Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)
An Open Access, Online International Journal Available at http:// http://www.cibtech.org/sp.ed/jls/2014/01/jls.htm
2014 Vol. 4 (S1) April-June, pp. 1492-1500/Borawski and Nermend.
Research Article

METHODOLOGY STUDIES ON SPATIAL AND TIME UNIFORMITY OF BUSINESS ENTITIES IN THE DECISION SUPPORT SYSTEM

[*] Mariusz Borawski[1] and Kesra Nermend[2]
[1]*Faculty of Computer Science and Information Systems, West Pomeranian University of Technology, Szczecin, Poland, mborawski@wi.zut.edu.pl*
[2]*Department of Computer Methods in Experimental Economics, Faculty of Economics and Management, University of Szczecin, Szczecin, Poland, kesra@wneiz.pl*
**Author for Correspondence*

ABSTRACT
In the article Mariusz Borawski proposes the application of the increment arithmetics in the construction of the synthetic vector measure for studying the spatial and time uniformity of business entities. The measure is composed of an ordered pair of mean value increments and a standard deviation increment. As a consequence, additional information about the uniformity of business entities may be gathered. Thanks to the implementation of the proposed method in the DSS system various decision-making variants can be generated in order to support management of the examined business entities.

***Keywords**:* synthetic vector measure, vector space of increments, the increment arithmetics, DSS system various decision-making

INTRODUCTION
The problem of harmonious development of countries has gained importance since the removal of borders within the European Union. This issue is extremely important in the face of the need to eliminate growth disproportions among the EU member states. The disproportions often result from difficult conditions related to a given country's geographical location, poor infrastructure, dominating inefficient industry (which is first of all the case of the new EU members). In order to erase these discrepancies a vast range of programmes have been developed on the local level in every country as well as centrally in Brussels. All of that requires continuous monitoring of the performance and development of individual parts of every country. It is important to learn the structure of each of the countries on all the NUTS levels (gmina, poviat, voivodship, kreis, landkreis, or regions and subregions, etc) (Borys, 1984; Hellwig, 1968; Kukuła, 2000; Młodak, 2006; Nermend, 2009), which makes the disproportions more visible and facilitates the assessment of the socio-economic growth. It also helps to find out which elements of a given state are of principal importance and in which areas domination or decline can be observed. What is more, in the light of today's economic processes, both on the local and global scale, it does not suffice just to describe the level of socio-economic development. We need more suitable measuring instruments to have a deeper insight into the structure of the countries in the European Union. We can make use of a range of methods, including the ones applied in studying time and spatial uniformity. Making such a distinction allows us to observe how a specific country is developing: is this development uniform in time and/or space?
In this paper the authors use a vector measure (Kolenda, 2006; Nermend, 2006; Nermend, 2006; Nermend, 2008) to analyse the uniformity of the EU member states' development. Its advantage is the flexibility of its application in economy, especially in the case of its vectoral variety which employs only a scalar product (Nermend, 2007). Using this approach we can determine a vector measure by means of the arithmetic of increments proposed by M. Borawski (Borawski, 2012), which is responsible for introducing to calculations an additional factor that can convey information relevant for the interpretation of the result (Nermend, 2006; Nermend and Borawski, 2006). This additional information can be the standard deviation increment or the variance increment. Depending on the adopted mode of calculating

the standard deviation increment and/or the variance increment, we obtain information about: uniformity of the set of objects constituting the analysed object (e.g. about the homogeneity of regions within a country) or the size of the change in the measure value over time.

THE METHOD FOR STUDYING SPATIAL AND TIME UNIFORMITY OF REGIONS

The detailed description of the method used by the authors in their study can be found in (Nermend, 2012). To conduct the study we need a real pattern. Therefore, further in the article the authors show how to use a chosen object as a pattern vector, which in this study was a country. In the stage III ordered pairs are computed for the pattern object. We can apply two kinds of approach to determine the ordered pairs' mean values. First, we assume that they are equal to the values of indicators that describe the object. In the second approach we determine them as mean values of indicators over years or as mean values of indicators constituting the object. The second approach was used in the study presented in this article. The values of standard deviations of indicators for the pattern object are not relevant, because they will not be taken into consideration in further calculations.

In the stage IV increments for the pattern object are calculated. Since the object does not differ from the ranked objects (being countries as well), its increments are calculated in the same manner as for the other objects. In the stage VII the chosen object must be normalised just as the other objects. The normalisation should be performed by means of standardisation (see (0). Standardisation parameters are the same as in case of the other objects. It means that the mean values and standard deviations determined for the analysed objects should be used in standardising the pattern object.

In the stage VIII no anti-pattern is determined. A pattern vector is an object that has been normalised. The values that describe this object can be used directly as the pattern vector coordinates. Due to the absence of the anti-pattern, in the stage VI we change the formula determining the values of a synthetic measure for the increments of mean values:

$$\Delta \underset{j}{m_{s\eta}} = \frac{\sum_{i=1}^{M} \Delta \underset{j}{\eta'_i} \Delta \underset{w}{\eta'_i}}{\sum_{i=1}^{M} \Delta \underset{w}{\eta'^2_i}} \qquad (11)$$

where

$\Delta \underset{j}{\eta'_i}$ – increment of the mean value of the i-th normalised variable for the *j*-th object,

$\Delta \underset{w}{\eta'_i}$ – increment of the mean value of the i-th normalised variable for the pattern.

Similarly, we change the way of determining the synthetic measure for standard deviation increments:

$$\Delta \underset{j}{m_{s\sigma \max}} = \frac{\max_i \left(\Delta \underset{j}{\sigma'_i} \right)}{\sqrt{\sum_{i=1}^{M} \Delta \underset{w}{\eta'^2_i}}} \qquad (12)$$

where

$\Delta \underset{j}{\sigma'_i}$ – increment of the mean value of the i-th normalised variable for the *j*-th object,

and for the variance increments:

$$\Delta \underset{j}{m}_{s\sigma^2 \max} = \frac{\sqrt{\max\limits_{i}\left(\Delta \underset{j}{\sigma}_i'^2\right)}}{\sqrt{\sum\limits_{i=1}^{M} \Delta \underset{w}{\eta}_i'^2}} \tag{13}$$

where

$\Delta \underset{j}{\sigma}_i'^2$ – increment of the variance of the i-th normalised variable for the *j*-th object,

The way of determining the maximum possible deviation of the synthetic measure is not changed. The formula is:

$$\Delta \underset{j}{m}_{s\sigma} = \max\left\{\Delta \underset{j}{m}_{s\sigma \max}, \Delta \underset{j}{m}_{s\sigma^2 \max}\right\} \tag{14}$$

In the proposed modified procedure of determining the synthetic measure we do not need to define stimulants and destimulants, because the indicators automatically become stimulants and destimulants conditional on if the values of the pattern object indicators are higher or lower than the mean object value. Calculations necessary to determine the measure are quite complicated and the number of data to be processed is very large, so manual computations are ineffective. The study covers 328 second-level NUTS, 17 indicators over 4 years which gives 22304 data to be analysed. Yet, NUTS2 is not the lowest level. Currently the lowest level of European territorial units is NUTS3, but there are plans to lower it to NUTS4. as a result, the number of the lowest level territorial units in the EU would rise to tens of thousands. There would be 6253 units in the Czech Republic alone. If we want to process such data effectively, we need to apply decision support systems (DSS) which can cooperate with statistical databases available via Internet, such as Eurostat, thus making it possible to automatically generate rankings and to present data in a form of charts or diagrams.

STUDIES ON SPATIAL AND TIME UNIFORMITY OF THE EUROPEAN UNION COUNTRIES

In their studies the authors focused on the structure of employment in technology and knowledge-intensive sectors. The first study dealt with the structure of employment and the changes that took place in the period of 2008-2012. The data came from Eurostat NUTS0 database. The authors used 17 variables: X1 – Agriculture, forestry and fishing; mining and quarrying, X2 – High-technology sectors (high-technology manufacturing and knowledge-intensive high-technology services), X3 – Manufacturing, X4 – Electricity, gas, steam and air conditioning supply; water supply and construction, X5 – Services, X6 – Wholesale and retail trade; accommodation and food service activities; activities of households as employers, X7 – Land transport, transport via pipelines, water transport, air transport, warehousing and support activities for transportation; travel agency, tour operator reservation services and related activities, X8 – Total knowledge-intensive services, X9 – Total less knowledge-intensive services, X10 – Financial and insurance activities, X11 – Professional, scientific and technical activities, X12 – Administrative and support service activities, X13 – Public administration; activities of extraterritorial organisations and bodies, X14 – Education, X15 – Human health and social work activities, X16 – Arts, entertainment and recreation, X17 – Other service activities. The authors used percentage indicators reflecting the relation between the employment in a given sector and the total employment.

Great Britain was selected as a pattern country, which means that in the study the employment structure of every country was compared to the employment structure in Great Britain. Table 1 contains the obtained results. The classification $\underset{j}{\Delta m_{s\sigma}}$ used p_1, p_2, p_3 at the levels of 0.5, 1 and 1.5. As expected, the pattern country falls into the first class, yet it is not the best. It is Sweden whose indicator value is the highest. It means that their employment structures are very similar, but the values of Swedish indicators are higher than the British ones. It may be a consequence of failing to include all the Swedish sectors in the study due to the lack of data. Those Swedish sectors that have not been included in the study (i.e. other than technology and knowledge-intensive sectors) are likely to have low indicators.

Table 1: Values of measures in the study on time uniformity

Object	$\underset{j}{\Delta m_{s\eta}}$	Class	$\underset{j}{\Delta m_{s\sigma}}$	Class	Object	$\underset{j}{\Delta m_{s\eta}}$	Class	$\underset{j}{\Delta m_{s\sigma}}$	Class
SE	1.04	1	0.53	2	IT	0.05	2	1.03	4
UK	1	1	0.68	3	LV	-0.06	3	0.82	3
IS	0.88	1	1.19	4	EE	-0.11	3	0.64	3
DK	0.64	1	0.45	2	LT	-0.13	3	0.34	2
NO	0.59	2	0.21	1	HU	-0.17	3	0.19	1
IE	0.58	2	0.45	2	EL	-0.32	3	0.19	1
FI	0.56	2	0.8	3	SI	-0.4	3	0.15	1
LU	0.54	2	0.6	2	PT	-0.41	3	0.21	1
NL	0.49	2	0.22	1	CZ	-0.57	3	0.24	1
BE	0.43	2	0.35	2	PL	-0.66	4	0.13	1
CH	0.39	2	0.78	3	HR	-0.66	4	0.23	1
DE	0.3	2	0.8	3	SK	-0.66	4	0.37	2
FR	0.29	2	0.56	2	BG	-0.71	4	0.21	1
ES	0.21	2	0.58	2	MK	-0.93	4	0.27	1
MT	0.2	2	0.29	1	TR	-1.09	4	0.41	2
CY	0.17	2	0.56	2	RO	-1.55	4	0.2	1
AT	0.07	2	0.29	1					

Figure 1 shows visualised results of the classification. In the classification $\underset{j}{\Delta m_{s\eta}}$ all the well developed countries belong to the first and the second class. New members of the European Union as well as the aspiring countries have fallen into the third and fourth class. Most of these countries had to transform their systems from communism to capitalism, which was associated with tremendous changes in various areas of life. We could expect that they are still transforming and adapting their economies to the free market conditions, hence such large discrepancies between the new EU members and the countries that used to be called Western Europe. However, the visualised classification $\underset{j}{\Delta m_{s\sigma}}$ does not imply any transformation processes in these countries. Most of them belong to Class I, which means that there are no rapid transformations going on. Changes in their employment structure are much smaller than other countries. The dynamics of changes in the well developed EU countries is much stronger than in the poorer ones.

The authors selected Denmark, Germany, France, Holland, Austria, Sweden and Norway as the group of the wealthiest EU countries and Bulgaria, the Czech Republic, Estonia, Romania, Poland and Slovakia as the less developed EU members. For both groups the mean values of indicators were determined in order to explain the differences in their ranking positions. In the first group we can see a significant difference in their involvement in the knowledge-intensive services (46% do 31 %). It implies their stronger involvement in knowledge-intensive technology and, consequently, in the implementation of these

technology and production of new innovative goods. This in turn requires a quick response to innovative solutions which means that some part of employees need to redirect their careers as a result of some of industries being abandoned and the emergence of the new ones. All of that can explain higher dynamics of changes in employment structure in these countries.
It is noteworthy that the countries from the latter group have a significantly higher Manufacturing indicator than the countries from the former group (ranging from 12.6% to 20%). It means that in the European Union the less developed countries are an industrial base for the wealthy states. Technology and innovations are generated in Western Europe while their production takes place mostly in Central Europe. Higher commitment to manufacturing carries with it increased indicators of Electricity, gas, steam and air conditioning supply; water supply and construction (8.2% in the former group and 10.3% in the latter). It should be noted, however, that the less developed countries' commitment in this area is falling steadily (from 12% in 2008 to 10.3% in 2012), which may mean that they have been redirecting to new technologies which do not require hiring so much workforce.
What is more, the countries from the first group employ more people in the service sector (74.8 % - 59.7%) and in the human health and social work activities (15% - 6,1%). It can be explained by higher living standards in these countries, thanks to which they are able to buy more goods and services and their governments can spend more money on health care. It is also interesting that the countries from the first group employ significantly less workers in agriculture, forestry and fishing; mining and quarrying (2.9 % - 9.9%), which may imply lower efficiency of those who are actually employed in these industries. Lower costs of labour, being a result of lower wages, may mean less need for mechanization.

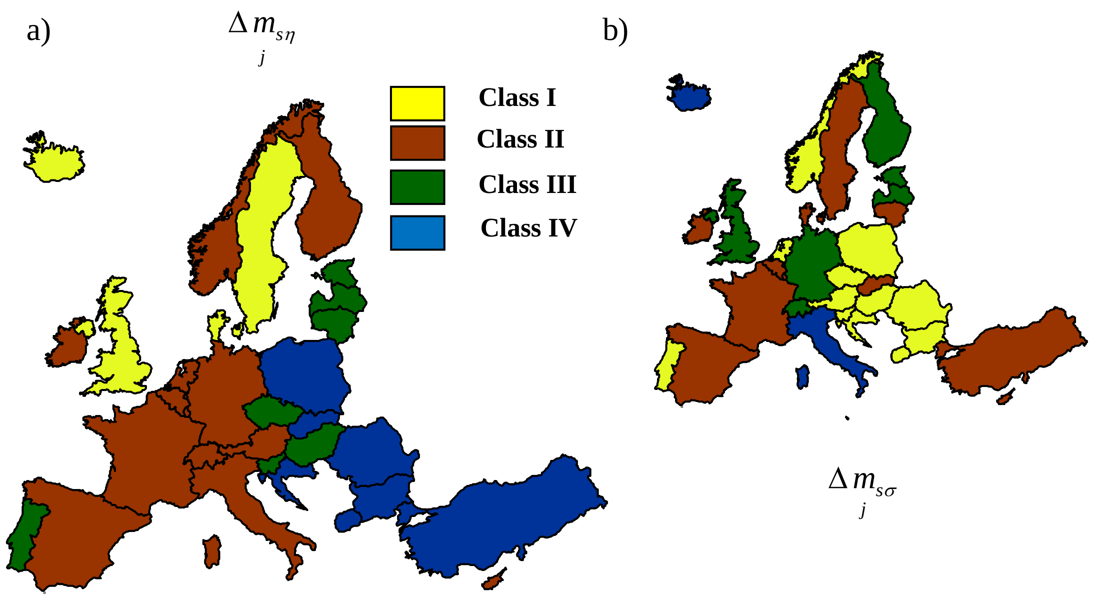

Figure 1: The result of the study on time uniformity: a) classification on the basis of $\underset{j}{\Delta m_{s\eta}}$, b) classification on the basis of $\underset{j}{\Delta m_{s\sigma}}$

In the second study the authors analysed the employment structure and its spatial structure in 2008 and 2011. The year of 2012 was not analysed due to substantial absence of data. The data about NUTS2 came from Eurostat. The analysis covered 17 variables that were analogous to the previous study. The analysis of NUTS0 was conducted on the basis of data for NUTS2. η_{i}^{j} was calculated as the countries' mean basing on NUTS2 data and, similarly, σ_{i}^{j} was computed as the countries' standard deviation also basing on the NUTS2 data. As in the previous study, Great Britain was selected as the patter country. Table 2 shows the study results for 2008, while Table 3 – for 2011. In the classification $\Delta m_{s\sigma}^{j}$ the values of p_1, p_2, p_3 were 0.7, 1 and 1.3, respectively.

Table 2: Values of measures for the study on spatial uniformity in 2008

Object	$\Delta m_{s\eta}^{j}$	Class	$\Delta m_{s\sigma}^{j}$	Class	Object	$\Delta m_{s\eta}^{j}$	Class	$\Delta m_{s\sigma}^{j}$	Class
UK	1.00	1	1.33	4	IT	0.04	2	1.04	4
SE	0.76	1	0.92	4	HU	-0.24	3	0.49	3
BE	0.58	1	0.37	2	SI	-0.26	3	0.50	3
IE	0.50	2	0.57	4	PT	-0.34	3	0.41	2
FI	0.44	2	0.93	4	SK	-0.38	3	0.49	3
DK	0.38	2	0.48	3	CZ	-0.39	3	0.55	3
FR	0.35	2	0.69	4	HR	-0.40	3	0.54	3
NL	0.35	2	0.40	2	EL	-0.43	3	0.38	2
CH	0.34	2	0.70	4	BG	-0.58	4	0.41	2
NO	0.28	2	0.35	2	PL	-0.70	4	0.35	2
AT	0.16	2	0.49	3	RO	-1.56	4	0.45	2
ES	0.10	2	0.53	3					

Table 3: Values of measures for the study on spatial uniformity in 2011

Object	$\Delta m_{s\eta}^{j}$	Class	$\Delta m_{s\sigma}^{j}$	Class	Object	$\Delta m_{s\eta}^{j}$	Class	$\Delta m_{s\sigma}^{j}$	Class
UK	1.27	1	1.56	4	IT	0.10	2	1.01	4
IE	0.86	1	0.91	4	PT	0.06	2	0.56	3
SE	0.86	1	0.94	4	SI	-0.01	3	0.64	4
BE	0.77	1	0.44	2	HU	-0.15	3	0.35	2
DK	0.72	1	0.85	4	SK	-0.19	3	0.48	3
FI	0.66	1	1.02	4	CZ	-0.30	3	0.49	3
NO	0.58	1	0.64	4	HR	-0.35	3	0.51	3
CH	0.53	2	0.86	4	EL	-0.36	3	0.35	2
FR	0.49	2	0.84	4	PL	-0.55	3	0.31	1
ES	0.44	2	0.62	4	RO	-1.22	4	0.49	3
NL	0.33	2	0.45	2	TR	-1.37	4	0.41	2
AT	0.20	2	0.47	3					

Figure 2 shows visualised results of the classification for 2008. It can be seen that, just like before, in the classification $\underset{j}{\Delta m_{s\eta}}$ all the highly developed countries fell in Class I and Class II, while those less developed ones – in Class III and IV. When analysing the findings of the classification $\underset{j}{\Delta m_{s\sigma}}$ we can see that there are many countries that are either well or less developed which are not spatially uniform. The lack of spatial uniformity should be regarded as a disadvantage. When its negative value is high, it means that there are vast discrepancies in the employment structure in a given country. NUTS2 administrative units are usually quite large. According to the EU recommendations their population should range from 800,000 to 3,000,000. Therefore, they are mostly areas of urban or metropolitan character. In many countries there are NUTS units covering just one city, but this form is not dominating locally. For example, in Germany there are 3 such metropolitan areas per 38 administrative units. Therefore, their effect on $\underset{j}{\Delta m_{s\sigma}}$ is not significant. Higher values of $\underset{j}{\Delta m_{s\sigma}}$ mean not the individual differing administrative units, but the differences in large groups of administrative units resulting from their varying geographical or historical background. A good example can be Great Britain where geographical conditions make employment structure in agriculture, forestry and fishing; mining and quarrying sector largely not uniform, especially in the north and central part of the country.

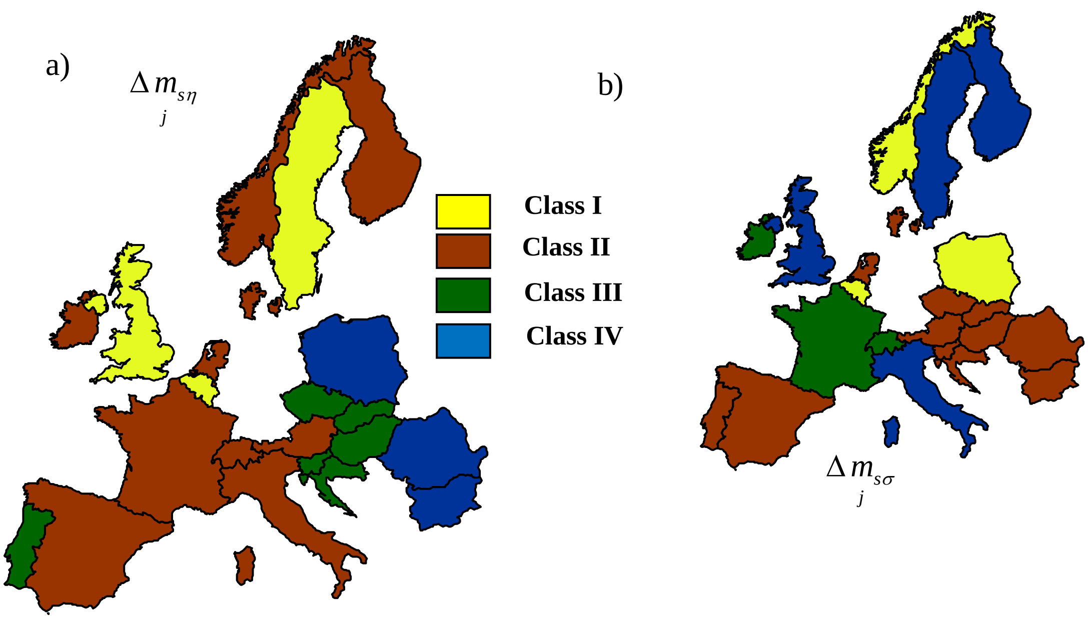

Figure 3: The result of the study on spatial uniformity in 2008: a) classification on the basis of $\underset{j}{\Delta m_{s\eta}}$, b) classification on the basis of $\underset{j}{\Delta m_{s\sigma}}$

CONCLUSIONS

The article presents methodology for the studies on spatial and time uniformity of the European Union countries. The studies on the time uniformity in the employment in technology and knowledge-intensive sectors covered the period of 2008-2012. The study results indicate that the new members of the EU have low volatility of employment structure in contrast to the wealthy EU members, which can be explained by the fact that manufacturing has been moved to the less developed countries due to lower costs of production. This is why the employment structure in the highly developed countries is more changeable than in the new EU member states.

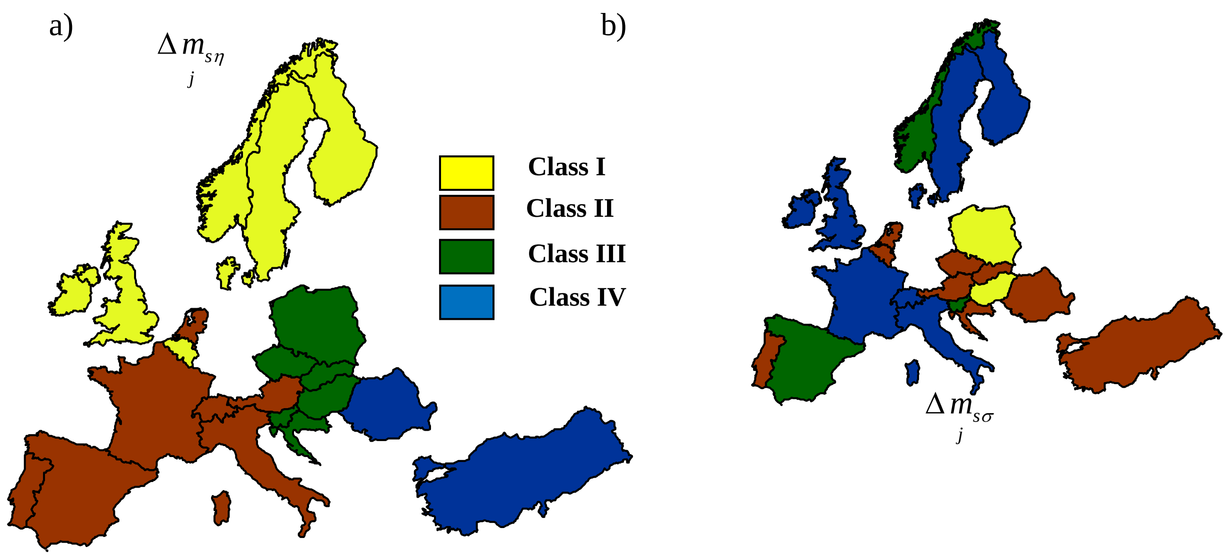

Fig. 1. The result of the study on spatial uniformity in 2011: a) classification on the basis of $\underset{j}{\Delta m_{s\eta}}$, b) classification on the basis of $\underset{j}{\Delta m_{s\sigma}}$

In the next step, the authors examined the spatial changes in the employment structure in these countries basing on data concerning NUTS2. Their research shows that highly developed countries are more changeable in this respect, which should be regarded as a disadvantage. For example, in Great Britain the regions located in the vicinity of the capital city have their employment structure different from the more distant regions. It implies larger concentration of certain types of business activity around a strong centre, which can consequently lead to the aggravation of regional differences. Studies on spatial uniformity can reveal such discrepancies, which can help governments to target specific areas in their programmes to remedy regional imbalances.

The implementation of the proposed method of DSS can be useful in investment and programme planning.

REFERENCE

Borawski M. (2012). Vector space of increments, Control and Cybernetics, **1**.

Borys T. (1984). Kategoria jakości w statystycznej analizie porównawczej, Prace naukowe AE, seria: monografie i opracowania, Wrocław **23**.

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

Kolenda M. (2006). Taksonomia numeryczna. Klasyfikacja, porządkowanie i analiza obiektów wielocechowych. Wrocław, Wydawnictwo Akademii Ekonomicznej im. Oskara Langego we Wrocławiu.

Kukuła K. (2000). Metoda unitaryzacji zerowanej. Warszawa, PWN.

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

Nermend K. (2006). A synthetic measure of sea environment pollution, Polish Journal of Environmetal Studies, **15 (4b)** 127-129.

Nermend K. (2006). Using average-variance representation in economic analyses, Polish Journal of Environmetal Studies, **15 (4C)** 123-126.

Nermend K. (2007). Taxonomic Vector Measure of Region Development (TWMRR). Polish Journal of Environmental Studies, **4A**.

Nermend K. (2008). Employing similarity measures to examine the development of technical infrastructure in Polish counties. Folia Oeconomica Stetinensia **15 (7)** 87-97.

Nermend K. (2009). Vector Calculus in Regional Development Analysis, Series: Contributions to Economics, Springer ISBN: 978-3-7908-2178-9.

Nermend K. (2012). Method for examining the variability of socio-economic objects quoting the example of Baltic Sea countries, Actual Problems of Economics Scientific Economics Journal **5 (2)** 201-211.

Nermend K. and Borawski M. (2006). Using average-variance number system in calculation of a synthetic development measure, Polish Journal of Environmetal Studies **15 (4C)** 127-130.