie biliniowe z wykorzystaniem pozycyjnej metody TOPSIS (T*echnique for Order Preference by Similarity to an Ideal Solution*). Metody te pozwoliły na ustalenie poziomów rozwoju w dwóch sferach: społecznej i gospodarczej, a także na wyznaczenie poziomu rozwoju społeczno-gospodarczego (6 poziomów – od bardzo niskiego do bardzo wysokiego). Wyróżniono też cztery główne typy pozycji rozwojowych: społecznie i gospodarczo korzystna, gospodarczo korzystną, społecznie korzystna oraz społecznie i gospodarczo mniej korzystna. Wyraźnie poprawiły pozycję rozwojową kraje Europy środkowo-wschodniej (szczególnie Polska) w 2016 w stosunku do 2005. Do krajów, które wyraźnie pogorszyły swoją sytuację można zaliczyć przede wszystkim Grecję. W obu badanych latach tylko Dania i Luksemburg osiągnęły i utrzymały bardzo wysoki poziom rozwoju społeczno-gospodarczego i jednocześnie ich pozycja rozwojowa była społecznie i gospodarczo korzystna. Podstawę empiryczną przeprowadzonych badań stanowiły dane pochodzące z Eurostatu.

AUTHORS

ALEKSANDRA ŁUCZAK, PROF. PULS, DR HAB.
ORCID: 0000-0002-3149-7748
Poznań University of Life Sciences
Department of Finance and Accounting
28 Wojska Polskiego St., 60-637 Poznań, Poland

FELIKS WYSOCKI, PROF. DR HAB.
ORCID: 0000-0003-2066-7163
Poznań University of Life Sciences
Department of Finance and Accounting
28 Wojska Polskiego St., 60-637 Poznań, Poland