DIGITAL ECONOMY AND UNEMPLOYMENT IN THE VISEGRAD COUNTRIES AT REGIONAL LEVEL

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Abstract

The main objective of the article is to assess relation between the level of development of digital economy infrastructure and unemployment in the Visegrad countries in regional perspective. The research is done at NUTS 1 level for the years 2012-2015 based on data provided by Eurostat. The digital economy was considered here as a multivariate phenomenon. Thus, the research was conducted within two stages. First, TOPSIS method with application of generalized distance measure GDM was used for assessing taxonomic measure of digital economy development. Then, panel data modelling procedures were applied for assessing the relation between unemployment and the digital economy. The conducted research has not confirmed the positive influence of the level of the digital economy development on unemployed at NUTS 1 level.

Key words: digital economy, generalized distance measure GDM, Visegrad countries, unemployment, panel data modelling

JEL Code: P25, C38

Introduction

The last thirty years have been the time of dynamic changes in the functioning of economies in developed countries in many aspects (see Balcerzak, 2016, Pietrzak & Ziemkiewicz, 2018a, 2018b, Wierzbicka, 2018; Simionescu *et al.*, 2017). During this period the significance of globalization in shaping international economic relations has increased and the role of potential related to development of a knowledge-based economy, or entrepreneurship based on modern technologies increased significantly (see Zygmunt, 2018; Markhaichuk & Zhuckovskaya, 2019; Dvorský *et al*., 2019.) The importance of a dynamic digital economy development is also usually pointed out, where due to introduction of new information and IT technologies, the socio-economic situation in many cases has significantly improved (see Grybaitė & Stankevičienė, 2018).

The main objective of the article is to assess relation between level of development of the digital economy infrastructure and unemployment in the Visegrad countries within the regional perspective. As a result, the study was carried out at the regional level (NUTS1) in 2012-2015. Six diagnostic variables were used to describe the level of development of the digital economy in the analysed countries, on the basis of which a taxonomic measure of development (TMD) was proposed. The TMD values were determined with application of the TOPSIS method, where the generalized distance measure GDM was used. Therefore, in the presented study, the TOPSIS method was used as a tool for multidimensional analysis (Pietrzak & Ziemkiewicz,2018a, 2018b). On the other hand, the situation on the labour markets in the analysed regions was assessed on the basis of the unemployment level. In the article a research hypothesis was tested, which states: "The dynamic development of digital economy positively affects the situation on the labour market".

1 Methods of the research

In connection with the research hypothesis given in the article, an econometric panel model was used, which allowed to determine the relationship between the level of the digital economy development and the situation on the labour market in the regions under evaluation. The adopted specification of the panel model was given with the equation 1:

$$\mathbf{Y}_{it} = \alpha_1 \mathbf{TMD}_{\mathrm{it}} + \boldsymbol{\mu}_i + \boldsymbol{\omega}_t + \boldsymbol{\varepsilon}_{it} \qquad (1)$$

where $\mathbf{Y}_{it}$ is a vector representing unemployment rate for *i*-region in *t*-time; $\mathbf{TMD}_{\mathrm{it}}$ is a vector of values of taxomic measure of development, which describes the level of development of the digital economy, α_1 is a structural parameter of the model, $\boldsymbol{\mu}_i$ is the vector of individual effects for the pannel model, $\boldsymbol{\omega}_t$ is a vector of time effects, and $\boldsymbol{\varepsilon}_{it}$ is a vector of disturbances.

In turn, the digital economy level at regional level was described with application of the taxonomic measure of TMD development (Piersiala, 2019), which was determined with the TOPSIS method (see Zemlickienė *et al*., 2018; Rogalska, 2018; Balcerzak, 2016b; Pietrzak, 2016). This method allows to determine a synthetic variable (TMD measure), which takes into account the influence of selected determinants on the examined economic phenomenon. In this case, the values of TMD measure determine the level of development of the digital economy for selected regions. The most common metrics, which is applied in the TOPSIS method for setting up the distances form positive and negative ideal solutions, is the

Euclidean distance. However, in the case of TOPSIS method it is also possible to apply the generalized distance measure GDM, which allows selection of diagnostic variables from any measurement scale (see Walesiak, 1999). The economic values of the positive ideal solution P_j and the negative ideal solution A_j are most often based on the maximum and minimum values of the adopted variables. The GDM distance from the positive ideal solution GDM_{it}^{P} and negative ideal solution GDM_{it}^{AP} for the *i*-th country in period *t* is determined according to the formulas (see Walesiak, 1999):

$$GDM_{it}^{P} = \frac{1}{2} - \frac{\sum_{j=1}^{m}(z_{ijt}-P_{kj})(P_{kj}-z_{ijt}) + \sum_{j=1}^{m}\sum_{\substack{l=1 \\ l\neq i,k}}^{n}(z_{ijt}-z_{ljt})(P_{kj}-z_{ljt})}{2\left[\sum_{j=1}^{m}\sum_{l=1}^{n}(z_{ijt}-z_{ljt})^{2}\sum_{j=1}^{m}\sum_{l=1}^{n}(P_{kj}-z_{ljt})^{2}\right]^{\frac{1}{2}}} \quad (2)$$

$$GDM_{it}^{P} = \frac{1}{2} - \frac{\sum_{j=1}^{m}(z_{ijt}-AP_{kj})(AP_{kj}-z_{ijt}) + \sum_{j=1}^{m}\sum_{\substack{l=1 \\ l\neq i,k}}^{n}(z_{ijt}-z_{ljt})(AP_{kj}-z_{ljt})}{2\left[\sum_{j=1}^{m}\sum_{l=1}^{n}(z_{ijt}-z_{ljt})^{2}\sum_{j=1}^{m}\sum_{l=1}^{n}(AP_{kj}-z_{ljt})^{2}\right]^{\frac{1}{2}}} \quad (3)$$

where z_{ijt} is the value of *j*-th diagnostic variable for *i*-th region in the years *t*; P_{kj} is the positive ideal solution, AP_{kj} is the negative ideal solution, *i*, *l* = 1, ..., *n* is number of the region, *j* = 1, ..., *m* is the number of the variable, *k* is the number of the regions which form positive ideal solution or negative ideal solution.

In the last stage, the values of TMD are determined, which allows for an overall assessment of the level of the digital economy development in each region. The values of the TMD measure range from zero to one. The high values of the measure indicate a high level of development of the studied phenomenon. The values of the taxonomic measure TMD_{it} for the *i*-th region are determined in accordance with the formula 4:

$$TMD_{it} = 1 - \frac{GDM_{it}^{P}}{GDM_{it}^{AP} + GDM_{it}^{P}}. \quad (4)$$

2 Results

According to the adopted objective of the article, the taxonomic value of TMD describing the digital economy level in the Czech Republic, Poland, Slovakia and Hungary at NUTS 1 level in the years 2012-2015 was first determined. Table 1 describes all diagnostic variables on the basis of which TMD values were calculated. The justification for their application is given in Pietrzak & Ziemkiewicz (2018a, 2018b). The values of diagnostic variables form table 1 as well as data on the registered unemployment rate were taken from the Eurostat database.

Tab. 1: The diagnostic variables for the digital economy at regional level

Variable	Description	Character
X_1	Individuals who ordered goods or services over the internet for private use	stimulant
X_2	Individuals who have never used a computer	disstimulant
X_3	Households with access to the internet at home	stimulant
X_4	Individuals who accessed the internet away from home or work	stimulant
X_5	Individuals who used the internet, frequency of use and activities	stimulant
X_6	Households with broadband access	stimulant

Source: own work based on Pietrzak & Ziemikiewicz (2018a, 2018b).

Next, based on the adopted diagnostic variables, the values of the taxonomic measure TMD for each region were determined based on equation 4. The results obtained are shown in Table 2. In addition, Table 3 presents the values of the unemployment rate for the analysed NUTS 1 regions in the period 2012-2015.

Tab. 2: The values of TMD for the level of the digital economy development in NUTS 1 regions in the Visegrad group countries

NUTS 1 region	2012	2013	2014	2015
Czech Republic	0,34	0,59	0,87	0,89
Kozep-Magyarorszag	0,61	0,75	0,92	0,94
Dunantul	0,18	0,34	0,85	0,88
Alfold Es Eszak	0,07	0,09	0,29	0,35
Makroregion Centralny	0,32	0,37	0,58	0,72

Makroregion Poludniowy	0,14	0,13	0,26	0,46
Makroregion Wschodni	0,10	0,15	0,34	0,55
Makroregion Polnocno-Zachodni	0,15	0,24	0,48	0,70
Makroregion Poludniowo-Zachodni	0,07	0,09	0,60	0,71
Makroregion Polnocny	0,07	0,19	0,40	0,38
Slovakia	0,93	0,96	0,99	0,98

Source: own estimation based on Eurostat data.

Tab. 3: The unemployment rate in NUTS 1 regions in the Visegrad group countries

NUTS 1 region	**2012**	**2013**	**2014**	**2015**
Czech Republic	7,0	7,0	6,1	5,1
Közép-Magyarország	9,5	8,7	6,2	5,3
Dunántúl	9,7	8,5	5,9	5,3
Dél-Dunántúl	12,1	9,3	7,8	8,1
Makroregion Centralny	11,8	11,7	9,7	8,5
Makroregion Poludniowy	9,8	10,2	8,8	7,2
Makroregion Wschodni	11,3	11,8	11,2	9,7
Makroregion Pólnocno-Zachodni	9,2	9,3	8,0	6,3
Makroregion Poludniowo-Zachodni	10,7	10,8	8,8	6,9
Makroregion Pólnocny	10,8	11,2	9,6	7,8
Slovakia	14,0	14,2	13,2	11,5

Source: Eurostat data.

The analysis of the variable values in Tables 2 and 3 allowed for simultaneous assessment of the digital economy development in the Visegrad Group countries and the situation on their labour markets. Taking into account the results obtained, it should be stated that within four analysed years the situation of all regions, both in terms of the digital economy development and the situation on the labour market, has improved significantly. There is a noticeable increase in the value of TMD as well as a steady decline in the unemployment rate between the years 2012 and 2015. Therefore, this means that the phenomenon of the digitization of economics is developing very dynamically in the selected

regions. Withn the context of improved situation on the labour markets, it may be a justification for the econometric analysis of the hypothesis given in the article.

The highest level of the digital economy in 2012 was held by the regions of Slovakia and Közép-Magyarország, and in 2015 they were joined by two more regions, Czech Republic and Dunántúl. On the other hand, in 2012 and in 2015 the lowest level of the digital economy development could be seen in the following regions: the North-West Region, the North Region, the South-Western Region, the Eastern Region and Alföld és Észak.

In turn, in the case of labour market, the situation was shaped in a different way. In 2012, the Slovakia region (14%), the Dél-Dunántúl region (12.1%) and selected regions in Poland were characterized by the highest unemployment rate. The Czech Republic region had the best situation on the labour market (7%). Within four years, the situation has improved for all regions. However, it should be noted that in 2015 the same relationship between the regions was preserved (again the Slovakia region was characterized by the highest unemployment rate and the Czech Republic region the lowest value).

According to the adopted specification of the panel econometric model, an estimation of its parameters was made with application of the least squares method. The estimation procedure was performed in the Gretl program, and the results of model parameter estimation are presented in Table 4. The model has a high degree of matching to empirical data (coefficient of determination at the level of 0.95) and the first order autocorrelation of the random component is not present. The parameters for individual and time effects of the panel model are statistically significant. On the other hand, the α_1 parameter turned out to be statistically insignificant. This means that no significant impact of changes in the level of the digital economy development on the situation on the labour market was found.

Tab. 4: The results of estimation of parameters of the panel model

Variable	Estimate	Standard Deviation	p-value
TMD	-1,75	1,10	0,12
Czech Republic	6,05	1,03	0,00
Közép-Magyarország	7,41	1,17	0,00
Dunántúl	6,91	0,92	0,00
Dél-Dunántúl	8,25	0,58	0,00
Makroregion Centralny	8,45	0,86	0,00
Makroregion Poludniowy	7,21	0,62	0,00

Makroregion Wschodni	8,38	0,65	0,00
Makroregion Pólnocno-Zachodni	9,11	0,75	0,00
Makroregion Poludniowo-Zachodni	9,65	0,73	0,00
Makroregion Pólnocny	10,03	0,63	0,00
Slovakia	13,49	1,34	0,00
Year 2012	2,38	0,53	0,00
Year 2013	2,24	0,46	0,00
Year 2014	1,08	0,29	0,00
R^2	0,95	Durbin-Watson statistics.	1,41
Autocorrelation of the random component	-0,01	Log-likelihood	-33,53

Source: own estimation.

Conclusion

The article concentrates on the problems of measuring the digital economy development in the Visegrad countries at the regional level and assessing its potential impact on the situation of the labor market. In accordance with the adopted objective of the article, the values of the taxonomic measure TMD describing the level of the digital economy in the years 2012-2015 were determined. In this study TOPSIS method was used, where the GDM was applied for assessing the distance of objects. Then, with application of the econometric panel model, the potential dependence between the level of the digital economy development and the situation on the labour market was checked.

The obtained results have not confirmed the significant impact of the digital economy level improvements on the positive changes of the situation on the labour market, which has not allowed to verify positively the research hypothesis set in the article. In this context, the econometric analysis carried out in the study did not provide arguments for the thesis, according to which the policy focused on the development of the digital economy translates directly into the improvement of the labour market conditions in the Visegrad group countries at regional level.

However, it should be emphasized, that the p-value obtained for the estimation of the TMD parameter is close to the significance level of 0.1. As a result, in subsequent surveys, the analysis period should be extended by additional years or the panel expanded to include more regions.

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