Chovancová, Petra

Article

Productivity convergence in the European Union : the role of labour market institutions

Ekonomický časopis

Provided in Cooperation with:
Slovak Academy of Sciences, Bratislava

Reference: Chovancová, Petra (2021). Productivity convergence in the European Union : the role of labour market institutions. In: Ekonomický časopis 69 (9), S. 928 - 953. https://www.sav.sk/journals/uploads/1213183609%2021%20Chovancov%C3%A1%20+%20SR.pdf. doi:10.31577/ekoncas.2021.09.03.

Productivity Convergence in the European Union – The Role of Labour Market Institutions[1]

*Petra CHOVANCOVÁ**

Abstract

Given the relatively low level of productivity and the persisting productivity gap (between the European Union and the United States, and among the member states), measures to enhance total factor productivity growth and productivity convergence in the member states of the European Union are inevitable. The aim of this paper is to determine the factors influencing productivity convergence in member states of the European Union, with emphasis on the role of selected labour market institutions. By means of fixed effects panel regression (LSDV estimator), a catch-up specification of production function and its extensions are estimated. The empirical analysis is conducted on a dataset covering observations from 1995 to 2017 for all member states of the European Union. The empirical results have approved the role of knowledge in determining total factor productivity convergence and the suggestion about the decisive role of labour market institutions.

Keywords: *total factor productivity, productivity convergence, the European Union, labour market institutions*

JEL Classification: C33**,** I25, J48, O43, O47

DOI: https://doi.org/10.31577/ekoncas.2021.09.03

Introduction

Total factor productivity (TFP) is often considered as the driving force of long-term growth and national competitiveness. Its crucial role in explaining economic growth and cross-country differences in income has been already approved in the works of Abramowitz (1956) or Solow (1956) and later by many

* Petra CHOVANCOVÁ, Masaryk University, Department of Economics, Lipová 41a, 602 00 Brno, Czech Republic; e-mail: petra.chovancova@mail.muni.cz

[1] The support of the Masaryk University internal grant No. MUNI/A/1064/2019 is gratefully acknowledged.

others. According to the latest annual review of the European Commission (EC, 2019), almost one third of the potential output growth in the EU is attributed to the growth of total factor productivity supporting its decisive role in determining economic performance. However, the current situation regarding the development of TFP in the European Union is disturbing. Although there was a slightly rising trend of TFP since 1990s, the European Union is still less productive than the United States that is usually considered as technological leader.[2] Beside a persisting EU – USA productivity gap, considerable differences in total factor productivity exist among the member states.

Without specification of the underlying forces, it is not possible to boost productivity in the member states or reduce the productivity gap. The economic theory provides numerous candidate determinants with stress on the role of knowledge accumulation through research and development (R&D) and human capital. New growth theories accentuate the role of institutions as fundamental sources of growth and prosperity, including labour market institutions. It is important to realize that these factors can influence productivity directly as well as indirectly via their impact on productivity convergence. Research and development activities stimulate innovations. At the same time, these activities may facilitate the implementation of innovations developed abroad and thus indirectly support the country's aggregate productivity. The same is true for human capital which has potential to promote technological transfer due to positive externalities of a better educated workforce. Moreover, we suggest that productivity convergence would be induced by appropriate institutional arrangement on labour markets as the impact of labour market institutions is diverse upon the country's distance to the technological frontier.

The aim of this paper is to *determine the factors influencing productivity convergence in the member states of the European Union, with emphasis on the role of selected labour market institutions.* More precisely, two knowledge variables (R&D and human capital) and five labour market institutions (active labour market policies, employment protection legislation, minimum wages, trade unions and unemployment benefits) are considered. On the contrary to existing research papers, the idea of appropriate institutions is applied for labour market institutions and it is incorporated into the analysis of productivity convergence extending the current state of knowledge about their role in determining total factor productivity. To estimate the impact of selected determinants, a catch-up specification of productivity equation augmented by knowledge accumulation and labour market institutions is derived.

[2] The average productivity gap of the EU with the US during the period 1990 – 2017 reached 21 percentage points. Own calculations based on data from Penn World Table, version 9.1 (Feenstra, Inklaar and Timmer, 2015).

The paper is organized as follows. After a brief introduction, the theoretical framework underlying the empirical analysis is described. The second section is devoted to the specification of empirical model and estimation methods. Moreover, the panel dataset and the calculation of applied variables are described. The empirical results are presented in the third section. The last section includes the conclusion of main findings and their policy implications.

1. Theoretical Framework

In this section, the concept of total factor productivity is presented, with emphasis on its endogenous character and determinants proposed by economic literature. The theoretical channels between LMI and TFP are presented, too. Moreover, the theoretical model underlying the empirical analysis is briefly described.

1.1. Endogenous Character of Total Factor Productivity and Its Determinants

Total factor productivity (TFP) is a residual that represents that part of output that is not created by the amount of inputs involved in a production process (Comin, 2010). It captures the effects of technological change, structural factors and other unmeasurable productivity shocks. It is often called the Solow residual after its original application in Solow (1957). In literature, numerous methods to calculate its level or growth rates can be found. From the theoretical point of view, the issue of its interpretation is important. The calculation of TFP only provides a decomposition of economic growth into extensive and intensive factors, while causal explanations require construction and testing economic theories.

In the context of neoclassical theories, the residual growth is viewed as a proxy for technological progress which is exogenously given (Solow, 1956; etc.). New growth theories allow for a wider interpretation as total factor productivity is generated endogenously and thereby investigate different sources of its growth, including policies and institutions.

According to the first wave of endogenous growth theories (Frankel, 1962; Romer, 1986), an increase in productivity growth was explained by positive externalities from capital accumulation (via technology spill-overs and learning by doing). Lucas (1988) extended the framework by emphasising the role of human capital accumulation. Later, innovation-based theories have analysed technological innovations as separated activities, accenting the role of research and development (Romer, 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1992; 1998).

Numerous empirical studies approved the importance of knowledge accumulation on economic performance through their positive impact on productivity. Evidence of productivity enhancing effects of research and development and technology transfer can be found in several empirical studies such as Coe and Helpman (1995), Frantzen (2000), Zachariadis (2003), Bronzini and Piselli (2009), Edquist and Henrekson (2017), etc. The same is true for empirical analysis on the impact of human capital (Griliches, 1970; Coe, Helpman and Hoffmaister, 1997; Engelbrecht, 1997; Männasoo et al., 2018; Barcenilla, Gimenez and López--Pueyo, 2019; etc.).

The empirical studies have also raised questions about the predictions of endogenous theories. For instance, Mankiw, Romer and Weil (1992) or Barro and Sala-i-Martin (1992) showed in their empirical studies that most countries are converging to almost the same long-run growth rates. On the contrary, endogenous growth theories predicted that countries should have different long-run growth paths due to differences in policies and institutions.

This problem has been overcome by the Schumpeterian model of Howitt (2000) that introduced an impact of technology transfer (the productivity effect of R&D activities in one country is improved by innovations in other countries). Consequently, economies with a positive level of R&D should converge to parallel long-term growth. The underlying idea of this theory can be found in Gerschenkron (1952) concept of *advantage of backwardness.*[3] It implies that the further the countries are from the technology frontier, the faster they will grow with a given level of expenditures spent on implementation of foreign technologies because in that case the contribution of implementation of foreign technology to productivity is bigger.[4]

The analysis of the impact of catch-up to a technological frontier and the idea of *appropriate institutions* (different institutional arrangements according to a distance from the global technology frontier) from Gerschenkron (1952) is also incorporated to the extended version of the Schumpeterian model proposed by Aghion and Howitt (2009).

Beside aforementioned, the economic literature offers other determinants that could be responsible for persisting cross-country differences in productivity, mainly institutions. They are considered in current socio-economic theories as fundamental sources of prosperity.

[3] Recently, various studies focus on the role of institutions to test and approve this assumption (e.g. Acemoglu, Aghion and Zilibotti, 2006).

[4] The convergence in all countries is not guaranteed, because: a) technologies developed in rich countries cannot be appropriate for conditions in poor follower countries (Acemoglu and Zilibotti, 2001), b) financial constraints may prevent poor countries from spending at the level needed to hold on with the frontier (Aghion, Howitt and Mayer-Foulkes, 2005).

For example, Acemoglu (2010) has stated that institutions have a crucial impact on productivity and growth as they create or alter political and economic incentives and influence the nature of equilibria. In this paper, attention is paid to specific formal economic institutions that operate on labour markets.

1.2. Labour Market Institutions and Their Impact on Total Factor Productivity

Labour market institutions (LMI) represent a set of laws, norms and conventions, outcomes of collective choice mechanisms, that alter individual decisions by imposing constraints or incentives (Boeri and van Ours, 2013). Numerous theoretical works deal with a question about the impact of labour market institutions on productivity, however, with ambiguous conclusions. As Freeman (1992) pointed out, the recent research in labour market institutions is dominated by two contradicting intuitions, distortionism and institutionalism. The former claims that institutions impede economic growth, while according to the latter institutions can reduce costs, enhance productivity or moderate crises.

The economic theory suggests different ways how labour market institutions may positively as well as negatively influence total factor productivity. Based on a review of theoretical works the following channels were identified as the more important ones: 1. incentive of firms to increase performance and implement productivity enhancing processes (Aidt and Tzannatos, 2002; Heyes and Rainbird, 2011; Sloane, Latreille and O'Leary, 2013; etc.), 2. incentives of firms to adapt new technologies (Mortensen, 2004; Griffith and Macartney, 2014; etc.), 3. development of potentially high-growth firms (Acs, 2008; Henrekson and Johansson, 2009; Henrekson, 2014; etc.), 4. ability of firms to adapt external shocks (Scarpetta, 2014; etc.), 5. workers' morale and motivation (Akerlof, 1984; Ichino and Riphahn, 2005; Bassanini and Venn, 2008; etc.), 6. skills of the labour force (Rosen, 1972; Cahuc and Michel, 1996; Agell and Lommerud, 1997; etc.), and 7. job matches and labour reallocation (Marimon and Zilibotti, 1999; Acemoglu and Pischke, 2003; Calmfors, Forslund and Hemstrom, 2001; etc.).

Apart from their direct productivity effect, labour market institutions influence productivity convergence (theoretically in both directions). They have an impact on the country's absorptive capacity as they may influence the implementation of foreign technologies through above mentioned channels.

Trade unions influence the implementation of foreign technologies as they involve firms to introduce productivity-enhancing measures when labour cost rises (Heyes and Rainbird, 2011). But as Aidt and Tzannatos (2002) concluded, management might be reluctant to introduce such measures if regulations negotiated by trade unions were limiting or if trade unions expected job loss due to new (foreign) technologies. Wage-setting institutions (minimum wage and trade

unions) in regulated labour markets also create barriers for potential high-growth firms (mainly small firms that cannot bear high costs at the beginning of their life cycles, including investment to innovations), which in turn may have a negative impact on the implementation of foreign technologies by those firms (Henrekson, 2014; Henrekson and Johansson, 2009).

Other institutions may influence the level of labour skills and thus the ability of firms to adapt new technologies and the productivity convergence. Minimum wages may involve more skilled labour in the production process leading to an increase in the level of aggregate skills (Neumark and Wascher, 2007; Aaronson and French, 2007). In addition, an incentive to invest more into the human capital of low skilled workers with the aim of avoiding unemployment can be induced (Cahuc and Michel, 1996; Agell and Lommerud, 1997). In contrast, a reduction in the wage differential between high-skill and low-skill jobs could reduce workers' incentive to invest in training. Rosen (1972) mentioned in his theoretical work on human capital that a minimum wage could create constraints on learning opportunities for workers. Lagos (2006) expected a positive productivity effect from generous unemployment benefit systems as they increase the proportion of high-skilled workers in the workforce. In contrast, overly generous systems likely increase the duration of unemployment, leading to human capital depreciation and inefficient use of resources (OECD, 2007). It has a negative impact on absorptive capacity.

Negative consequences from generous unemployment benefit systems might be mitigated by suitable active labour market policies. Thus, the final effect of both passive and active policies is given by the relative extent of concrete programmes. Active labour market policies may affect the allocation of the labour force and shift workers from stagnating low-productivity sectors to expanding high-productivity sectors (Calmfors, Forslund and Hemstrom, 2001). In this manner, they have a positive effect on productivity convergence.

Theoretically, employment protection legislation encourages investments in human capital thanks to longer job tenure and worker commitment (Soskice, 1997; Belot, Boone and van Ours, 2007). In contrast, it may also constraint implementation of new technologies due to high adjustment costs (Griffith and Macartney, 2014). Reduced incentives to experiment with new technologies in the case of strict employment protection legislation have been argued by Mortensen (2004), who used a Schumpeterian growth model to explain how employment protection legislation reduces firms' incentives. Similarly, Calmfors and Holmund (2000) found out that such regulations reduce employers' incentives to introduce new technologies. Scarpetta (2014) suggested that lower flexibility in the case of strict protection decreases the ability of firms to adapt to

shocks in labour demand and technological progress. Less stringent regulations may increase the flexibility of high-risk entrepreneurial firms and their chance to expand and become high-growth firms (Acs, 2008). In contrast, Betcherman (2015) argued that reduced flexibility in the labour market may encourage firms to adjust by investing more into both physical and human capital.

1.3. Theoretical Background of the Model

To describe the theoretical model that will serve as the basis for the empirical analysis, the first step is to derive total factor productivity from a production function. Let's assume a standard Cobb-Douglas aggregate production function for country *i* in time *t* in this form

$$Y_{it} = TFP_{it} K_{it}^{\alpha} L_{it}^{1-\alpha} \tag{1}$$

with capital *K* and labour *L* as extensive factors of growth and productivity parameter *TFP* representing technological progress. By dividing both sides of equation (1) by *L*, the following expression is derived

$$y_{it} = TFP_{it} k_{it}^{\alpha} \tag{2}$$

where *y* is total output per worker (labour productivity) and *k* is capital stock per worker. The growth rate of output per capita *g*, under the assumption that the growth rate of population and labour force are same, can be expressed as the growth rate of output per worker

$$g_{it} = \frac{\dot{TFP}_{it}}{TFP_{it}} + \alpha \frac{\dot{k}_{it}}{k_{it}} \tag{3}$$

where the first right-hand side element represents the growth rate of total factor productivity and the second one is the capital deepening component.

Then the measure of total factor productivity growth can be expressed by rearranging the equation (3)

$$\frac{\dot{TFP}}{TFP} = g - \alpha \frac{\dot{k}}{k} \tag{4}$$

where $\frac{\dot{TFP}}{TFP}$ is a residual after accounting the effect of capital accumulation. Parameter α stands for marginal product of capital and it can be estimated as a share of capital income in total national income.

Based on the theoretical framework of Griffith, Redding and van Reenen (2004) and the underlying literature on determinants of productivity growth (see Subsection 1.1), total factor productivity is a function of R&D stock *G* and a residual set of factors *X*.

Approximating the growth rates of variables by first differences of logarithms, the growth rate of TFP can be expressed as follows

$$\Delta lnTFP_{it} = \mu \Delta lnG_{it} + \gamma X_{it-1} + \varepsilon_{it} \tag{5}$$

where $\mu \equiv (dY / yG)(G / Y)$ is the elasticity of output to R&D stock, *X* is a vector of additional determinant including human capital and labour market institutions,[5] and ε represents a stochastic error.

In continuous time, the derivative of R&D stock with respect to time is expressed as $\dot{G}_{it} = RD_{it} - \lambda G_{it}$, where *RD* stands for research and development activity. Assuming small rates of depreciation of the R&D knowledge λ, the equation (5) can be expressed as follows

$$\Delta lnTFP_{it} = \rho \left(\frac{RD}{Y} \right)_{it-1} + \gamma X_{it-1} + \varepsilon_{it} \tag{6}$$

where $\rho \equiv (dY / dG)$ represents a rate of return to R&D.

Based on the general equilibrium model of endogenous growth of Griffith, Redding and van Reenen (2000),[6] the productivity equation can be extended to include the impact of technology transfer as an additional source of productivity growth in countries behind the technological frontier. The potential for technology transfer in a follower country increases with higher growth at the technological frontier and larger distance from the frontier (larger productivity gap). Then, expression (6) becomes

$$\Delta lnTFP_{it} = \rho \left(\frac{RD}{Y} \right)_{it-1} + \beta \Delta lnTFP_{Ft} - \delta ln \left(\frac{TFP_i}{TFP_F} \right)_{t-1} + \gamma X_{it-1} + \varepsilon_{it} \tag{7}$$

where the second right-hand side term approximates the growth rate of TFP at the technological frontier and the third right-hand side term stands for the productivity gap.

[5] In the original work of Griffith, Redding and van Reenen (2004), international trade was applied as a control variable. With respect to the research aim of this study, beside human capital, labour market institutions are used as additional determinants.

[6] Their model follows the innovation-based theory of Aghion and Howitt (1992; 1998).

After accounting for a theoretical prediction that R&D activities may ease an implementation of foreign technologies,[7] the equation (7) can be extended by inclusion of the country's absorptive capacity[8]

$$\begin{aligned}&\Delta lnTFP_{it} = \\ &= \rho_1 \left(\frac{RD}{Y}\right)_{it-1} + \beta \Delta lnTFP_{Ft} - \delta_1 ln\left(\frac{TFP_i}{TFP_F}\right)_{t-1} - \delta_2 \left(\frac{RD}{Y}\right)_{it-1} ln\left(\frac{TFP_i}{TFP_F}\right)_{t-1} + \\ &+ \gamma X_{it-1} + \varepsilon_{it}\end{aligned} \tag{8}$$

where the fourth right-hand side interaction term catches-up an impact of R&D on technology transfer. Then, the speed of technology transfer is equal to $\delta \equiv \delta_1 + \delta_2 \left(RD / Y\right)_{it-1}$. If R&D really promotes technology transfer, the rate of return to R&D will be higher in countries behind the technology frontier. The overall return to R&D arising from innovation and imitation is given as $\rho \equiv \rho_1 - \delta_2 ln\left(\frac{TFP_i}{TFP_F}\right)_{t-1}$.[9]

Assuming that labour market institutions may also influence productivity convergence, equation (7) may be extended analogously to expression (8) by including an interaction term of labour market institutions and productivity gap. This assumption follows a theoretical framework of Aghion and Howitt (2009) about *distance-dependent institutions* or *appropriate institutions* that are growth enhancing only at a certain level of technological development. In their view, countries at different stages of development require different institutional set-ups to maximize their productivity.

2. The Empirical Model, Methods and Data

To estimate the impact of knowledge variables and selected labour market institutions on total factor productivity growth and its convergence a catch-up specification of productivity equation augmented by knowledge accumulation and five labour market institutions is derived. The analysis is conducted on an unbalanced panel data set that includes the author's estimation of total factor productivity index and derived variables.

[7] For details on the suggestion that R&D promote technology transfer, see e.g. Cohen and Levinthal (1989).

[8] For more details see Griffith, Redding and van Reenen (2004).

[9] For more details see Cameron (1996) or Cameron, Proudman and Redding (1998).

2.1. The Regression Model – Specification and Estimation

The main assumption behind the empirical specification can be summarized in 3 points. First, an endogenous determination of total factor productivity is assumed. Therefore, the TFP growth is determined by knowledge accumulation (proxied by human capital and research and development) and residual set of factors including institutions. Second, technological progress can be induced by new innovations or by adoption of technologies developed elsewhere. Finally, the impact of selected labour market institutions may vary across countries with different technological levels.

Given these assumptions, the baseline model will be derived using a catch-up specification of productivity equation augmented by two control variables and five selected labour market institutions. Similar specifications were used by Scarpetta and Tressel (2002; 2004), who included employment protection legislation as an additional control variable to catch-up the stringency of labour market regulations, or Bourles et al. (2009) for the issue of product market regulations. However, this model will provide a more complex study of the impact of labour market institutions on TFP by accounting for different LMI and their interactions with the productivity gap in the European Union.

Under the described theoretical framework, total factor productivity for a given country i in time t can be expressed using an auto-regressive distributed lag ADL(1,1) process in which the level of TFP is co-integrated with the level of TFP at the technological frontier TFP_F. Hence, total factor productivity can be formally modelled, following Scarpetta and Tressel (2002), as

$$lnTFP_{it} = \beta_1 lnTFP_{it-1} + \beta_2 lnTFP_{Ft} + \beta_3 lnTFP_{Ft-1} + \omega_{it} \tag{9}$$

where a subscript F stands for the frontier country (cross section with the highest level of total factor productivity) and ω represents all observable and unobservable factors influencing the level of total factor productivity.

Assuming long-run homogeneity $(\beta_1 + \beta_2 + \beta_3 = 1)$ and rearranging the equation (9) the following equation for TFP growth is derived

$$\Delta lnTFP_{it} = \beta_2 \Delta lnTFP_{Ft} - (1-\beta_1) ln\left(\frac{TFP_i}{TFP_F}\right)_{t-1} + \omega_{it} \tag{10}$$

where the second right-hand side term represents *the productivity gap* between the follower country i and the frontier country F. The equation implies that the follower countries' productivity is determined, beside other factors ω, by the productivity growth in the frontier country (e.g. via larger production possibility set)

and the distance from the technological frontier (possibility for adoption of foreign technologies).

The last term of this equation (10), which catches up all other determinants of the TFP growth, can be expressed in the following way:

$$\omega_{it} = \sum\nolimits_k \gamma_k X_{kit-1} + \varepsilon_{it} \tag{11}$$

where X_{kit} is a vector of the TFP determinants and ε_{it} are the error terms.

Assuming the presence of unobserved heterogeneity (country specific differences) through individual intercepts, country fixed effects are applied. Moreover, time fixed effects are applied to control for common aggregate shocks that could have impact on all the analysed countries in a specific year. Then, the equation (11) can be rewritten as

$$\omega_{it} = \sum\nolimits_k \gamma_k X_{kit-1} + \alpha_i + \psi_t + \mu_{it} \tag{12}$$

where α_i stands for country specific effects, ψ_t is a time dummy and μ_{it} are iid error terms.

In the first step, two control variables and five labour market institutions as determinants of TFP are considered. Then, the baseline model for the productivity growth becomes

$$\begin{aligned} \Delta lnTFP_{it} = {} & \beta_2 \Delta lnTFP_{Ft} - (1-\beta_1) ln\left(\frac{TFP_i}{TFP_F}\right)_{t-1} + \theta HC_{it-1} + \vartheta RD_{it-1} + \\ & + \sum\nolimits_m \rho_m LMI_{mit-1} + \alpha_i + \psi_t + \mu_{it} \end{aligned} \tag{13}$$

where *RD* denotes research and development intensity, *HC* is human capital and *LMI* represents a set of five analysed labour market institutions.

In the second step, the baseline model (13) is extended by interaction term of the productivity gap and knowledge variables/labour market institutions to assess the potential impact of these determinants on the absorption capacity of the EU member states. Then, the extended model becomes

$$\begin{aligned} \Delta lnTFP_{it} = {} & \beta_2 \Delta lnTFP_{Ft} - \sigma_1 ln\left(\frac{TFP_i}{TFP_F}\right)_{t-1} - \sigma_2 \left[ln\left(\frac{TFP_i}{TFP_F}\right) \sum\nolimits_k \gamma_k X_{ki} \right]_{t-1} + \\ & + \sum\nolimits_k \gamma_k X_{kit-1} + \alpha_i + \psi_t + \mu_{it} \end{aligned} \tag{14}$$

where $\sigma_1 = (1-\beta_1)$.

To estimate the regression equation (13) and its extensions based on (14) the least squares dummy variable (LSDV) estimator is applied. The fixed effect model is appropriate as the analysis focuses on the specific set of member states of the EU and the inference is restricted on the behaviour of these countries. Applying this estimator, it is possible to control for unobserved heterogeneity (country specific differences) through individual intercepts and thereby solve the problem of omitted variables. The correctness of the choice between fixed and random effect model is tested using the Hausman test (Hausman, 1978).[10] In addition, redundant fixed effects tests were provided to get more reliable results. The results of provided Hausman tests for all regressions are reported in Appendix A.

Notice that lag values of control variables as well as institutions to control for a potential issue of endogeneity are applied. It is reasonable to assume that aggregate shocks to European economies may have simultaneous impact on explanatory variables and total factor productivity (the issue of omitted variable bias is partially overcome by applying the fixed effect estimator). Moreover, the observed relationship between productivity growth and the institutional variable may also reflect the reverse causality from productivity change to changes in knowledge accumulation and institutions. Therefore, lag values of regressors are used supposing that the covariances between error terms and lag values of explanatory variables are zero. To check the violation of this weak exogeneity condition, the presence of serial correlation in residuals is tested. The problem with endogeneity may also arise due to the presence of the lagged gap of TFP (that contains the lagged dependent variable) as a regressor. The application of this explanatory variable in the empirical analysis is based on the described theoretical framework and cited empirical works. However, the robustness of results is checked by using the dynamic panel data method. All additional estimations of the equations (13) and (14) are conducted on the same sample for the same period, including the same explanatory and dependent variable.[11] Finally, standard residual tests are provided in the case of all estimations.

2.2. Data

The empirical analysis is conducted on an unbalanced panel data set covering observations on 28 member states of the European Union from 1995 to 2017. More precisely, the dataset includes observations on total factor productivity

[10] The Hausman test (Hausman, 1978) is based on testing a central assumption in a random effect model such that the random effects are uncorrelated with the regressors. Under the null hypothesis there is no misspecification, i.e. the random effect is a preferred model. Otherwise, the fixed effect model is a preferred one.

[11] As a transformation method for eliminating the fixed effects from the specification, first differences were used (in line with Arellano and Bond, 1991).

index and derived variables (productivity growth in the frontier country and productivity gap), two knowledge variables and five labour market institutions.

The choice of explanatory variables was determined by 1. research question, 2. theoretical assumptions behind the model, 3. estimation techniques, 4. availability of data, and 5. author's previous research findings about the impact of labour market institutions (Chovancová, 2020a; 2020b). The last reason refers to the application of concrete alternatives of possible variables for labour market institutions: employment protection on temporary contracts instead of regulations on regular contracts, trade union coverage instead of trade union density rate and net replacement rate in unemployment instead of net replacement rate in long-term unemployment. The description of variables and references to sources are depicted in Table 1.

The dependent variable in the analysis is total factor productivity growth proxied by the first difference of the superlative index of total factor productivity index *(TFP_index)*, following Griffith, Redding and van Reenen (2004). The index compares the country's level of total factor productivity to a common reference (geometric average over all cross-sections). It makes possible an international comparison of total factor productivity levels.[12]

The index can be calculated as follows

$$TFP_{it} = ln\left(\frac{Y_{it}}{\underline{Y_t}}\right) - \widetilde{a_{it}} ln\left(\frac{K_{it}}{\underline{K}_{it}}\right) - \widetilde{b_{it}} ln\left(\frac{L_{it}}{\underline{L}_{it}}\right) \tag{15}$$

where a *bar* stands for a geometric average over all the countries *i* for a given time *t*, $\widetilde{a_{it}}$ stands for capital index and $\widetilde{b_{it}}$ is labour index. The labour index $\widetilde{b_{it}}$ is given by the expression

$$\widetilde{b_{it}} = \frac{b_{it} + \underline{b}}{2} \tag{16}$$

where b_{it} is the labour share in country *i* and time *t,* and $\underline{b}$ is the cross-country average over all the countries *i* through all periods. As the labour and capital shares give together 1, the capital index $\widetilde{a_{jit}}$ is given as follows

$$\widetilde{a_{it}} = 1 - \widetilde{b_{it}} \tag{17}$$

The total output Y_t is proxied by nominal gross domestic product in euro from the Eurostat Database. The nominal GDP is converted to real GDP by implicit deflator (base year in 2010) from the Eurostat Database.

[12] Thanks to its transitiveness, this index makes possible an international comparison of total factor productivity levels. For more details see Caves et al. (1982).

The capital stock K_t is calculated via Perpetual Inventory method with geometric depreciation rates that are common across countries and constant over time but unique for industries. The data on gross fixed capital formation (current prices, euro) required for the calculation are obtained from the Eurostat Database and represent a sum of gross fixed capital formation for AN_F6 asset types: dwellings, other buildings and structures, machinery and equipment + weapon systems (transport equipment, ICT equipment, other machinery and equipment and weapon systems), cultivated biological resources, intellectual property products. The data at current prices are converted to real ones by implicit deflator (2010 as base year) from the Eurostat Database.

The labour input L_t is proxied by total annual hours worked from The Conference Board Total Economy Database (TED, 2018). The partial elasticities of output to labour and capital are proxied by labour and capital compensation. The rate of labour income in the total income b_t is calculated as the ratio of compensation of employees plus mixed income to total income. The data on compensation of employees, mixed income and GDP is obtained from the Eurostat Database. The rate of capital income a_t is calculated as 1 minus labor compensation (labor income and capital income give together one).

The growth rate of TFP at frontier *(TFP_frontier)* is proxied by the first difference of *TFP_index* in the country with the highest level of total factor productivity. The difference between the level of total factor productivity in the frontier country and the follower country refers to the productivity gap *(TFP_gap)*.

T a b l e 1

Data – Description and Reference to Source

Variable	Source	Description
TFP_index	Own calculation	Superlative index of total factor productivity
TFP_frontier	Own calculation	TFP index in country with the highest level of total factor productivity
TFP_gap	Own calculation	TFP difference between frontier country and follower country
HC_st	Eurostat	Population with upper secondary and tertiary education as % of total population
RD_exp	Eurostat	Total research and development expenditure as portion of GDP
UB_NRR	OECD.Stat	Net replacement rate in unemployment
MW_MEAN	OECD.Stat, WSI, MLWSI, CYSTAT	Minimum relative to average wages of full-time workers
ALMP_U	Labour Market Policies Database, Eurostat	Participant stocks in active policy measures as % of unemployed
TU_COV	ILOSTAT, ICTWSS 5.1	Collective bargaining coverage rate in %,
EPL_temp	OECD.Stat	Strictness of employment protection, temporary contracts (index 0 – 7)

Source: Own construction.

Due to the large number of missing values for *EPL_temp* and *UB_NRR*, observations for 1995 – 2003 and 2017 were dropped from the sample. The descriptive statistics of variables for the reduced sample (2004 – 2016) are presented in Appendix B.

3. Empirical Results

The regression results for the catch-up specification of the productivity equation (13) and for its extended form (14) are reported in Table 2. All regressions were conducted on an adjusted sample including 213 observations for 24 cross-sections over the period 2004 – 2016. Four EU member states (Bulgaria, Cyprus, Malta and Romania) were dropped from the sample due to a lack of observations. Moreover, time dummies had to be left out from the regressions due to the issue of near singular matrix (only country dummies were applied).[13] The potential problem with omitted variable bias was tested by the Omitted Variable Test. Based on the test statistics and associated p-values, the null hypothesis couldn't be rejected. The problem with near singular matrix is usually caused by inclusion of indicators that are highly collinear. In addition, the robustness of the estimated results was tested by re-estimation of equations after dropping the variable highly collinear with time dummies[14] (applying both country and time effects). The estimations indicated that the results are not sensitive to inclusion/elimination of the time dummies.[15]

The reported results of the baseline model and its extensions confirmed the theoretical suggestions. The estimate for the growth rate of productivity at the technological frontier was estimated as positive and highly significant in all regressions. According to the estimates, the 1% increase in the growth rate of productivity at the technological frontier increased total factor productivity growth by 0.162% when the baseline model is considered. In the case of the extended models, the size effect of the TFP growth at the frontier is a little bit smaller with the largest difference (0,014 pp) in the case of the equation (14b). The positive estimates means that the total factor productivity growth at the frontier had a positive effect on productivity growth in the member states of the

[13] The test allows adding a set of explanatory variables to an existing equation and test whether these variables make a significant contribution to explaining the variation in the dependent variable. Under the null hypothesis the additional set of regressors are not jointly significant.

[14] The problem with near singular matrix is usually caused by inclusion of indicators that are highly collinear. In this case, the inclusion of *TFP_frontier* caused a problem.

[15] The coefficients were similar after accounting for time dummies with only small differences in their sizes.

European Union. Moreover, it is in line with the baseline assumption about a positive long-run relationship between total factor productivity growth rates in frontier and follower countries. In contrast, the estimates for the productivity gap were negative and highly significant in all regressions (the only exception was (14a)). This implies that the larger a country's distance to the technological frontier was, the higher its TFP growth was, i.e. there was technology convergence. This finding can be explained by the larger potential for technology transfer in such countries. This finding is in line with the theoretical concept[16] of *advantage of backwardness* originally proposed by Gerschenkron (1952) and with outcomes of previous empirical studies[17] (see e.g. Scarpetta and Tressel, 2004 or Griffith, Redding and van Reenen, 2000).

Regarding the impact of the control variables, their direct effects on total factor productivity growth were estimated as positive and statistically significant at conventional significance levels. Both human capital (proxied by the proportion of the population with secondary and tertiary education) and research and development intensity (proxied by R&D expenditures relative to GDP) had productivity-enhancing effects in the member states of the European Union. These findings are in line with the theoretical predictions about the role of knowledge in determining total factor productivity growth. Regarding the size effect of the knowledge variables, research and development activities indicated a larger impact. The overall rate of return from R&D expenditures was estimated about 2% (second column in Table 2).[18]

The interaction term between research and development intensity and total factor productivity gap did not show any significant effect (fourth column of Table 2). Therefore, there was no significant evidence that research and development intensity enhanced convergence. To compare these results with current empirical findings, the regressions were re-estimated while replacing the research and development intensity variable (RD_exp) with business and government expenditures on research and development as a proportion of GDP (RD_busexp, RD_govexp). It was determined that business expenditures had a significantly greater impact on productivity growth (almost two times higher size effect) and

[16] For more details on this theoretical concept see Section 1.1.

[17] The studies found evidence of technological convergence for the sample of OECD countries. For the EU member states, there is no empirical study considering this relation.

[18] This estimate is higher compared to those from the empirical works of Scarpetta and Tressel (2002; 2004). They estimated the rate of return about 1%. The difference can be partially induced by the fact that their sample includes 18 OECD countries with, on average, larger stock of R&D. Therefore, a given level of expenditures spent on R&D activities may induce greater productivity growth in the EU member states. In addition, their analysis was carried out on the dataset covering observation from 1984 to 1998. Regarding the speed of technological progress, better technologies from the last decades may induce higher rates of return at the given level of expenditures.

their interaction with the productivity gap was also significant, i.e. it promoted technology convergence in follower countries. These findings are in line with those in, for example, Griffith, Redding and van Reenen (2004).

In the case of human capital, it was possible to confirm the theoretically expected role of knowledge on absorptive capacity. The coefficient for the interaction between the total factor productivity gap and human capital (14a) was negative and statistically significant. This means that those member states further beyond the technological frontier (i.e. with larger productivity gaps) had greater potential for technology transfer via human capital accumulation, which in turn had a positive effect on total factor productivity growth. It can be explained by the fact that a better educated labour force (in this case proxied by the portion of the population with higher education) may ease the implementation of foreign technologies from frontier to follower countries.

T a b l e 2

Regression Results of the Baseline Model and Its Extensions

	(13)	**(14a)**	**(14b)**	**(14c)**	**(14d)**
Constant	–0.086 (0.070)	0.008 (0.050)	–0.034 (0.071)	–0.092 (0.070)	–0.125 (0.069)
TFP_frontier	0.162*** (0.060)	0.156*** (0.59)	0.148** (0.061)	0.158** (0.061)	0.158*** (0.060)
lag_TFP_gap	–0.207*** (0.036)	–0.057 (0.060)	–0.164*** (0.036)	–0.222*** (0.035)	–0.284*** (0.052)
lag_HC_st	0.001* (0.001)	–	0.001* (0.001)	0.001* (0.001)	0.001* (0.001)
lag_RD_exp	0.020*** (0.007)	0.018** (0.007)	–	0.020*** (0.007)	0.020*** (0.007)
lag_ALMP_U	4.14e–05 (5.04e–05)	5.51e–05 (5.04e–05)	5.58e–05 (5.09e–05)	4.21e–05 (5.05e–05)	3.92e–05 (5.02e–05)
lag_EPL_temp	–0.012** (0.005)	–0.010* (0.005)	–0.013** (0.005)	–	–0.012** (0.005)
lag_MW_MEAN	–0.173** (0.079)	–0.204** (0.078)	–0.191** (0.081)	–0.174** (0.080)	–0.180** (0.078)
lag_TU_COV	–0.35e–03 (0.29e–03)	–0.36e–03 (0.28e–03)	–0.43e–03 (0.29e–3)	–0.41e–03 (0.28e–03)	–0.37e–03 (0.29e–03)
lag_UB_NRR	–0.62e–03** (0.32e–03)	–0.81e–03** (0.33e–03)	–0.62e–03* (0.32e–03)	–0.67e–03** (0.32e–03)	–
*lag_TFP_gap*lag_HC*	–	–0.002** (0.001)	–	–	–
*lag_TFP_gap*lag_RD*	–	–	–0.012 (0.010)	–	–
*lag_TFP_gap*lag_EPL*	–	–	–	0.014** (0.006)	–
*lag_TFP_gap*lag_UB*	–	–	–	–	0.001** (0.47e–03)
F Statistic	3.03	3.15	2.75	2.99	3.06
P-value (F)	0.00	0.00	0.00	0.00	0.00

Note: For all regressors coefficients, standard errors (in brackets) and significance levels are reported.

Source: Own estimations via EViews10.

Regarding the regression results for the institutional variables, three of the five LMI had a statistically significant direct impact on TFP growth in the member states of the EU, all negatively. These results suggest that employment protection regulations on temporary contracts, minimum to mean wages, and net replacement rates in unemployment had productivity-impeding effects in the EU with the highest magnitude in the case of minimum wages. The results showed that an increase in relative minimum wages (minimum to average wages of full-time workers) by one unit decreased TFP growth in the member states by 0.173 over the period from 2004 to 2016. The size effect of hiring regulations for workers under temporary contracts had been estimated as smaller (an increase in the index by one unit led to decrease in TFP growth by 0.012) similarly as the size effect of net replacement rate in unemployment (an increase in indicator by one unit led to decrease in TFP growth by 0.06).

It is important to mention that the strictness of employment protections regarding temporary contracts was used as a proxy for employment protection legislation. This choice was determined by the preliminary results. They did not show any statistically significant role for strictness of employment protections regarding regular contracts in explaining productivity growth (the same findings can be found in Aiginger, 2004). This can be explained by developments in the 21st century: a) only small-scale decline in the strictness of regulations on regular contracts in the majority of EU member states, and b) increasing differences between regulations on temporary and permanent contracts.[19]

These findings are in line with theoretical expectations about the negative impact of wage-setting institutions, strict employment regulations, and generous unemployment benefits as well as with outcomes of current empirical works.[20] Regarding the results from the author's previous research[21] (e.g. Chovancová, 2020c; 2020d), the above mentioned labour market institutions showed robust impact on total factor productivity growth (negative effect even though catch-up specification of the production function had been considered). To take into account the outcomes of empirical models with similar theoretical assumptions, only the impact of employment protection legislation had been considered. Scarpetta and Tressel (2002; 2004) found out a negative impact of strict regulations on TFP growth but with higher magnitude.[22]

[19] For a more detailed discussion of the topic, see, e.g., Sloane, Latreille and O'Leary (2013).

[20] For more details on the findings of current empirical and theoretical works see Section 1.2.

[21] The research had been devoted to the analysis of the role of LMI in determining TFP. Evidence was found for the importance of the selected LMI across numerous specifications and after accounting for different channels, institutional interactions, etc.

[22] The size of their estimate is 0,095. The difference is likely caused by different EPL indicators.

The direct effects of active labour market policies did not show any significant impact on productivity growth. Note that the regressions were re-estimated by applying alternative measures for ALMP. The estimates were not significant in any of the alternative empirical specifications.

The direct effect of the trade union coverage rate did not show a significant impact on TFP growth. The impact of trade union density rate was also tested, but there was no indication of a decisive role in determining TFP growth in the member states of the EU.

In addition, employment protection legislation for temporary contracts and net replacement rates in unemployment also seemed to have had significant indirect effects on productivity through their impact on technology convergence. The interaction between *TFP_gap* and *EPL_temp* (14c) was estimated as positive and significant at $\alpha = 0.05$. This means that the larger a member state's productivity gap was, the larger the productivity-impeding effect of strict regulations on temporary contracts was. The same held true for the generosity of unemployment systems as the interaction of the *TFP_gap* with *UB_NRR* (14d) was estimated as positive and statistically significant. These findings support the expectation about the different role of labour market institutions depending on the countries' distance to frontier. The significant and positive interaction terms for these institutions with the productivity gap can be interpreted in terms of their detrimental impact on technology convergence and consequently on TFP growth. It can be explained by the fact that strict employment protection legislation reduces the incentives of firms to adapt new technologies, partially due to high adjustment costs induced by these strict regulations. Moreover, strict regulations create barriers for potential high-growth firms and thus slow down the adoption of new technologies. In the case of unemployment benefits, generous systems likely increase the duration of unemployment leading to human capital depreciation. Therefore, it is probable that the negative impact on knowledge may hinder the adaptation of foreign technologies.

The robustness of the results was checked by using dynamic panel estimators. More precisely, the Dynamic Panel Data Method in EViews was applied to estimate the Equations 13 and 14. The estimations showed that the results about the impact of knowledge variable and labour market institutions on the productivity convergence are robust to the usage of an alternative dynamic estimation method. The estimates for explanatory variables differ only slightly in their range. Only exception is the impact of EPL on productivity convergence. The interaction term of the productivity gap and employment protection legislation (14c) have been estimated as positive but not significant at any reasonable significance level.

Conclusion

Total factor productivity is an essential determinant of long-run growth, cross--country differences in income and national competitiveness. Given the relatively low level of total factor productivity and persisting productivity gap (between the European Union and the United States, and among the member states), a creation of adequate policy measures to promote productivity growth and induce convergence is essential for better economic performance of the European Union as well as the member states. However, economic policy measures would not induce productivity convergence without determination of key sources of total factor productivity growth.

The main goal of this paper has been to determine the factors influencing productivity convergence in the member states of the European Union, with emphasis on the role of selected labour market institutions. Based on a review of theoretical and empirical works and the author's previous research findings, the impact of two knowledge variables and five labour market institutions have been analysed. While economic theory gives relatively straightforward answers on the role of knowledge (embodied in human capital and research and development) as determinants of productivity, theoretical views on the impact of labour market institutions are ambiguous. On the one hand, labour market institutions are introduced with the aim to resolve market failures and have potential to promote productivity growth. On the other side, these institutions have potential to increase inefficiency, having in turn negative impact on aggregate productivity. Apart from their direct productivity effect, all these determinants would theoretically promote productivity catch-up in follower countries and reduce the productivity gap between them and the technological leader.

The regression results have confirmed theoretical assumptions behind the empirical model. First, given the significant positive estimates for the growth rate of productivity at the technological frontier, the positive long-run relation between TFP growth rates in frontier and follower countries have been approved. Second, the significant negative estimates for the productivity gap (that measures the potential for technology transfer or absorptive capacity) provide evidence of technology convergence. In addition, theoretical expectations about the role of knowledge accumulations in determining the growth of TFP in the member states of the European Union have been approved. Both variables, human capital and research and development intensity, have indicated a significantly positive effect on the total factor productivity growth in the European Union in all regressions. Moreover, these variables have indicated a decisive role in boosting productivity convergence in the EU (via their impact on absorptive capacity). In the case of human capital, the significant negative estimate of the interaction

term with the productivity gap gives evidence of the theoretically expected role of knowledge in boosting technology transfer from frontier to follower country. In the case of research and development intensity, it has been found out that the interaction of business expenditure with productivity gap is significant, i.e. promote technology convergence in follower countries.

The main findings about the impact of selected labour market institutions on productivity convergence in the member states of the European Union can be summarized as follows. It has been proven that the productivity impeding impact of employment protection legislation and unemployment benefits is larger in the EU member states further behind the technological frontier. These findings support the expectation about different roles of labour market institutions depending on the countries' level of development (distance to technological frontier). These results also imply that these institutions have detrimental impact on technology convergence and consequently on productivity growth.

The presented findings have important policy implications. First, both European and national authorities would actively support the accumulation of human capital in order to increase total factor productivity growth and in turn the overall economic performance. It is even more important in the member states behind the technological frontier as it can enhance technology transfer and thus boost productivity convergence. Also important is to devote funds to research and development activities that have potential to increase the TFP growth through innovations and imitation of foreign technologies. In the member states behind the technological frontier, policy makers would implement measures to support businesses to invest more in R&D. Moreover, policy measures leading to less strict employment protection regulation (mainly for temporary contracts), less generous unemployment systems and lower rate between minimum and mean wages would enhance total factor productivity growth in the member states. More flexible employment protection regulations and less generous unemployment systems would also facilitate the technology transfer in countries behind the technological frontier and induce productivity convergence.

Naturally, these conclusions have certain limitations. The first is related to the sample adjustment. The full sample had to be reduced due to a lack of observations. Therefore, the conclusions are limited to only 24 member states of the European Union and the period from 2004 to 2016. However, it was not possible to extend the regressions for all member states without leaving out certain institutions. In addition, it was not possible to check the robustness of results for the subsamples of old and new member states (violation of the assumption of normal distribution). The second issue is related to time dummies. The dummies were left out from the regression due to the issue of the near singular matrix. This

problem was likely caused by inclusion of indicators that are highly collinear with time dummies. However, it wouldn't have been possible to meet the theoretical assumptions behind the empirical model if the indicator that caused the problem (productivity growth at the frontier) had been dropped. Similarly, it was not possible to include country-time dummies to control for potential country specific time shocks. The potential problem of omitted variable bias was tested in all regressions by application of appropriate tests. Moreover, the sensitivity of the results to exclusion of time dummies were tested. The third issue is related to the proposed policy measures. Prior to implementing any policy measures, it is necessary to assess their impact on other economic aggregates and consider their social impacts. In addition, authorities may be reluctant to implement unfavourable labour market policy measures. Moreover, the analysis does not consider other potential variables that could have affected total factor productivity growth directly or via technology transfer. Controlling for other possible institutions, policies, and aggregates could enrich the analysis beyond the scope of the current research question.

References

AARONSON, D. – FRENCH, E. (2007): Product Market Evidence on the Employment Effects of the Minimum Wage. Journal of Labor Economics, *25*, No. 1, pp. 167 – 200.

ABRAMOWITZ, M. (1956): Resource and Output Trends in the United States since 1870. American Economic Review*, 46*, No. 2, pp. 5 – 23.

ACEMOGLU, D. – ZILIBOTTI, F. (2001): Productivity Differences. Quarterly Journal of Economics, *116*, No. 2, pp. 563 – 606.

ACEMOGLU, D. – PISCHKE, J. (2003): Minimum Wages and On-the-Job Training. Research in Labor Economics, *22*, pp. 159 – 202.

ACEMOGLU, D. (2010): Growth and Institutions. In: DURLAUF, S. N. and BLUME, L. E. (eds): Economic Growth. London: Pagrave Macmillan, pp. 107 – 115.

ACEMOGLU, D. – AGHION, P. – ZILIBOTTI, F. (2006): Distance to Frontier, Selection, and Economic Growth. Journal of the European Economic Association, *4*, No. 1, pp. 37 – 74.

ACS, Z. J. (2008): Foundations of High Impact Entrepreneurship. Foundations and Trends in Entrepreneurship, *4*, No. 6, pp. 535 – 620.

AGELL, J. – LOMMERUD, K. E. (1997): Minimum Wages and the Incentives for Skill Formation. Journal of Public Economics, *64*, No. 1, pp. 25 – 40.

AGHION, P. – HOWITT. P. (1992): A Model of Growth through Creative Destruction. Econometrica, *60*, No. 2, pp. 323 – 351.

AGHION, P. – HOWITT, P. (1998): Endogenous Growth Theory. Cambridge: The MIT Press. ISBN 9780262011662.

AGHION, P. – HOWITT, P. (2009): The Economics of Growth. Cambridge: The MIT Press. ISBN 978-0-262-01263-8.

AGHION, P. – HOWITT, P. – MAYER-FOULKES, D. (2005): The Effect of Financial Development on Convergence: Theory and Evidence. Quarterly Journal of Economics, *120*, No. 1, pp. 173 – 222.

AIDT, T. – TZANNATOS, Z. (2002): Unions and Collective Bargaining: Economic Effects in a Global Environment. Washington, DC: World Bank. ISBN 0-8213-5080-3.

AIGINGER, K. (2004): Labour Market Reforms and Economic Growth. The European Experience in the Nineties. [WIFO Working Papers, *232*.] Vienna: Austrian Institute of Economic Research.

AKERLOF, G. A. (1984): An Economic Theorist's Book of Tales. Cambridge: Cambridge University Press. ISBN 9780521263238.

ARELLANO, M. – BOND, S. R. (1991): Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. Review of Economic Studies, *58*, No. 2, pp. 277 – 297.

BARCENILLA, S. – GIMENEZ, G. – LÓPEZ-PUEYO, C. (2019): Differences in Total Factor Productivity Growth in the European Union: The Role of Human Capital by Income Level. Prague Economic Papers, *28*, No. 1, pp. 70 – 85.

BARRO, J. R. – SALA-i-MARTIN, X. (1992): Convergence. The Journal of Political Economy, *100*, No. 2, pp. 223 – 251.

BASSANINI, A. – VENN, D. (2008): The Impact of Labour Market Policies on Productivity in OECD Countries. International Productivity Monitor, *17*, pp. 3 – 15.

BELOT, M. – BOONE, J. – VAN OURS, J. (2007): Welfare-improving Employment Protection. Economica, *74*, No. 295, pp. 381 – 396.

BETCHERMAN, G. (2015): Labor Market Regulations. What Do We Know about their Impacts in Developing Countries? World Bank Research Observer, *30*, No. 1, pp. 124 – 153.

BOERI, T. – VAN OURS, J. (2013): The Economics of Imperfect Labor Markets. Princeton: Princeton University Press. ISBN 978-0-691-15893-8.

BOURLES, R. – CETTE, G. – LOPEZ, J. – MAIRESSE, J. – NICOLETTI, G. (2009): Do Product Market Regulations in Upstream Sectors Curb Productivity Growth? Panel Data Evidence for OECD Countries. [Working Paper, No. 283.] Paris: Banque de France.

BRONZINI, R. – PISELLI, P. (2009): Determinants of Long-run Regional Productivity with Geographical Spillovers: The Role of R&D, Human Capital and Public Infrastructure. Regional Science and Urban Economics, *39*, No. 2, pp. 187 – 199.

CAHUC, P. – MICHEL, P. (1996): Minimum Wage, Unemployment and Growth. European Economic Review, *40*, No. 7, pp. 1463 – 1482.

CALMFORS, L. – FORSLUND, A. – HEMSTROM, M. (2001): Does Active Labour Market Policy Work? Lessons from the Swedish Experiences. Swedish Economic Policy Review, *85*, No. 1, pp. 61 – 124.

CALMFORS, L. – HOLMUND, B. (2000): Unemployment and Economic Growth: A Partial Survey. Swedish Economic Policy Review, *7*, No. 1, pp. 107 – 153.

CAMERON, G. (1996): Catch-up and Leap-frog between the USA and Japan. Nuffield College: Oxford University Mimeo.

CAMERON, G. – PROUDMAN, J. – REDDING, S. (1998): Productivity Convergence and International Openness. In: PROUDMAN, J. and REDDING, S. (eds): Openness and Growth. London: Bank of England.

CHOVANCOVÁ, P. (2020a): Total Factor Productivity in the EU – Direct and Indirect Impact of Labor Market Institutions. In: Proceedings of the International Scientific Conference Hradec Economic Days 2020. Hradec Králové: University of Hradec Kralove, pp. 265 – 274.

CHOVANCOVÁ, P. (2020b): Unemployment Benefits in the EU – Obstacle or Booster of Total Factor Productivity? In: Proceedings of IAC 2020 in Vienna. Praha: CIAE, pp. 52 – 70.

CHOVANCOVÁ, P. (2020c): Labour Market Institutions in the European Union and their Impact on Total Factor Productivity Growth. Ekonomická Revue, (Forthcoming).

CHOVANCOVÁ, P. (2020d): The Long-run Impact of Minimum Wages on Total Factor Productivity in the European Union. In: Proceedings of the 5th International Conference on European Integration 2020. Ostrava: Technical University of Ostrava, pp. 313 – 321.

COE, T. D. – HELPMAN, E. (1995): International R&D Spillovers. European Economic Review, *39*, No. 5, pp. 859 – 887.

COE, T. D. – HELPMAN, E. – HOFFMAISTER, A. (1997): North-South R&D Spillovers. The Economic Journal, *107*, No. 440, pp. 134 – 149.
COHEN, W – LEVINTHAL, D. (1989): Innovation and Learning: Two Faces of R&D. Economic Journal, *99*, No. 397, pp. 569 – 596.
COMIN, D. (2010): Total Factor Productivity. In: DURLAUF, S. N. and BLUME, L. E. (eds): Economic Growth. London: Palgrave Macmillan, pp. 260 – 263. ISBN 978-0-230-23883-1.
EDQUIST, H. – HENREKSON, M. (2017): Do R&D and ICT Affect Total Factor Productivity Growth Differently? Telecommunications Policy, *41*, No. 2, pp. 106 – 119.
EC (2019): Employment and Social Developments in Europe 2019. Sustainable Growth for All: Choices for the Future of Social Europe. Brussel: European Commission. ISBN 978-92-76-08609-3.
ENGELBRECHT, H. J. (1997): International R&D Spillovers, Human Capital in OECD Economies: An Empirical Investigation. European Economic Review, *41*, No. 8, pp. 1479 – 1488.
FEENSTRA, R. C. – INKLAAR, R. – TIMMER, M. P. (2015): The Next Generation of the Penn World Table. American Economic Review, *105*, No. 10, pp. 3150 – 3182.
FRANKEL, M. (1962): The Production Function in Allocation and Growth: A synthesis. American Economic Review, *52*, No. 5, pp. 995 – 1022.
FRANTZEN, D. (2000): R&D, Human Capital and International Technology Spillovers: A Cross-country Analysis. Scandinavian Journal of Economics, *102*, No. 1, pp. 57 – 75.
FREEMAN, B. R. (1992): Labor Market Institutions and Policies: Help or Hindrance to Economic Development? The World Bank Economic Review, *6*, No. 1, pp. 117 – 144.
GERSCHENKRON, A. (1952): Economic Backwardness in Historical perspective. In: HOSELITZ, B. F. (ed.): The Progress of Underdeveloped Area. Chicago: University of Chicago Press.
GRIFFITH, R. – MACARTNEY, G. (2014): Employment Protection Legislation, Multinational Firms and Innovation. The Review of Economics and Statistics, *96*, No. 1, pp. 135 – 150.
GRIFFITH, R. – REDDING, S. J. – VAN REENEN, J. (2004): Mapping the Two Faces of R&D: Productivity Growth in a Panel of OECD Industries. The Review of Economics and Statistics, *86*, No. 4, pp. 883 – 895.
GRIFFITH, R. – REDDING, S. J. – VAN REENEN, J. (2000): Mapping the Two Faces of R&D: Productivity Growth in a Panel of OECD Industries. [CEPR Discussion Paper, No. 2457.] London: Centre for Economic Policy Research.
GRILICHES, Z. (1970): Notes on the Role of Education in Production Functions and Growth Accounting. In: HANSEN, W. L. (ed.): Education, Income, and Human Capital. New York: National Bureau of Economic Research, pp. 71 – 127.
GROSSMAN, G. M. – HELPMAN, E. (1991): Innovation and Growth in the Global Economy. Cambridge: MIT Press. ISBN 9780262071369.
HAUSMAN, J. A. (1978): Specification Tests in Econometrics. Econometrica, *46*, No. 6, pp. 1251 – 1271.
HENREKSON, M. – JOHANSSON, D. (2009): Competencies and Institutions Fostering High-growth Firms. Foundations and Trends in Entrepreneurship, *5*, No. 1, pp. 1 – 80.
HENREKSON, M. (2014): How Labor Market Institutions Affect Job Creation and Productivity Growth. IZA World of Labor, *38*, pp. 1 – 10.
HEYES, J. – RAINBIRD, H. (2011): Mobilising Resources for Union Learning: A Strategy for Revitalisation? Industrial Relations Journal, *42*, No. 6, pp. 565 – 579.
HOWITT, P. (2000): Endogenous Growth and Cross-country Income Differences. American Economic Review, *90*, No. 4, pp. 829 – 846.
ICHINO, A. – RIPHAHN, R. (2005): The Effect of Employment Protection on Worker Effort: Absenteeism during and after Probation. Journal of the European Economic Association, *3*, No. 1, pp. 120 – 143.
LAGOS, R. A. (2006): Model of TFP. Review of Economic Studies, *73*, No. 4, pp. 983 – 1007.
LUCAS, E. R. (1988): On the Mechanics of Economic Development. Journal of Monetary Economics, *22*, No. 1, pp. 3 – 42.

MANKIW, N. G. – ROMER, D. – WEIL, D. (1992): A Contribution to the Empirics of Economic Growth. Quarterly Journal of Economics, *197*, No. 2, pp. 407 – 437.

MÄNNASOO, K. – HEIN, H. – RUUBEL, R. (2018): The Contributions of Human Capital, R&D Spending and Convergence to Total Factor Productivity Growth. Regional Studies, *52*, pp. 1598 – 1611.

MARIMON, R. – ZILIBOTTI, F. (1999): Unemployment vs. Mismatch of Talents: Reconsidering Unemployment Benefits. The Economic Journal, *109*, No. 455, pp. 266 – 291.

MORTENSEN, D. (2004): Innovation, Growth, and Labor Market Policy. [Meeting Papers, No. 77.] Society for Economic Dynamics.

NEUMARK, D. – WASCHER, W. L. (2007): Minimum Wages and Employment. Foundations and Trends in Microeconomics, *3*, No. 1 – 2, pp. 1 – 182.

OECD (2007): Employment Outlook 2007. Paris: Organisation for Economic Co-operation and Development. ISBN 9789264033047.

ROMER, M. P. (1990): Endogenous Technological Change. The Journal of Political Economy, *98*, No. 5, pp. 71 – 102.

ROMER, M. P. (1986): Increasing Returns and Long-run Growth. The Journal of Political Economy, *94*, No. 5, pp. 1002 – 1037.

ROSEN, S. (1972): Learning and Experience in the Labor Market. The Journal of Human Resources, *7*, No. 3, pp. 326 – 342.

SCARPETTA, S. – TRESSEL, T. (2004): Boosting Productivity via Innovation and Adoption of New Technologies: Any Role for Labor Market Institutions? [Working Paper, No. 3273.] Washington, DC: World Bank.

SCARPETTA, S. – TRESSEL, T. (2002): Productivity Convergence in a Panel of OECD Industries: Do Regulations and Institutions Matter? [Working Papers, No. 342.] Paris: OECD.

SCARPETTA, S. (2014): Employment Protection. IZA World of Labor, *12*, pp. 1 – 10.

SLOANE, P. – LATREILLE, P. – O'LEARY, N. (2013): Modern Labour Economics. Abingdon: Routledge. ISBN 978-0415469814

SOSKICE, D. (1997): German Technology Policy, Innovation and National Institutional Frameworks. Industry and Innovation, *4*, No. 1, pp. 75 – 96.

SOLOW, R. (1956): A Contribution to the Theory of Economic Growth. Quarterly Journal of Economics, *70*, No. 1, pp. 65 – 94.

SOLOW, R. (1957): Technical Change and the Aggregate Production Function. The Review of Economics and Statistics, *39*, No. 3, pp. 312 – 330.

TED (2018): The Conference Board Total Economy Database. Available at: <www.conference-board.org/data/economydatabase>.

ZACHARIADIS, M. (2003): R&D, Innovation, and Technological Progress: A test of the Schumpeterian Framework without Scale Effects. The Canadian Journal of Economics, *36*, No. 3, pp. 35 – 40.

Appendices

Appendix A

Hausman Specification Test for Baseline Model and Its Extensions

Baseline regression model based on equation (13)			
Test Summary	*Chi-Sq. Stat.*	*Chi-Sq. d.f.*	*Probability*
Cross-section random	55.343	9	0.000
Extended regression model based on equation (14a)			
Test Summary	*Chi-Sq. Stat.*	*Chi-Sq. d.f.*	*Probability*
Cross-section random	55.833	9	0.000
Extended regression model based on equation (14b)			
Test Summary	*Chi-Sq. Stat.*	*Chi-Sq. d.f.*	*Probability*
Cross-section random	46.153	9	0.000
Extended regression model based on equation (14c)			
Test Summary	*Chi-Sq. Stat.*	*Chi-Sq. d.f.*	*Probability*
Cross-section random	44.964	9	0.000
Extended regression model based on equation (14d)			
Test Summary	*Chi-Sq. Stat.*	*Chi-Sq. d.f.*	*Probability*
Cross-section random	53.658	9	0.000

Note: Cross-section radom effects test, null hypothesis of no misspecification.

Source: Own construction based on estimations via EViews 10.

Appendix B

Dataset – Descriptive Statistics of the Reduced Sample (2004 – 2016)

Variable	**Descriptive Statistics**				
	Mean	*Median*	*Max*	*Min*	*Std. Dev.*
TFP_index	0.001	0.016	0.702	–0.710	0.357
HC_st	70.66	73.95	88.00	26.00	12.69
RD_exp	1.485	1.285	3.750	0.340	0.876
UB_NRR	80.41	81.00	126.00	58.00	10.33
MW_MEAN	0.308	0.362	0.541	0.000	0.167
ALMP_U	54.79	36.53	240.56	0.534	48.21
TU_COV	58.84	58.65	100.00	7.100	28.96
EPL_temp	1.705	1.563	3.750	0.375	0.889

Source: Own construction based on descriptive statistics from EViews 10.