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Regional Productivity Convergence in Advanced and Emerging European Economies

Abstract

Europe's competitiveness is a topical question garnering academic and professional interest. We investigate productivity drivers across European regions after the European Union's eastward enlargement. We compare the regions of advanced economies in the EU-15 and the EFTA-3 with the regions in new member states. While consistent with the academic literature, our analysis, however, discerns strikingly disparate patterns in the drivers of productivity growth between the regions of 'old' and 'new' Europe. While the regions of advanced Europe realise productivity gains mainly from their internal sources such as human capital quality, research and development, the regions in the new member states are largely reliant on external productivity spillovers and their growth is largely driven by the convergence effect arising from the productivity gap. If the size of the productivity gap is too large however, it could be a serious impediment to convergence, as regions falling below a critical level are at risk of permanent underdevelopment.

1 Introduction

The European Union's rapid enlargement starting from the accession wave of 2004 has almost doubled the number of member states. New member states in Central, South and Eastern Europe have increased the economic, cultural and regional diversity within the union. This has affected the actions and incentives of European cohesion policies. The economic and political tensions provoked by the global financial crisis in 2008 and the subsequent European debt crisis, along with the recent mass immigration of refugees, have placed considerable strains on coherence strategies and the principles of common solidarity. European solidarity is hotly debated at both the national and EU-wide levels, with some national authorities reaping notable political changes from the discussion, most dramatically in the British EU referendum and Brexit decision on 23 June 2016.

Against this background, Europe's economic, political and social strength is undoubtedly of central importance. European governments see investments in research and development (R&D) and education as a means for achieving their nations' long-term goals such as economic progress, sustainable growth and competitiveness. In Europe 2020, the EU's strategy for 'smart, sustainable and inclusive growth', knowledge and innovation are identified as the keys to unlocking Europe's future growth. The strategy also proposes specific targets, such as 3% of the EU's GDP being invested in R&D, or 40% of the younger generation having a tertiary degree (European Commission, 2010). Each member state and the EU in general have to set these clear aims in order to increase commitment towards sustained economic growth and higher productivity while promoting

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education and other means for improved human capital quality, increasing investment in R&D and supporting economic collaboration.

This study investigates the sources of productivity growth over 2000-2013 while looking separately at and comparing two groups of European NUTS1 level regions: first, the regions from advanced economies of the EU-15 and the three EFTA countries – Switzerland, Norway and Iceland; and secondly, the 13 new member states which joined the EU in 2004 or later. Therefore, we focus on three key factors of productivity growth suggested in the academic literature: (1) human capital quality, (2) commitment to investing in R&D, and (3) convergence via economic collaboration leading to spillovers in knowledge, technology and skills.

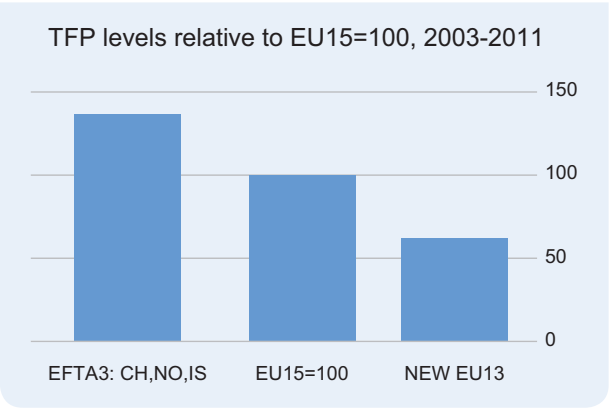
We confirm the theoretical postulations that all three factors contribute to productivity growth for the EU as a whole. However, intriguing patterns emerge when analysing regions in the EU's advanced economies and in new member states separately. While advanced Europe improves productivity predominantly by investing in human capital qualification and R&D, in accordance with contemporary growth theory, the productivity enhancement in new member states is critically dependent on their pre-accession starting position in 2003 and relies largely on regional convergence with more prosperous neighbouring regions. Several other interesting patterns emerge, which are more closely presented and discussed in section 5 below.

The paper is organised as follows. Section 2 briefly explains the concept of productivity and provides stylised facts and broad-based empirical evidence on productivity drivers. Section 3 discusses the two channels of productivity growth. The data are described and illustrated in section 4, while section 5 reports the results and section 6 concludes. The policy considerations are outlined in section 7. The annex describes the analytical framework along with the econometric model.

2 Stylised facts on productivity growth

Productivity levels across countries and regions vary to a large degree and these differences tend to be persistent over time. Considerable productivity gaps are also prevalent in the European common market despite extensive economic and policy measures, such as the strategies of EU cohesion policy and structural funds. Moreover, aggregate productivity growth accounts for a major part of per capita income differences across regions and countries. The ultimate challenge for research and policy is to reach a better understanding of the reasons behind prevailing productivity gaps and how to escape from the low productivity trap (see Figure 1).

FIGURE 1 2003-2011 AVERAGE PRODUCTIVITY LEVELS



Simply stated, productivity denotes the efficiency with which production factors as inputs are converted into products as output. The concept of productivity is operationalised either with measures of single-factor productivity, where labour productivity is the measure most commonly used, or with a multi-factor productivity measure called total factor productivity (TFP). Contemporary research mostly uses the second concept, since TFP is all-inclusive and is invariant to the composition and intensity of input factors. The input factors used in the simplest production function are capital and labour. TFP enters the production function as a multiplier capturing the residual variation in output that is not explained by the composition and intensity of the production inputs.

The obvious explanation for higher TFP is the quality and allocation of production inputs. Hsieh and Klenow (2010) stress that the misallocation of inputs across industries and firms plays a central role in TFP variation across countries. According to Romer (1986, 1990), a large population alone is not enough to sustain growth, as the quality of human capital matters. Human capital value is reflected in a highly qualified labour force, in terms of both formal education and vocational training that is well aligned with the demands of the structure of the economy. Nelson and Phelps (1966) propose in their model that the rate of return to human capital quality is greater for technologically advanced economies. Capital also varies in the degree to which it embodies technological progress or opens avenues for further technological improvements and R&D. Nelson and Phelps (1966) suggest that progressive technology has an effect on the optimal capital structure. There is a broad

literature on the linkages between R&D and productivity (Griliches, 1998). Most of that literature demonstrates the considerable amount of productivity growth that R&D expenditures explain. Product variety and export activity have been found to be further drivers of productivity. Romer (1990) claims that integration with global markets leads to growth. Competitive pressure is also a well-documented source of productivity growth. In microeconomic studies, the two components of this mechanism set in motion by competitive pressures are disentangled, with the 'within' component reflecting the increase in efficiency at the producer level, and the 'between' component arising from less efficient firms exiting and being replaced by more efficient entrants.

The more recent lines of research (see Bloom and Van Reenen, 2007) have explored productivity gains reaped from the quality of management and business practices. Best practice management has been found to be positively correlated with competitive markets and negatively associated with primogeniture succession in the ownership of firms. Inefficient managerial practices tend to allocate inputs inefficiently (Syverson, 2011).

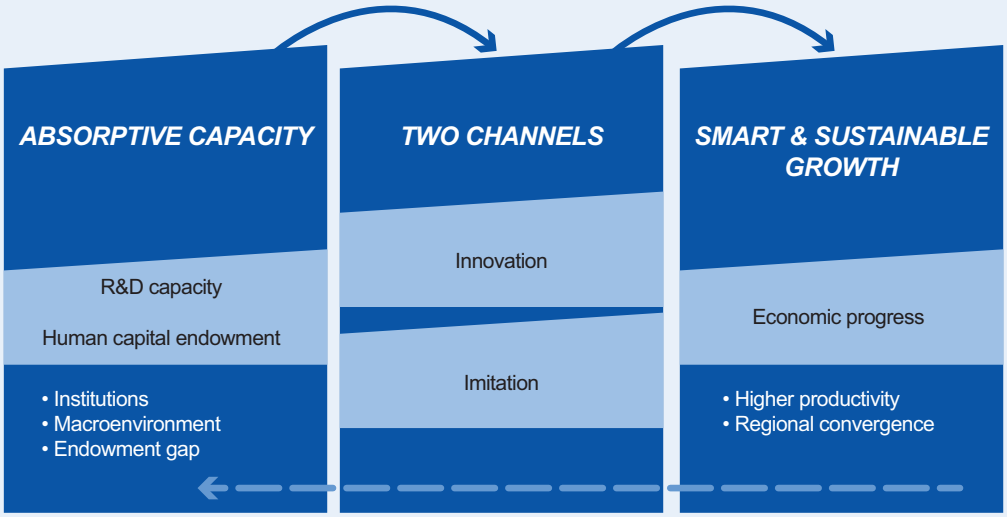
There are also external factors, such as productivity spillovers and knowledge transfers that drive productivity growth. However, Syverson (2011) notes that the persistency in productivity differences across countries and industries suggests that the spillover process is far from perfect. The strength of spillover effects is positively associated with geographical and technological proximity, and increases with the productivity level of the partnering region. He further stresses the intriguing evidence on how productivity convergence ceases if the productivity level falls far enough behind the frontier.

3 Two channels for growth

There is an ample supply of endogenous growth literature associating TFP with R&D and human capital, but knowledge and innovation are also in the centre of the concept of absorptive capacity. The term 'absorptive capacity' was first introduced in Cohen and Levinthal's seminal papers (1989, 1990) and has been discussed widely since. In this concept, R&D has two faces. First, research creates new knowledge and innovation, then it develops absorptive capacity, or the ability to identify, assimilate and exploit outside knowledge (Cohen and Levinthal, 1989: 596). The direct and indirect effects of TFP are also stressed by Hsieh and Klenow (2010), who refer back to the seminal paper by Nelson and Phelps (1966).

Literature linking endogenous growth theories and the concept of absorptive capacity argues that the technological progress of a country or region depends both on its own innovative capabilities and on its capacity to absorb and exploit external knowledge and to imitate technologies of the technological frontier (Vogel, 2013). R&D and human capital are important for both capabilities as they boost the ability to create original innovation and the ability to imitate the creations of others (Griffith et al., 2004: 883-884). This is not a one-way process, as increased economic prosperity also makes it possible to invest more in R&D

FIGURE 2 GROWTH VIA TWO CHANNELS: INNOVATION AND IMITATION



and education. Klenow and Rodriquez-Clare (1997) argue that higher levels of productivity stimulate investment and capital accumulation in advanced technologies. Figure 2 illustrates these connections.

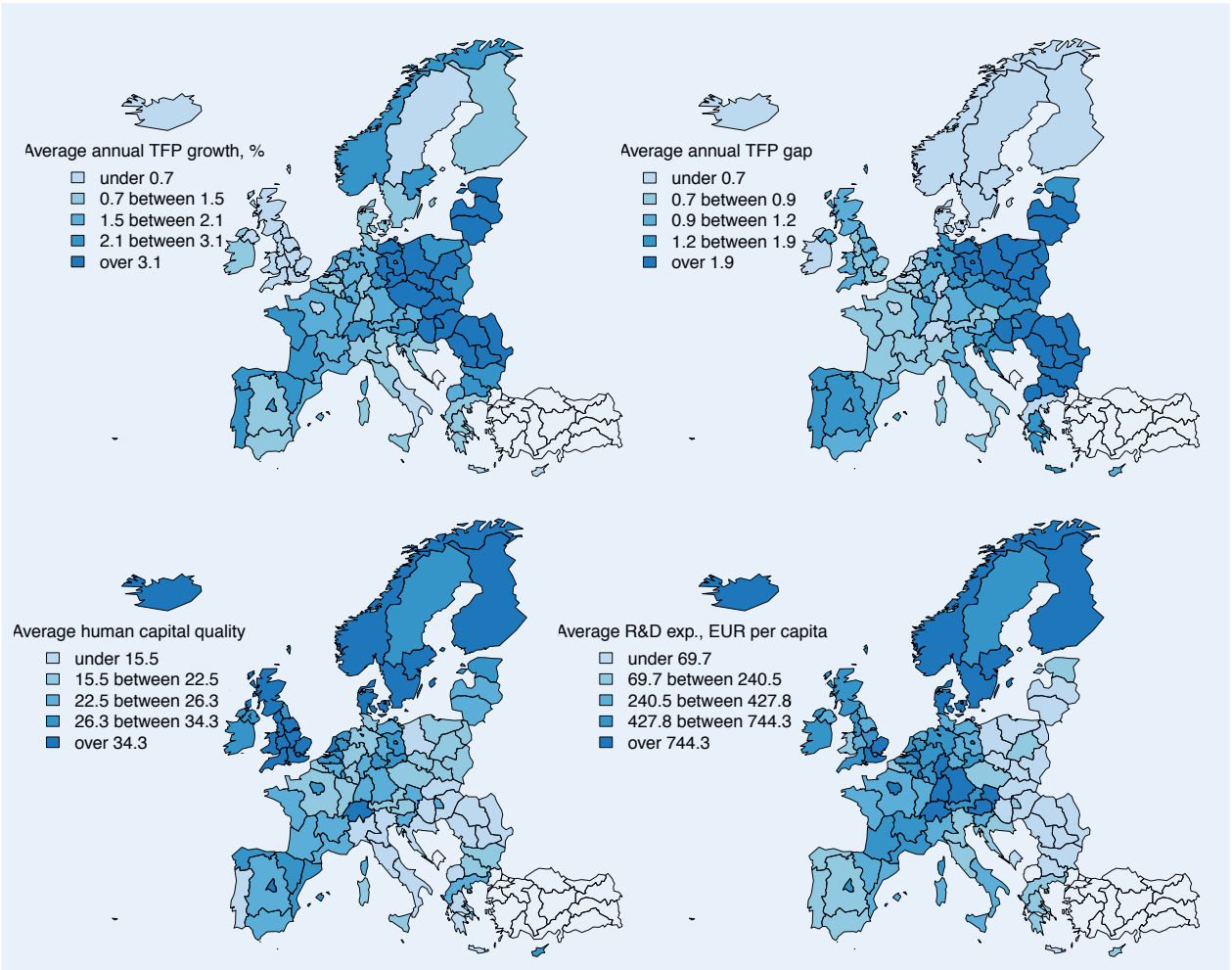
The empirical framework of our study is based on a Schumpeterian endogenous growth model that accounts for the effect of absorptive capacity on TFP growth. The model was proposed by Griffith et al. (2004) and takes into consideration the effect of convergence on TFP growth while investigating the dual effects of human capital and R&D. We complement this model by including regional spillovers, which add a spatial dimension to our study, while also accounting for the region's initial level of productivity.

The following section on Empirical Strategy and Box 1 below outline the further details of our empirical approach and econometric model.

4 Regional TFP, human capital and R&D indicators

Our sample includes 99 European NUTS1[1] regions from 31 countries, of which 28 are EU Member states and three are European Free Trade Association (EFTA) countries (Iceland, Norway and Switzerland). Additionally, we define two subsamples so that the *advanced Europe* subsample covers the EU-15 countries plus three EFTA countries and the *emerging Europe* subsample contains the 13 new member states that joined the EU in 2004 or in later waves.

FIGURE 3 REGIONAL NUTS1 LEVEL INDICATORS FOR TFP, R&D AND HUMAN CAPITAL, AVERAGES FROM 2000-2013



Source: Authors own calculations, based on Eurostat.

[1] NUTS1 is the European Nomenclature for Territorial Units of 3-7 million inhabitants.

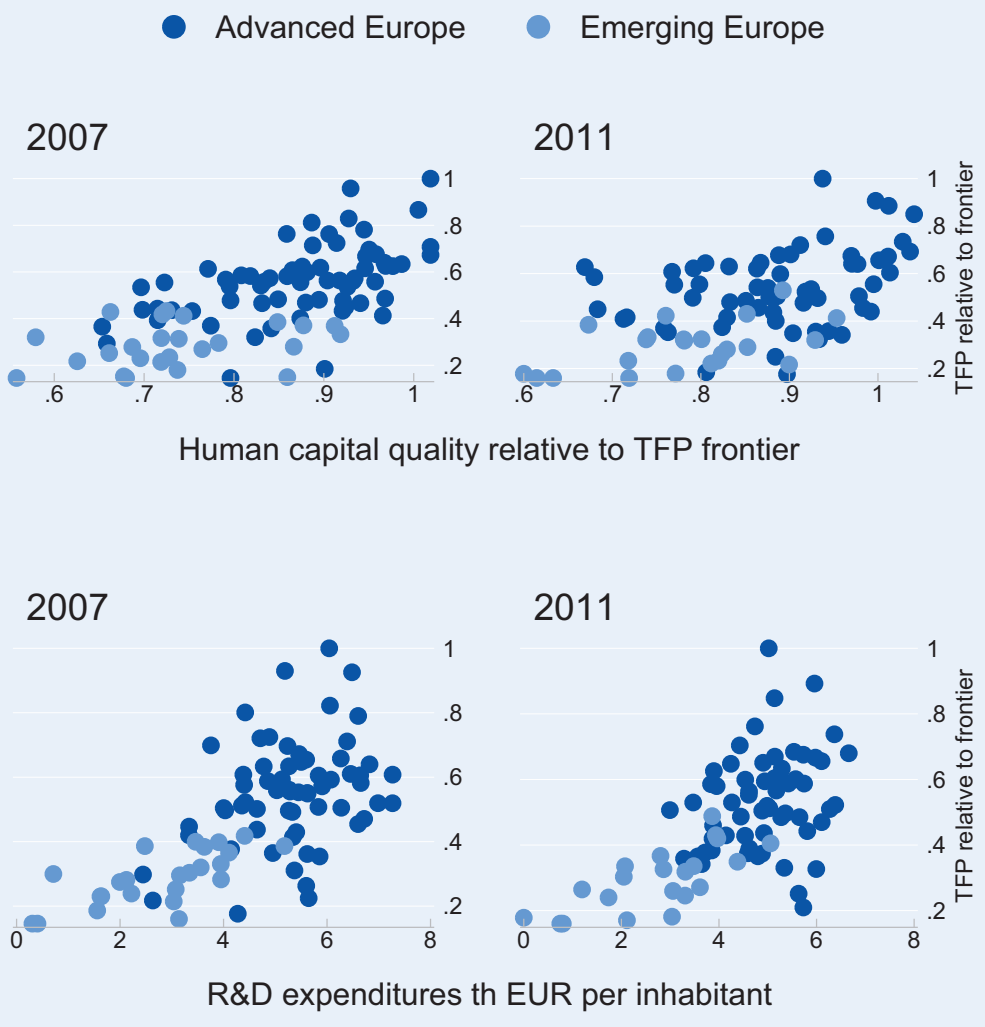
The time frame of this study spans from 2000-2013, and it uses annual regional data retrieved from Eurostat.

The regional TFP level, each region's TFP gap with respect to the frontier, and TFP growth are calculated using three key indicators. First, the gross domestic product of the region is used as a proxy for the production function output. Secondly, the number of people employed, which includes both employees and the self-employed, is taken as the labour input. Thirdly, gross fixed capital formation is used to approximate the capital stock of a given period.

The level of human capital is estimated as the first principal component of two variables, the percentage of the population aged 25-64 with tertiary education, and the percentage of people aged 25-64 who have participated in education or training within the last four weeks. Each region's commitment to R&D is measured by gross domestic expenditure on R&D per inhabitant.

Figure 3 illustrates the distribution of the main variables across regions. The top left-hand panel demonstrates TFP growth levels. During the sample period, most of the regions with the highest average TFP growth rates were in the catching-up regions of Central and Eastern Europe. The top right-hand map, depicting TFP levels, shows that these were also the regions that had the highest TFP gap with respect to the frontier. The region with the *highest* level of TFP in a given year is used as the frontier region in our analysis.

FIGURE 4 EACH REGION'S PROXIMITY TO THE TFP FRONTIER, HUMAN CAPITAL QUALITY AND R&D EXPENDITURES BEFORE (2007) AND AFTER (2011) THE GLOBAL FINANCIAL CRISIS



The bottom right-hand panel shows the average spending per inhabitant on R&D. Advanced regions invested most in research, while regions in emerging Europe spent comparatively little. The biggest spender was Eastern Sweden. The bottom left-hand panel highlights that high average levels of human capital could be found in the Nordic countries and in several regions of the United Kingdom. The lowest average levels of human capital meanwhile were recorded in three Romanian regions.

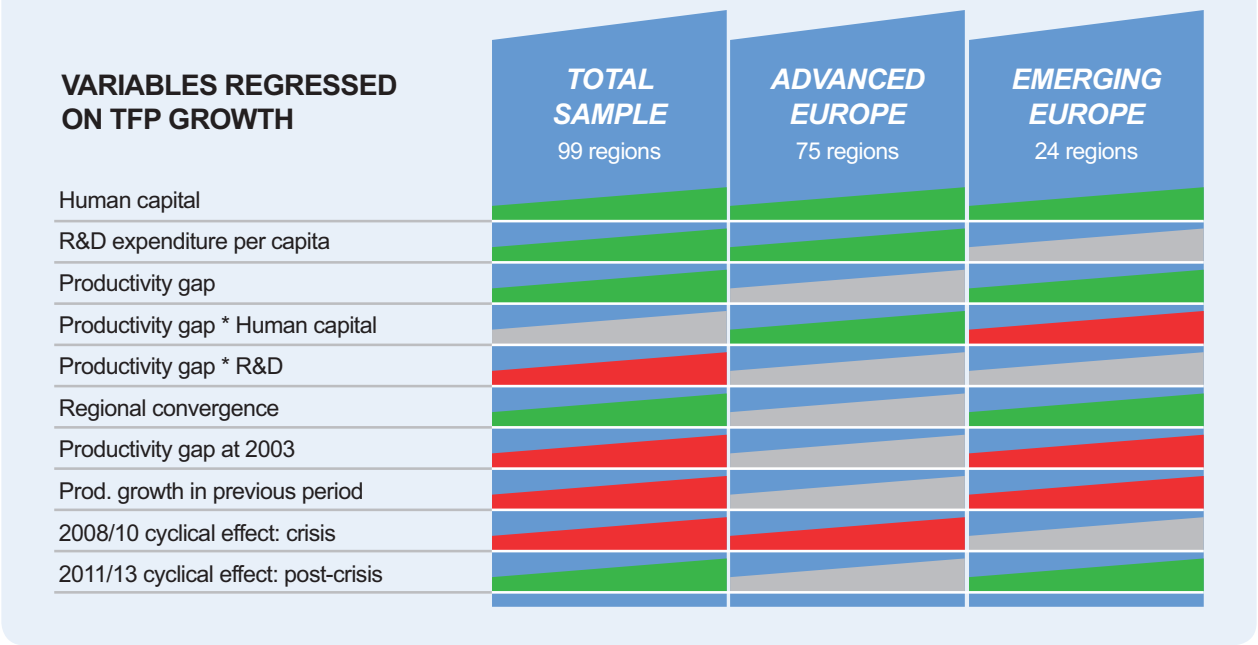
The descriptive scatterplot graphs in Figure 4 show that human capital quality and R&D expenditures are positively related to regions' TFP levels. Interestingly, however, the advanced economies tend to exhibit consistently higher levels of TFP than those of emerging European regions with similar levels of human capital quality. This evidence is in line with the model of Nelson and Phelps (1966) proposing a positive link between the return to education and the level of technological advancement. A similar pattern is visible for R&D, implying that higher returns to R&D expenditures relate to higher levels of TFP. More interesting, however, is the high variation of TFP given R&D expenditures above five thousand euros per inhabitant, a level observed only for the regions in advanced Europe. This suggests that there are strong confounding factors that determine the return on R&D at higher levels of productivity and technological advancement. While the overall patterns remain similar in the pre-crisis year of 2007 and the post-crisis year 2011, there is a notable tendency for regions to be more highly dispersed in their R&D expenditures in the aftermath of the crisis.

5 Unpacking the sources of productivity growth

The descriptive patterns displayed above (see Section 4) call for further explanation as to how and how much the human capital quality and R&D expenditures foster productivity and how they interact with the prevailing productivity gaps. The question of their intertemporal and spatial nature also arises, since both converge over time and regional spillovers deserve consideration in our analysis. Figure 5 summarises our baseline estimation results, which are explained in more detail below.

Main effects of human capital and R&D. The main effects for both human capital and R&D expenditures are positive, but the effect for R&D is statistically insignificant for the emerging Europe subsample. The main effects of human capital and R&D expenditures are interpreted as the impact of the variables at the productivity frontier, which is where the productivity gap equals zero. So while an increase in human capital quality does drive productivity growth at the frontier in the advanced Europe sub-group as well as in the emerging sub-group, R&D expenditures only contribute to TFP growth in the advanced economies of Europe. The insignificant direct effect from R&D in emerging Europe

FIGURE 5 ECONOMETRIC ESTIMATION RESULTS ON TFP GROWTH FACTORS



The cell colours indicate the following: green: positive effect, red: negative effect, grey: no effect.

could indicate that the effort put into R&D only contributes to building up the primary structures of knowledge and technology enough to facilitate the absorptive capacity, while being insufficient (or lacking the high-level innovation) to contribute to TFP growth directly.

Convergence. The importance of convergence in productivity growth is reflected in the positive effect of the productivity gap. Similar evidence is reported by Islam (2009), but he found a significant effect for the OECD countries as well as for the developing countries. Since the productivity gap is interacted with human capital and R&D expenditures, the main effect is interpreted as the effect of the gap keeping R&D spending or human capital quality unchanged. As expected, the convergence effect is statistically significant only in the emerging Europe subsample, showing the growth potential from catching-up that has not yet been depleted for the new EU-13.

Human capital and R&D interactions with the productivity gap. Our study demonstrates important differences between the subsamples (see Figure 5). In the advanced Europe subsample, the effect of human capital increases with a greater distance to the productivity frontier. This implies an absorptive capacity effect which enables faster productivity gains from improved human capital quality in advanced European regions. The opposite is found for the regions of emerging Europe where the positive effect of human capital upon productivity growth decreases with a wider gap to the productivity frontier. This finding stresses the adverse effect of backwardness and may be an indication of institutional deficiencies that impede the positive impact of human capital from taking full effect on productivity growth at low productivity levels.

Spatial spillovers. As the time frame of our study captures a moment of intense European integration, additional measures were included in the estimation to disentangle the catching-up process. Firstly, our proposed spillover measure for capturing the spatial spillovers weights the productivity levels of other European regions by their geographical distance to the region under focus. This spatial spillover term has a significant positive effect for the total sample. However, the effect stems only from the emerging Europe subsample, stressing again the catching-up potential of productivity growth and the importance of the spatial dimension in regional convergence.

Initial productivity gap. The productivity gap in 2003, a year before the eastward enlargement of the EU, was added to investigate whether the region's starting position has a persistent influence on its eventual productivity growth path. A significant negative impact is revealed in the total sample, again stemming from the emerging Europe subsample. This evidence indicates the critical level of capacity necessary for sustained improvement in productivity (Benhabib and Spiegel, 2005) and regions falling below that threshold cannot keep pace with productivity growth. The accumulative advantage stemming from well-developed economic and institutional structures plays a critical role in the outlook for future growth in the region.

Volatility correction mechanism. The term for the productivity growth in the preceding period has a negative impact for emerging Europe and also for the total sample. This reflects a volatility correction mechanism or a growth path reverting to the mean where periods of fast growth are followed by periods of slower growth and vice versa.

Cyclical effects. The study also controlled for cyclical effects. The period of financial crisis in 2008-2010 affected productivity growth rates negatively for regions in advanced Europe and the total sample, while the period from 2011-2013 had a positive impact for emerging Europe and the total sample. This might imply there is pro-cyclical productivity growth in advanced regions of Europe while counter-cyclical productivity enhancing mechanisms prevail in the catching-up regions of emerging Europe.

Robustness of results. In order to check the robustness of the baseline estimation results, the estimation was also conducted using an alternative measure for human capital and employing the regional spillover measure as the interaction term instead of the TFP gap. The alternative estimations had qualitatively similar results.

6 Conclusions

The improvement in human capital qualification has an overall positive effect upon productivity in European regions, though it has a suppressed impact in the emerging regions of the new member states. This reveals that as the productivity gap in emerging EU economies widens, the positive effect of higher human capital qualification on productivity decreases. Evidently this implies that regions lagging far below the productivity frontier exhibit immature or underdeveloped economic structures that are not able to exploit and fully utilise the increase in the level of human capital qualification. The productivity enhancement is a gradual, medium to long-term process characterised by the accumulative nature of capacity building. While the advanced economies benefit from their accumulative advantage, the regions in new member states have to put

more effort and commitment into building capacity in knowledge, technologies and innovation.

In the same vein, the R&D expenditures that have a significant positive impact on productivity in the advanced Europe subgroup prove insignificant in the new member states. Unlike in the EU-15 and the EFTA-3, the main source of productivity growth in the new EU-13 stems from spatial spillovers and regional convergence and is crucially dependent on the pre-accession starting position in the productivity gap in 2003. A further intriguing finding shows that while the years of the Global Financial Crisis in 2008-2010 had a negative effect upon productivity growth in the advanced economies of Europe, the effect remained insignificant for the new member states, which saw productivity growth pick up in the post-crisis period in 2011-2013. This dynamic implies there is a countercyclical productivity enhancing mechanism in the new member states in contrast to the pro-cyclical productivity growth in the EU-15 and EFTA-3 regions.

Overall, the results imply that the productivity drivers in the advanced and emerging economies of Europe differ to a large degree. Productivity growth in the new member states in the post-accession period 2004-2013 has been largely reliant on spillover effects from the more affluent and productive neighbouring regions. The gap-driven potential for productivity growth is decreasing over time however, and the regions in the new member states need to shift their growth drivers gradually towards internal sources in human capital quality and R&D, enabling the development of efficient market structures and growth promoting regulations and institutions.

7 Policy considerations

Our study indicates a critical need for structural development of low productivity regions and especially so in new EU member states. The sharp contrasts in productivity levels are associated with sluggish convergence and a simple increase in the level and quality of production inputs might not help in closing the gap. The economic structures have to allow high value-added production and service lines to be accommodated. Founding knowledge and technology intensive activities will generate the necessary incentives and can constitute a further source of productivity growth.

Moreover, the incentives given by regulators, institutions and policies need to promote better utilisation of human capital and contemporary technologies. Sustained support for education, R&D, and life-long learning are key to maintaining the region's competitiveness and increasing its absorptive capacity. However, education and training alone are not enough if the economy does not provide an adequate environment for people to utilise knowledge, acquire new skills, or gain experience from learning-by-doing. Sustained productivity growth calls for consistent policies and a medium- to long-term commitment to capacity building.

The European Structural and Investment Funds (ESI Funds) have set out eleven objectives for achieving smart, sustainable and inclusive growth in Europe. Three of them enhance productivity directly and focus on strengthening R&D and innovation, the competitiveness of small and medium sized enterprises, and investments in education, training and lifelong learning. Our study finds that the last objective was particularly important in explaining productivity growth in European regions. Socio-economic disparities in Europe are specifically targeted by the European Regional Development Fund (ERDF) and the Cohesion Fund. The ERDF covers all the regions of Europe, but the Cohesion Fund targets only member states with Gross National Income below 90% of the EU average. This is a threshold that all new member states meet. The objectives of the Cohesion Fund, however, are to enhance productivity implicitly through environmental protection, the promotion of sustainable development, the development of infrastructures, and improved efficiency of public administration. All these aims are economically and socially valuable, but are not explicit or primary means for improving productivity. The objectives financed by the ERDF are more promising from the productivity perspective as they target innovation, research, the digital agenda, and small and medium sized enterprises. The crucial productivity component of education and the development of human capital is, however, in the European Social Fund's agenda. The capacity building for productivity enhancement warrants serious consideration of all the integral components – human capital, technology, R&D, innovation, and competitive markets. Capacity building for productivity growth and convergence would benefit from a concerted set of objectives being financed from the same source.

Beyond policies and regulations, the economic environment matters. A stable and reliable economic environment encourages investment and establishment of new businesses. Markets open to free competition will force producers and service providers to enhance their productivity as an attractive business environment and openness to importers and exporters create pressure for greater efficiency and productivity. Convergence has to be gradually replaced as a source of potential productivity and growth, however, by the establishment of more sophisticated lines of business

along with an increase in product and service variety. The catching-up by emerging regions through knowledge and technology spillovers will still remain a significant source of growth in the coming years. The crucial aim must be to broaden the collaborative frameworks beyond close neighbourhoods so that the benefits of knowledge and technology transfer can be reaped to the fullest extent at the European and global levels.

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Appendix: Analytical framework

To address our research question, we set up a simple Cobb-Douglas production function with labour and capital as the two input factors and TFP as the residual:

$$Y = AK^{\alpha}L^{1-\alpha}$$

where Y is the production output, $F(.)$ is a function of observable inputs capital K and labour L and A represents TFP, which captures the residual variation in output that is not explained by the composition and intensity of the production inputs. We use the traditional $a=1/3$ share of capital in our baseline estimations, but we also control the country-year varying shares of labour (from The Conference Board Total Economy Database™, May 2015, http://www.conference-board.org/data/economydatabase/) to validate our results.

After extracting TFP from the production function, we proceed with stochastic analysis to explain the growth in TFP. Regarding empirical estimation, we have taken the contemporary approach to panel data econometrics by using the General Method of Moments (GMM) estimator from Arellano and Bover (1995) and Blundell and Bond (1998), which takes account of the panel data structure by observing the same regions over several years and has the power to deal with endogenous feedback effects between our explanatory variables and TFP growth as the dependent variable.

The preceding year's TFP growth may have a significant effect upon TFP growth in a given year, and to account for this we include the one period lagged autoregressive TFP term in our model (see Box 1). The change in human capital quality and R&D expenditures in the previous period are the main explanatory variables of TFP growth and they enter the model with their main effects and in interaction with the TFP gap variable. The main effects of human capital quality and R&D expenditures show the conditional effect on the country being at the productivity frontier. The interaction effects are proportional to the country's distance from the productivity frontier. The GAP2003 variable denotes the region TFP gap in 2003, which is one year before the 2004 accession wave. Regional spillover effects from more affluent regions with higher TFP levels are weighted by the geographical proximity of the regions and by whether the regions are in the same country, meaning there is higher proximity between them. Period dummies for the crisis years 2008-2010 and post-crisis years 2011-2013 are added to capture the cyclical effects (note that the pre-crisis period is left as a reference category).

BOX 1 MODELLING PRODUCTIVITY GROWTH

$$TFPgrowth_{it} = \beta_0 + \beta_1 TFPgrowth_{i,t-1} + \beta_2 TFPgap_{i,t-1} + \beta_3 \Delta HC_{i,t-1} + \beta_4 RD_{i,t-1} + \beta_5 \Delta HC_{i,t-1} \times TFPgap_{i,t-1} + \beta_6 RD_{i,t-1} \times TFPgap_{i,t-1} + \beta_7 GAP2003_i + \beta_8 REG_{it} + \beta_{9,2008-2010} + \beta_{10,2011-2013} + \varepsilon_{it} + \alpha_i$$

$\beta_1 TFPgrowth_{i,t-1}$ – TFP growth in the preceding year;
$\beta_2 TFPgap_{i,t-1}$ – TFP gap with respect to the frontier;
$\beta_3 \Delta HC_{i,t-1}$ – Change in human capital;
β_4 – R&D expenditures;
$\beta_5 \Delta HC_{i,t-1} \times TFPgap_{i,t-1}$ – Change in human capital interacted with the TFP gap with respect to the frontier;
$\beta_6 RD_{i,t-1} \times TFPgap_{i,t-1}$ – R&D expenditures interacted with the TFP gap with respect to the frontier;
$\beta_7 GAP2003_i$ – TFP gap in 2003;
$\beta_8 REG_{it}$ – Regional spillovers;
$\beta_{9,2008-2010}$ – Time dummy for 2008-2010;
$\beta_{10,2011-2013}$ – Time dummy for 2011-2013.

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