

DETERMINANTS OF TOTAL FACTOR PRODUCTIVITY IN EIGHT EUROPEAN COUNTRIES

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Abstract

Since the study of Solow (1957) that recognised that growth in developed economies was not due to accumulation of production factors, but a residual – total factor productivity (TFP), TFP and its determinants became important topic of research. TFP growth has become the most important factor of growth in developed and developing countries. The aim of this research is to find TFP determinants in eight European countries through implementation of empirical analysis and to recognise the more effective ones. Understanding the TFP growth determinants is important to build individual growth model. The article analyses the determinants of TFP growth in eight European countries: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic and Slovenia during 1997–2016. The theory indicates there are such determinants of TFP growth as trade openness, R&D, foreign direct investment, education, institutional framework. The study takes these determinants into account and bases the analysis on panel data and regressions. The results show a positive, significant influence of openness of trade and the share of labour force with tertiary education on TFP growth. Unfortunately, such variables as FDI share and R&D expenses that were expected to have positive influence do not appear as significant determinants of TFP growth.

Key words: total factor productivity, growth model

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INTRODUCTION

Between 1995 and 2012, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic and Slovenia have followed an extensive and investment-oriented growth model. During this period the region countries became the most dynamically developing in the world (Becker *et al.*, 2010). Despite brilliant economic growth and development, all the countries were hit hard by the global crisis. As the result, they experienced a large decline of capital stock, low investment rate, low productivity growth and faced slow recovery (Conference Board, 2015). Circumstances define that the countries are struggling to attract capital investments and need to find a new sustainable and long-term source of growth.

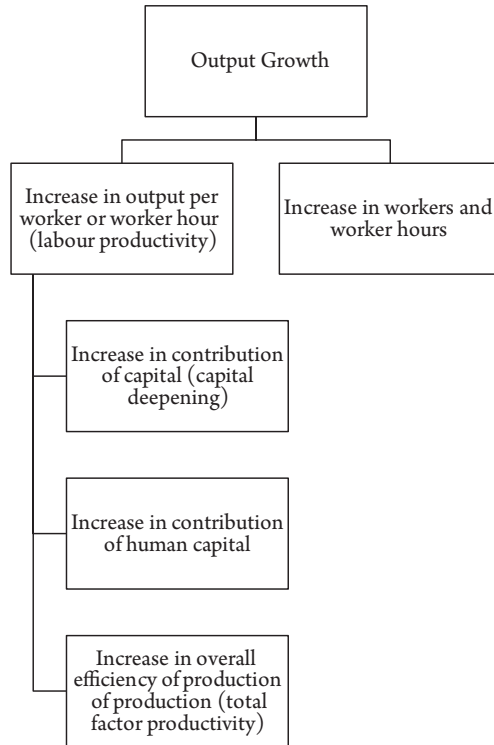
Recent economic literature assumes that total factor productivity (TFP) growth is considered to be a sustainable source of long-term economic growth. TFP measurement history started with Solow (1957) when the author introduced the additional production factor. The reason was that the other two factors – labour and capital, were not able to explain output produced, and the new component of the equation was explained as measure of efficiency of factors used in production. In a Cobb-Douglas production function (1) TFP is captured by the variable A , and it measures technology contribution to output (Y_{ct}) in country c at time t .

$$Y_{ct} = A \cdot K_{ct}^{\beta k} \cdot L_{ct}^{\beta l} \quad (1)$$

Following early attempts Solow (1957), growth accounting with TFP growth started to really develop with the work of various scholars, including Kendrick (1961), Denison (1962) and Jorgenson and Griliches (1967). The importance of TFP is reflected in overall output growth that is determined by labour productivity, number of workers and working hours involved in production. Labour productivity reflects the increase in the contribution of capital, increase in the contribution of human capital and the increase in overall efficiency of production – total factor productivity (see Figure 1). However, TFP growth measure is not influenced by other production input factors, and it exists by itself. Mainly the contribution of productivity of the factor endowments as labour and capital drives TFP growth that may occur as a spillover result from use of better technology and equipment or improved management and human capital input. Both production factors, physical and human capital, are important and are influenced by free trade that will be discussed in the next section.

Moreover, TFP relates to both technology improvements and human capital improvements that lead to better technology use. TFP refers to methods employed by labour and capital that lead to more efficient and faster production, for example, productivity input brought by R&D, education, government efficiency, etc. (Grossman and Helpman, 1991; Borensztein *et al.*, 1998; Barro, 2001).

The theoretical literature and empirical studies offer a number of possible TFP growth determinants, such as R&D, trade openness, education, institutional framework. Empirical studies propose that trade openness and increasing FDI result in R&D – through not only international cooperation and spillovers, as well through rising competition in internal market. Grossman and Helpman (1991) argue that foreign competition brought by import forces domestic firms to innovate. Innovation-based growth model discussed by Grossman and Helpman (1991) suggests that R&D leads to innovations, and that results in increase of output. FDI has been admitted as an important source of productivity due to its effect on spillovers between domestic and foreign firms. Borensztein *et al.* (1998) considers that FDI influences economic growth through improvements of technology and productivity. Barro (2001) states that higher human capital leads to TFP growth. The influence discussed in Barro (2001) is due to high-skilled



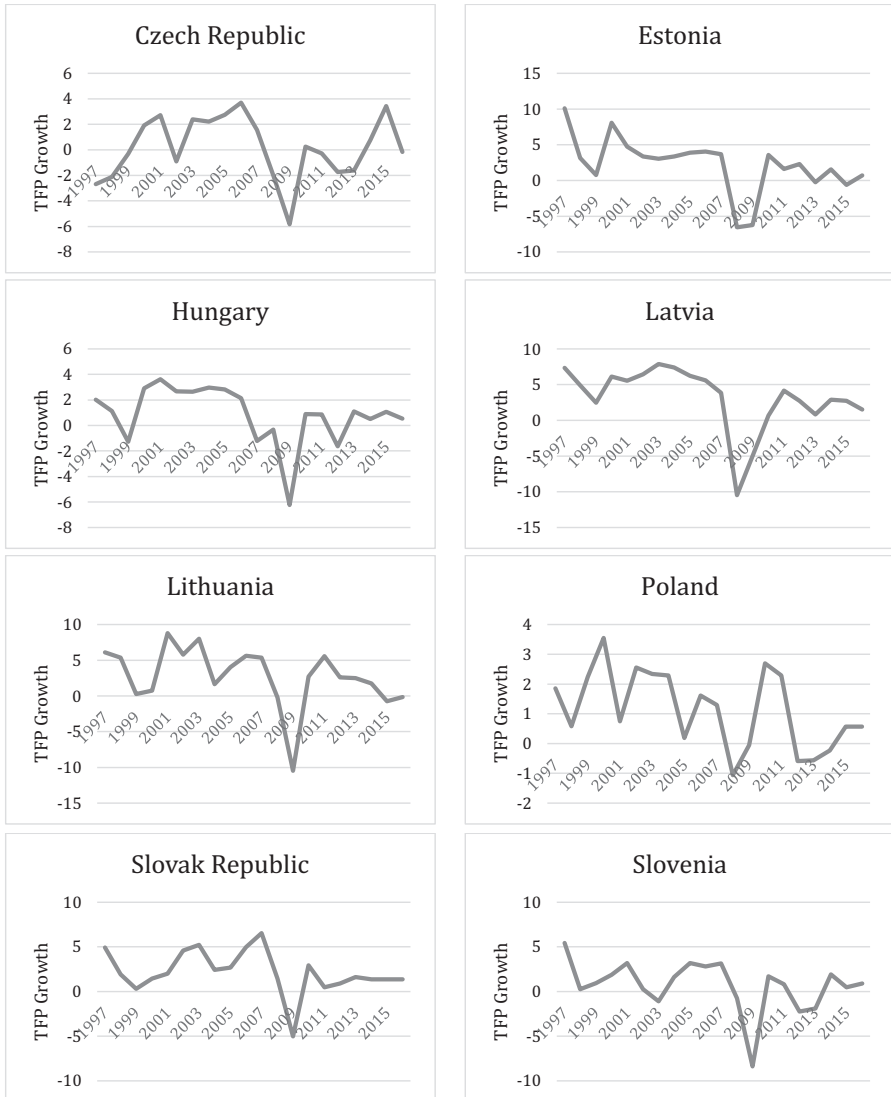
Source: *The Conference Board, 2015*

Fig. 1. **Defining Output Growth**

and well-educated labour abilities to absorb and apply superior technologies. A country with better labour quality is more able to benefit from openness of trade and FDI. Moreover, studies also focused on political and institutional framework as possible productivity drivers. For example, Becker et al. (2010, 2012) found a positive impact of the EU Structural Funds on output growth. The majority of Eastern European countries used the opportunity of the EU funds to catch up to developed union members. Efficient and productive institutions have a positive impact on aggregate productivity through boosting investments. There are many specific influence channels that are captured under the institutional framework, such as political situation, regulation and implementation systems that need to be addressed as possible TFP determinants.

Figure 2 shows TFP growth among eight EU countries from 1997 until 2016. TFP growth has been various during the period, and there is not any country-outlier that has been showing only positive or only negative TFP growth during this period. Almost all countries experienced negative TFP growth in 2008 and 2009 that is a result of global crisis in 2008. TFP growth in Poland is captured with huge fluctuations. The lowest TFP growth among all countries refers to Lithuania. It was -12.43% in 2010. The highest TFP growth was in Estonia in

1998 -9.77%. The changes in TFP growth observed from the Figure 2 cannot be explained without insight into TFP growth determinants and their changes during the period due to the fact that TFP growth in different countries shows such variation without any common trends. TFP growth experienced fluctuations without any trend except crisis in 2009.



Source: Conference Board Total Economy Database

Fig. 2. TFP growth (%)

The main aim of the research is to investigate determinants of TFP in eight European countries – Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic, and Slovenia. The research question is – “Which TFP determinants do positively influence TFP growth in 8 European countries?” The observed time period is 1997–2016. As the determinants of TFP growth were chosen and checked were such variables as openness of trade, cover ratio, FDI share of GDP, labour force with tertiary education, government effectiveness, corruption control and R&D expenses as share of GDP. The author found a positive, significant influence of openness of trade on TFP growth. The share of labour force with tertiary education also is positively associated with TFP growth. Such variables as FDI share and R&D expenses that were expected to have positive influence do not appear as significant determinants of TFP growth.

Understanding the TFP growth determinants is important for future economic growth of the union, because the empirical results may not follow the theoretical framework.

RESEARCH RESULTS AND DISCUSSION

The regression model (2) used in the research consists of 13 independent variables that were selected from theoretical and empirical literature as TFP determinants or indicators that may affect TFP growth:

$$\begin{aligned}
 TFP_{Growth_{ct}} = & \beta_0 + \beta_1 Openness_{ct} + \beta_2 CoverRatio_{ct} + \\
 & \beta_3 FDI_{Share}_{ct} + \beta_4 TertEduc_{ct} + \\
 & \beta_5 ManufShare_{ct} + \beta_6 RD_{ct} + \beta_7 \ln LabProdLevel_{ct} + \\
 & \beta_8 GovEffect_{ct} + \beta_9 CorrCntrl_{ct} + \beta_{10} TFPpre_{ct} + \\
 & \beta_{11} \ln LabProdLevelPreYear_{ct-1} + \\
 & \beta_{12} DummyEU_{ct} + \beta_{13} DummyCrisis2008_{ct} + u_{ct}
 \end{aligned} \tag{2}$$

The model consists of such variables as trade openness (share of trade with respect to GDP), cover ratio (export divided by import), FDI share, share of labour with tertiary education, manufacturing share, R&D expenses with the respect to GDP, the World Bank index of government effectiveness, the World Bank corruption control index – the variables that may influence TFP growth, and control variables – labour productivity level of current and previous year, TFP growth of previous year, dummy of EU membership, dummy of crisis in 2008.

The data on the aggregate TFP growth and GDP growth is taken from Conference Board Total Economy Database. Data on import, export, foreign direct investment inflow and labour share with tertiary education is obtained from the World Bank World Development Indicators database. Data on government effectiveness and corruption control is obtained from the World Bank Worldwide Governance Indicators database. Data on labour productivity

per person employed in 2014 \$ US is obtained from the Conference Board Total Economy Database. Data on R&D expenses as a percentage of GDP is obtained from UNESCO database. Unfortunately, data on R&D expenses is missing for Lithuania for time period from 1997 until 2004.

The Model 1 includes 12 independent variables. Model 2 includes 13 independent variables. As mentioned before, there are missing R&D expenses observations for Lithuania, therefore, they were not included in Model 1. The two models are conducted to fixed effects, and Driscoll and Kraay standard errors were applied to solve cross-sectional dependence. The models show highly significant and positive impact of trade openness on TFP growth. The labour share with tertiary education has a positive influence on TFP growth, but at the same time, it is poorly significant in the Model 1. The introduced variable of R&D expenses has a high coefficient value, but at the same time, it is insignificant and has the largest standard error. After introducing the variable other coefficients experience little changes. Tertiary education model doubles its value and becomes highly significant. Conversely, government effectiveness variable loses its significance. Such control variables as labour productivity level of current and previous year, TFP growth of previous year, and dummy of crisis in 2008 appear as significant. The estimate results of the models are represented in the Table 1.

Table 1

Estimate results (Models 1, 2)

VARIABLES	Model 1 TFP Growth	Model 2 TFP Growth
Openness	6.724*** (1.601)	5.672*** (1.529)
CoverRatio	1.307 (1.163)	1.164 (1.175)
FDIShare	0.217 (1.091)	0.621 (1.320)
TertEduc	4.998* (2.558)	9.286*** (1.504)
GovEffect	0.133*** (0.0400)	0.0688 (0.0430)
CorrCntrl	-0.0246 (0.0399)	0.0106 (0.0451)
lnLabProdLevel	61.26*** (15.07)	65.27*** (15.38)
lnLabProdLevelPreYear	-65.31*** (13.80)	-69.60*** (13.93)
TFPpre	0.116* (0.0627)	0.116* (0.0597)
Manuf	0.613*** (0.126)	0.615*** (0.175)
DummyEU	-0.876 (0.590)	-0.763 (0.695)
DummyCrisis2008	-1.881*** (0.372)	-1.643*** (0.350)
RD		44.73 (68.40)
Constant	12.28 (30.19)	17.24 (29.73)
R-sq	0.76	0.77
Standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1		

Source: author's calculations

The Table 2 represents results of Model 3, Model 4, Model 5 and Model 6. The Model 3 captures determinants of TFP growth in Czech Republic, the Model 4 captures determinants of TFP growth in Estonia, the Model 5 captures determinants of TFP growth in Hungary, and the Model 6 captures determinants of TFP growth in Latvia. The Table 2 captures the features we saw in the Table 1. Significant determinants of TFP growth in all four countries is trade openness. FDI share is poorly significant in Estonia and Hungary, the later one shows FDI share as negatively related to TFP growth. Labour share with tertiary education is significant in Hungary and Latvia. R&D is significant determinant of TFP growth in Estonia and Latvia, and is poorly significant in Czech Republic.

Table 2

Estimate results (Models 3, 4, 5, 6)

VARIABLES	Model 3 Czech Republic TFP Growth	Model 4 Estonia TFP Growth	Model 5 Hungary TFP Growth	Model 6 Latvia TFP Growth
Openness	9.471*** (1.324)	7.492*** (1.995)	2.015*** (1.368)	6.611*** (3.138)
CoverRatio	3.926 (7.521)	3.874 (8.802)	0.057 (3.656)	-4.102 (3.128)
FDIShare	18.901 (17.292)	4.638695* (6.98794)	-1.84766* (7.017)	7.331 (3.733)
TertEduc	62.283 (67.428)	-1.856 (15.883)	3.881*** (109.043)	4.727** (60.070)
GovEffect	0.380* (0.218)	-0.116 (0.218)	-0.328* (0.736)	0.462* (0.233)
CorrCntrl	0.008 (0.209)	-0.547 (0.277)	-0.004 (0.476)	-0.269 (0.169)
lnLabProdLevel	41.27*** (15.07)	38.14*** (14.78)	39.27*** (15.24)	42.34*** (15.36)
lnLabProdLevel-PreYear	-45.40*** (12.47)	-39.37*** (16.73)	-38.28*** (12.90)	-40.53*** (15.93)
TFPpre	0.024* (0.097)	0.056* (0.129)	0.095* (0.062)	0.074* (0.054)
Manuf	0.589*** (0.128)	0.725*** (0.174)	0.590** (0.137)	0.852** (0.195)
DummyEU	0.919 (0.470)	0.582 (0.525)	-0.734 (0.590)	-0.052 (0.725)
Dummy Crisis2008	-1.690*** (0.362)	-1.723*** (0.363)	-1.712*** (0.421)	-1.943*** (0.402)
RD	0.284* (0.001)	2.53 (3.470)***	14.83 (25.187)	1.14 (2.032)**
Constant	-3.278 (45.945)	21.382 (31.721)	24.146 (97.858)	7.455 (17.188)
R-sq	0.82	0.88	0.79	0.78
Standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1				

Source: author's calculations

The Table 3 represents results of Model 7, Model 8, Model 9 and Model 10. The Model 7 captures determinants of TFP growth in Lithuania, the Model 8 captures determinants of TFP growth in Poland, the Model 9 captures determinants of TFP growth in Slovak Republic, and the Model 10 captures determinants of TFP growth in Slovenia. Trade openness shows positive and significant relation to TFP growth in all models. For Lithuania, trade openness

is more favourable for TFP growth, because coefficient is times bigger than in the models of other countries. Government effectiveness is highly significant for TFP growth in Slovenia. Tertiary education is poorly significant in Model of Lithuania, Slovak Republic and Slovenia, and insignificant in the Model of Poland. Labour share with tertiary education is significant in Lithuania, Slovak Republic and Slovenia. R&D is significant determinant of TFP growth in Slovak Republic. In the Model of Lithuania R&D is not taken into account due to a lack of data.

Table 3

Estimate results (Models 7, 8, 9, 10)

VARIABLES	Model 7 Lithuania TFP Growth	Model 8 Poland TFP Growth	Model 9 Slovak Republic TFP Growth	Model 10 Slovenia TFP Growth
Openness	6.871*** (3.138)	1.214*** (8.175)	2.914*** (2.662)	1.724*** (1.601)
CoverRatio	1.762 (3.007)	-6.210 (10.813)	4.924 (3.305)	1.307 (1.163)
FDIShare	3.731 (2.128)	3.159 (21.304)	0.916 (4.565)	0.217 (1.091)
TertEduc	5.727** (10.070)	24.621 (26.30437)	0.216 (2.275)	4.998*** (2.558)
GovEffect	0.450* (0.212)	0.461 (0.127)	0.120 (0.057)	0.133*** (0.0400)
CorrCntrl	-0.349 (0.190)	-0.525 (0.028)	-0.015 (0.056)	-0.0246 (0.0399)
lnLabProdLevel	40.32*** (11.05)	44.67*** (13.12)	50.34*** (16.64)	61.26*** (15.07)
lnLabProdLevel- PreYear	-38.13*** (10.03)	-42.44*** (12.60)	-48.51*** (14.32)	-65.31*** (13.80)
TFPpre	0.142* (0.454)	0.129** (0.827)	-0.153 (0.056)	0.116* (0.0627)
Manuf	0.171* (0.192)	-1.068 (0.381)	-0.009 (0.167)	0.613*** (0.126)
DummyEU	-0.183 (0.124)	-0.133 (0.247)	-0.102 (0.012)	-0.876 (0.590)
DummyCrisis2008	-3.294*** (0.370)	-1.339*** (0.472)	-1.271 (0.526)***	-1.881*** (0.372)
RD		10.53 (3.297)	4.37 (2.109)**	0.14 (2.082)
Constant	3.175 (15.106)	-7.233 (14.030)	-8.953 (2.435)	12.28 (30.19)
R-sq	0.77	0.82	0.75	0.76
Standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1				

Source: author's calculations

CONCLUSIONS, PROPOSALS, RECOMMENDATIONS

1. There are only few TFP growth determinants that are revealed by the research. Trade openness is positively associated with the TFP growth in eight European countries. This relation shows that deeper involvement into international trade raises TFP growth. It might be caused by competition due to new export channels or imported substitutes that forces domestic firms to innovate and implement new technologies into production. It is not possible to assume that exactly export or import influences of TFP growth.

2. Higher education (tertiary) level of labour force is positively associated with TFP growth only in Hungary, Latvia, Lithuania and Slovenia. Its significance level grows with R&D expenses, and it evidences that labour force with tertiary education has an influence on TFP growth due to accumulation of innovative technologies.
3. Such institutional indicator as government effectiveness index is highly significant contributor to TFP growth, but in the case, when R&D expenses are taken into account, government effectiveness index loses its power and shows poor contribution to TFP growth.
4. FDI share of GDP, corruption control index and R&D expenses as a share of GDP do not appear as significant forces that would influence TFP growth. FDI shows poor significance in the case of Estonia and Hungary.
5. Government effectiveness appears as determinant of TFP growth only in Slovenia. In other countries, its influence is poor or none. Corruption control does not appear as determinants of TFP growth at all. It may be due to small share of corruption in the countries and effective governmental environment overall.
6. The applicability of the results is restricted to eight EU countries. Future researches may assign the same TFP growth determinants to the whole union.

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