OECONOMIA
COPERNICANA

2012 NR 3
ISSN 2083-1277

Marta Kuc[*]
Nicolaus Copernicus University

THE IMPLEMENTATION OF SYNTHETIC VARIABLE FOR CONSTRUCTING THE STANDARD OF LIVING MEASURE IN EUROPEAN UNION COUNTRIES

JEL Classification: *C38*

Keywords: *standard of living, synthetic variable, taxonomy methods, comparative analysis*

Abstract: *This paper proposes the use of synthetic variable to examine differences in the standard of living in the EU countries. The synthetic variable allows to replace the whole set of variables into one aggregated variable. This variable is the basis for organizing and grouping countries in terms of standard of living. The subject of empirical analysis are 24 member states of the European Union in 1995-2010. The analysis of synthetic variable reveals that there are significant disparities between countries in the field of overall socio-economic development. The analysis show favorable situation in Ireland and very unfavorable conditions in Romania, Bulgaria and the Baltic countries.*

Date of submission: May 24, 2011; date of acceptance: April 21, 2012.

[*] Contact: martakuc@doktorant.umk.pl, Nicolaus Copernicus University, Faculty of Economic Sciences and Management, ul. Gagarina 13a, 87-100 Toruń.

INTRODUCTION

The socio-economic policy has a very important role in the European Union integration process, hence the living standard is the subject of interest for both practitioners and theorists. Without doubts there is a need to analyze the standard of living issue because it is a source for defining the goals and measuring the effectiveness of social policy.

The standard of living is a multidimensional and interdisciplinary category, thus it is hard to define and quantify it in a direct manner. In this paper, the definition proposed by Bywalec and Wydmus (1992) has been used – by standard of living we can understand the degree of satisfying the population's needs of material goods and services consumption, as well as natural and social environment benefits.

The study was carried out for the 24 European Union member states in 1995-2010. The empirical material was taken from databases published by Eurostat, Euromonitor and the World Health Organization.

The synthetic taxonomic variable has been used to describe changes in the standard of living in the European Union countries during 1995-2010. The synthetic variable allows the identification and measuring of spatial differentiation among given countries. To construct the synthetic variables 35 diagnostic variables have been used. All those variables according to formal and essential conditions are crucial to describe the examined phenomenon. The results of analyses allowed to order and group objects in the considered time period.

THE CONSTRUCTION OF SYNTHETIC VARIABLE

In this paper, the standard of living is analyzed using synthetic variable. Such analysis allows to transform the units described by many variables into the one-dimensional space. The transformation from multidimensional space in one-dimensional space requires the following stages (Zeliaś, 2002):

- defining a set of diagnostic variables,
- reduction of the classification dimension,
- determining the impact of variables on the analyzed phenomena,
- determining weights for variables and units,
- variables normalization,
- construction of the synthetic variables.

In the first stage of the study a wide range of potential diagnostic variables has been prepared (84 variables divided into 10 categories). The variables which do not meet the following conditions of formal correctness have been eliminated (Zeliaś 2004):

- data completeness in the considered time period, the accepted level of data missing 10%;
- relatively high volatility,
- no high correlation between variables in the same group,
- asymmetric distribution.

The set of data after elimination consists of 35 variables for 24 European Union countries in time period 1995-2010. Variables have been divided into $p = 10$ groups, which consist of $k_1 = 2$, $k_2 = 2$, $k_3 = 7$, $k_4 = 2$, $k_5 = 2$, $k_6 = 1$, $k_7 = 8$, $k_8 = 3$, $k_9 = 3$, $k_{10} = 5$ respectively. See table 1.

In the second stage of study, the nature of variables has been shown. According to Borys (1978) variables can be divided into three groups:

- stimulants – the higher the value of analyzed variable, the better the studied issue is evaluated,
- destimulants – the lower value of analyzed variable, the better the studied issue is evaluated,
- nominants – there are variables with recommended value range.

Table1. The final set of variables

Variable's symbol	Variables
	1. Population
$X_{1,1}$	Total fertility rate
$X_{1,2}$	Demographic dependency ratio of elderly people (in %)
	2. Labour market and job security
$X_{2,1}$	Unemployment rate (in %)
$X_{2,2}$	Number of deaths due to accident at work per 100000 inhabitants
	3. Health and social care
$X_{3,1}$	Number of deaths due to cancer per 100000 inhabitants
$X_{3,2}$	Number of deaths due to diabetes per 100000 inhabitants
$X_{3,3}$	Number of new AIDS cases per 100000 inhabitants
$X_{3,4}$	Number of doctors per 100000 inhabitants
$X_{3,5}$	Number of nurses per 100000 inhabitants
$X_{3,6}$	Number of hospital beds per 100000 inhabitants
$X_{3,7}$	Obese population (BMI 30kg/sq m or more) as a percentage of population aged 15+

Table 1 Continued

Variable's symbol	Variables
	1. Education
$X_{4,1}$	Number of university students per 1000 inhabitants
$X_{4,2}$	Number of academic teachers per 1 student
	2. Recreation, culture and leisure time
$X_{5,1}$	Annual cinema trips per capita
$X_{5,2}$	Number of hotels per 1000 inhabitants
	3. Living conditions
$X_{6,1}$	Number of newly built dwellings per 1000 households
	4. Transport and communication
$X_{7,1}$	Number of newly registered cars per 1000 inhabitants
$X_{7,2}$	Length of expressways in km per 1 sq km of land
$X_{7,3}$	Proportion of paved roads as a percentage of total road network
$X_{7,4}$	Density of road network in km per 1 sq km of land
$X_{7,5}$	Length of public railway network operated per 1000 sq km of land
$X_{7,6}$	Number of mobile phones subscribers per 100 inhabitants
$X_{7,7}$	Railway passenger traffic in million passenger-km per 1000 inhabitants
$X_{7,8}$	Airline passenger traffic in millions of passenger-km per 1000 inhabitants
	5. Social security
$X_{8,1}$	Number of suicides and self-harm per 100 thousand inhabitants
$X_{8,2}$	Number of divorces per 1000 inhabitants
$X_{8,3}$	Number of crimes per 100 thousand inhabitants
	6. Population incomes and expenditures
$X_{9,1}$	Annual average rate of inflation (in %)
$X_{9,2}$	Gross domestic product per capita in USD
$X_{9,3}$	Household saving as % of disposable income
	7. Degradation and protection of the environment
$X_{10,1}$	Sulfur oxides emissions in kg per capita
$X_{10,2}$	Nitrogen oxide emissions in kg per capita
$X_{10,3}$	Carbon monoxide emissions in kg per capita
$X_{10,4}$	Nationally protected areas as a percentage of land
$X_{10,5}$	Forest land as a percentage of land

Source: Author's own study.

In order to standardize the variables all destimulants has been transformed into stimulants:

$$x'_{ijt} = c - x_{ijt} \qquad (1)$$

$$i = 1,2,\dots,m; j = 1,2,\dots,k; t = 1,2,\dots,n,$$

where:
$x_{ijt} = (x_{1jt}, x_{2jt}, \dots, x_{njt})$ is a destimulant,
$x'_{ijt} = (x'_{1jt}, x'_{2jt}, \dots, x'_{njt})$ is x_{ijt} after transformation into stimulant.
c – constans: $c = 2\bar{x}_{UEj1}$; where $\bar{x}_{UEj1}$ is a weighted average for EU countries in a given time $t = 1$ for jth variable.

Diagnostic variables tend to have different scopes so their direct comparisons are impossible. In this case, the normalization procedures should be applied. In this study the following transformation has been used:

$$s_{ijt} = \frac{x_{ijt}}{\max_i\{x_{ijt}\}}, \qquad (2)$$

$$\max_i\{x_{ijt}\} \neq 0 \;\; i = 1,2,\dots,m; j = 1,2,\dots,k; t = 1,2,\dots,n),$$

where:
s_{ijt} – normalized value of the jth variable on object i in a time t,
x_{ijt} – real value of the jth variable on object i in a time t,
$\max_i\{x_{ijt}\}$ – maximum value of the jth variable.

The value of the pattern should be regarded as a "moving target", i.e. the maximum value which can be achieved in a given year.

In this paper, diagnostic variables have not been weighted because in the case of diagnostic features, most researchers believes that the weighing should rather be avoided (Młodak 2006).

There are variety of methods for creating a synthetic variable Hellwig (1968), Grabiński (1992), Grabiński, Wydmus, Zeliaś (1993), Zeliaś, Malina (1997). In this paper, the Zielias's method has been used. The matrix of standardized diagnostic variables is the basis for the construction of a synthetic variable z according to the formula:

$$z_i = \frac{1}{p}\sum_{q=1}^{p} z_{iq}\,, \qquad (3)$$

$$i = 1,2,\ldots,n;\;\; q = 1,2,\ldots,p,$$

where:
z_i – synthetic variable value describing standard of living in country i,
z_{iq} – synthetic variable value for country i calculated on the base of variables belonging to q group,
p – number of groups.

Creation of a synthetic variable proceeded as follows:
- calculation the synthetic variable for a given group as a mean of the standardized variables,
- construction the synthetic measure according to formula (3) as a mean of synthetic variables calculated for each group.

To allow direct comparison of synthetic variables obtained in different periods of time those variables have to been transformed according to formula:

$$z^*{}_i = \frac{z_i}{\max\limits_i z_i}, \qquad (4)$$

$$i = 1,2,\ldots,n,$$

where:
$z^*{}_i$– transformed synthetic variable,
z_i – synthetic measure value for ith country.

Table 2. Values of synthetic variables for EU countries in a chosen years

No.	Country	1995		1999		2007		2010	
		z_i	z'_i	z_i	z'_i	z_i	z'_i	z_i	z'_i
1	Austria	0,6187	**0,9030**	0,6138	**0,7936**	0,6380	**0,8419**	0,7394	**0,7433**
2	Belgium	0,5492	**0,8015**	0,5283	**0,6831**	0,5548	**0,7321**	0,6592	**0,6626**
3	Bulgaria	0,3104	**0,4530**	0,4323	**0,5590**	0,4382	**0,5782**	0,4793	**0,4818**
4	Denmark	0,5232	**0,7635**	0,5747	**0,7430**	0,5513	**0,7274**	0,6458	**0,6491**
5	Estonia	0,3136	**0,4577**	0,4778	**0,6178**	0,3786	**0,4996**	0,5565	**0,5594**
6	Finland	0,5451	**0,7956**	0,5408	**0,6993**	0,5581	**0,7364**	0,7009	**0,7045**
7	France	0,5949	**0,8682**	0,5936	**0,7675**	0,6001	**0,7919**	0,7319	**0,7357**
8	Greece	0,5441	**0,7940**	0,5708	**0,7380**	0,5567	**0,7346**	0,5992	**0,6024**
9	Spain	0,5249	**0,7661**	0,6128	**0,7923**	0,5766	**0,7609**	0,6164	**0,6196**
10	Netherlands	0,6490	**0,9472**	0,6245	**0,8074**	0,6378	**0,8416**	0,7496	**0,7535**
11	**Ireland**	**0,6852**	**1,0000**	**0,7734**	**1,0000**	**0,7578**	**1,0000**	**0,9948**	**1,0000**
12	Lithuania	0,3655	**0,5333**	0,4374	**0,5655**	0,4281	**0,5649**	0,5427	**0,5456**
13	Latvia	0,3352	**0,4893**	0,4433	**0,5732**	0,4158	**0,5486**	0,4881	**0,4906**
14	Germany	0,6194	**0,9039**	0,5702	**0,7373**	0,6107	**0,8059**	0,6245	**0,6277**
15	Poland	0,4551	**0,6642**	0,5026	**0,6498**	0,4889	**0,6451**	0,5953	**0,5984**
16	Portugal	0,5340	**0,7793**	0,4696	**0,6072**	0,5452	**0,7194**	0,5826	**0,5856**
17	Czech Rep.	0,4583	**0,6688**	0,5210	**0,6736**	0,4855	**0,6407**	0,5966	**0,5998**
18	Romania	0,4011	**0,5854**	0,4720	**0,6103**	0,3578	**0,4722**	0,5247	**0,5275**
19	Slovakia	0,4815	**0,7026**	0,5167	**0,6681**	0,4749	**0,6267**	0,5870	**0,5901**
20	Slovenia	0,4578	**0,6681**	0,5156	**0,6666**	0,4525	**0,5971**	0,5871	**0,5901**
21	Sweden	0,5276	**0,7700**	0,5512	**0,7127**	0,5328	**0,7031**	0,6656	**0,6691**
22	Hungary	0,3866	**0,5642**	0,4501	**0,5820**	0,4127	**0,5446**	0,5384	**0,5412**
23	Great Britain	0,5797	**0,8460**	0,5825	**0,7532**	0,5826	**0,7688**	0,6734	**0,6769**
24	Italy	0,5454	**0,7960**	0,5673	**0,7335**	0,5558	**0,7334**	0,5979	**0,6000**

Source: Author's own study.

After such transformation the values of synthetic variables are normalized in the range $\langle 0,1 \rangle$. The countries in which the value of z'_i variable is closer to 1 have a higher standard of living. Table 2 shows values of synthetic variables z_i and z'_i in all European Union countries in a chosen years.

The highest value of the synthetic indicator describing the standard of living throughout the whole period was obtained in Ireland. The high position of Ireland is mainly due to above-average values of variables from the groups: recreation, culture and leisure time, housing and transport and communications. During the analyzed period in Ireland, we can see a significant growth in tourism and leisure infrastructure. In Ireland, the lowest number of divorces and deaths due to cancer havs been reported. During the whole period Ireland was located at the top in terms of GDP per capita, in the period 2004-2007 Ireland reached a maximum value of this indicator among all EU countries. Ireland is also at the forefront when it comes to education and the widely understood health care. A high value of

described factors places Ireland in the first place in the ranking. The second position in terms of standard of living in 1995-1998 and 2001-2010 was occupied by the Netherlands and Austria in the other years. The countries with the lowest standard of living were Bulgaria, Romania and Latvia.

RANKING OF EUROPEAN UNION COUNTRIES ACCORDING TO THE STANDARD OF LIVING

The calculated values of synthetic variable describing the standard of living in the European Union countries are the basis for organizing these countries from the best to the worst in terms of the studied phenomenon. Grades were given to each country, in such a way that the rank 1 represents the country with the highest value of the synthetic variable, and the rank 24 represents the country with the lowest value of the variable. Table 3 contains the results of organizing the countries of the European Union according to the achieved standard of living.

Analyzing the data in the table below, we can see that substantial changes in ranking order occur. We can observe changes both in plus and in minus. A significant improvement in the standard of living can be observed in Spain which reported a sudden increase in ranking from 13th position in 1995 to 4th position in the year 2007. Spain experienced a boom from 1997 to 2007, but because of the employment crisis and property bubble reached 7th position in 2009 and 11th in 2010. Also in Denmark, a high improvement in the standard of living was noted – moving up in classification from 14th position in 1995 to 7th in 2007. After the global crisis Finland increased in ranking from 12th place in 2007 to 5th place in 2008-2010.

In the whole analyzed time period, the highest position in ranking belongs to Ireland, and later to the Netherlands, Austria and Spain. Countries with the lowest standard of living are Bulgaria, Romania, Lithuania, Latvia and Estonia. A significant deterioration in living standards took place in Portugal which drop in the ranking from number 11th in 1995 to 20th position in 2007. A huge decline in standard of living were also reported in Germany From 3rd position in 1995 to 9th in 2007.

Table 3. Position of EU countries in 1995-2007 according to the achieved standard of living

Country	Year															
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
AT	4	3	3	3	2	2	3	3	3	4	5	4	3	6	4	3
BE	7	8	9	9	11	12	12	13	13	13	13	13	13	10	10	8
BG	24	24	22	22	19	23	22	24	24	23	23	24	24	24	23	24
DK	14	12	11	12	12	10	11	10	10	10	10	8	7	7	9	9
EE	23	23	23	23	23	22	24	23	23	24	22	21	18	19	20	19
FI	9	11	10	10	8	11	10	11	12	12	11	12	12	5	5	5
FR	5	5	5	5	5	5	4	4	5	5	6	5	5	3	3	4
GR	10	7	7	7	9	8	9	8	8	9	4	10	8	11	12	12
ES	13	10	12	11	7	6	5	5	4	3	3	3	4	4	7	11
NL	2	2	2	2	3	3	2	2	2	2	2	2	2	2	2	2
IE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
LT	21	19	19	19	20	21	21	21	22	22	24	23	23	20	19	20
LV	22	22	20	20	21	19	20	20	19	20	21	22	22	22	24	23
DE	3	4	4	4	4	4	6	6	6	7	8	7	9	12	11	10
PL	18	16	16	16	15	16	15	18	16	18	18	17	17	15	13	15
PT	11	14	13	13	13	14	14	14	14	16	17	18	20	16	16	18
CZ	16	17	17	17	16	17	17	15	15	15	15	15	14	14	14	14
RO	19	21	24	24	24	24	23	22	21	21	20	19	19	23	22	22
SK	15	15	15	15	17	15	16	16	18	17	16	16	15	18	17	17
SI	17	18	18	18	18	18	18	17	17	14	14	14	16	17	18	16
SE	12	13	14	14	14	13	13	12	11	11	12	11	11	9	8	7
HU	20	20	21	21	22	20	19	19	20	19	19	20	21	21	21	21
UK	6	6	6	6	6	7	7	7	7	6	7	6	6	8	6	6
IT	8	9	8	8	10	9	8	9	9	8	9	9	10	13	15	13

AT – Austria, BE – Belgium, BG – Bulgaria, DK – Denmark, EE – Estonia, FI – Finland, FR – France, GR – Greece, ES – Spain, NL – the Netherlands, IE – Ireland, LT – Lithuania, LV – Latvia, DE – Germany, PL – Poland, PT – Portugal, CZ – Czech Republic, RO – Romania, SK – Slovakia, SI – Slovenia, SE – Sweden, HU – Hungary, UK – Great Britain, IT – Italy

Source: Author's own study.

In order to verify concordance between two linear orders, the Spearman rho was calculated (B. Monjeardet), according to the formula:

$$r = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)}, \qquad (5)$$

where:
r – Spearman rho,
$d_i = r_{1i} - r_{21}$,
r_{1i} – rank of ith unit in the first ranking,

r_{2i} – rank of ith unit in the second ranking,
n – number of units.

Table 4. Values of Sperman rho comparing the ordering of the European Union in 1995-2010 and the corresponding t-statistic values

Compared years	Values of Spearman's rank correlation coefficient	t-statistic values
1995 and 1996	0,977	21,681
1996 and 1997	0,988	29,784
1997 and 1998	0,999	112,399
1998 and 1999	0,977	21,681
1999 and 2000	0,977	21,681
2000 and 2001	0,990	33,667
2001 and 2002	0,989	30,929
2002 and 2003	0,993	39,557
2003 and 2004	0,988	29,784
2004 and 2005	0,981	23,634
2005 and 2006	0,977	21,262
2006 and 2007	0,986	27,823
2007 and 2008	0,930	11,827
2008 and 2009	0,982	24,206
2009 and 2010	0,981	23,634
1995 and 2010	0,893	9,309

Source: Author's own study.

Afterwards, the statistical significance of the correlation coefficient was examined: Null hypothesis: $Q_s = 0$, Alternative hypothesis: $Q_s \neq 0$, using t-student statistics:

$$t_{(n-2)} = \frac{|r|}{\sqrt{\frac{1-r^2}{n-2}}}, \qquad (6)$$

where:
r – value of Spearman rho,
n – number of units.

The obtained values of t-student statistics were compared to t-student critical distribution for $n-2$ degrees of freedom and $\alpha = 0{,}01$. The critical value for $n = 22$ and $\alpha = 0{,}01$ is $t_\alpha = 2{,}819$.

For all the values presented in table 4 there is a relationship $t_{(n-2)} > t_{\alpha}$ so the null hypothesis is rejected, therefore Spearman rho is statistically significant for α = 0.01. This means that there is a high correlation between rankings of EU countries in the given units of time.

GROUPING THE EUROPEAN UNION COUNTRIES WITH SIMILAR STANDARD OF LIVING BASED ON THE VALUE OF SYNTHETIC VARIABLE

On the basis of previous considerations, the initial classification of EU countries has been made. To create the synthetic measure variable interval was built using mean $\bar{z}$ and the standard deviation s_z. The groups were formed as follows:

- group I (high quality of life): $z_i \geq \bar{z} + s_z$,
- group II (medium quality of life): $\bar{z} + s_z > z_i \geq \bar{z}$,
- group III (low quality of life): $\bar{z} > z_i \geq \bar{z} - s_z$,
- group IV(the lowest quality of life): $z_i \leq \bar{z} - s_z$,

Table 5 includes data underlying the construction of groups of objects.

Table 5. Synthetic variable interval underlying the construction of groups of objects in chosen time units

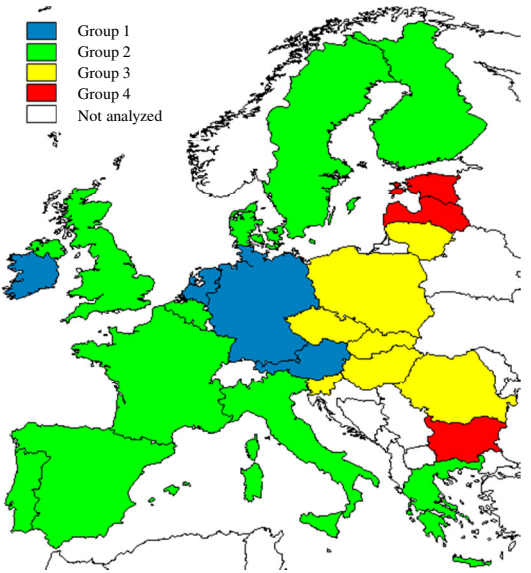
	1995	1999	2007	2010
Group I	$z_1 \geq 0{,}606$	$z_1 \geq 0{,}619$	$z_1 \geq 0{,}616$	$z_1 \geq 0{,}735$
Group II	$0{,}606 > z_i \geq 0{,}500$	$0{,}619 > z_i \geq 0{,}525$	$0{,}616 > z_i \geq 0{,}539$	$0{,}735 > z_i \geq 0{,}628$
Group III	$0{,}500 > z_i \geq 0{,}395$	$0{,}525 > z_i \geq 0{,}430$	$0{,}539 > z_i \geq 0{,}462$	$0{,}628 > z_i \geq 0{,}521$
Group IV	$z_i < 0{,}395$	$z_i < 0{,}430$	$z_i < 0{,}462$	$z_i < 0{,}521$

Source: Author's own study.

Analyzing the results of the classification of the European Union countries based on the value of the synthetic indicator, we can see that significant changes in the standard of living have been observed. Germany and Austria, which in 1995 were in group together with Ireland and the Netherland, in 2003, joined the middle-level group. We can see that the living standard in Portugal and Belgium decreased, in the early years of the analyzed period they belonged to the group of countries with medium standard of living, and later this two countries joined the group of countries with

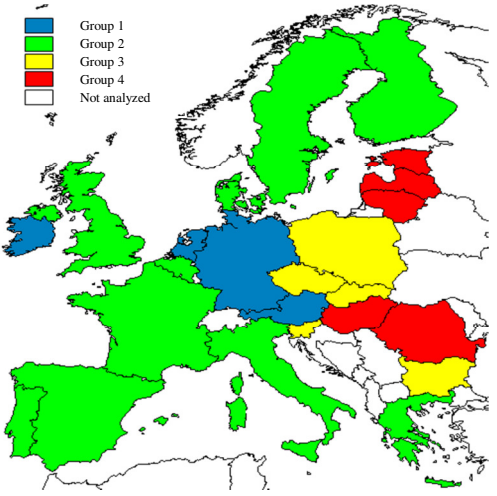
low standard of living. Hungary, originally belonging to the group of countries with low living standards, in the last analyzed year has become a country with the lowest living standard. However, the standard of living has been improved in Estonia, which in 1995, belonged to the group of countries with the lowest standard of living, and in 2007 joined the third group. It is interesting what the situation looked like in 2010. Group III is much bigger than before – it consist of 14 countries, which have the standard of living below the average. We can presume that this is the result of global crisis. Some countries were more affected by global crisis than other. Between 1995-2007 the gap among poor and rich countries was getting smaller, but as a research show after 2007 the disproportions in the standard of living are getting wider. The results of the classification are presented in the figures 1 to 4.

Figure 1. The classification of European Union countries based on the value of synthetic measure in 1995



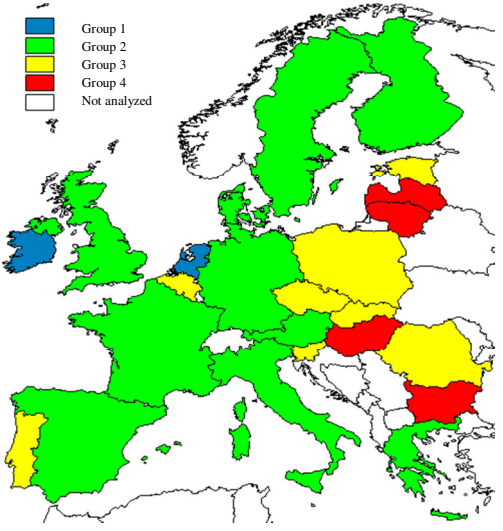
Source: Author's own study.

Figure 2. The classification of European Union countries based on the value of synthetic measure in 1999



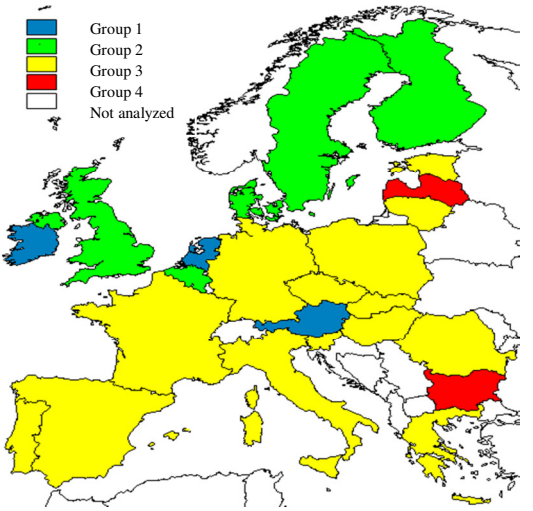
Source: Author's own study.

Figure 3. The classification of European Union countries based on the value of synthetic measure in 2007



Source: Author's own study.

Figure 4. The classification of European Union countries based on the value of synthetic measure in 2010



Source: Author's own study.

CONCLUSIONS

The article explains how to build a synthetic indicator of the standard of living, as well as the possibility of its implementation for organizing and grouping objects. Thanks to using the synthetic variable it was possible to obtain an overall view of the spatial diversity of the living condition in the EU countries. In 1995-2007 an improvement of living conditions in all analyzed countries occurred, however, as the research shows there are still considerable differences in living standards among the "old" and "new" European Union member states. That diversity is connected with the overall socio-economic development of analyzed countries. The gap between poor and reach countries became bigger after the global crisis. In 2010 only 8 countries have the standard of living above the average value. We can presume that the global crisis increases the disproportion among countries in the field of standard of living. The inequities were confirmed by comparing the value of synthetic variable between countries. However, it is clear, that an objective assessment of the standard of living is an exceptionally difficult task, which is mainly due to the complexity of the phenomenon and the difficulty in measurability of diagnostic variables.

LITERATURE

Borys T. (1978), *Metody normowania cech w statystycznych badaniach porównawczych*, „Przegląd Statystyczny" nr 2.

Bywalec Cz., Wydmus S. (1992), *Poziom życia ludności Polski w porównaniu z krajami Europejskiej Wspólnoty Gospodarczej*, „Ekonomista" nr 5.

Grabiński T. (1992), *Metody taksonometrii*, Wydawnictwo AE, Kraków.

Grabiński T., Wydmus S., Zeliaś A. (1993), *Metody prognozowania rozwoju społeczno-gospodarczego*, Wydawnictwo AE, Kraków.

Hellwig Z. (1968), *Zastosowanie metody taksonomicznej do typologicznego podziału krajów ze względu na poziom rozwoju oraz zasady i strukturę wykwalifikowanych kadr*, „Przegląd Statystyczny", nr 4.

Młodak A. (2006), *Analiza taksonomiczna w statystyce regionalnej*, Difin, Warszawa.

Zeliaś A. Malina A. (1997), *O budowie taksonomicznej miary jakości życia.,* „Taksonomia", z. 4.

Zeliaś A. (red.) (2002), *Taksonomiczna analiza przestrzennego zróżnicowania poziomu życia w Polsce w ujęciu dynamicznym*, Wydawnictwo AE, Kraków.

Zeliaś A. (red.) (2004), *Poziom życia w Polsce i krajach Unii Europejskiej*, Wydawnictwo Naukowe PWE, Warszawa.