QUALITY OF HUMAN CAPITAL AND TOTAL FACTOR PRODUCTIVITY IN NEW EUROPEAN UNION MEMBER STATES

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Abstract

Closing development gap and avoiding middle income trap are currently considered as the main challenges for the new EU member states. To obtain both those aims the countries must implement policies that support total factor productivity (TFP) growth. The main scientific purpose of the article is to examine the influence of quality of human capital (QHC) on TFP in Central European countries in the years 2000-2010. All the EU countries must be able compete internationally in reality of global knowledge economy. Thus, the QHC was analysed from the perspective of the knowledge-based economy. As the QHC is a multidimensional phenomenon in order to measure it and obtain time series for further econometric research, TOPSIS method was applied. To evaluate TFP the parameters of the Cobb-Douglas production function for the new EU members were estimated. Finally, it was possible to identify the relationship between the QHC and the level of TFP with application of dynamic panel model. The analysis was conducted for the years 2000-2010 based on Eurostat data. It confirmed a significant influence of the QHC on the level of TFP in the new EU members states.

Key words: multiple-criteria decision analysis (MCDA), TOPSIS method, panel model, TFP, human capital, new EU members

JEL Code: C23, C38, O47

Introduction

After two decades of transformation and reaching such long term objectives as obtaining a significant role in the European and global supply chain (Pietrzak & Łapińska, 2015), improving quality of institutions and modernising economic structure (Balcerzak, 2009; Wilk *et al*., 2013, Pietrzak *et al*., 2014, Balcerzak, 2015), most of Central European economies still face a fundamental challenges of closing development gap and avoiding middle income trap. In order to reach these purposes governments of the new EU members must find and

effectively implement policies that increase total factor productivity (TFP) growth in the long term. Based on some models belonging to endogenous growth theory, it is assumed that investments in quality of human capital (QHC) can be an important growth factor especially in the case of developed economies or the once that are closing the development gap. As a result the main scientific aim of the paper is to examine the influence of the QHC on TFP in Central European countries in the years 2000-2010. The following hypothesis was the base of the analysis: There is a positive influence of the QHC on TFP in the case of new EU member countries in the years 2000-2010.

Macroeconomic perspective is taken in the proposed research. In order to measure the QHC at macroeconomic level multiple-criteria analysis with TOPSIS method is applied, as the QHC is considered as multivariate phenomenon. In order to assess TFP in the new EU members states parameters of the Cobb-Douglas production function were estimated. The relationship between the QHC and the level of TFP was analysed with application of dynamic panel modelling. The research was based on Eurostat data. It is a continuation of previous studies of the authors (Balcerzak & Pietrzak, 2016a).

1 Assessment of TFP in the New EU Member States

TFP is understood as a measure of organizational and technological progress at macroeconomic level, which is also commonly defined as residual of Solow model. The empirical investigations on the determinants of organizational and technological progress concentrate on finding explanations on the sources of changes in TFP. In that context econometric models are usually proposed, where TFP is a dependent variable.

In the literature one can find many approaches to assessing TFP (Gehringer *et al*., 2015, Severgnini & Burda, 2010, Aimar & Dalgaard, 2005). The analysed countries can be considered as relatively homogenous in relation to structural and institutional factors affecting productivity (Balcerzak & Pierzak 2016b, Pietrzak & Balcerzak, 2016). As a result, the Cobb-Douglas production function for assessing productivity for 10 new EU members could be applied. Eurostat data on total employment (annual averages in persons - *E*), real gross value added (million euro, reference year 2000 - *GVA*) and gross fixed capital formation (million euro, reference year 2000 - *GFCF*) were used for the estimation.

The Cobb-Douglas production function function after taking the logarithm of both sides of equation was given as follow:

$$\ln GVA_{it} = \eta_i + \alpha \ln GFCF_{it} + (1-\alpha) \ln E_{it} + gt + \varepsilon_{it} \quad (1)$$

where: GVA_{it} – vector of real gross value added in the country *i* and the period *t*, $GFCF_{it}$ – vector of gross fixed capital formation in the country i and the period *t*, E_{it} – vector of employment in the country *i* and the period *t*, $\boldsymbol{\eta}_i$ – vector of values of individual effects, in the period *t*, *t* – time trend, α – elasticity of labour productivity to the capital, *g* – rate of technological progress in the sense of Hicks, $\boldsymbol{\varepsilon}_{it}$ – a vector of disturbances.

The level of labour productivity relative to the capital to labour ratio is obtained after subtracting the expression ln(*E*) from both sides of equation (1), which is given with equation 2.

$$\ln GVA/E_{it} = \eta_i + \alpha \ln GFCF/E_{it} + gt + \boldsymbol{\varepsilon}_{it}, \tag{2}$$

where: GVA/E – vector of value GVA/E – labour productivity, GFCF/E – vector of the capital to labour ratio, and the remaining variables are the same as in the case of equation 1.

Estimation of parameters of panel model FE for equation 2 enables to assess the value of TFP_{it}. To do so the estimated value of parameter α is used, which is given with equation 3.

$$TFP_{it} = \frac{GVA/E_{it}}{(GFCF/E_{it})^{\bar{\alpha}}}. \tag{3}$$

The results of estimation of parameters of panel model FE with individual effects for equation 2 are given in table 1. Individual effects for all countries and parameters α i g were statistically significant. The value of estimates of the parameter α indicates that flexibility of labour productivity to capital to labour ratio is equal to 0,176. The value of estimate of the parameter *g* at the level 0,032 indicates that the economies are characterized with 3,2% rate of technological progress in the sense of Hicks. Thus, when one assumes that capital investments and the employment are kept constant, the countries are characterized with rate 3,2% of production growth.

Tab. 1: The results of estimation of parameters of panel model FE for labour productivity

Parameter	Estimate	t-student statistics
α	0,176	~0,00
g	0,032	~0,00
Coefficient of determination	0,991	

Source: own estimation based on Eurostat data

The value of parameter α enables to estimate TFP_{it}, which was done according to the equation 3. TFP for the first and last year of the research and the percentage change of its value in the whole period are given in table 2.The countries ware ordered from the one with the highest value of TFP to the one with its lowest value. Then, the countries were grouped with application of natural breaks method into homogenous three subsets (Jenks, 1967).

Tab. 2: Total factor productivity in the new UE member states

2000			2010			2000-2010		
Country	***TFP***	***Subsets***	**Country**	***TFP***	***Subsets***	**Country**	***% change of the value of TFP***	***Subsets***
Slovenia	15,052	1	Slovenia	18,989	1	Romania	56,06%	1
Czech Republic	9,675	2	Czech Republic	12,666	2	Lithuania	54,65%	1
Poland	9,528	2	Poland	11,981	2	Latvia	51,72%	1
Hungary	9,085	2	Hungary	11,303	2	Slovakia	40,35%	2
Estonia	7,733	2	Lithuania	10,891	2	Estonia	32,44%	2
Slovakia	7,687	2	Slovakia	10,788	2	Czech Republic	30,92%	2
Lithuania	7,042	2	Latvia	10,364	2	Bulgaria	26,98%	3
Latvia	6,831	2	Estonia	10,241	2	Slovenia	26,15%	3
Bulgaria	4,429	3	Bulgaria	5,624	3	Poland	25,75%	3
Romania	3,573	3	Romania	5,576	3	Hungary	24,41%	3

Source: own estimation

The grouping of the countries to three subsets indicates differentiation of the Central European economies in terms of TFP. The classification of countries was the same in both the first and last year of the research. In the first group one could only find Slovenia. Then, in the second the biggest subset there were all the remaining countries that joined EU in the year 2004: Czech Republic, Poland, Hungary, Estonia, Latvia, Lithuania and Slovakia. In the last group characterised with the lowest level of TFP there are Bulgaria and Romania that joined EU in the year 2007.

In the years 2000-2010 all the economies were characterised with the significant improvement of TFP. For all the countries its growth ranges from 24,42 to 56,06%, which confirms the effectiveness of modernisation process in Central Europe. In the first group with the highest dynamics of TFP one can find: Romania, Lithuania and Latvia. They obtained improvement of TFP above 50%. In the second group there are: Czech Republic, Slovakia and Estonia, where the improvement of TFP ranged from 30,92 to 40,35%. In the third group there were Bulgaria, Slovenia, Poland and Hungary. In this group TFP improved form 24,42 to 26,98%.

2 Assessment of Influence of Quality of Human Capital on TFP

All the EU economies compete internationally in reality of global knowledge economy (Madrak-Grochowska, 2015; Balcerzak, 2015). This is especially important in the case of Central European countries, if these societies want to avoid middle income trap. Thus, in the research the QHC was analysed from the perspective of the knowledge-based economy, which determined the choice of diagnostic variables for the macroeconomic analysis and its international comparisons. The diagnostic variables were classified to one of the three aspects crucial in the reality of knowledge-based economy. The variables are given in table 3**.**

Tab. 3: Diagnostic variables used for obtaining synthetic measure of the QHC

Aspect 1 (A_1) - macroeconomic and labour market effectiveness
– Effectiveness of Labour force (percentage of EU28 total based on PPS per employed person)
– Employment rate (in the group of people in the age 20 to 65)
Aspect 2 (A_2) - quality of education
– Lifelong learning - participation rate in education and training (last 4 weeks) (% of population 25 to 64)
– Science and technology graduates (tertiary graduates in science and technology per 1 000 inhabitants aged 20-29 years)
Aspect 3 (A_3) - national innovation system
– Exports of high technology products as a share of total exports
– (GERD) Total intramural R&D expenditure (percentage of GDP)

Source: onw work.

The QHC at macroeconomic level is a multidimensional phenomenon. As a result in order to measure it an approach typical for multiple-criteria decision analysis (MCDA) with application of TOPSIS method was applied (Zavadskas *et al.*, 2014, Jantoń-Drozdowska & Majewska, 2015, Balcerzak, 2016, Balcerzak & Pietrzak, 2016d). In the research an assumption of constant ideal solution for all the period was made. The assumption was a necessary condition for obtaining the dynamic comparability of the results and receiving the time series for the dynamic econometric research. The application of TOPSIS method enabled to assess a value of synthetic indicator for the QHC for every country in the years 2000-2010[1].

Table 4 presents the results of the QHC assessment for the first and last year of the research. It also provides dynamics of the QHC indicator for the whole period of the research.

[1] The detailed description of the procedure applied for evaluation of the QHC with TOPSIS method is available in Balcerzak & Pietrzak (2016c).

As previously in the case of TFP the countries were grouped to three homogenous subsets with application of natural breaks method.

Tab. 4: Quality of human capital in the new EU member states

2000			2010			2000-2010		
Country	***TFP***	***Subsets***	**Country**	***TFP***	***Subsets***	**Country**	***% change of the value of TFP***	***Subsets***
Slovenia	0,652	1	Czech Republic	0,663	1	Bulgaria	36,28%	1
Czech Republic	0,583	1	Slovenia	0,651	1	Romania	15,77%	1
Estonia	0,549	1	Estonia	0,543	1	Czech Republic	13,62%	1
Lithuania	0,521	1	Slovakia	0,458	2	Slovakia	9,35%	2
Hungary	0,424	2	Lithuania	0,456	2	Poland	2,05%	2
Slovakia	0,419	2	Hungary	0,415	2	Slovenia	-0,15%	2
Latvia	0,403	2	Poland	0,395	2	Estonia	-1,03%	2
Poland	0,387	2	Romania	0,355	2	Hungary	-2,27%	2
Romania	0,307	2	Latvia	0,293	3	Lithuania	-12,61%	3
Bulgaria	0,167	3	Bulgaria	0,228	3	Latvia	-27,34%	3

Source: own estimation.

In the year 2000 in the first subset grouping the countries with the highest value of synthetic indicator for the QHC one could find Slovenia, Czech Republic, Estonia and Lithuania. In the second group there were Hungary, Slovakia, Latvia, Poland and Romania. In the third group with the lowest level of the value of indicator there was only one country Bulgaria. In the last year of the research in the first subset there were only three countries Czech Republic, Estonia and Slovenia. In the second group there were Slovakia, Lithuania, Hungary, Poland and Romania. In the last subset one could find Latvia, which was seriously negatively influenced by the global financial crisis and Bulgaria.

In the years 2000-2010 in the group with the highest dynamics of the indicator for the QHC there were Bulgaria, Romania and Czech Republic. Bulgaria in spite of the highest dynamics due to the low starting position in the year 2000 was still classified as the country with the lowest value of the indicator in the year 2010. On the other hand, high dynamics of Czech Republic enabled the country to reach the first position in the ranking in the year 2010. The second subsets grouped such countries as Slovakia, Poland, Slovenia, Estonia and Hungary, where the first two countries reached positive dynamics, whereas the remaining once were characterised with the decrease of the value of the indicator. Lithuania and Latvia

were characterised with the highest negative dynamics of the indicator, which can confirm strong negative influence of the global financial crisis in the case of these economies.

The comparison of the results presented in table 2 and 4 justify the econometric analysis of the relationships between TFP and the QHC in the new EU member states in the years 2000-2010. To do so the parameters of a dynamic panel model given with equation 4 were estimated.

$$\ln TFP_{it} = \boldsymbol{\eta}_i + \beta \ln TFP_{it-1} + \alpha TMD_{it} + gt + + \boldsymbol{\varepsilon}_{it}, \quad (4)$$

where the dependent variable was defined as the logarithm of TFP, independent variable was the measure of TMD for the QHC, α, β were the structural parameters of the model, η_{it} was a vector of individual effects of panel model, and $\varepsilon_{i,t}$ was a vector of disturbances.

Tab. 5: The results of estimation of parameters of panel model for determinants of TFP for new UE member states in the years 2000-2010

Parameter	Estimate	t-student statistics
β	0,744	~0,00
g	0,005	0,087
α	0,351	~0,00
Sargan Test	**Statistics of the test**	**p-value**
	7,932	0,991

Source: own estimation.

The results of the estimation of the parameters of dynamic panel model are presented in table 5. The statistically significant and positive estimation of parameter α confirms positive influence of the QHC on TFP. The results enable to verify the hypothesis of the research. The econometric analysis confirms the importance of policies and programs that are aimed at improving the QHC, which can be the source of direct and indirect benefits for middle and long term growth in the case of new EU members.

Conclusion

The main empirical aim of the article was to investigate the determinants of changes of TFP as a measure of organizational and technological progress in the case of new UE member states in the years 2000-2010. The hypothesis on positive influence of the QHC on TFP was given. The Cobb-Douglass production function was used for evaluating TFP. The QHC at

macroeconomic level was analysed with the application of multiple-criteria decision analysis methodology (TOPSIS method with constant ideal solution). Finally, the application of dynamic panel model enabled to confirm the positive influence of the QHC on TFP in Central European economies.

The research confirms the organizational and technological modernization of economies of the new EU members and proves that concentration on the improvements of the QHC can be a important factor for solving the problem of middle income trap.

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