DIGITAL ECONOMY IN THE OLD EUROPEAN UNION MEMBER STATES

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Abstract

The main purpose of the article is to conduct comparison of the level of development of digital economy in so called "old" member states of the European Union. In order to measure the digital economy at national level ten diagnostic variables were used, which were provided by Eurostat. To compare the countries taxonomic measure of development proposed by Zdzisław Hellwig was applied. Based on the method a synthetic measure of development was obtained after assessing the distance of the analysed objects to pattern of development. The method was chosen due to its universality and high applicability in economic sciences. The research was done for the years 2011 and 2017. The conducted research enabled to propose ranking of the countries. Additionally, the obtained taxonomic measure of development enabled to group the analysed economies. In spite of the fact that creating the digital economy is often pointed as a potential chance for lower developed countries for closing their development gap to the best developed economies, the research confirmed the traditional disparities between the "old" European member states.

Key words: Hellwig's method, taxonomic measure of development, digital economy, old European member states, EU-15

JEL Code: C38, O33

Introduction

Building highly competitive knowledge based economy has been the main objective of the European policy makers since declaration of the Lisbon Strategy. It has been also confirmed in the Europe 2020 plan (Balcerzak, 2015; Stanickova, 2017). Creating the conditions for developing effective digital economy is currently considered as an important factor, which helps to reach that aim. Additionally, improving the effectiveness of the digital economy is a condition for keeping international competiveness of the European Union economies (Simionescu *et al.*, 2017). As a result, the main aim of the current research is to conduct comparison of the level of development of the digital economy in so called "old" member states of the European Union. In the research data provided by Eurostat was used. The analysed phenomenon was considered as a multivariate problem, where taxonomic measure of development proposed by Zdzisław Hellwig was applied as the main research tool. The analysis was done for the years 2011 and 2017, which was the result of availability of data. However, this time span can be still considered as long enough for verifying the potential structural changes in regard to the analysed phenomenon.

The current research is the continuation of the previous studies of the authors, where the digital economy phenomenon was analysed at regional level in the Visegrad countries (Balcerzak & Pietrzak, 2017).

1 Linear ordering method and diagnostic variables

Most of economic problems cannot be analysed with small number of simple variables, but they represent difficult to quantify and measure multiple-criteria problems that should be verified with application of multiple-criteria methods (see: Balcerzak *et al.*, 2017; Meluzin *et al.*, 2017; 2018a; 2018b; Skvarciany et al, 2018). Among that group of methods linear ordering methods are commonly used to rate and order economic objects due to the level of analysed phenomena (Balcerzak, 2016a). In the case of the linear ordering methods the procedure of determining a taxonomic measure of development (TMD) is one of the most common in applied economics. TMD as a synthetic variable can be applied to majority of multidimensional socio-economic phenomena. Economic studies based on the application of the TMD have been widely described in the literature and they concern many aspects of the EU economies such as: analysis of the level of socio-economic development (Kuc, 2017), level of competitiveness (Cheba & Szopik-Depczyńska, 2017) and analysis of technological potential both at macro and micro level (Balcerzak, 2016c; Zemlickienė *et al.*, 2018).

The procedure for determining the TMD with application of Hellwig‘s methods and their modifications are presented by Cheba and Szopik-Depczyńska (2017) and Balcerzak (2016a). Its application allows to order economic objects, and then to propose a ranking of objects due to the TMD values obtained. The values of the TMD are the resultant of the level of variables, which were applied for description of various aspects of the studied phenomenon and allow for its synthetic quantification. It should be emphasized that the concept of the TMD is a simple and useful tool that gives the possibility of universal application in economic research. The huge advantage of the Hellwig's concept lies in its cognitive qualities in the process of explaining economic reality and flexibility of its application. This tool can be used to analyse most of the socio-economic issues. In addition, any economic objects as part of a research problem (e.g. countries, enterprises, households, consumers) can be analysed.

The procedure for the determination of the TMD should start with a choice of the analysed multi-dimensional phenomenon, selection of the set of investigated objects O_i and selection of a set of diagnostic variables X_j, which can be applied for description of the phenomenon.

The next step of the procedure is to determine the nature of the diagnostic variables. Variables are stimulants if their high values indicate a high level of the analysed phenomenon. Otherwise, variables are dis-stimulants.

Then normalisation of the diagnostic variables X_j should be carried out. For this purpose unitaristion method (Balcerzak, 2016b) or classic standardisation are commonly applied. In the current paper the second option was applied. Thus, from the value of variables their arithmetic mean $M(X)$ was subtracted, and then the obtained result was divided by standard deviation of diagnostic variables $S(X)$ according to the formula:

$$Z_j = \frac{X_j - M(X)}{S(X)} \tag{1}$$

The applied procedure enabled to obtain the standardized diagnostic variables Z_j.

In the next step, the values of the pattern of development P_j for each of the diagnosed diagnostic variables Z_j are determined. The values of P_j are determined as the maximum values of the diagnostic variable in the case of stimulants and as the minimum values for dis-stimulants. Based on the set of pattern values, the pattern reference object O_p is created. Then for each object O_i the distance Euclidean D_i is determined, between the O_i object and the pattern reference object O_p according to the formula:

$$D_i = \sqrt{\sum_{j=1}^{k} \left(Z_j - P_j\right)^2} \tag{2}$$

In the last step of the procedure, the values of the TMD for the object O_i are determined based on the formula

$$TMD_i = 1 - \frac{D_i}{M_{D_i} + 2S_{D_i}} \tag{3}$$

where M_{D_i} is an avaerage disstance of the object O_i to pattern reference object O_p, and S_{D_i} is a standard deviation determined on the basisi of set of the distances D_i.

The proposed procedure was applied for assessment of the level of the digital economy in the old European countries (EU-15). The analysis is restricted to that group of economies as they are relatively homogenous in regard to the level of socio-economic development. A set of diagnostic variables given in table 1 has been adopted for the digital economy description in every country, the values of the variables describe a selected digital economy aspects. The selection of the diagnostic variables is based on the previous literature review concerning the phenomenon (Balcerzak & Pietrzak, 2017, see also: Wierzbicka 2018).

Tab. 1: Diagnostic variables for the digital economy assessment in the EU countries

Variable	Name	Character	Description
x1	Households - level of internet access	stimulant	Household internet connection: all type; percentage of population
x2	Households - type of connection to the internet	stimulant	Household internet connection type: broadband; percentage of population
x3	Households - availability of computers	stimulant	Households having access to, via one of its members, a computer; percentage of population
x4	Individuals - mobile internet access	stimulant	Individuals used a laptop, notebook, netbook or tablet computer to access the internet away from home or work; percentage of population
x5	Individuals - frequency of computer use	stimulant	Frequency of computer use: daily; percentage of population
x6	Individuals - computer use	stimulant	Last computer use: within last 12 months; percentage of population
x7	Individuals - frequency of internet use	stimulant	Frequency of internet access: once a week (including every day); percentage of population
x8	Internet purchases by individuals	stimulant	Last online purchase: in the last 3 months; percentage of population
x9	E-government activities of individuals via websites	stimulant	Internet use: interaction with public authorities (last 12 months); percentage of population
x10	E-commerce purchases	stimulant	Enterprises having purchased via computer mediated networks; percentage of population

Source: own work based on Eurostat data.

2 Empirical research

The article analyses the level of the digital economy development in the selected EU countries in 2011 and 2017. The study covered 15 EU countries – old member states – that became the EU members before 2004. Analysis performed for countries in 2011 and 2017 allowed to compare changes in the level of the digital economy at a time span of six years, which form the perspective of the speed of development of the phenomenon can be considered as long enough time for verifying potential structural changes. To evaluate the digital economy level in the selected EU countries, the TMD was used. The values of the TMD were calculated in accordance with the previously presented procedure, where fixed values of patterns of development for the years 2011 and 2017 were adopted, which was condition for comparability of the results for both periods.

The obtained values of the TMD and its percentage changes in the period 2011-2017 are presented in Table 2 and Figure 1. The study made it possible to assess separately the situation regarding the digital economy development in 2011 and 2017 and to indicate trends in the level of development of this phenomenon. Additionally, on the basis of the calculated values of the TMD, the analysed countries were grouped up to three classes. For this purpose the natural breaks method was applied (Balcerzak & Pietrzak, 2017) (see Table 2, Figure 1).

Tab. 2: Ranking and grouping of the EU-15 countries in the years 2011 and 2017

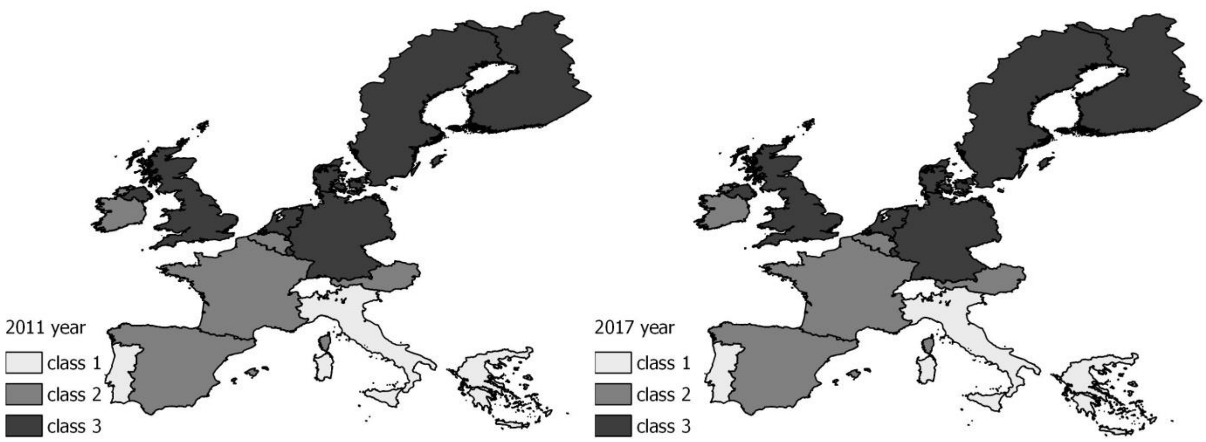
Country	2011			2017			Percentage change of TMD value
	TMD	Rank	Class	TMD	Rank	Class	
Denmark	0,814	1	3	0,850	1	3	4,43%
Sweden	0,825	2	3	0,824	2	3	-0,17%
Netherlands	0,708	3	3	0,789	3	3	11,39%
Finland	0,796	4	3	0,768	4	3	-3,62%
United Kingdom	0,709	5	3	0,711	5	3	0,23%
Luxembourg	0,691	6	3	0,704	6	3	1,94%
Germany	0,729	7	3	0,664	7	3	-8,92%
Austria	0,630	8	2	0,619	8	2	-1,89%
Belgium	0,541	9	2	0,563	9	2	3,99%
Ireland	0,523	10	2	0,531	10	2	1,42%
France	0,539	11	2	0,526	11	2	-2,51%
Spain	0,369	12	2	0,448	12	2	21,33%
Portugal	0,230	13	1	0,223	13	1	-2,96%
Italy	0,220	14	1	0,218	14	1	-1,03%
Greece	0,151	15	1	0,187	15	1	23,58%

Source: own estimation based on Eurostat data.

It should be emphasized that in both periods, in the years 2011 and 2017, the classification of countries into classes did not changed. Most of percentage changes in the TMD level in the period 2001-2017 are at a low level. Only in the case of four countries, the percentage changes exceeded 5% (Holland + 11.39%, Germany -8,92%, Spain 21.33%, Greece 23.58%). A special attention should be given to a more than 20% increase in the digital economy level in the case of Spain and Greece, which can be considered as a significant positive change in these countries.

Both in 2011 and 2017, to class 3 with a very high level of the digital economy development, the following countries were included: Denmark, Sweden, Netherlands, Sweden, Finland, United Kingdom, Luxembourg and Germany. It should be emphasized that the relative decline in the value of the TMD for the digital economy in Germany in the subsequent years may result in Germany being assigned to the second class with a lower level of the digital economy development. In the class 3, the Scandinavian countries are the leaders, where the digital economy development is at the highest level. This result is consistent with previous research of that kind of other authors (Balcerzak, 2009).

Fig. 1: The level of the digital economy development in the EU-15



Source: own estimation based on Eurostat data.

The following countries were assigned to Class 2 with an average level of the digital economy development: Austria, Belgium, Ireland, France and Spain. In this group, Spain should be positively distinguished, as it recorded a 21.33% increase in the value of the TMD for the digital economy level in 2011-2017.

On the basis of the natural breaks method, also class 1 was obtained, where countries with the lowest level of the digital economy development were grouped. The southern European countries: Portugal, Italy and Greece have been assigned to this class. These countries are characterized by the weakest economic situation and the highest level of indebtedness among the 15 analysed countries. In the case of Portugal and Italy, the value of the TMD for the digital economy development dropped. However, in the case of Greece, 23.58% increase in the TMD value was obtained. However, both in 2011 and in 2017, the level of this phenomenon is the lowest for Greece in the group of the UE-15 countries. Therefore, the obtained result to high extent can be considered as a low base effect.

Conclusion

The objective of the article was to conduct comparison of the level of development of digital economy in the EU-15. In the research the taxonomic measure of development proposed by Zdzisław Hellwig was applied, which enabled to propose ranking of the economies and group them with the application of the natural breaks method.

The research confirmed the traditional disparities between the EU-15 economies. The group of the worst performing economies consisted of Southern European economies: Portugal, Italy and Greece. The first two countries obtained negative dynamics of the TMD measure in the analysed period. Greece managed to reach the highest dynamics of the TMD value for the analysed phenomenon. However, the country started with the lowest value of the TMD in the 2011 year, thus, it was not able to diminish significantly its distance to the other European economies.

From the policy perspective the contribution of the paper can be related to the fact that it confirms the significance of fundamental macroeconomic and structural reforms in the process of modernisation. The digital economy phenomenon was considered as a potential chance for lower developed economies for reaching higher level of convergence process to the most developed economies. The research confirms that this process can be only based on high quality reforms and macroeconomic policy.

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