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QUALITY OF INSTITUTIONS AND TOTAL FACTOR PRODUCTIVITY IN THE EUROPEAN UNION

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ABSTRACT

The key challenge for mid- and long-term policy in the European Union countries is to use the potentials of knowledge-based economy (KBE), which is a condition for maintaining high total factor productivity in Europe. For this reason, the relationship between the quality of an institutional system and total factor productivity in the EU countries has been examined. The quality of the institutional system is defined here from the perspective of incentives that influence the use of the potential of KBE. In order to determine the level of effectiveness of the institutional system in the analysed countries the method for linear ordering of objects was applied based on data from Fraser Institute. The main hypothesis of the article states that the quality of the institutional system in the context of KBE has a significant influence on the level of total factor productivity in the EU. In order to verify this hypothesis, the parameters of the Cobb-Douglas production function were estimated, which allowed the evaluation of TFP for the EU countries. The calculation made in the article based on Eurostat data. In order to identifying the relationship between the quality of the institutional system and the level of TFP a panel model was applied using data from a conducted for years 2000-2010.

Key words: KBE, TFP, quality of intuitions, European Union, panel model.

1. Introduction

The efforts devoted to the research on the determinants of Total Factor Productivity (TFP) growth both at the international (Coe and Helpman, 1995, pp. 859–887, Coe *et al.*, 2008; Aiyar and Dalgaard, 2005, pp. 82–102) and regional level, for example for Poland (Tokarski 2008, pp. 38–53; Tomaszkiewicz and Świeczewska 2011, pp. 36–55), have been significant for the last decade. However, due to many structural changes in the world economy that have been

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observed for the last years, the famous postulate of Edward Prescott on the need to strengthen the research intensity on the theory of TFP is still valid (see Presott, 1998, pp. 525–551). This is especially important in the context of a growing role of many intangible and difficult to measure factors, which affect productivity differences between developed countries in a globalized, knowledge-based economy (KBE) (see: van Ark, 2014, pp. 17–19; Fraumeni, 2014, pp. 20–21). This article can be treated as a proposal for research in this field. Thus, the aim of the paper is to analyse TFP in the European Union countries in the years 2000-2010 and to evaluate the influence of the quality of institutions in the context of KBE on the productivity growth in the years 2000–2010.

The first hypothesis of the article was formed as follows: the quality of the institutional system in the context of KBE has a significant influence on the level of TFP in the EU countries.

The second hypothesis of the research concerned the institutional literature that indicated many important weaknesses of the institutional order in former transformation countries of Central Europe and the concept of an institutional lag in the case of these economies, especially in regard to formal regulations and governance influencing the speed of diffusion of technology and new organizational ideas. As a result, the second hypothesis was formed as follows: countries that joined the European Union after 2004, under the conditions of improving the quality of their institutions for KBE, can use the potential of reducing institutional lag for increasing the speed of TFP growth more than proportionally in comparison with "old" member states. This factor is important from the perspective of guidelines for policy that is aimed at increasing the speed of convergence process in the EU. The article is a continuation of previous research presented in Balcerzak and Pietrzak (2015a, pp. 71–91; 2015b, 2016, pp. 312–337).

2. Total factor productivity in the European Union countries

Obtaining high level of productivity and improving the effectiveness of utilization of production factors is considered as an important mid- and long-term aim of economic policy in the European Union (European Commission, 2010; Forgo and Jevcak 2015). Based on the aim and objective of this paper, the analysis of TFP changes for 24 European Union countries for the years 2000–2010 was carried out.

Luxemburg, Malta, Cyprus and Croatia were not included in the research. The first three countries were excluded due to lack of data, additionally Croatia became a member state in 2013. In the analysis the following data was used: total employment (annual averages in thousands of persons), real gross value added (million euro, reference year 2000) and gross fixed capital formation (million euro, reference year 2000). Eurostat was the source of the data.

The starting point of the research was the assessment of the productivity level for all the countries in the years 2000-2010 based on the Cobb-Douglas production function. The Cobb-Douglas production function, after taking the logarithm of both sides of equation into account, can be written as follows:

$$\ln GVA_{it} = \boldsymbol{\eta}_i + gt + \alpha \ln GCF_{it} + (1-\alpha)\ln E_{it} + \boldsymbol{\varepsilon}_{it} \tag{1}$$

where:

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

After subtracting the expression ln(E) from both sides of equation (1), equation (2) is obtained. It describes the level of labour productivity relative to the capital to labour ratio.

$$\ln GVA/E_{it} = \boldsymbol{\eta}_i + gt + \alpha \ln GCF/E_{it} + \boldsymbol{\varepsilon}_{it} \tag{2}$$

where:

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

In the literature, one can find many empirical approaches to evaluating TFP (see. Welfe (ed.) 2007; Severgnini and Burda, 2010, pp. 447–466; Gehringer *et al*., 2014). In the article, the method proposed by Tokarksi was applied. Estimation of the parameters of model (2) for labour productivity enables the determination of the value of total factor productivity TFP_{it} for the EU countries. To calculate TFP_{it} the estimated value of parameter α is used. It can be done based on the formula (see Tokarski, 2008, pp. 39–53):

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

The general assumption commonly used in many proposals for estimation of TFP at the national or regional level is the application of homogeneous production functions for all the countries or regions. However, in spite of the convergence process the member countries are still characterized by significant development differences in the case of the European Union. There are relatively big differences in labour productivity and the factors that can influence TFP. As a result, the analysed countries are heterogeneous. The most obvious structural differences can be seen between the so-called "old" and "new" member states. Thus, the assumption on homogeneous production functions is unrealistic here. In order to face the problem of heterogeneity, the authors divided the EU countries into two groups – the "old" member states and the ones that joined the EU after the year 2004. As a result, separate parameters α_1 and α_2 for „old" and „new" member states were introduced in the case of the model for labour productivity (equation 2). They can be written as follows[3]:

$$\ln GVA/E_{it} = \boldsymbol{\eta}_i + gt + \alpha_1 \ln GCF/E_{it}^1 + \alpha_2 \ln GCF/E_{it}^2 + \boldsymbol{\varepsilon}_{it}, \quad (4)$$

where:

α_1 and α_2 – elasticity of labour productivity to the capital to labour ratio for the group of "old" and "new" member states, respectively.

The remaining variables are understood in the same way as in the case of equation 1 and 2.

Additionally, the model given in equation 4 was estimated with a FE panel model estimator with individual effects in order to observe the country-specific factors. The results of the estimation of the parameters of the model can be found in Table 1. Individual effects for all 24 countries were statistically significant, which is consistent with previous argumentation. The estimations of parameters α_1, α_2 and g were statistically significant too[4]. The value of estimates of the parameter α_1 and α_2 indicates that the flexibility of labour productivity to capital to labour ratio equals 0.129 in the case of the countries that joined the EU before 2004 and 0.290 for "new" members. The value of the estimate of the parameter g at the level of 0.017 indicates that the European Union economies are characterized by 2% rate of technological progress in the sense of Hicks. These results are generally consistent with previous research both at the national (Gehringer *et al.* 2014; Severgnini and Burda, 2010, pp. 447–466) and regional

[3] The components of GCF/E_{it}^1 vector make the value of capital to labor ratio for the countries in the first group and 0 otherwise. A similar situation occurs in the case of GCF/E_{it}^2 vector.

[4] The statistics for Durbin-Watson test points to statistically significant autocorrelation in the residuals.

level in the case of Poland (Dańska-Borsiak and Laskowska, 2012, pp. 17–29; Tokarski, 2008, pp. 38–53; Tokarski, 2010, pp. 23–39).

Table 1. The results of estimation of parameters of FE panel model with individual effects for labour productivity

Parameter	**Estimate**	**Standard error**	**Parameter**	**Estimate**	**Standard error**
α_1	0.129	0.034	g	0.017	0.003
α_2	0.290	0.050	-	-	-
Individual effects	**Estimate**	**Standard error**	**Individual effects**	**Estimate**	**Standard error**
Austria	3.550	0.096	Ireland	3,640	0,098
Belgium	3.610	0.097	Italy	3.497	0.091
Bulgaria	1.436	0.021	Lithuania	1.982	0.049
Czech Republic	2.138	0.072	Latvia	1.907	0.059
Germany	3.550	0.091	Netherlands	3.480	0.090
Denmark	3.595	0.096	Poland	2.142	0.056
Estonia	1.930	0.071	Portugal	2.813	0.070
Spain	3.172	0.089	Romania	1.405	0.020
Finland	3.551	0.093	Sweden	3.667	0.095
France	3.597	0.093	Slovenia	2.508	0.091
Greece	3.122	0.080	Slovak Republic	1.972	0.056
Hungary	2.089	0.060	United Kingdom	3.626	0.089
Coefficient of determination		0.99	Durbin-Watson Statistics		0.42

[all the parameters are statistically significant with 5% significance level]

Source: own estimation based on Eurostat data.

The estimated value of the parameter α_1 and α_1 enable the estimation of the logarithm of TFP_{it} for every country in the years 2000-2010 according to the formula:

$$\ln TFP_{it} = \ln GVA/E_{it} - \widehat{\alpha}_j \ln GCF/E_{itj}. \quad (4)$$

Table 2 presents the logarithm of TFP for the years 2000 and 2010 and the percentage change of this value in the period 2000–2010. Additionally, Table 2 shows the results of grouping the countries into classes, which was done with the use of natural breaks method. The results presented in Figure 1 confirm the heterogeneity between "old" and "new" member states.

Table 2. Total factor productivity in the European Union member countries in 2000 and 2010 (lnTFP)

2000			2010			2000-2010		
Country	**lnTFP**	**Class**	**Country**	**lnTFP**	**Class**	**Country**	**Percentage difference**	**Class**
Sweden	3.70	5	Ireland	3.86	5	Romania	38.71%	5
France	3.69	5	Sweden	3.82	5	Lithuania	23.47%	4
Denmark	3.68	5	United Kingdom	3.76	5	Latvia	22.24%	4
Ireland	3.68	5	Denmark	3.72	4	Bulgaria	17.56%	4
Belgium	3.67	5	Belgium	3.72	4	Slovak Republic	16.76%	4
United Kingdom	3.66	5	France	3.70	4	Estonia	14.49%	3
Italy	3.61	5	Finland	3.68	4	Czech Republic	11.95%	3
Germany	3.60	5	Austria	3.67	4	Poland	10.87%	3
Austria	3.59	5	Germany	3.66	4	Hungary	9.65%	3
Finland	3.58	5	Netherlands	3.64	4	Slovenia	8.11%	3
Netherlands	3.54	5	Italy	3.60	4	Portugal	5.55%	3
Spain	3.29	4	Spain	3.34	3	Greece	5.37%	2
Greece	3.13	4	Greece	3.30	3	Ireland	4.93%	2
Portugal	2.85	3	Slovenia	3.02	3	Sweden	3.15%	2
Slovenia	2.80	3	Portugal	3.01	3	Finland	2.89%	2
Czech Republic	2.34	2	Czech Republic	2.61	2	United Kingdom	2.75%	2
Poland	2.30	2	Poland	2.55	2	Netherlands	2.63%	2
Hungary	2.26	2	Hungary	2.48	2	Austria	2.29%	2
Estonia	2.10	2	Lithuania	2.45	2	Germany	1.52%	2
Slovak Republic	2.09	2	Slovak Republic	2.44	2	Denmark	1.28%	1
Lithuania	1.98	2	Estonia	2.40	2	Spain	1.26%	1
Latvia	1.96	2	Latvia	2.40	2	Belgium	1.17%	1
Bulgaria	1.49	1	Romania	1.75	1	France	0.34%	1
Romania	1.26	1	Bulgaria	1.75	1	Italy	-0.29%	1

Source: own estimation based on Eurostat data.

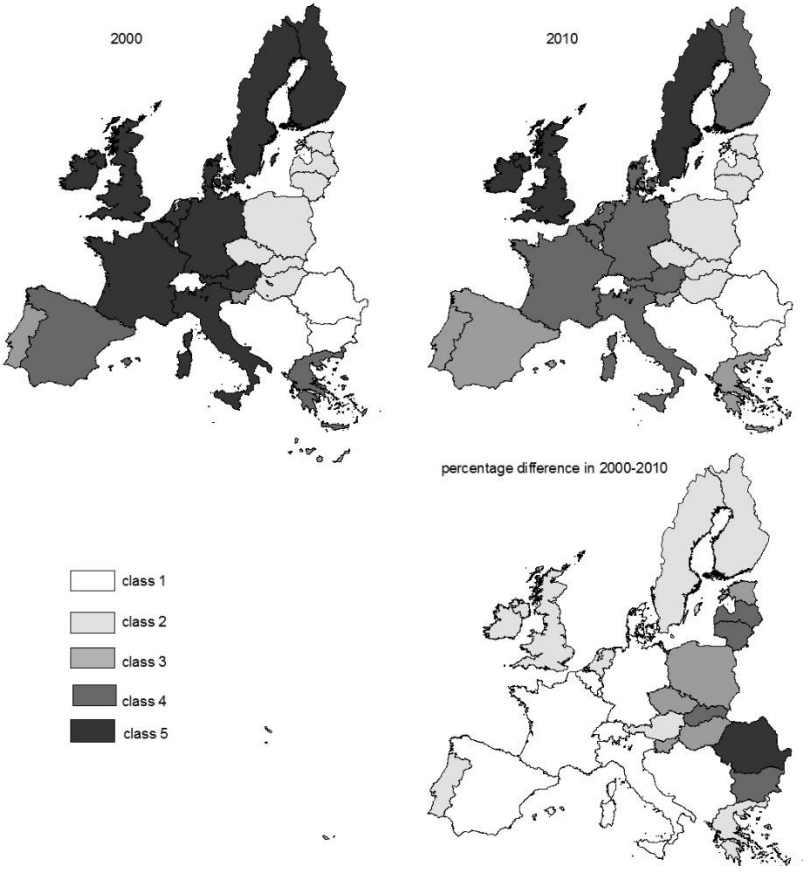

Figure 1. Total factor productivity in the European Union member countries in 2000 and 2010 (lnTFP)

Source: own estimation.

3. Quality of institutions in the context of knowledge-based economy as a determinant of total factor productivity

The mid- and long-term growth potential of developed countries is currently dependent on the ability to use the potential of KBE (Welfe (ed.), 2007; Balcerzak, 2009b, pp. 711–739, OECD, 1995; Ciborowski, 2014, pp. 57–72, Wronowska 2013, pp. 71–80). In the case of developed economies, empirical research, which has been carried out for the last two decades, confirmed the influence of institutional conditions affecting transaction costs of technological changes on the number of enterprises, which are able to use new ideas and knowledge effectively and to achieve further technological breakthroughs (OECD, 2001; McKinsey Global Institute 2002). Thus, the quality of institutions in the context of KBE should be a significant factor influencing total factor productivity in the case of developed countries. The verification of the influence

of this factor is the main objective of this analysis. Its confirmation, from the point of view of policy guidelines, means that in the reality of KBE the creation of high quality institutions and their constant improvement should be treated as an essential condition for maintaining the high rate of productivity growth[5].

The analysis of empirical research in the context of the theory of new institutional economics enables one to indicate four fundamental segments of institutional systems, which on the one hand can be modified by governments in relatively short time, and which on the other hand have significant influence on the speed of technological change[6]. Additionally, based on the arguments of new institutional economics, high quality institutions are defined here as the ones that tend to lower the transaction costs of technological progress and diffusion of new organizational ideas.

The first segment of the institutional system is the effectiveness of legislation influencing entrepreneurship. High level of entrepreneurship is conducive to increasing the supply of companies with high growth potential, and increases the likelihood of the emergence of new innovative start-ups.

The second institutional segment relates to the effectiveness of juridical system in keeping the low level of transaction costs and supporting effectiveness of market mechanism. Formal regulation that reduces the level of transaction costs favours the elimination of formal barriers to the diffusion of new organizational and technological solutions in the economy.

The third segment of the institutional system is the competitive pressure and effectiveness of labour markets. The high level of competitive pressure under conditions of relatively effective labour markets creates incentives for reorganization activities, which is conducive to improving microeconomic efficiency of enterprises. It increases the potential of enterprises that are able to find and implement new technological and organizational solutions.

The fourth institutional segment refers to financial market institutions, which should act as a stimulator of development of enterprises with high growth potential. The financial markets should support a faster reallocation of capital from industries with low to new sectors with high growth potential.

These four instructional segments can be treated as the incentive pillar of the concept of pillars of KBE according to the World Bank (see Chen and Dahlman 2005, 2004, Madrak-Grochowska 2015, 7–21).

For the identified key institutional segments, the authors selected a set of diagnostic variables, which are presented in Table 3. Detailed data for all the variables were obtained from the database of Fraser Institute[7]. Due to the design

[5] From the institutional perspective the analysis proposed in the research concentrates on the institutions that can be influenced by policy action in relatively short or medium term (Williamson, 2000, pp. 595–613; North, 1994, pp. 359–368). The influence of institutions that are the result of long-term evolutionary process is not the subject or the analysis.

[6] A more detailed discussion on the research which gave the theoretical and empirical background for highlighting these segments of institutional systems as important elements of institutional matrix influencing the possibility of utilization of the potential of, KBE is available in Balcerzak, Pietrzak (2016, 2015, pp. 71–91), Balcerzak (2015b, pp. 51–63).

[7] http://www.freetheworld.com/reports.html (1.10.2014).

of the database all diagnostic variables were stimulants with the values from 0 to 10. It should be emphasized that the variables presented in Table 3 enable one to quantify the quality of the segments of the institutional system only, which are essential in the context of a country's ability to exploit the potential of KBE. This research should not be interpreted as a proposal for holistic quantification of all segments of institutional matrix influencing economic activity and welfare in the analysed countries (see Gruszewska, 2011, pp. 103–120).

Table 3. The potential variables concerning quality of institutions from the perspective of KBE potential

Y_1 – formal regulations influencing entrepreneurship
X_{1t}^1 – Administrative requirements for entrepreneurs
X_{2t}^1 – Bureaucracy costs for entrepreneurs
X_{3t}^1 – The cost of starting business
X_{4t}^1– Extra payments/bribes/favouritism
Y_2 – effectiveness of juridical system in keeping low level of transaction costs and supporting effectiveness of market mechanism
X_{1t}^2 – Judicial independence
X_{2t}^2 – Impartial courts
X_{3t}^2 – Protection of property rights
X_{4t}^2 – Integrity of the legal system
Y_3 – competitive pressure and effectiveness of labour markets
X_{1t}^3 – Revenue from trade taxes (% of trade sector)
X_{2t}^3 – Mean tariff rate
X_{3t}^3 – Standard deviation of tariff rates
X_{4t}^3 – Non-tariff trade barriers
X_{5t}^3 – Compliance costs of importing and exporting
X_{6t}^3 – Regulatory trade barriers
X_{7t}^3 – Foreign ownership/investment restrictions
X_{8t}^3 – Capital controls
X_{9t}^3 – Controls of the movement of capital and people
X_{10t}^3 – Hiring regulations and minimum wage
X_{11t}^3 – Hiring and firing regulations
X_{12t}^3 – Centralized collective bargaining
Y_4 – financial markets institutions as a stimulator of development of enterprises with high growth potential
X_{1t}^4 – Private sector credit
X_{2t}^4 – Interest rate controls/negative real interest rates

Source: own work based on the discussion presented in Balcerzak (2015b, pp. 51–63, 2009a, pp. 71–106, 2009b, pp. 711–739), Balcerzak and Pietrzak (2016), Balcerzak and Rogalska (2008, pp. 71–87).

At the next stage, the ability of the variables to differentiate the objects was verified. Then, based on the diagnostic variables describing the discussed four segments of an instructional system a taxonomic measure of development (TMR_{it}) was calculated. The TMR measure enables the evaluation of the quality of institutions for 24 EU countries for the years 2000-2010. The applied method of taxonomic measure of development was proposed by Zdzisław Hellwig 1968 (1968, pp. 307-327; 1972, pp. 131-134). It is based on the comparison of the distance of the object from a pattern of economic development. The application of the method enables one to order the objects and divide them into homogenous classes. The value of taxonomic measure of development is influenced by many variables describing different elements of a multivariate phenomenon, thus it enables to measure it synthetically.

The value of taxonomic measure of development (TMR_{it}) was evaluated in two stages. At the first stage, after normalization of the values of the variable with classic normalization formula, the values of TMR_{it}^{k} for every institutional segment showed in Table 1 were calculated based on Hellwig's method. In the case of every variable the pattern of economic development was set as a maximum value for the years 2000-2010. As a result a fixed pattern of development was used here, which enabled a dynamic comparison of the final results in the whole period[8]. The values of four measures for every institutional segment were calculated: TMR_{it}^{1} describing formal regulations influencing entrepreneurship, TMR_{it}^{2} measuring the effectiveness of juridical system in keeping low level of transaction costs and supporting effectiveness of market mechanism, TMR_{it}^{3} for competitive pressure and effectiveness of labour markets, and TMR_{it}^{4} for financial markets institutions as a stimulator of development of enterprises with high growth potential.

At the second stage, an arithmetic mean for all the four measures TMR_{it}^{k} was calculated according to the following formula:

$$TMR_{it} = \sum_{k=1}^{4} TMR_{it}^{k} / 4, \tag{5}$$

where:

i – index for the object (country),
t – index for time.

Based on the values of TMR_{it} the European Union countries were grouped to one of five classes. As in the case of TFP, it was done with the application of natural breaks method. Some sets of countries, which are relatively homogenous from the perspective of the quality of intuitions in the context of KBE, were obtained. The results for the year 2000 and 2010 are presented in Table 4 and Figure 2.

[8] The detailed formal description of the applied procedure is available in Balcerzak (2011, pp. 456–467).

Table 4. The values of TMR for the quality of institutions in the EU countries in the year 2000 and 2010

2000			2010			2000-2010		
Country	**TMR**	**Class**	**Country**	**TMR**	**Class**	**Country**	**Percentage difference**	**Class**
United Kingdom	0.78	5	Denmark	0.81	5	Romania	65.25%	5
Netherlands	0.78	5	Finland	0.78	5	Bulgaria	23.51%	4
Finland	0.77	5	Sweden	0.76	5	Slovak Republic	22.08%	4
Denmark	0.76	5	Estonia	0.72	5	Estonia	18.61%	4
Belgium	0.72	4	Netherlands	0.71	5	Poland	10.91%	3
Sweden	0.71	4	United Kingdom	0.69	4	Latvia	9.88%	3
Germany	0.70	4	Belgium	0.66	4	Sweden	8.03%	3
Ireland	0.69	4	Ireland	0.64	4	Lithuania	6.92%	3
Austria	0.68	4	Austria	0.64	4	Denmark	6.49%	3
France	0.64	3	France	0.62	4	Hungary	5.89%	3
Spain	0.63	3	Germany	0.59	3	Czech Republic	2.59%	3
Estonia	0.60	3	Hungary	0.56	3	Finland	1.71%	3
Portugal	0.55	2	Latvia	0.53	3	France	-2.96%	2
Italy	0.54	2	Spain	0.53	3	Austria	-6.65%	2
Hungary	0.53	2	Romania	0.52	2	Ireland	-7.46%	2
Slovenia	0.51	2	Czech Republic	0.52	2	Italy	-8.50%	2
Czech Republic	0.50	2	Slovak Republic	0.51	2	Netherlands	-8.61%	2
Latvia	0.48	2	Bulgaria	0.50	2	Belgium	-9.22%	2
Lithuania	0.46	2	Italy	0.49	2	Greece	-9.43%	2
Poland	0.42	1	Lithuania	0.49	2	Slovenia	-9.70%	2
Slovak Republic	0.42	1	Portugal	0.48	2	United Kingdom	-11.85%	1
Greece	0.42	1	Poland	0.46	2	Portugal	-11.87%	1
Bulgaria	0.41	1	Slovenia	0.46	2	Spain	-15.16%	1
Romania	0.31	1	Greece	0.38	1	Germany	-15.53%	1

Source: own estimation based on the data from Fraser Institute.

As it could be seen in the case of TFP presented in Table 1 and Figure 2, the results presented in Table 4 and Figure 2 confirm analogous heterogeneity between the EU countries in the case of the quality of institutions for KBE. The "old" member states are generally grouped in classes 5 and 4, whereas the "new" member states can be found in classes from 3 to 1 with the exception of Estonia in 2010.

The highest values of TMR for the quality of institutions in the context of KBE were obtained by Scandinavian countries grouped in class 5, followed by

Austria, France, Germany and Spain grouped in classes 4 and 3. The southern European countries: Portugal, Italy and Greece are characterized by a lower quality of institutions for KBE.

Central European "new" member states are grouped in classes 3 to 1, with the lowest values of TMR for Poland, Bulgaria and Romania. As a result, the biggest improvement in the sphere of the quality of institutions was obtained by the countries that joined the EU after 2004 (especially Romania, Bulgaria, Slovakia and Estonia), which was due to "the benefits" of institutional lag and the institutional convergence process in the analysed period (see more Balcerzak, 2011, pp. 17–34).

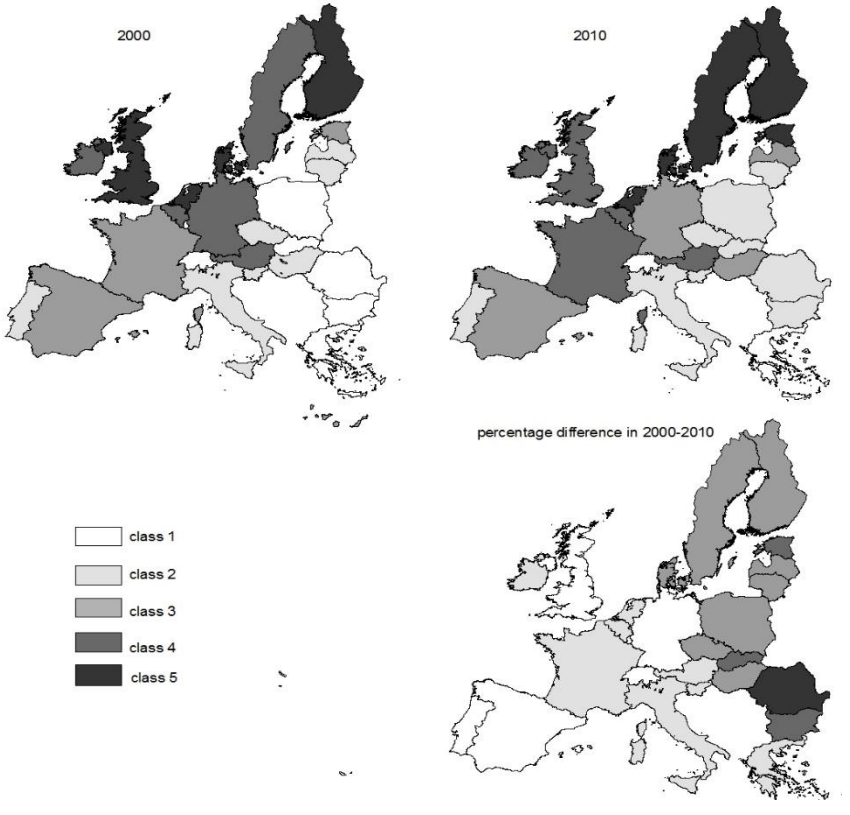

Figure 2. Quality of institutions for KBE in the EU countries in the year 2000 and 2010

Source: own estimation based on the data from Fraser Institute.

The calculated values of TMR were used at the next stage of the research, where the impact of the level of the quality of institutions on TFP was examined.

For this purpose, a specification of a FE panel model with individual effects was drawn up. The model was written with the following equation[9]:

$$\ln FTP_{it} = \boldsymbol{\eta}_i + gt + \beta_1 TMR_{it}^1 + \beta_2 TMR_{it}^2 + \boldsymbol{\varepsilon}_{it}, \quad (6)$$

where due to the heterogeneity of the analysed countries separate parameters β_1 and β_2 were used for two groups of economies; the dependent variable is logarithm of TFP while logarithm of TMR_{it}^1 and TMR_{it}^2 serve as independent variables.

Table 5. The results of estimation of parameters of FE panel model with individual effects for determinants of TFP

Parameter	**Estimate**	**Standard error**	**Parameter**	**Estimate**	**Standard error**
β_1	0.379	0.229	g	0.018	0.003
β_2	0.898	0.280	-	-	-
Individual effects	**Estimate**	**Standard error**	**Individual effects**	**Estimate**	**Standard error**
Austria	3.289	0.169	Ireland	3.374	0.172
Belgium	3.362	0.161	Italy	3.306	0.127
Bulgaria	1.070	0.127	Lithuania	1.697	0.134
Czech Republic	1.911	0.141	Latvia	1.612	0.148
Germany	3.317	0.152	Netherlands	3.204	0.178
Denmark	3.294	0.193	Poland	1.943	0.115
Estonia	1.568	0.181	Portugal	2.617	0.129
Spain	2.957	0.141	Romania	1.075	0.114
Finland	3.259	0.187	Sweden	3.389	0.179
France	3.363	0.152	Slovenia	2.349	0.139
Greece	2.957	0.111	Slovak Republic	1.709	0.135
Hungary	1.813	0.143	United Kingdom	3.352	0.176
Coefficient of determination		0.99	Durbin-Watson Statistics		0.55

[all the parameters are statistically significant at 5% significance level]

Source: own calculations based on Eurostat data.

The results of the estimation of the parameters of a panel model (6) are presented in Table 5. The parameters for individual effects for all the countries, the parameters β_1 and β_2, were statistically significant[10]. Positive values of the

[9] The components of TMR_{it}^1 vector consist of the values of *TMR* for the first group of „old" member states and 0 otherwise. A similar situation occurs in the case of TMR_{it}^2 vector and the second group of "new" member states.

[10] The statistics for Durbin-Watson test indicates statistically significant autocorrelation in the residuals.

estimation of the parameters β_1 and β_2 at the level 0.379 and 0.898 confirm the significant influence of the quality of institutions in the context of KBE on the level of TFP in the case of both groups of "old" and "new" member states. This allows the verification of the first hypothesis of the research. Additionally, a higher value of parameter β_2 for "new" member states can indicate that in the case of effective institutional policy and reforms of regulations, which will lead to a significant improvement in the quality of institutions in the context of KBE, the "new" member states would be able to improve their TFP more than proportionally in relation to "old" member states. This factor can become a significant contributor in the process of reducing development differences and supporting the convergence process of the European Union countries. This result is consistent with the previous analysis of the influence of the quality of institutions for KBE on the convergence process in Europe, which was done by the authors within conditional β-convergence framework (Balcerzak and Pietrzak 2015b). Thus, the outcome of the analysis enable one to verify the second hypothesis of the research.

4. Theoretical reference and policy implications

From the theoretical perspective, the presented results are consistent with the argumentation of new institutional economics in the context of evolutionary research on the determinants of technological changes. Additionally, the formal quantitative methodology applied in the research can be a complementary proposal to the qualitative approach, which dominates in the case of institutional framework.

From the policy perspective, the results of the research highlight the importance of institutional reforms in the European Union. The modifications of formal regulations that are up to the requirements of KBE would improve the productivity of the European countries and the European economy as a whole. It is consistent with the discussion concerning the implementation of Europe 2020 strategy (see Hobza and Mourre, 2010, Denis *et al*. 2005, Balcerzak 2015a, pp. 190–210). In the case of the "new" member states the institutional reforms are essential for increasing the speed of catching up with the "old" members. From the perspective of the common European market, they are important for keeping and eventually improving the European competitive position in the global economy.

5. Conclusions

The article concentrates on the issue of the evaluation of TFP changes in the EU countries in the years 2000-2010. Special attention was given here to the influence of the quality of intuitions on TFP. In the first part, TFP at the national level for the EU was evaluated. Then, a method for quantifying the quality of

institutions in the context of KBE was proposed. From the institutional perspective, the presented approach was rooted in the transaction cost theory. Form the numerical point of view, it was based on Hellwig's concept of the pattern of economic development. Referring to the research on the determinants of productivity changes in OECD countries, the authors proposed four segments of an national institutional system that are important form the perspective of the utilization of the potential of technological changes and KBE as a whole. Based on these four segments the total measure of development for the quality of institutions in the EU countries was calculated.

Then, the influence of the quality of institutions for KBE on TFP in the EU countries was estimated with the application of a panel model. The results of the econometric analysis enabled the verification of both hypotheses of the article, the first one concerning the positive influence of the quality of institutions on TFP in the EU countries, and the second one, which indicated especially high potential in the case of the "new" member states in improving their TFP under the condition of effective institutional reforms.

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