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Productivity Gap between the "New" and "Old" Europe and Role of Institutions

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Abstract: The present study examines how policy makers should consider the quality of institutional framework to reduce the productivity gap and increase a country's ability to absorb superior technologies developed elsewhere. This paper analyzes the impact of components of economic freedom, such as the size of government, regulation, and freedom to trade internationally, and world government indicators, such as political stability and absence of violence/terrorism, regulatory quality, and control of corruption on the productivity gap between the "Old" and "New" Europe countries. This is among the first studies to investigate, in a sample of former socialistic countries, the impact of institutions on a country's ability to adopt superior technology developed elsewhere. A static panel analysis was applied on cross-sectional data from the eleven EU countries. The results strongly support the productivity convergence between the "Old" and "New" Europe countries, with a positive impact of the institutions on the productivity growth. However, the impact of the institutions fades the further the country is from the frontier.

Keywords: Total Factor Productivity; productivity convergence; institutions; quality of the institutional framework

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1. Introduction

It has been over three decades since the collapse of the Berlin Wall and Eastern Bloc, and almost two decades since the former socialist countries have joined the European Union (EU). Following the collapse of the Berlin Wall, the former Soviet Union economies have entered the transition process from socialistic central planning to a market economy, which led to a substantial fall in efficiency (Roland 2018). After an initial period of rapid convergence, the countries of Central and Eastern Europe (CEE) are still behind Western Europe in terms of efficiency, and there is a persistent gap in productivity and income between the "Old" and "New" Europe (Männasoo et al. 2018).

For the CEE regions, it is vital to enhance their productivity and efficiency to achieve a successful productivity catch-up. The main question for the CEE countries is which factors would enhance their efficiency and productivity, and more importantly, what affects a country's ability to absorb superior technologies that have been developed somewhere else. This paper attempts to quantify the impact of institutions on productivity growth based on the "Schumpeterian" creative destruction mechanism. The growth theories based on the "Schumpeterian" creative destruction mechanisms are more effective than the standard neoclassical growth models in describing growth performance (Aghion and Howitt 2008; Nelson and Phelps 1966; Abramowitz 1986; Benhabib and Spiegel 1994; Aghion et al. 2015; Aghion 2016; Aghion and Festré 2017). In this "Schumpeterian" world, institutions and policies play a key role in determining the relative position of countries in the global innovation race (Havik et al. 2008, p. 5; Mc Morrow et al. 2010). The country's ability to gain from the innovation and knowledge spillovers, and from the adoption of more efficient existing technologies, is directly affected by the quality of the institutional framework (Hall and Jones 1999; Nicoletti and Scarpetta 2003; Havik et al. 2008; Mc Morrow et al. 2010). Therefore, it is of crucial interest to investigate the quality of institutions in the contest of productivity gap, and to provide necessary information to policymakers regarding the efficiency of institutions to create and uphold the policies that will help a lagging country to narrow, or even to close the productivity gap. The institutional framework is best understood as an environment that supports growth (Acemoglu et al. 2004). The proper institutional framework, unregulated private markets, and limited government role in protecting liberty, property, and enforcing contracts are key factors for creating prosperity (Borovic 2014). Rodrik et al. (2004) stress that institutional quality outweighs other growth factors. North (1990) argues that institutions boost productivity through reduction of uncertainty and transaction cost.

The present study is a result of the authors' continuous work on the productivity gap between former socialistic countries and the "Core" European countries. In the previous study carried by Radicic et al. (2023), the authors were investigating the productivity gap between the" New" and "Old" EU countries at the industry level, covering three specific industries, namely ICT producing manufacturing (i.e., electrical and optical equipment), market services, and manufacturing. The conditional productivity convergence has been proven for all three industries, including the macro-level control variables: research and development (R&D), human capital, and informational and communicational technology (ICT) capital stock ratio. This study investigates the impact of the quality of the institutional framework on the productivity and productivity gap at a country level, between the "Old" Europe and "New" Europe countries. More specifically, this study investigates the impact of the quality of institutions and institutional framework on conditional productivity convergence between the "New" and "Old" EU countries at a macro level. The "New" Europe consists of ten countries that have been full EU members since 2004. The "Old" Europe countries are taken on average as the eleventh country. To measure the productivity and productivity gap, the two measures of the Total Factor Productivity (TFP) are applied: one measure is based on raw labor, and the second one is based on human capital. We have applied two measures of the TFP to test the robustness of empirical results. The main results are robust to a change in productivity measure. This paper focuses on a different and yet more comprehensive set of institutional variables than previous studies (McGuinness 2007; Hall and Jones 1999; Nicoletti and Scarpetta 2003; Havik et al. 2008; Mc Morrow et al. 2010). This study is based on the standard model of technology transfer. We derive the empirical model from the equilibrium correction model (ECM) represented by the autoregressive distributed lag (ADL) (1,1) process (Bournakis 2011; Nicoletti and Scarpetta 2003). For the estimation of the convergence equation, we apply the Fixed Effect (FE) panel estimator and the instrumental variable (IV)-GMM estimator (Mc Morrow et al. 2010; Nicoletti and Scarpetta 2003; Havik et al. 2008; Inklaar et al. 2008; Bournakis 2011; Männasoo et al. 2018; Pietrucha and Żelazny 2020). The FE is known to suffer from the problems of cross-sectional dependence, as well as the problems of autocorrelation, and heteroskedasticity (Wursten 2018; Bai et al. 2021; Hambaba 1992; Muthama 2015; Bramati and Croux 2017), which is why we apply the Feasible Generalized Least Square (FGLS) with the specification of heteroskedastic and correlated error structure, with the use of a panel-specific AR (1) autocorrelation structure, if such problems arise from empirical analysis. To test the robustness of results, we first estimate the convergence equation based on the raw labor TFP, and then we estimate the same equation based on the human capital TFP.

The research question of this study is whether institutions create convergence by reducing the productivity gap. This study offers insight into the efficiency of implemented polices. For policymakers, it is vital to identify which policies are increasing productivity and which are not fulfilling their role, so that they can increase the quality of the institutional framework. The aim of this study is threefold. The first objective is to estimate the productivity gap at the country level between the "Old" Europe and "New" Europe countries. The second objective is to determine whether there is a productivity convergence at the country level between the "Old" Europe and "New" Europe countries and to make a contribution to the existing literature on economic convergence. The third objective is to estimate the impact of the quality of the institutional framework on productivity, and on a country's ability to absorb superior technologies that have been developed somewhere else. To address these objectives, the econometric specification is applied on a standard model of technology transfer.

This paper offers some contributions to the literature on the TFP and institutions. The first contribution of the present study is that it combines the Economic Freedom and World Governance Indicators, for the former socialistic countries, in the frame of the "Schumpeterian" creative destruction mechanisms. The second contribution of the present study is that it offers insight into the effectiveness of the policies, depending on proximity to the frontier. This is among the first studies to combine a different set of institutional variables on a sample of former socialistic countries, to investigate the sources of productivity growth in the frame of convergence.

This paper is organized as follows. Section 2 discusses the existing literature and gives some theoretical background. Section 3 provides information on the model specification and applied methodology. Section 4 presents the data. Section 5 contains the empirical results. Section 6 contains the discussion of the empirical results. Section 7 concludes the paper.

2. Theoretical Framework

The transition process for the CEE countries started with the partially free elections in Poland, which followed the collapse of the Berlin Wall in 1989, which ended the existing communist regimes (Roland 2018). The fall of the Berlin Wall marked the beginning of the Europe reunification, which was divided by the Iron Curtain and by the Cold War for almost half a century. By the end of 1997, the EU launched the enlargement process for the 13 applicant States. By the end of 2002, the Copenhagen European Council declared that 10 out of 13 applicant States met the criteria for joining the EU. The Accession Treaty was signed in Athens on 16 April 2003. The CEE countries are officially members of the EU since 1 May 2004.

The TFP is the portion of output that is not explained by the number of inputs used in production (Comin 2010). According to the conventional view (Law, Krugman, Young), a change in TFP measures the rate of technical change. A large part of the difference in income per capita between rich and poor countries is due to the difference in TFP (Hall and Jones 1999; Klenow and Rodriguez-Clare 1997; Gallardo-Albarran and Inklaar 2021). This is the reason why it is necessary to directly measure the technology. The characteristic of former socialistic countries is a long-term equilibrium between the TFP and institutional quality (Borovic et al. 2020). The quality institutions are a necessary precondition that should motivate domestic companies to engage in export activities and should enable them to learn by exporting (Pietrucha and Żelazny 2020).

Institutional quality and governance are widely used and discussed by policymakers and scholars (Schönfelder and Wagner 2019; Pérez-Moreno et al. 2020; Glawe and Wagner 2021a), yet there is no consensus on a single definition of governance or institutional quality (Kaufmann et al. 2010; Schönfelder and Wagner 2019). In the literature, there is a wide array of definitions of governance and institutional quality, both narrow and overly broad (Banerji et al. 2002; Kaufmann et al. 2010). In one of the most comprehensive definitions, governance is defined as "the traditions and institutions by which authority in a country is exercised. This includes (a) the process by which governments are selected, monitored and replaced; (b) the capacity of the government to effectively formulate and implement sound policies; and (c) the respect of citizens and the state for the institutions that govern economic and social interactions among them" (Kaufmann et al. 2010, p. 4).

According to Hall and Jones (1999), the differences in social infrastructure (institutions and government policies) are recognized as a main driving force behind the differences in productivity between countries. The quality of institutions can affect the country's ability to adopt superior technologies developed at the frontier (Nicoletti and Scarpetta 2003; Havik et al. 2008; Mc Morrow et al. 2010). Following Rodríguez-Pose and Ganau (2022), institutional quality is at the heart of the productivity challenge in Europe. They have analyzed the impact of institutional quality on labor productivity. Empirical findings show that institutional quality has a direct impact on productivity growth, as well as an indirect effect via increased short and long-term returns of human capital and of innovations. To deal with the productivity challenge, the quality of local and regional institutions must be improved significantly, especially in the areas of corruption (Ganau and Rodríguez-Pose 2019; Rodríguez-Pose and Ganau 2022; Égert 2017).

To increase its productivity and economic efficiency, it is vital that a country secures quality institutions (Acemoglu et al. 2004). Quality institutions with a high level of economic freedom are a necessary condition for increasing predictability and reducing uncertainty, which will lead to a higher TFP growth. The growth-supporting environment should result in productivity-enhancing innovations in products, processes, and ways of organizing productive activities (Bjørnskov and Foss 2010; Borovic et al. 2020; Radicic et al. 2023) The study carried out by Borovic et al. (2020) focuses on the impact of institutional quality, measured by the Index of Economic Freedom, on the TFP growth for the countries that are full members of the EU since 2004. Their results show that institutional quality has a long-term impact on productivity growth.

Nicoletti and Scarpetta (2003) focused on the Multi-Factor Productivity (MFP) and regulative reforms in the OECD countries for 1984–1998. They have found strong evidence that all reforms that increase market competition and decrease the size of the public sector tend to raise productivity. Similar results were obtained by Égert (2017) in a study focused on the OECD countries, covering the last three decades. The MFP levels tend to be lower in the presence of the anticompetitive product market regulations. For the OECD countries, the variations in the MFP are mainly the result of the variations in regulations and in quality of institutions (Égert 2017).

When analyzing the TFP for the five European countries (France, Germany, Italy, Spain, and United Kingdom), United States of America (USA), and Japan, Calcagnini et al. (2021) show that the level of institutional quality and market efficiency is positively corelated with the long-term TFP growth. Their analysis was based on the ranking on the ease of Doing Business (DB) in 2005 and 2017. Moreover, a positive impact of the institutional variables (government effectiveness or political stability) on the TFP growth has been confirmed by Pietrucha and Żelazny (2020). They have stressed that institutional environments should be designed to encourage exporting and to foster learning through exporting. Based on the above literature review, we formulate the following:

H1. *The quality of institutional framework has a positive impact on productivity growth of the "New" Europe countries.*

In the recent economic literature, the quality of institutions and their impact on productivity and economic development has been stressed as one of the key factors in narrowing the gap between the rich and poor countries (Glawe and Wagner 2021a, 2021b; Rodríguez-Pose and Ganau 2022). The difference in TFP is recognized in the literature as the main reason for almost all per capita income disparities across economies both at national and sub-national levels (Klenow and Rodriguez-Clare 1997; Easterly and Levine 2001; Jerzmanowski 2007). Burda and Severgnini (2009) have conducted an analysis on a sample of 30 European economies for the time 1994–2005. They have applied three TFP measurements: Solow–Tornqvist, Direct Substitution, and Generalized Difference. Their results show that the TFP growth has been slowing down since 2000 for most countries of Western Europe. However, "Old" Europe countries have a smaller TFP growth, and they have experienced a higher deceleration of TFP growth since 2000 than the "New" Europe countries (Burda and Severgnini 2009). van Ark and Piatkowski (2004) argue that the convergence process between the regions of "New" and "Old" Europe may slow down, even though more evidence supports the convergence process. The core EU countries were characterized by the process of income, nominal, and institutional convergence, but only before 2008, i.e., prior to the financial crisis.

The EU has been described as a "convergence machine" (Raiser and Gill 2012), but the global financial crisis has slowed down the "convergence machine" (Ridao-Cano and Bodewig 2018). Even though productivity is slowing down within the EU, especially in the countries of South Europe, the CEE countries are experiencing productivity growth, and they are catching up with the EU average (Ridao-Cano and Bodewig 2018).

Männasoo et al. (2018) have stated that for the EU regions, the TFP growth is mainly driven by the TFP gap. Countries that are behind the technological frontier are growing faster than the countries closer to the technological frontier. The TFP gap is identified as a driving force behind the TFP growth for the 91 developing countries, for the period 1960–2015, which proves the presence of convergence (Maryam and Jehan 2018).

A previous study carried out by Radicic et al. (2023) was focused on the productivity convergence between the former socialistic countries and core European countries. The authors have applied a static panel analysis on the TFP measure based on the raw labor, for the three specific industries: ICT producing manufacturing (i.e., electrical and optical equipment), market services, and manufacturing. Conditional convergence has been proven for all three industries. Since the productivity gap is closing at the industry level, the present study investigates convergence at the macro level, and impact of the institutional framework on the conditional convergence, for the same sample of countries, by applying a similar methodology. Based on the above literature review, we define a second hypothesis:

H2. *The productivity gap between the "New" and "Old" Europe is closing.*

As mentioned in the Introduction, institutions and policies play a key role in determining the relative position of countries in the global innovation race (Havik et al. 2008, p. 5; Mc Morrow et al. 2010). Without a high-quality institution, the potential for innovation and human capital will never be fully utilized. The development of the institutions is a necessary precondition for productivity growth, and for speeding up the catching up process. The present study is among the first in recent years to deal with the institutional framework and productivity convergence for the former socialistic countries, therefore the available literature is scarce.

A study carried out by Nicoletti and Scarpetta (2003) offers evidence that private governance, privatization, entry liberalization, and competition boost productivity for the OECD countries. According to Mc Morrow et al. (2010), the impact of the regulations on productivity, and on the countries' absorptive capacity is sector specific. They have stressed that for manufacturing, market regulations have a positive impact on the TFP growth, and for the market services, market regulations reduce the TFP growth. The further a country is from the frontier, the slower its TFP growth (Mc Morrow et al. 2010).

The impact of the labor market institutions (LMI) on the TFP was investigated by Chovancová (2021). The results suggest that employment protection regulations on temporary contracts and net replacement rates of unemployment have a negative impact on the EU TFP growth. A further country falls behind the technological frontier, a negative impact of the LMI on the TFP growth is stronger.

McGuinness (2007) investigates the impact of institutions on the TFP growth on the global level. The results provide some evidence of catching up between poorer countries and wealthier ones. The catch-up process has been influenced by the institutions, both directly, through adoption of the technology developed elsewhere, and indirectly, through the impact of the institutions on the productivity gap, and yet that impact has been very small.

Glawe and Wagner (2021a) identify institutional convergence clubs, which are formed mainly on the basis of geographic regions. They have analyzed the WGI indicators by applying Phillips and Sul's (2007, 2009) methodology. North and West Europe are the clubs with a higher institutional quality, while South and Eastern Europe are clubs with a lower institutional quality. Since the last enlargement, all countries, except for Estonia, Lithuania, and Latvia, are stuck in poor institutional traps. Countries that are stuck in poor institutional traps are those countries whose transition curves lie below the cross-section mean and that have a stagnating and declining tendency (Glawe and Wagner 2021a, p. 869). In the same study, Glawe and Wagner (2021a) were investigating the income per capita clubs. Their results suggest that the formation of the income clubs is determined by institutional clustering.

According to Pipitone and Seta (2012), a high level of quality of the institutions tends in the short term to substitute the effect of the physical capital accumulation on productivity, while in the long term, it intensifies the effect of human capital accumulation on productivity. Based on the above literature review, we posit the following:

H3. *Institutions create convergence towards the "Old" Europe countries.*

3. Methodology

The present study relies on the standard model of technology transfer, which slightly differs from the model presented in Acemoglu (2009). This model, with some variations, was applied by Nelson and Phelps (1966), Bernard and Jones (1996), Nicoletti and Scarpetta (2003), Bournakis (2011), and McGuinness (2007).

The basic assumption of the model is the existence of the leading country, and that all other countries fall behind the leader. The leader's technology level is denoted with X, which grows at the level g, and all other countries have the technology level Y; in other words, we can say that $X > Y$. Under the second assumption, the efficiency of a country that falls behind the leader depends on a country's characteristics as well as on the technological and organizational transfers from the leading country. Following the first assumption, the productivity in a particular country grows at the rate of:

$$\dot{Y} = \lambda(X - Y) \tag{1}$$

where $\dot{Y}$ is productivity growth rate for the following country, λ represents the fraction of the gap between the technological leader and a country that falls behind the technological frontier, that can be closed by increasing the convergence speed. This can be achieved by adopting innovation and knowledge that are developed in the technologically most advanced country (Havik et al. 2008; Mc Morrow et al. 2010). In this way, the standard growth model presented in Aghion and Howitt (2008) is extended by assuming that countries' own characteristics, as well as the transfer of technology and knowledge from the leader, are determinants of the efficiency.

3.1. Total Factor Productivity

The TFP is estimated by applying two different procedures. The first procedure is based on the growth accounting, whereby the TFP is calculated as the Solow residual (Solow 1957) in a logarithmic form:

$$\Delta\, logY = \Delta\, logA + \alpha\Delta\, logK + \beta\Delta\, logL \tag{2}$$

In this notation, the Gross Value Added (GVA) is used as a proxy for the Y, the capital stock is K, and labor is L. The parameters α and β are the factors of marginal (social) products, and the constant return to the scale is assumed such that $\alpha + \beta = 1$. The TFP growth is obtained from Equation (2) as a residual. The value of parameter α is set at 0.33, as done in Hall and Jones (1999), McQuinn and Whelan (2007b), Burda and Severgnini (2009), and McGuinness (2007), which implies that the value of parameter β is set at 0.67.

The second procedure to estimate TFP is based on the standard Cobb–Douglas production function in per capita terms, proposed by Hall and Jones (1999).

$$Y = K^{\alpha}(AH)^{\beta} \tag{3}$$

where Y is GVA, the parameter α is capital income share in GVA, and H represents the human capital. According to Hall and Jones (1999), the L (labor) is homogenous within a country and each unit of labor has been trained with E years of schooling.

$$H = e^{\Phi(E)}L \tag{4}$$

The Function $\Phi(E)$ reflects the efficiency of a unit of labor with E years of schooling relative to one with no schooling, that is, $\Phi(0) = 0$ (Hall and Jones 1999, p. 87). The data on human capital H are taken from the Penn World Table 10 (PWT) (Feenstra et al. 2015). The rate of return to education is based on estimations of the Mincerian wage regression as the first derivation $\Phi'(E)$ (Mincer 1974). The Equation (3) can be rearranged as:

$$y = (k)^{\frac{\alpha}{1-\alpha}} hA \tag{5}$$

where y is GVA per worker, k is capital–output ratio (K/Y), and h is human capital per worker. Then the TFP is obtained from Equation (5):

$$TFP = \frac{y}{k^{\frac{\alpha}{1-\alpha}} h} \tag{6}$$

3.2. Capital Stock

Every TFP growth measure suffers from the same weakness, as they all require estimation of the capital stocks time series. The capital stocks are fundamentally unobservable, and their estimation relay on the theoretical model with a significant error in their measurement (Burda and Severgnini 2009). To assess the capital volume, the perpetual inventory method (PIM) has been applied, which represents the solution of the Goldsmith difference equation:

$$K_t = I_{t-1} + (1-\delta)K_{(t-1)} \tag{7}$$

where I stand for investments and δ stands for depreciation rate. Even though the data on investments are generally available for a long period of time, the first problem with the capital stock estimation is the depreciation rate. According to Burda and Severgnini (2009), the depreciation rate may be time-varying and may even depend on the state of the business cycle. This study follows the McQuinn and Whelan (2007a) regarding capital depreciation. The capital stock is combined from various types of capital, and they all depreciate at very different rates. For example, for structures, the depreciation rate is less than 2% annually, and for equipment, the depreciation rate is above 10% (McQuinn and Whelan 2007a). The depreciation rate is set at 0.06 or 6%, as done in McQuinn and Whelan (2007a), Burda and Severgnini (2009), McGuinness (2007), and Radicic et al. (2023).

To be able to calculate the current capital stock, data on the initial capital stock are required. Here, the US Bureau of Economic Activity (BEA) procedure is applied to calculate the initial capital stock, as done in Burda and Severgnini (2009):

$$K_0 = I_0 \frac{1+\delta}{g+\delta} \tag{8}$$

where K_0 stands for initial capital, I_0 stands for the investment in the initial year, and g represents a ten-year annual average output growth rate (Bernanke and Garkaynak 2002). Full capital utilization is assumed, even though this assumption could lead to an over (under)-estimated TFP measure. Over or underestimated measure of the TFP means the failure of the exogeneity condition of the Solow residual. To obtain the current capital stock, the linear depreciation method is applied:

$$K_t = (1-t\delta)K_0 + \sum_{i=0}^{t-1} (1-t\delta)I_{t-i} \tag{9}$$

The linear depreciation method will enable a full depreciation of the initial capital in $1/\delta$ years. The current capital stock is the weighted sum of initial capital value, K_0, and intervening investment expenditures, with weights corresponding to their undepreciated components (Burda and Severgnini 2008).

3.3. The Institutions

To measure the quality of institutions, the combination of the Economic Freedom Index (EFI) subcomponents, on one hand, and the WGI indicators, on the other hand, will be used in this study. Our first motivation to use these specific indicators of institutional quality is that this is the first study, known to us, that combines these two types of institutional indicators in the conditional convergence analysis for this specific sample of countries. The second reason why we have focused the analysis on these specific indicators of institutional quality is that these indicators fully reflect the very essence of institutions, which is a reduction of transaction costs through the creation of favorable environment and incentives for economic growth and development (Rodríguez-Pose 2013). Some authors have used the EFI (the composite index), or its subcomponents as an indicator of the institutional quality (Borovic et al. 2020; Havik et al. 2008; Mc Morrow et al. 2010). Similarly, some authors have used the WGI as an indicator of institutional quality (Glawe and Wagner 2021a, 2021b; Badalyan et al. 2016; Pietrucha and Żelazny 2020). The EFI index is reported annually by the Fraser Institute since 2000 in Economic Freedom of the World.

There are six components of the WGI: Voice and Accountability, Political Stability and Absence of Violence/Terror, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. The WGI as a composite measure of governance are in units of a standard normal distribution, with mean zero, standard deviation of one, and running from approximately −2.5 to 2.5, with higher values corresponding to better governance (Kaufmann et al. 2010). In this paper, the following EFI subcomponents and WGI Indicators are used:

- Size of government (EFI1),
- Freedom to Trade Internationally (EFI4),
- Regulation (EFI5),
- Political Stability and Absence of Violence/Terrorism (WGI2),
- Regulatory Quality (WGI4),
- Control of Corruption (WGI6)

3.4. Model Specification

The TFP gap is defined as a logarithmic difference between the *TFP* level in the frontier (EU-15 average) and each country's estimated TFP (EU-10 countries):

$$TFPgap = \left(logTFP_x - logTFP_y\right) \tag{10}$$

where TFP_x represents the *TFP* level at the frontier, and TFP_y, represents each country's estimated *TFP*. The reverse value of the *TFP* gap represents the relative *TFP* (*RTFP*):

$$RTFP = \left(logTFP_y - logTFP_x\right) \tag{11}$$

The empirical convergence equation for the "New" Europe countries is an equilibrium correction model (ECM) represented by an ADL (1,1) process (Bernard and Jones 1996). The level of productivity in industry i is co-integrated with productivity in the frontier country ("Old" Europe countries), as follows:

$$log\ TFP_y = \alpha + \beta log\ TFP_{y,t-1} + \gamma log\ TFP_x + \theta log\ TFP_{x,t-1} + \mu_{y,t} \tag{12}$$

where μ stands for all the observed and unobserved effects that may impact the *TFP* growth of the "New" Europe countries, and it is further decomposed as:

$$\mu_{y,\,t} = \sum_{n} \gamma_n Z_{y,t-1} + \rho + d_t + \varepsilon_{y,t} \tag{13}$$

The right side of the Equation (13) includes all the observed factors that have an impact on *TFP*, namely, the *EFI* index and its subcomponents. To control for industry- and year-specific effects, we use vectors ρ and d. Under the assumption of the long-run homogeneity condition (i.e., $1 - \beta = \gamma + \theta$), after the transformation, Equation (12) can be written as:

$$\Delta\log\ TFP_y = \alpha + \gamma\Delta\log TFP_x + (1-\beta)TFP_{gap} + \mu_{y,t} \tag{14}$$

By substituting Equation (12) into Equation (13), the following expression is obtained:

$$\Delta\log\ TFP_y = \rho_y + \vartheta\Delta\log\ TFP_x + \gamma Z_{y,t-1} + \lambda TFP_{gap} + \mu Z_{y,t-1} TFP_{gap} + \varepsilon_{y,t} \tag{15}$$

The dependent variable is *TFP* growth for the "New" Europe countries, the ρ_y controls for industry individual heterogeneity, ϑ captures the impact of the *TFP* growth at the frontier, λ denotes the speed of technological transfer, and Z captures the impact of the institutions. The impact of the absorptive capacity on the *TFP* growth is captured by μ, and the $\varepsilon_{y,t}$ is the time-varying error term.

4. Data

The analysis is conducted on the EU countries for the time period 2000–2019. The "Old" Europe contains the 15 countries that are full EU members since 1995: Belgium (BEL), France (FRA), Germany (GER), Italy (ITA), Luxemburg (LUX), Netherlands (NET), Denmark (DEN), Ireland (IRE), United Kingdom (UK), Grece (GRE), Portugal (POR), Spain (SPA), Austria (AUS), Finland (FIN), and Sweden (SWE). The UK left the EU on 31 January 2020. The "New" Europe contains 10 countries that are full EU members since 2004: Cyprus (CYP), Czechia (CZE), Estonia (EST), Hungary (HUN), Latvia (LAT), Lithuania (LIT), Malta (MAL), Poland (POL), Slovakia (SLO), and Slovenia (SLV). Luxembourg, Cyprus, and Malta are excluded from the sample due to their relatively small size. Variables, their definition, and sources are presented in Table 1.

Table 1. Variables description.

Variable	Description	Source	Author
Y	GVA—Chain linked volumes (2005), million euro;	EUROSTAT https://ec.europa.eu/eurostat, accessed on 10 July 2022	Radicic et al. (2023); Hall and Jones (1999); Nicoletti and Scarpetta (2003); Burda and Severgnini (2009); Borovic et al. (2020)
y	Output per worker; calculated as GVA per employee	Authors' calculation based on data from EUROSTAT	Radicic et al. (2023); Hall and Jones (1999); Nicoletti and Scarpetta (2003); Burda and Severgnini (2009); Borovic et al. (2020)
I	Gross fixed capital formation, the chain linked volumes (2005), in millions of euros	EUROSTAT https://ec.europa.eu/eurostat, accessed on 10 July 2022	Radicic et al. (2023); Hall and Jones (1999); Nicoletti and Scarpetta (2003); Burda and Severgnini (2009); Borovic et al. (2020)
K	Capital Stock	Authors' calculation based on data from EUROSTAT	Radicic et al. (2023); Hall and Jones (1999); Nicoletti and Scarpetta (2003); Burda and Severgnini (2009); Borovic et al. (2020)

Table 1. *Cont.*

Variable	Description	Source	Author
k	Capital/output ratio	Authors' calculation based on data from EUROSTAT and Penn World Table	Radicic et al. (2023); Hall and Jones (1999); Nicoletti and Scarpetta (2003); Burda and Severgnini (2009); Borovic et al. (2020)
L	Employment type: Harmonized ILO definition (in millions)	Penn World Table	Radicic et al. (2023); Borovic et al. (2020)
α	Capital marginal (social) product	Parameter is set to equal to 1/3	Hall and Jones (1999); McQuinn and Whelan (2007b); Burda and Severgnini (2009); McGuinness (2007); Borovic et al. (2020)
β	Labor marginal (social) product	Parameter is set to equal to Set at 2/3	Hall and Jones (1999); McQuinn and Whelan (2007b); Burda and Severgnini (2009); McGuinness (2007); Borovic et al. (2020)
TFPL	Total Factor Productivity, raw labor	Authors' calculation based on data from EUROSTAT and Penn World Table	Radicic et al. (2023); Borovic et al. (2020); Burda and Severgnini (2009)
TFPh	Total Factor Productivity, human capital	Authors' calculation based on data from EUROSTAT and Penn World Table	Hall and Jones (1999); Radicic et al. (2023); Pietrucha and Żelazny (2020)
gapl	Total Factor Productivity gap, raw labor	Authors' calculation based on data from EUROSTAT and Penn World Table	Radicic et al. (2023); McGuinness (2007); Nicoletti and Scarpetta (2003); Havik et al. (2008); Mc Morrow et al. (2010)
gaph	Total Factor Productivity gap, human capital	Authors' calculation based on data from EUROSTAT and Penn World Table	Radicic et al. (2023); Pietrucha and Żelazny (2020)
h	Human capital per worker	Penn World Table	Hall and Jones (1999); Radicic et al. (2023)
EFI1	Size of government	Fraser institute https://www.fraserinstitute.org/economic-freedom/map?geozone=world&page=map&year=2020, accessed on 10 July 2022	Borovic et al. (2020); Gwartney and Lawson (2003); Borovic (2014); Havik et al. (2008); Mc Morrow et al. (2010)
EFI4	Freedom to Trade Internationally	Fraser institute https://www.fraserinstitute.org/economic-freedom/map?geozone=world&page=map&year=2020, accessed on 10 July 2022	Borovic et al. (2020); Gwartney and Lawson (2003); Borovic (2014); Havik et al. (2008); Mc Morrow et al. (2010)
EFI5	Regulation	Fraser institute https://www.fraserinstitute.org/economic-freedom/map?geozone=world&page=map&year=2020, accessed on 10 July 2022	Borovic et al. (2020); Gwartney and Lawson (2003); Borovic (2014); Havik et al. (2008); Mc Morrow et al. (2010)
WGI2	Political Stability and Absence of Violence/Terrorism	World Bank https://databank.worldbank.org/source/worldwide-governance-indicators, accessed on 10 July 2022	Pietrucha and Żelazny (2020); Glawe and Wagner (2021a, 2021b); Badalyan et al. (2016); Schönfelder and Wagner (2019)
WGI4	Regulatory Quality	World Bank https://databank.worldbank.org/source/worldwide-governance-indicators, accessed on 10 July 2022	Pietrucha and Żelazny (2020); Glawe and Wagner (2021a, 2021b); Badalyan et al. (2016); Schönfelder and Wagner (2019)

Table 1. *Cont.*

Variable	Description	Source	Author
WGI6	Control of Corruption	World Bank https://databank.worldbank.org/source/worldwide-governance-indicators, accessed on 10 July 2022	Pietrucha and Żelazny (2020); Glawe and Wagner (2021a, 2021b); Badalyan et al. (2016); Schönfelder and Wagner (2019)
INTWGI2	Interaction variable; calculated as gap*WGI3	Authors' calculation based on data from World Bank	
INTWGI4	Interaction variable; calculated as gap*WGI4	Authors' calculation based on data from World Bank	
INTWGI6	Interaction variable; calculated as gap*WGI1	Authors' calculation based on data from World Bank	
INTEFI1	Interaction variable; calculated as gap*EFI1	Authors' calculation based on data from Fraser institute	
INTEFI4	Interaction variable; calculated as gap*EFI4	Authors' calculation based on data from Fraser institute	
INTEFI5	Interaction variable; calculated as gap*EFI5	Authors' calculation based on data from Fraser institute	

Table 2 presents the descriptive statistics for the main variables.

Table 2. Descriptive statistics for the main variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
TFPL	152	0.0280	0.0310	−0.1212	0.0825
gapl	160	0.6996	0.1379	0.4091	1.1214
TFPh	152	0.0359	0.0459	−0.1858	0.1147
gaph	160	1.0982	0.1875	0.6792	1.6141
EFI1	160	6.2976	0.6954	4.93	7.66
EFI4	160	9.0731	0.5933	7.09	9.88
EFI5	160	8.1768	0.4851	6.36	9.25
WGI2	152	0.8211	0.2155	0.1446	1.1904
WGI4	152	1.0309	0.2369	0.5668	1.6981
WGI6	152	0.9428	0.1524	0.3440	1.2144

Source: Authors' calculation.

The RTFP is substantial; it is 50% for the TFP based on the raw labor, and 66.6% for the TFP based on the human capital.

5. Results

In many studies, Equation (15) was estimated by applying the FE panel estimator (Mc Morrow et al. 2010; Nicoletti and Scarpetta 2003; Havik et al. 2008; Inklaar et al. 2008; Bournakis 2011). The same equation is estimated in Männasoo et al. (2018) and Pietrucha and Żelazny (2020) by applying the instrumental variable (IV)-GMM estimator.

In a situation where T > N, where T is the number of years and N is the number of cross-sections, the FE estimator performs better than the instrumental variable (IV)-GMM estimator (Judson and Owen 1999). In the present study, the panel consists of 20 years and eight countries. According to Judson and Owen (1999), the FE within-group estimator will perform more efficiently than the instrumental variable (IV)-GMM estimator. Estimations are carried out in statistical software STATA 15. The results of the FE estimator for both TFP measures are presented in Tables 3 and 4. As an additional robustness check of the results from Tables 3 and 4, the GMM estimator has been applied, but the lagged dependent variable was not statistically significant at any conventional level. Therefore, the focus is on a static panel analysis using the FE estimator.

Table 3. Results, raw labor.

	Model (1)	**Model (2)**	**Model (3)**	**Model (4)**	**Model (5)**	**Model (6)**
	Dependent variable: ΔlogTFPL					
TFPLx	1.527 *** (0.139)	1.554 *** (0.18)	1.011 *** (0.021)	1.473 *** (0.092)	1.541 *** (0.083)	0.996 *** (0.009)
gapl	0.172 *** (0.136)	0.16 *** (0.027)	0.978 *** (0.017)	0.084 *** (0.017)	0.176 *** (0.026)	0.991 *** (0.006)
WGI2		0.032 ** (0.011)	0.041 ** (0.014)		0.027 ** (0.006)	0.035 ** (0.007)
WGI4		−0.023 (0.023)	−0.01 (0.033)		−0.015 (0.1)	−0.015 (0.011)
WGI6		0.023 (0.021)	0.007 (0.006)		0.027 ** (0.01)	0.012 * (0.007)
EFI1		0.093 * (0.043)	−0.025 (0.027)		0.047 * (0.026)	0.029 * (0.018)
EFI4		0.044 (0.043)	0.36 *** (0.048)		0.08 ** (0.036)	0.416 *** (0.03)
EFI5		−0.121 ** (0.034)	0.307 *** (0.05)		−0.089 *** (0.025)	0.188 *** (0.027)
INTWGI2			−0.056 ** (0.02)			−0.05 *** (0.01)
INTWGI4			0.022 (0.048)			0.023 (0.017)
INTWGI6			−0.013 * (0.006)			−0.018 * (0.01)
INTEFI1			0.004 (0.006)			−0.06 * (0.04)
INTEFI4			−0.064 *** (0.006)			−0.076 *** (0.005)
INTEFI5			−0.059 *** (0.009)			−0.038 *** (0.005)
Constant	−0.117 *** (0.027)	−0.143 (0.104)	−1.355 *** (0.101)	−0.052 *** (0.012)	−0.175 * (0.092)	−1.333 *** (0.019)
Cross. Sec. Dependence	4.505 (0.000)	2.473 (0.013)	−0.063 (0.950)			
Wooldridge Test F (1,7)	486.223 (0.000)	139.494 (0.000)	101.063 (0.000)			
Modified Wald Test Chi^2 (8)	106.96 (0.000)	55.9 (0.000)	75.72 (0.000)			

Notes: Standard errors in brackets. For the FE robust standard errors. All variables are expressed in logs. The null hypothesis of the Modified Wald test is H0: σi2 = σ2. The cross-sectoral dependence test relies on the Pesaran test under the null H0: E (ei,t ek,t) = σi,k, where i ≠ k denote countries. The null hypothesis of the Wooldridge test is no serial correlation after allowing for an AR (1) process of the residuals. All the estimates reported from FGLS regression refer to the second-stage results. The country dummy variables are included. Estimates from column (6) are specified assuming no cross-sectional dependance. Standard error normalized by N-k instead of N. * significance at 10%; ** significance at 5%; *** significance at 1%. Source: Authors' calculation.

Table 4. Results, human capital.

	Model (1)	**Model (2)**	**Model (3)**	**Model (4)**	**Model (5)**	**Model (6)**
	Dependent variable: ΔlogTFPh					
TFPLx	1.483 *** (0.171)	1.531 *** (0.176)	0.995 *** (0.006)	1.533 *** (0.099)	1.525 *** (0.084)	0.998 *** (0.004)
gapl	0.087 ** (0.027)	0.166 *** (0.03)	0.995 *** (0.006)	0.17 *** (0.03)	0.198 *** (0.029)	0.995 *** (0.002)
WGI2		0.048 ** (0.165)	0.027 ** (0.001)		0.041 *** (0.009)	0.021 *** (0.004)
WGI4		−0.034 (0.035)	−0.018 (0.023)		−0.023 (0.015)	0.01 (0.006)
WGI6		0.034 (0.033)	0.003 (0.004)		0.044 *** (0.015)	0.005 * (0.003)
EFI1		0.147 * (0.067)	−0.03 * (0.013)		0.077 ** (0.039)	0.02 * (0.014)
EFI4		0.047 (0.061)	0.297 *** (0.26)		0.108 ** (0.054)	0.351 *** (0.02)
EFI5		−0.168 ** (0.058)	0.246 *** (0.047)		−0.121 *** (0.037)	0.125 *** (0.02)
INTWGI2			−0.023 ** (0.009)			−0.019 *** (0.004)
INTWGI4			0.021 (0.021)			0.01 (0.006)
INTWGI6			−0.003 (0.003)			−0.005 * (0.003)
INTEFI1			0.028 (0.016)			−0.019 * (0.013)
INTEFI4			−0.279 *** (0.028)			−0.333 *** (0.018)
INTEFI5			−0.023 *** (0.045)			−0.125 *** (0.019)
cons	−0.087 ** (0.033)	−0.226 (0.160)	−1.068 *** (0.041)	−0.134 *** (0.025)	−0.3 ** (0.140)	−1.039 *** (0.009)
Cross. Sec. Dependence	5.697 (0.000)	2.467 (0.014)	0.932 (0.351)			
Wooldridge Test F (1,7)	461.829 (0.000)	147.086 (0.000)	68.8 (0.000)			
Modified Wald Test Chi^2 (8)	168.37 (0.000)	63.48 (0.000)	83.88 (0.000)			

Notes: Standard errors in brackets. For the FE robust standard errors. All variables are expressed in logs. The null hypothesis of the Modified Wald test is H0: σi2 = σ2. The cross-sectoral dependence test relies on the Pesaran test under the null H0: E (ei,t ek,t) = σi,k, where i ≠ k denote countries. The null hypothesis of the Wooldridge test is no serial correlation after allowing for an AR (1) process of the residuals. All the estimates reported from FGLS regression refer to the second-stage results. The country dummy variables are included. Estimates from column (6) are specified assuming no cross-sectional dependance. Standard error normalized by N-k instead of N. * significance at 10%; ** significance at 5%; *** significance at 1%. Source: Authors' calculation.

In Tables 3 and 4, Models 1, 2, and 3 refer to the FE estimator, while Models 4, 5, and 6 refer to the FGLS estimator. When analyzing the results from the FE and FGLS estimator, for all six models, the TFP growth of the "New" Europe countries is mainly driven by the growth of the leader ($p < 0.01$). The results provide strong evidence of productivity convergence ($p < 0.01$), which means that the countries that are further behind the technological frontier experience higher rates of productivity growth. This confirms the second hypothesis *H2*. In other words, international technology transfers benefit laggard countries more than countries close to the frontier.

The results displayed under Models 5 and 6 in Table 3 suggest that all institutional variables have a positive impact on productivity growth (except for EFI5, in Model 5). The WGI2 indicator refers to the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism (Kaufmann et al. 2010). It has a positive impact on the productivity growth ($p < 0.01$). Higher values of this variable correspond to better governance, i.e., a high level of political stability, without violence. Stability, especially political stability, is a necessary precondition for any kind of investment activity, which is essential for productivity growth. The WGI6 indicator refers to the perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests (Kaufmann et al. 2010). In general, higher values of this variable correspond to lower levels of corruption within society. This variable has a positive impact on the productivity growth ($p < 0.05$, and $p < 0.1$).

The EFI1 indicator refers to the degree to which a country relies on personal choice and markets rather than government budgets and political decision-making (Gwartney et al. 2022). This variable has a marginally significant effect on the productivity growth at the 10% level ($p < 0.1$). The more a country relies on personal choice and markets, the higher the productivity growth rates will be. Size and the scope of the state-owned enterprises limits the productivity gains from more extensive privatization.

Higher values of the EFI4 variable correspond to low tariffs, easy clearance and efficient administration of customs, a freely convertible currency, and few controls on the movement of physical and human capital (Gwartney et al. 2022). This variable has a positive impact on productivity growth ($p < 0.05$, and $p < 0.01$).

The EFI5 indicator refers to the regulations that restrict entry into markets and interfere with the freedom to engage in voluntary exchange. Higher values of this variable correspond with the lower level of regulation. In Table 3, under Model 5, this variable has a negative impact on the productivity growth ($p < 0.01$), i.e., the more regulated markets are, the higher the productivity growth. The results of the previous analysis confirm the first hypothesis.

The negative coefficient on the interaction variable suggests that the higher level of institutional quality is associated with a faster TFP convergence. These results, in combination with the stationarity analysis from Appendix A, confirm the third hypothesis *H3*. The negative sign also could mean that being further away from the frontier reduces the impact of institutional quality variables. In Table 3, under Model 6, all interaction variables have negative signs, which means that they are reducing the productivity gap, and they are creating convergence. The negative sign also means that the impact of institutions fades the further the country is from the frontier.

To investigate the sensitivity of the results, Equation (15) includes an alternative measure of the TFP. Table 4 contains estimations of Equation (15), with the measure of the TFP on human capital. For all model specifications, the estimated coefficients in Table 4 are almost the same as in Table 3. This means that these additional estimations are in line with the main results, which implies that the main results are robust.

6. Discussion

The result of econometric analysis suggests that the institutional framework has a positive impact on the productivity growth of the "New" EU countries. All institutional quality variables, except for EFI5 in Model 5, have a positive impact on the productivity growth of the "New" EU countries, which confirms hypothesis *H1*.

The higher value of the EFI5 corresponds to a lower level of regulation. A negative impact of this variable on the productivity growth suggests that a higher level of regulations means stronger employment protection, which leads to an increased job tenure and investment in job-specific skills, which may speed up productivity growth (Acemoglu and Shimer 2000). Political stability and absence of corruption enhance productivity growth. The absence of corruption is a necessary precondition for any kind of investment activity, as well as political stability. The transition process is a fertile ground for political instability and for corruption. Without investment activity, from residents, or from nonresidents, a country will not be able to get in the possession of the technology that is developed elsewhere. Therefore, the possibility for productivity growth will be diminished. On the other hand, in countries without political stability and with high corruption, privatization and capital concentration will not result in increased efficiency. This will lead to rising inequality and, eventually, poverty. These results are in line with Pietrucha and Żelazny (2020). Corruption and political instability might result in an unfavorable environment for investment and for the entrepreneurial experimentation, without which there will be no productivity-enhancing innovations in products, processes, and ways of organizing productive activities (Bjørnskov and Foss 2010). The countries with less government ownership of assets will experience higher productivity growth rates, which is in line with Nicoletti and Scarpetta (2003). Removing the restrictions on flows of goods and services, as well as on capital movements between countries, could increase the supply of venture capital, which may lead to a huge increase in innovation, and to increased competition in domestic sectors. These results are in line with the results of Cagetti and DeNardi (2006), Alcalá and Ciccone (2004), Coe and Helpman (1995), Greenaway and Kneller (2007), and Wagner (2007).

The present study provides evidence that the productivity gap between the "New" and "Old" EU countries is closing. Results from Tables 3 and 4 and A1 show that, regardless of applied methodology and measures of productivity, the productivity gap is narrowing. Thus, hypothesis *H2* is confirmed. The productivity convergence has been confirmed for the USA and EU (Mc Morrow et al. 2010; Inklaar et al. 2008), for the OECD countries Nicoletti and Scarpetta (2003), for the Greece and Germany (Bournakis 2011), for the overall sample of the European NUTS-1 regions (Männasoo et al. 2018), and for the "Old" and "New" Europe countries at industry level (Radicic et al. 2023).

The results from Tables 3 and 4, under Model 6, suggest that the institutional variables are creating convergence, which proves hypothesis *H3*. But this also means that the impact of the institutions fades with the country being further away from the technological frontier. The country that is close to the frontier has a high-quality institutional framework, which will enable them to gain from the innovation and knowledge spillovers and from the adoption of more efficient existing technologies developed elsewhere. The institutional framework of high quality is a necessary precondition for productivity growth. Countries far behind the technological frontier are characterized by the institutional framework of low quality, which prevents them from using technology developed at the frontier. For this reason, it is vital to identify which policies create convergence.

7. Conclusions

The present study examines the impact of institutions and institutional framework on TFP growth through the pure learning effect, as well as through the indirect effect of institutions on TFP growth through the gap. The sample covers ten former socialist countries that have been full EU members since 2004. Two TFP measures have been applied, the classical growth accounting with raw labor, and the measure based on human capital. The sample covers the EU countries for the time period 2000–2019.

The "New" Europe countries fall far behind the "Old" Europe countries in all macroeconomic variables. The TFP gap is between 50 and 66%, which means that there is more space for improvement. Empirical findings from this study suggest that the TFP growth of the "New" Europe countries is mainly driven by the growth of the leader and by the size of the technology gap. This means that the productivity growth of "New" Europe countries is driven by the adoption of more efficient technologies developed elsewhere, and by innovation and knowledge spillovers from the "Old" Europe countries. The extent to which the "New" Europe countries could gain from the adoption of new technologies, and from the innovation and knowledge spill overs, is limited by the quality of their institutional framework. All institutional quality variables have a positive impact on the TFP growth, which means that institutional quality increases the TFP. Our main findings are summarized in Table 5.

Table 5. Summary of main findings.

Hypothesis	Hypothesis Is Supported	Implication
H1	The first hypothesis is supported	The institutions of the CEE countries are increasing the productivity growth
H2	The second hypothesis is supported	The productivity gap between the core EU countries and CEE countries is closing
H3	The third hypothesis is supported	The institutions of the CEE countries are creating the productivity converge toward the rest of the EU

Given a substantial productivity gap, this study offers some policy implications. The "New" Europe countries need to design and implement public policies that enhance the concentration of human capital and more intensive use of the ICT, which, in turn, will enable them to enhance economic efficiency. These policies need to be focused on creating a favorable environment for investments and for entrepreneurial experimentation, which should lead to productivity-enhancing innovations in products and processes. This will enable more rapid technological development in "New" Europe countries, which will increase a positive impact of their institutions on convergence. This will, eventually, lead to narrowing, or even closing the productivity gap. The present study offers evidence, based on two TFP measures, that even after almost two decades of convergence, a positive impact of institutions on productivity growth is diminished by the severe productivity gap. To the best of our knowledge, this conclusion is novel compared to previous studies on the productivity gap between the "New" and "Old" Europe countries.

This study has some limitations that can serve as suggestions for future research. The data and the model of analysis have prevented us from using a dynamic panel analysis, which would reveal any persistence in the productivity gap as well as enable the estimation of long-run effects of institutions. Moreover, further research could focus on the analysis of the TFP gap in the EU countries at a micro and firm level, which could provide managerial implications and reveal which firm-level characteristics are critical for closing the productivity gap.

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Appendix A

Following Bernard and Durlauf (1995) and Bernard and Jones (1996), we will apply the unit root test as a formal test of convergence. In the present paper, it is said that the

"New" Europe countries converge towards the "Old" Europe countries' average if the TFP gap is stationary. We will test the gap on both TFP measures. We will use a three-unit-root test. The first test that we use is the Levin–Lin–Chu (LLC) test. The second test that we use is the Im–Pesaran–Shin (IPS) (Im et al. 2003) test. And the third test that we use is the Fisher Augmented Dickey–Fuller unit root test. The null hypothesis for each test is that all panels contain a unit root (nonstationary). The results of the unit root tests are presented in Table A1.

Table A1. Unit-root tests results.

Variable	gapl		gaph	
	Test Statistics	p Value	Test Statistics	p Value
LLC	−2.9296	0.0017	−2.8668	0.0021
IPS	−2.9692	0.0015	−2.6929	0.0035
ADF	−3.1985	0.0007	−2.8916	0.0019

Source: Authors' calculation.

The results of unit root tests confirm previous findings from Tables 3 and 4 regarding the productivity convergence between the "New" Europe countries and the "Old" Europe countries. The null hypothesis of nonstationarity has been strongly rejected, which means that Equation (15) is a close approximation of an ECM.

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