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How to revive productivity growth?

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1 Introduction

Productivity is one of the most important indicators of competitiveness for enterprises, sectors and the economy as a whole. Productivity is so important because it measures efficiency in the use of inputs, such as labour, capital, energy and materials, in the production process. Indeed, productivity can be intuitively described as the ratio between the quantity of output produced (by a firm, a sector, or the whole economy) and the amount of inputs used. The most commonly used measure of (labour) productivity, is the quantity of output produced by one unit of labour, but this notion can be extended to multiple inputs at once, and this is the idea between total factor productivity (TFP).

Labour productivity is a widely used indicator of the competitiveness of an industry or an entire economy because it is largely determined by the production technology. Technological progress is therefore also reflected in an increase in labour productivity, or in other words, technical progress is one of the most important determinants of labour productivity (see Gomez-Salvador et al., 2006).

The informative value of labour productivity as a comprehensive indicator of competitiveness is limited, among other things, by the fact that it is cyclical. During an economic downturn, production usually falls faster than employment because firms aim to maintain employment levels for as long as possible, especially if they expect the downturn to be short-lived. This allows them to quickly expand production again during an upswing without the need for time-consuming and costly hiring and training of the labour force. This “labour hoarding” reduces measured productivity during recessions, but it is a purely cyclical phenomenon and does not in itself indicate a decline in competitiveness. For this reason, it makes more sense to analyse long-run trends of productivity rather than focus on its cyclical fluctuations.

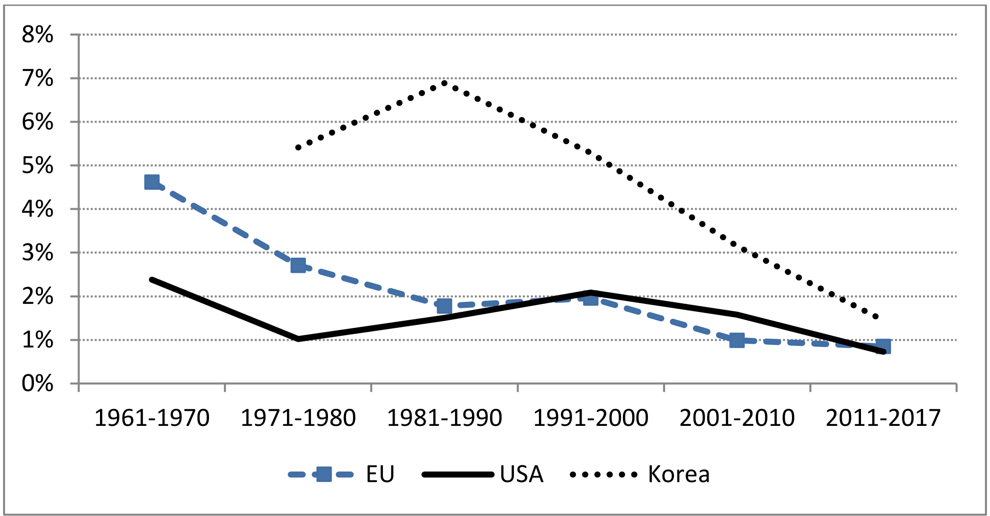
Technological progress is often measured via total factor productivity (TFP) and it is based on the estimation of a production function. In the simple, but frequently used Cobb Douglas production function, labour and capital are considered as inputs. If the growth rate of these input factors, weighted with their production elasticities, is subtracted from real GDP growth, a residual remains. Going back to the seminal work by Robert Solow (1957), this unexplained rest is dubbed Solow residual, and it represents multi-factor productivity, i.e. the contribution to economic growth that is not explained by labour force participation or capital deepening. For a long time, the Solow residual was treated as exogenous, but since the emergence of the endogenous growth theory (see, e.g. Romer, 1990), numerous attempts have been made to explain TFP, in particular by factors related to innovation, research and development, education, as well as determinants thereof.

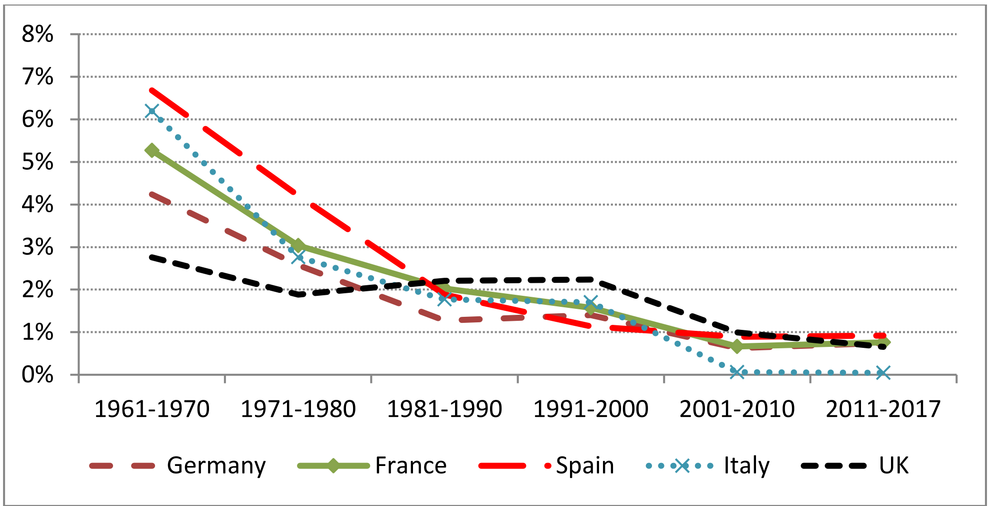
This report analyses the recent trends in labour and total factor productivity in the EU and beyond (Section 2), then it identifies several factors that influence productivity, based on a literature survey and a cross-country empirical analysis (Section 3). Section 4 investigates the role of intangible investment and digitalization, while Section 5 looks at the relationship between competition, market power, and productivity. All these elements lead us to formulate some policy recommendations for the revival of productivity growth in the concluding Section.

2 Recent trends in labour and total factor productivity growth

In most industrialised countries, productivity growth has declined over the past decades. Figures 1 and 2 display labour productivity and TFP growth in the EU (including the UK), its largest member states as well, the USA and South Korea. The Figures are consistent with the analysis put forward by the OECD (2018) in its latest *Compendium of Productivity Indicators*: even during the most recent upturn in the world economy, several advanced economies have featured productivity growth below long-run averages. Moreover, these weak dynamics span the entire spectrum of economic activities, even if growth in manufacturing activities outpaces the rise in productivity observed in the service sector.

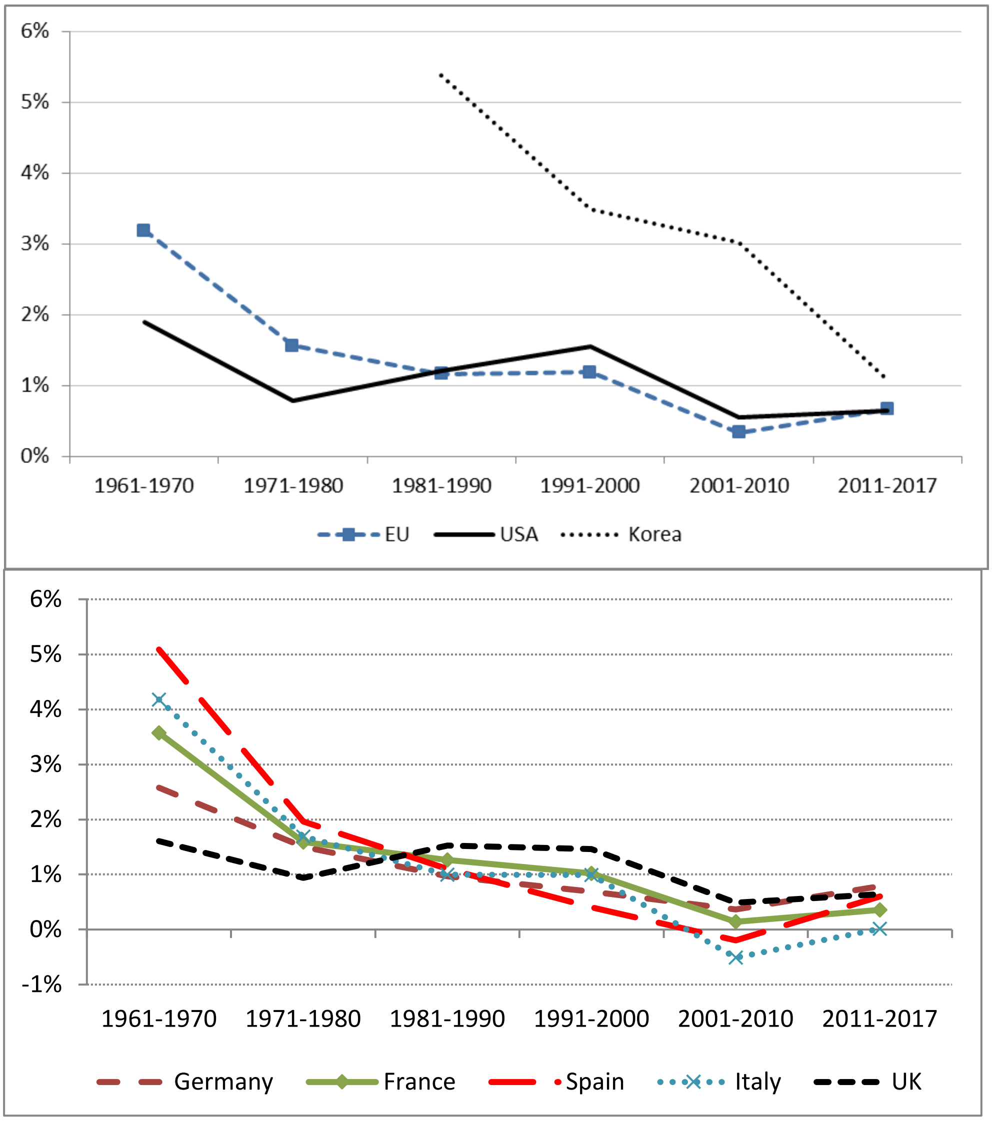
Figure 1: Development of labour productivity growth





Note: the figure shows 10 year average growth rates of real GDP per person employed.
South Korea: data start in 1970.
Sources: AMECO database, own calculations and illustration.

Figure 2: Development of total factor productivity growth



Note: the figure shows 10 year average growth rates of TFP. South Korea: first period covers 1985 to 1990. Sources: AMECO database, OECD productivity statistics (South Korea), own calculations and illustration.

Until the 1990s, many European countries experienced faster productivity growth than the US, but since then the situation has reversed. Furthermore, the EU is characterized by substantial heterogeneity in productivity growth across member states. Labour and total factor productivity displayed differentiated trends with some EU economies recovering immediately after the financial crisis (2008-2009) while others still lag behind, notably Italy. Among the group of OECD countries, South Korea displays a very high productivity growth. At the beginning this was in part due to a rapid integration into global value chains and the ensuing catching-up process. However, even more recently South Korea has achieved higher productivity growth than the US or most of the EU countries, which is certainly a result of the existence of an important high-tech sector.

The possible causes for the slowdown in productivity and economic growth across most of the industrial countries have been thoroughly investigated by a large number of studies, which have put forward multiple explanations, although no clear consensus has emerged so far. In a recent literature review, Lo and Rogoff (2015) mention "a secular deficiency in aggregate demand, a slowdown in innovation, adverse demographics, lingering policy uncertainty, post-crisis political fractionalisation, debt overhang, insufficient fiscal stimulus, excessive financial regulation and some mix of all of the above". Further causes include cyclical factors related to the financial crisis, measurement errors, misallocation of production inputs, changes in the sectoral composition of the economy, as well as the increasing necessity to adopt new business models to compete in the global market (ECB 2017).

Ollivaud, et al. (2018) analyse labour productivity trends with a particular focus on the link between capital formation and labour productivity. The authors find that the currently low labour productivity growth in many OECD countries reflects historically weak contributions from both total factor productivity growth and capital deepening. The slowdown in trend productivity growth in the period before the Great Financial Crisis is mostly explained by a long-established slowdown in TFP growth, but since then the further deceleration is mainly due to weak capital deepening in most OECD countries. Much of the weakness in the growth rate of the capital stock can be explained by an accelerator response of investment to continued demand weakness, leading to a deterioration of potential output via lower capital deepening (Ollivaud, et al., 2018). Taking into account the positive links between capital formation and total factor productivity as well as between TFP and labour productivity, low capital formation also depresses TFP growth, further contributing to subdued labour productivity growth.

The idea that sluggish growth is due to weak investment is reminiscent of the "secular stagnation" hypothesis advocated by Summers (2015) in the aftermath of the financial crisis. In a nutshell, proponents of this view claim that advanced economies suffer from the mismatch between an increased propensity to save and a decreasing propensity to invest. Such trends are ultimately associated with demographic change and technology. This "saving glut", as Bernanke (2005) labelled it before the crisis, drags down demand and puts downward pressure on interest rates and inflation, leaving central banks with fewer options and increasing the risk of excessive borrowing.

Sceptics of the secular stagnation hypothesis contend the notion that aggregate demand can be a major driver of long-term growth, and take a supply-side view of long-run productivity determinants. Hence, the attention is turned to the fact that the technological frontier is no longer expanding as fast as it once did. Along this line, Gordon (2012) argued that the impact of the ICT revolution in terms of economic growth is proving much more modest than thought, and far lower than the impact of 20th century technological breakthroughs. A more optimistic take on the matter is offered by Brynjolfsson and McAfee (2011), who argue that the slowdown is temporary, and mainly due to a lag in technology adoption.

3 Determinants of productivity growth

3.1 What does the literature tell us?

A large number of theoretical and empirical studies have been published on the drivers of productivity growth. Many of these analyses deal with labour productivity, but even more are devoted to TFP. Since TFP is one of the most important determinants of labour productivity (cf. Gomez-Salvador et al., 2006), policies fostering TFP would also positively influence labour productivity. In the following, the factors influencing total factor productivity are elaborated, based on Outlan (2016), Syverson (2011), Danquah et al. (2014), and UNIDO (2007) as well as other studies cited below. Related literature reviews and empirical analyses have been published in Weyerstraß (2018a, 2018b).

First of all, research and development (R&D) is often identified as the main driver of TFP growth. From the microeconomic viewpoint of a company, R&D activities conducted by the company itself as well as research achievements of other companies (if these are generally accessible) and of universities or other research institutions are important. Therefore, innovations as the result of R&D activities are an important driver of TFP growth. With regard to the research achievements of universities or universities of applied sciences, it is essential that the knowledge gained there is widely disseminated and applied in the whole economy in order to become productive. In a study for the OECD countries, Guellec and van Pottelsberghe de la Potterie (2001) conclude that R&D financed from abroad is a crucial determinant of long-term TFP growth, followed by R&D conducted by domestic companies and finally public research. Learning, be it "learning by doing", imitation, or the result of local spillover effects, also fosters TFP growth.

Due to the typical methodology of measuring TFP based on a production function with labour, capital and TFP as inputs, technical progress embodied in new capital goods is not attributed to TFP, but to capital inputs. This raises the question of the proper measurement of productivity, especially in a context of digital transformation and growing role of intangible capital (see Section 4).

Moreover, the standard approach to measure labour by means of the number of persons employed or total hours worked implicitly treats all workers as equal and disregards quality differences in the labour force. Alternative approaches use the wage structure since higher education and knowledge are usually reflected in higher wages, at least if there is no oversupply of certain qualifications. However, if the labour factor is only recorded quantitatively, improvements in the education level are not attributed to the labour, but to TFP. The educational attainment can be measured by the average number of school years or the share of persons with tertiary education.

Numerous studies theoretically and empirically investigate the influence of the use of information technology (IT). A literature review can be found in Syverson (2011). Positive productivity effects of an increased use of IT can be attributed to the opportunities of processing more data, to the faster availability of information for planning production processes or transport logistics, as well as to shorter changeover times in the production of different product varieties.

Graetz and Michaels (2015) find that robotisation is associated with higher total factor productivity and wages. A further determinant of TFP is gross fixed capital formation, in empirical studies usually measured as a share of GDP. Investment in fixed assets facilitates the emergence and dissemination of technological progress, even beyond the technical progress that is embodied in new machinery and equipment (Jäger et al., 2015).

In addition to domestically financed capital formation, also foreign direct investment (FDI) boosts TFP. This is particularly due to the transfer of technology and management knowledge that is typically brought about by FDI. The larger the gap in the level of development between the sending and the receiving economy, the larger the technological boost will be, provided that FDI flows to countries with enough absorptive capacity. Developed economies can therefore expect FDI to have significantly less productivity-enhancing effects than emerging economies.

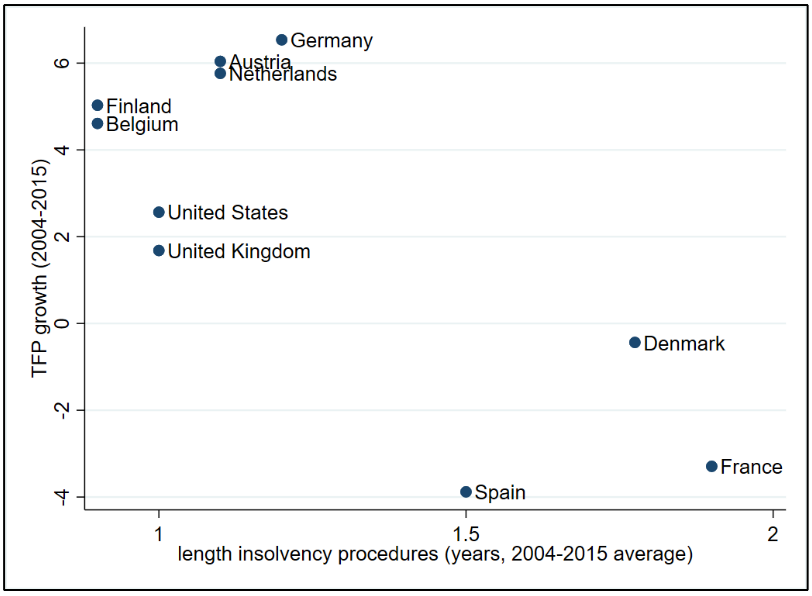
Besides FDI, there is convincing theoretical and empirical evidence that openness to international trade positively influences productivity (Miller and Upadhyay, 2000). Exporting companies are generally more productive than companies that produce exclusively for their domestic market. The competitive pressure on foreign markets is often fiercer, which leads exporting companies to increase productivity.

In the last 20 years or so, thanks to the increasing availability of administrative datasets providing detailed information about individual firms, a vast empirical literature has documented the presence of large and persistent differences in productivity among companies, even those operating in the same country and the same narrowly-defined industry. A typical measure of productivity dispersion, namely the 90:10 ratio (i.e. the ratio between productivity levels characterizing firms at the 90th and the 10th percentile of the distribution), ranges between two for advanced countries such as the US and five for emerging economies such as India (Syverson, 2011). This means that within the same industry we can observe firms producing twice (or five times) as much output with the same bundle of inputs.

Such microeconomic heterogeneity implies that structural change in the economy also affects TFP. This happens either though a redistribution of input factors from less productive to more productive companies, or through a restructuring within companies. According to an OECD study (McGowan et al., 2017), part of the observed decline in productivity growth in many industrialised countries has been caused by a growing number of so-called zombie companies. Zombie firms are old companies that have permanent difficulties in servicing their loans. The production factors captured by these zombie firms prevent young and rapidly growing firms from entering the market. This inhibits productivity gains by means of creative destruction. According to the argumentation brought forward by McGowan et al (2017), these companies are artificially kept alive by public subsidies, aiming at protecting the financial sector (banks) from possible solvency problems.

Figure 3 presents a pictorial representation of this phenomenon. It plots the relationship between the average length of insolvency procedures over the period 2004-2015 for a selection of OECD countries and their TFP growth over the same period, and shows a negative correlation between the two variables (albeit based on a small number of countries). Calvino et al. (2016) provide supportive econometric evidence that speeding up insolvency procedures can have important positive effects on business dynamism, especially on young firms.

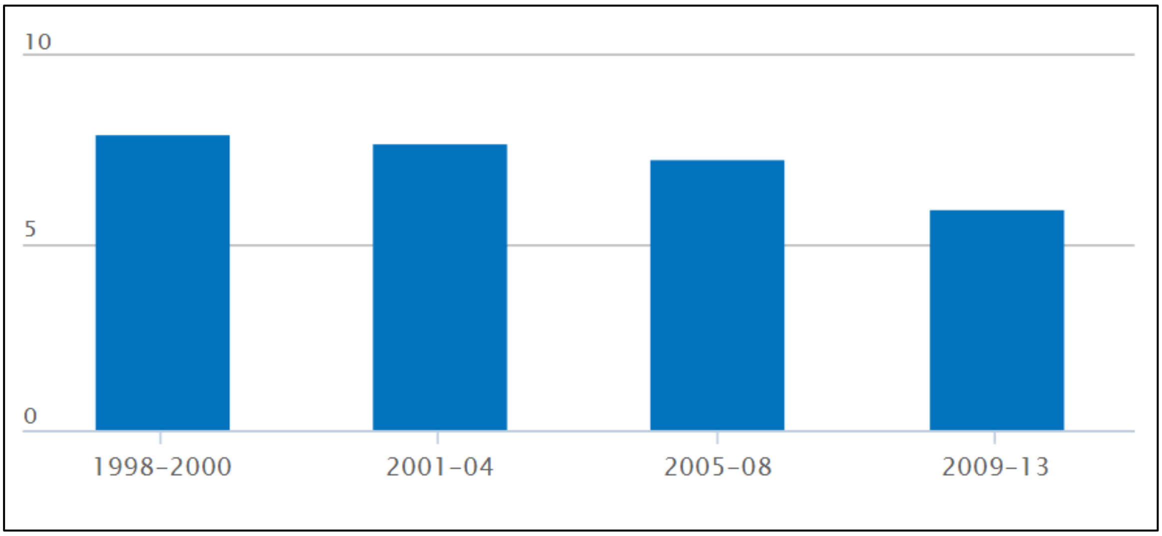
Figure 3: TFP growth and length of insolvency procedures – selected countries (2004-2015)



Source: TFP growth is taken from the EU Klems database and refers to value-added based total factor productivity; data on insolvency procedures come from the World Bank Doing Business Indicators.

In fact, several authors have documented a slowdown in business dynamism in recent years, both in the US and in Europe, and pointed to this lack of "creative destruction" as a possible explanation for the slowdown in productivity growth across industrial countries (see Figure 4), whilst misallocations of productive factors may act as a drag on efficiency, productivity and ultimately economic growth.

Figure 4: Cross-country average start-up rate



Source: OECD. The start-up rate is defined as the number of entrants with positive employment over the total number of units with positive employment.

This evidence brings us to discuss the influence of the government and the public sector on productivity. Negative influences may arise from market distortions such as taxes or regulation that hinder the efficient allocation of resources. If government receipts are used for productive expenditures such as R&D, education, or fast internet connections, the negative impacts from the distortions caused by the taxation may be more than compensated by the benefits of public investment. However, such positive effects are not to be expected from consumptive public expenditures. Also the regulation of goods markets has an influence on productivity. Regulation that affects competition, for example by creating barriers to market entry, is detrimental to productivity growth since such barriers reduce incentives for innovation activities by incumbent companies. Similarly, theoretical and empirical evidence suggests that state-owned enterprises have fewer incentives for productivity-enhancing innovation than privately owned enterprises.

A recent paper by the Centre for Economics and Business Research in the UK blames changing preferences of employees for the decline in productivity growth (Williams, 2017). The author argues that preferences have shifted away from high-wage jobs towards so-called "lifestyle jobs", for example in the creative industry. As the argument goes, such jobs might bring more satisfaction, but contribute less to measured productivity relative to conventional jobs.

Finally, total factor productivity is subject to measurement errors. The usual approach of attributing quality improvements of labour and capital to TFP is strictly speaking a measurement error. The same applies if intangible assets are not explicitly recognized but are allocated to TFP. Too little recognition of quality improvement in the growth of the capital stock leads to an overestimation of the increase in capital goods prices and thus to an underestimation of real investment. An underestimation of the growth of the capital stock results in an overestimation of the contribution of TFP. However, underestimating capital growth also leads to underestimating GDP growth. This is due to the fact that GDP growth can be calculated as the weighted sum of the growth rates of the expenditure components, with the weights representing the shares of the individual components in GDP. The net error, i.e. the difference between the measurement error of the contribution of the capital stock on the input side and investment on the expenditure side, depends on the size of the weights (the investment share of GDP and the profit share as an approximation of the output elasticity of capital; see Oulton, 2016).

3.2 Empirical analysis

On the basis of the determinants discussed in the previous section, a panel econometric analysis has been carried out. A panel model combines longitudinal data over a period of time with cross-sectional data for several units (here several countries). The endogenous variable, i.e. the variable explained in the model, is TFP calculated on the basis of a Cobb Douglas production function with labour, capital and TFP. In accordance with the European Commission in its approach of estimating potential GDP (Havik et al., 2014), the output elasticities were set to 0.65 for labour and 0.35 for capital.

The following variables were considered as explanatory factors:

- R&D expenditures relative to nominal gross domestic product (*R&D*)
- Number of triadic patent applications (patent applications in the USA, EU and Japan) per million inhabitants (patents)
- Share of industry (*industry*) or the service sector (*services*) in gross value added
- Gross fixed capital formation as a share of GDP (*Invest*)
- Government consumption as a share of GDP (*G*)

- Degree of openness, defined as the average of the export and the import share of GDP (*openness*)
- "Economic Freedom of the World" - Index (*Freedom*)
- *Rule of Law* Index.

The last two indicators are thought to capture the influence of the regulatory framework on productivity. Data on the GDP expenditure aggregates and gross value added come from Eurostat, TFP data from the AMECO database, patent applications from the OECD, R&D expenditure from Eurostat and the OECD. The "Economic Freedom of the World" index is published by the Fraser Institute. It is a comprehensive measure of the economic freedom of economies and includes the size of the government sector, the legal system and the guarantee of property rights, the monetary system, the freedom of international trade, as well as credit market, labour market and entrepreneurial freedom regulations. The World Bank's Rule of Law indicator measures business confidence in the quality of contract enforcement, property rights, police and courts, and the likelihood of crime and violence. Some of the variables may be interdependent, i.e. they are subject to possible collinearity. As mentioned, the Freedom of the World index includes information on openness. However, as this index is based on qualitative assessments, there should not be too close a correlation with the degree of openness based on the share of exports and imports in GDP. The same applies to the "Freedom of the World" index and the "Rule of Law" index, which overlap partly but not too strongly. Due to correlations between R&D expenditure and the number of patent applications as well as between the industrial share and the service share, these variables were only considered separately in different models.

32 countries are included in the analysis: the 28 EU countries excluding Croatia (due to lack of data availability), plus Switzerland, the USA, Canada, Japan and South Korea. Thus, the analysis comprises the EU, the G7, as well as South Korea and Switzerland, i.e. two countries with very high R&D expenditures by international comparison. Country and year fixed effects are also included. The data are available partly from 1981, partly only from 1996 and mostly until 2015 or 2016. However, at the time of the analysis, the "Economic Freedom of the World" index was only available until 2014.

The results of the panel estimations can be found in Table 1. Three models, differing in the set of explanatory variables, were estimated. Model 1 considers R&D expenditures in relation to GDP, the share of investment in GDP, the share of government consumption in GDP, the share of services in value added, the openness of the economy, the economic freedom index and the rule of law index. Model 2 contains the number of patents instead of R&D expenditure and the share of industry in value added instead of the services share. Furthermore, in this model the rule of law indicator turned out not to be significant. Finally, model 3 contains R&D expenditures (as model 1), the industry share (as model 2), and like model 2, the rule of law index is not present.

All coefficients are highly significant and have the expected sign. More research expenditure or patent applications, a larger openness to international trade, more economic freedom and legal certainty, as well as a higher investment rate and a larger share of industry (the sector that is most affine to the use of robots and machines instead of labour) are conducive to total factor productivity (as a measure of technological progress). On the other hand, a larger government sector and a higher share of services in value added have a negative impact on TFP.

Table 1 Determinants of TFP

	Model 1	Model 2	Model 3
Constant	yes	yes	yes
Patents		++	
R&D	++		+++
Industry		+++	++
Services	--		
Invest	+++	+++	+++
G	---	---	---
Openness	+++	+++	+++
Freedom	+++	+++	+++
Rule of law	+++		
Adjusted R^2	0.78	0.81	0.82
F-Statistics	38.66	55.60	54.10
Period	1996-2014	1985-2014	1981-2014

Each model comprises 32 countries and fixed country and time effects. +++ (---): positively (negatively) significant at the 1% level; ++,--: significant at the 5% level.
Sources: own estimations on the basis on data from Eurostat, OECD, UN, Fraser Institute.

4 Intangible investment and productivity growth in the digital age[1]

The empirical evidence suggests that after the financial crisis, the labour productivity slowdown in the United States and in Europe has been driven primarily by total factor productivity associated with a marked reduction of capital deepening. Despite relevant heterogeneities within the EU and with respect to the US, the common feature is a productivity growth rate that remains low relative to historical levels, averaging around 1% or less in many countries. This evidence is particularly puzzling because the same countries are also experiencing a digital transformation that is expected to boost productivity-enhancing investment in innovation and to reduce the costs of a range of business processes (OECD, 2018). A prevailing view is that, as happened with the big innovations in the past (e.g. steam engines, electricity), it takes time before a visible impact on productivity growth materializes. Additionally, to realize the growth potential of innovations related to digitalization it is necessary to invest in intangible assets (Brynjolffson, Syverson, and Rock, 2017).[2] Measurement errors related to unmeasured intangible investment thus play a key role in explaining the slowdown in productivity growth (Corrado et al., 2019).

Intangibles are sometimes purchased and sometimes generated internally within firms, and these cases are treated differently in accounting, i.e., the ignored intangibles may (a) be treated as intermediates, not investment or (b) not counted at all, in which case they are unrecognized own-

[1] Section 4 of this report is extracted from Corrado, Haskel, Iommi and Jona-Lasinio (2019).

[2] Corrado et al. (2005, 2009, hereafter CHS) set out a framework that expanded the core concept of business investment in national accounts to treat long-lived spending on “intangibles"—computerized information (software and databases), R&D, design and other non-science-based new product development costs, brand equity, firm-specific training, and business process reorganization—as fixed investment. Although the fixed asset boundary in national accounts has been continuously expanded in recent decades to better account for the role of intangibles, official SNA-based estimates treat as investment only a limited range of intangible assets: R&D, mineral exploration, computer software and databases, and entertainment, literary and artistic originals

account production. Corrado et al. (2019) provide a theoretical framework and empirical evidence to quantify the impact of missing own-account intangibles on TFP. They look at ten European countries and the United States over the period 1996-2016 using a recent release of the INTAN-Invest©2018 dataset.[3] [4]

The investment slowdown experienced by advanced economies has been highly debated since the onset of the Global Financial Crisis in 2008, and analysis has often looked at the tangible–intangible divide between Europe and the United States (e.g., Corrado et al., 2016; European Investment Bank, 2018).

Figure 5 shows data on the share of intangible and tangible investment over Gross Value Added in Europe and the United States in panel (a).[5] As may be seen, intangible investment overtook tangible one after the Global Financial Crisis, during which intangible investment fell comparatively less than tangible investment. Panel (b) of figure 5 distinguishes between investment shares for Europe versus the United States. The US intangibles share is higher and more volatile than the aggregate share for our 10 EU countries. The fallback in the US share in 2015 and 2016 is due to sharp contractions in mineral exploration in those years; excluding this component (not shown), the US share continues to rise. In the EU countries, the intangible investment share follows a steadily increasing trend over all years while the tangible share declines, on balance, in both geographic entities.

Figure 6 shows labour productivity growth and contributions to it from labour composition, tangible and intangible capital deepening, and total factor productivity. The decomposition is for Europe and the United States, and for both before and during/after the Global Financial Crisis.[6] In the pre-crisis years (1999–2007), labour productivity grew at faster pace in the United States (2.7% per year) compared with Europe (1.8% per year); both were largely driven by capital deepening that accounted for about 60% of the advances in labour productivity. Tangible capital provided a larger growth contribution compared to intangible capital and was a relatively more important driver in Europe. TFP growth was a relevant driver in both regions during this period, accounting for 37% and 33% of labour productivity growth in the United States and Europe, respectively. Labor composition provides a small contribution in both areas.

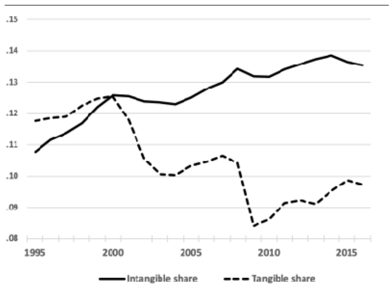
[3] The next two sections draw from Corrado et al. (2019) and summarize their main findings.

[4] Country coverage is: Austria (AT), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), Italy (IT), Netherlands (NL), Sweden (SE), and United Kingdom (UK) and the United States (US) for 21 NACE industry sectors that represent most non-agricultural private business activity in the two geographies: mining, manufacturing, construction, wholesale and retail trade, transportation and storage, accommodation and food services, finance and insurance, professional services, administrative services, and other services.

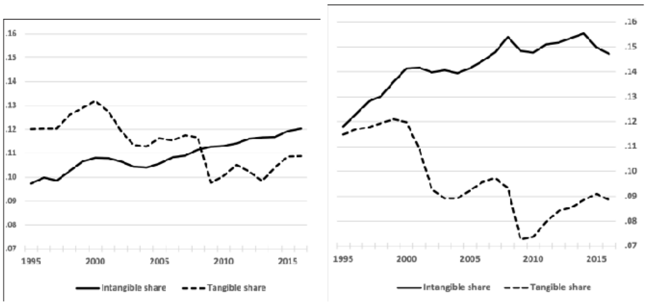
[5] Value added refers includes capitalized non-national accounts intangibles investment. “Industry output" refers to adjusted industry GVA in real terms.

[6] The European sovereign debt crisis years (2010–2012) are of course included in the second period.

Figure 5: Intangible and Tangible Investment Shares



(a) Europe plus United States

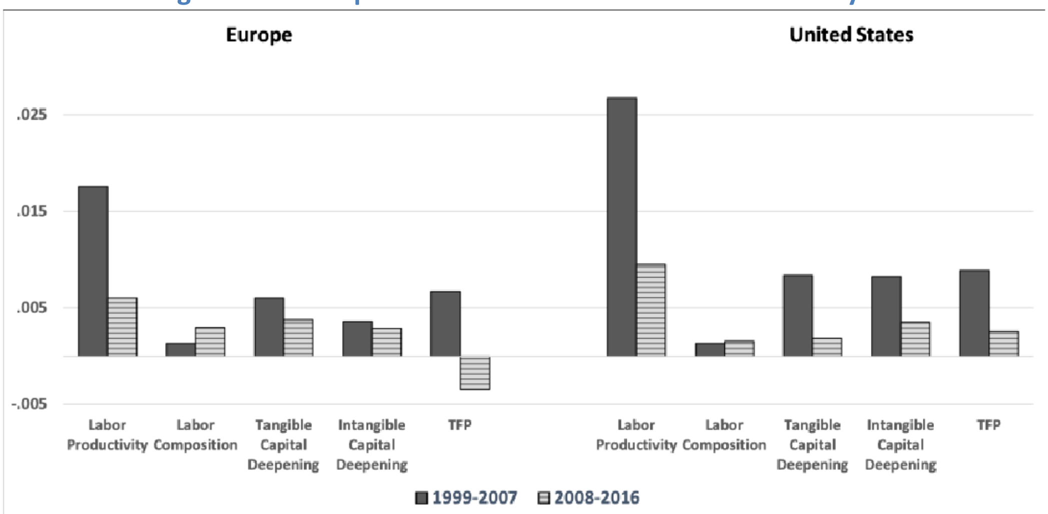


(b) Europe (left) versus United States (right)

Source—Figure 16.2 in Corrado et al (2019). Shares are of aggregate GVA including all intangibles. Authors' elaboration of data from INTAN-Invest@2018, EU KLEMS, Eurostat, and national accounts for European countries and the United States.

The overall picture is remarkably different in the during/post-crisis period (2008–2016), reflecting a combination of factors that negatively affected productivity dynamics in all advanced economies: increasing economic and political uncertainty, weak demand, and low wage growth (Remes et al., 2018). Labour productivity growth slowed markedly, to 0.9 and 0.6% per year in the United States and Europe, respectively, driven by both a decline in capital intensity and weak/negative changes in TFP. On balance, TFP growth in Europe was negative over the period, reflecting an incomplete recovery from the large drops occurred in 2008 and 2009.

Figure 6: Decomposition of Growth in Labour Productivity



Source: Figure 16.5 in Corrado et al (2019). Figures are natural log differences. Authors' elaboration of data from INTAN-Invest@2018, EU KLEMS, and national accounts for European countries and the United States.

Changes in real market sector output in 2008 and 2009 were somewhat larger in Europe than in the United States (-4.2% in Europe versus -3.4% in the United States, at average annual rates), but downward adjustments to person hours were very sharp in the United States (-4.9%) whereas Europe curtailed hours more moderately (-2.3%). Thus, although capital deepening rose in both areas in these years, the drop in total factor productivity was especially large in Europe; it fell 1.6% in 2008 (compared with a 2.0% drop in the United States) and plunged nearly 6% in 2009 (compared with edging down 0.4% in the United States).

All this told, TFP growth in Europe, after accounting for intangibles, slowed from 0.67% per year prior to the crisis (1999–2007) to -0.35% per year after the crisis (2008–2016). In the United States, TFP growth slowed from 0.89% per year before to 0.26% on average after the crisis. Thus, total factor productivity slowed down by 1.0 percentage point per year (Europe) and 0.63 percentage points per year (United States).

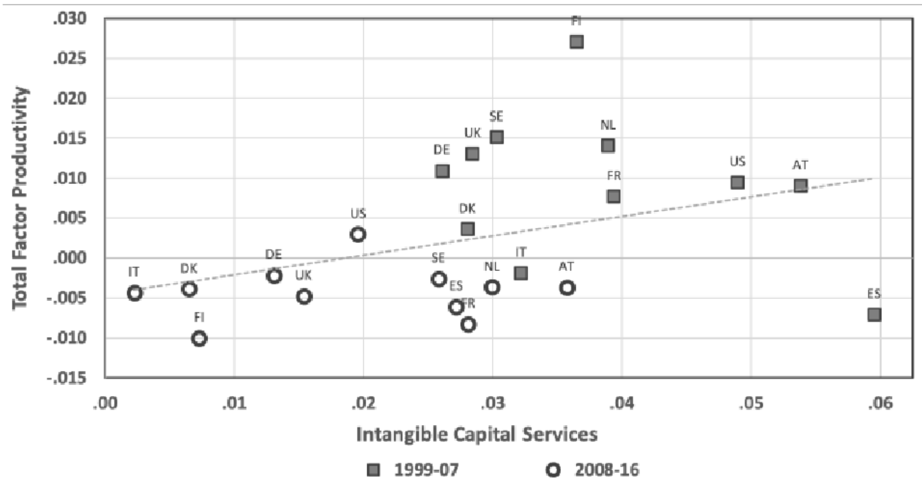
What might account for these slowdowns and what is the contribution of intangible capital? Consider first measured productivity excluding non-national accounts (nonNA) intangible assets.[7] Although the weight on nonNA assets is fairly large, their investment path (in the aggregate) is not very dynamic after the early 2000s. If nonNA intangible assets are not classified as investment, they contribute to generate a greater deceleration in TFP growth. Data reported in figure 6 show that TFP slowdown is 0.1 percentage point per year larger for both Europe and the United States when non NA intangibles are left outside the asset boundaries and thus excluded from the sources of growth.
Intangibles affect productivity growth not only via capital deepening but also generating spillovers (Corrado et al 2017). Data confirm that commercial knowledge spillovers are proportional to growth of intangible capital services. Figure 7 shows this relationship before (squares) and after (circles) the financial crisis. The figure points to a positive correlation between TFP and intangible capital services growth rates, consistent with a spillover relationship driven by partial appropriability (Corrado et al., 2017). Figure 7, as reported in Corrado et al. (2019)[8], suggests that a relationship persists in recent years (no obvious slope difference between the pre- and post- crisis time periods) and that a significant slowdown in intangible capital services accompanied the post- crisis slowing in productivity (or vice versa). The authors show that over the period 1999-2016 knowledge spillovers accounted for *nearly all* of the TFP slowdown in productivity the United States and one-third of the decline in TFP growth in Europe.

Moreover, Corrado et al. (2019) conclude that (1) the decline of capital deepening (tangible and intangible) directly accounts for a large part of the labour productivity slowdown after the financial crisis, but that intangible capital growth recovered comparatively faster than tangible capital, especially in the United States; (2) the positive cross-country relationship between TFP and intangibles suggests that knowledge spillovers arise from investments in both R&D and nonR&D intangible assets; and (3) when the estimated spillover relationship is applied to recent data, the decline in intangible capital growth accounts for the decline in estimated TFP growth in the United

[7] Intangibles classified as investment in National Accounts include: Software, R&D, Entertainment, literary, and artistic originals and Mineral exploration. Intangibles not classified as investment in National Accounts (nonNA) include: Design and other new product development, Brands, Organizational capital, Employer-specific human capital.
[8] The analysis considers the pre-crisis years using data that since has been substantially revised.

States but explains very little of the larger TFP growth decline in Europe, which remains somehow puzzling.

Figure 7: Spillovers to Intangible Capital Services



Source: Figure 16.6 from Corrado et al (2019). Figures plotted are natural log differences. Dotted line is linear trend through all observations. Authors' elaboration of data from INTAN-Invest@2018, EU KLEMS, Eurostat, and national accounts for European countries and the United States.

Overall, the intangible approach offers a valuable framework to better understand the drivers of economic growth in the digital era where unmeasured investment and knowledge spillovers significantly affect productivity trends, although additional work is needed to better integrate intangible assets into standard productivity measures. For instance, the measurement effort developed so far by INTAN-Invest does not allow yet to quantify investments in AI to then evaluate whether missing investments in AI "explain" part of the productivity slowdown. In fact, investments in AI, such as spending for the creation and curation of databases, are not regularly broken out in the source data used to estimate market sector intangibles in INTAN-Invest.[9] That said, at present INTAN-Invest is unlikely to be missing significant digital-related investments in intangibles by firms in market sector industries, but there is obviously more to do on incorporating AI and the digital economy into intangibles measurement (Corrado et al., 2019).

5 Competition, market power and their implications for productivity

The ability of competition and market pressure to affect productivity has long been recognized by the economic profession. The issue received a lot of attention in the 1990s when, due to the collapse of the Soviet Union, most countries in Central and Eastern Europe as well as Central Asia underwent massive processes of deregulation and privatization in order to move from a planned system to a

[9] Note, too, that the Brynjolfsson et al. (2018) study did not rely on investment data coherent with national accounts, which is the objective of INTAN-Invest. See Appendix A in Corrado et al (2019) for further details on INTAN-Invest.

market economy. In the same decade, privatisations were pursued also in several Western European economies, such as Italy, Spain, France and Germany.

The empirical evidence supports the intuition that greater competition and lower entry barriers enhance productivity growth, and this holds true across a variety of countries and periods (see for instance Nicoletti and Scarpetta, 2003, or Ospina and Schiffbauer, 2010). In a recent World Bank working paper, Schiffbauer and Sampi (2019) use quasi-experimental evidence from Peru to show that the proper enforcement of competition by authorities (namely the elimination of administrative barriers to entry and competition) can have significant effects on aggregate productivity.

As for the mechanisms that drive productivity growth, the microeconomic literature recognizes that competition affects productivity through two different channels. The first is selection, whereby market pressure moves resources toward more efficient companies. The second channel concerns within-firm gains in efficiency dictated by the need to keep up with (actual or potential) competitors. These two channels are typically associated with the "between" and "within" components in decomposition exercises that use firm-level data to pin down the relative contributions of the two mechanisms to aggregate productivity growth. Entry and exit also play a role and are often included as separate terms in the decomposition.

Most of the relevant literature finds a dominant contribution for the within component, i.e. changes in productivity of incumbents over time. Even if different decomposition methods exist, this broad conclusion holds true across different approaches. For instance, a recent contribution by Melitz and Polanec (2015) applies three different decomposition methods to Slovenian data covering the period between 1995 and 2000. They find that the within component accounts for something between 60% and over 85% of aggregate productivity growth (which is quite large, standing at 40-50% depending on whether one looks at labour productivity or at TFP), but emphasize the important role played by entry and exit as well.

Market pressure shapes the incentives for firms to undertake costly productivity-enhancing investment that would not take place if firms did not fear losing their market shares. In fact, Syverson (2011) reviews many examples of sectors where the reduction in entry barriers or increased competition led to significant improvements in average productivity. The flip side of the coin is that regulation and policy measures that restrict competition may have unintended consequences in the realm of productivity growth if they reduce incentives to invest in productivity-enhancing technology.

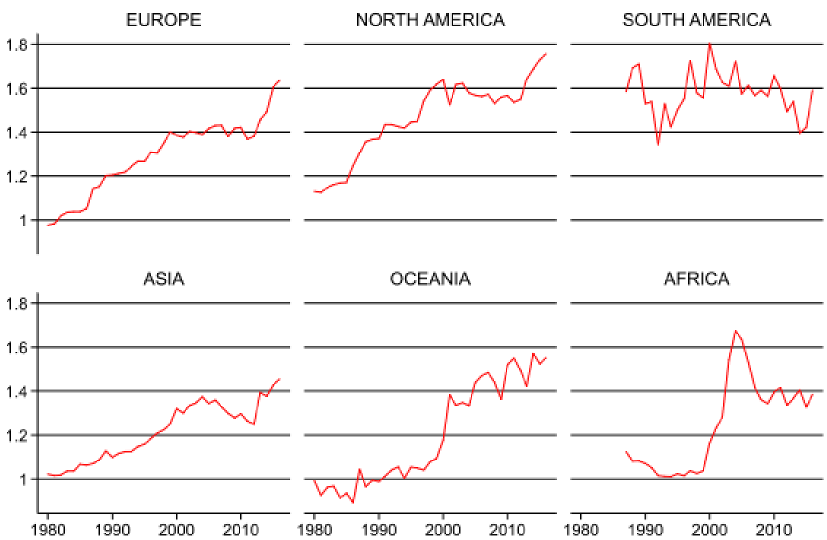
Trade liberalization has emerged as a preferred testbed to investigate the impact of increased competition on productivity. In fact, since the seminal paper by Pavcnik (2002) that studies the Chilean trade liberalization of the 1970s, several papers find a positive effect of liberalization on productivity, and interpret this in terms of a decrease in inefficiencies as domestic firms become leaner and fitter in the wake of greater competition, or are otherwise forced out of the market.

As already mentioned in Section 3, the ability of market selection to allocate correctly resources toward the most productive firms seems to have diminished over time. A recent paper by Caselli et al. (2018) documents that a large fraction of French firms display negative price-cost margins, and this phenomenon increases after 2000. This means that, for protracted periods of time, a significant number of firms (around 14% in the sample used by Caselli and co-authors) charge prices that are lower than marginal costs. Inefficient credit markets, government subsidies or the existence of uncertainty and irreversibility in investment decisions may provide possible explanations for this kind of behaviour, which nonetheless remains at odds with the idea of an effective market selection process.

The potential role of competition and market power to shape macroeconomic dynamics has recently gained centre stage after a series of papers by De Loecker and Eeckhout (2017, 2018) documented a long-run increase in markups in the US economy and most of the world. More important for the present report, the two scholars highlight the impact that such a phenomenon can have on a series of policy-relevant issues such as the fall in the labour share of income, the rise in inequality and polarization in the labour market, the reduction in business dynamics and labour mobility and, finally, low output growth.

Using data on a large number of US companies, De Locker and Eeckhout (2017) show that while price-costs margins had remained fairly stable until 1980, they have sharply increased afterwards. This phenomenon appears to be quite general and not concentrated in specific sectors of the economy. Moreover, an extension of their analysis that covers several other countries reveals similar dynamics in Europe, Asia and Oceania (see Figure 8).

Figure 8: Global Market Power



Source: De Locker and Eeckhout (2018).

As it is clear from Figure 8, the upward trend in markups is significant: average price-cost margins jump from 20% in the early 1980s to around 60% in the US. On average, markups have increased by nearly 40% in advanced economies since the 1980s (Díez et al. 2018). What is more, the rise is driven by the right tail of the distribution (the firms charging the highest markups being able to further increase their price-cost margins), implying an increase in market power and concentration. De Loecker and Eeckhout (2017) investigate whether the rise in price-cost margins may be due to an increase in overhead costs that may justify extra profits as a way to finance large fixed upfront costs in presence of imperfect financial markets. For instance, if rapid technical change requires larger R&D investment by top firms, then larger markups may be a way to respond to this increased financial needs that are difficult to fund through bank lending. However, the authors conclude that the empirical evidence is not supportive of this interpretation and the rise in price-cost margins rather signals an increase in market power, i.e. a greater ability by firms (especially large ones) to extract surplus from consumers.

What is the impact of the evolution of market power? Everything else equal, an increase in market concentration leads to a reduction in the quantity of output and an increase in its price, which translates into a fall in (real) GDP. Moreover, since TFP is normally computed as a residual, a reduction in output for a given level of inputs would be registered as decrease in measured productivity. De Loecker and Eeckhout show that, on the contrary, properly accounting for market power leads to a revised measure of TFP that displays no significant slowdown of US productivity growth. Hence, this line of analysis calls into question our ability to properly measure productivity and provides a novel explanation to the anaemic growth performance experienced by several industrial countries in the last few decades. According to this view, the responsibility seems to lie more with a decrease in competition than with an actual slowdown in productivity growth.

At the same time, the rise in market power is also associated with a lower responsiveness of labour and other production factors to shocks and, more in general, with a lower business dynamism, that is consistent with the evidence discussed in Section 3. Given the relationship between competition, market selection, and productivity that we have discussed above, a slower reallocation of resources in the wake of shocks may act as a drag on productivity; hence, the rise of market power may affect both actual and measured productivity, with a compounded negative effect on GDP growth.

6 Policy Conclusions

The slow pace of productivity growth in Europe is a major source of concern for policy-makers, as productivity is a key determinant of living standards. This report has offered an overview of the relevant stylized facts, as well of the possible explanations put forward in the economic literature.

The presence of substantial heterogeneity among firms both within and across sectors and countries suggests that the same policy interventions can have very different effects on different groups of companies, and not all agents will react in the same way to policy measures.

The imperfect knowledge about the key drivers of productivity and, above all, of the lags with which the economic system responds to policy shock calls for an experimental and tailor-made approach that addresses the most pressing bottlenecks affecting countries and sectors while refraining from a one-size-fits-all attitude.

Policy interventions should aim at establishing the proper incentives for companies to invest in productivity-enhancing technologies and practices (i.e. tangible and intangible capital), by reducing the costs of and barriers to investment. These costs can take the form of either direct financial outlays or the opportunity costs associated with lost output when adopting a new technology.

Also, the emergence of new business models in the digital economy (as well as new modes of delivering public and private services) requires strong support to investment in training and workforce skills to exploit the productivity potential of the digital transformation.

Competition policy, although not directly related to productivity, is emerging as an important tool to shape those incentives and foster the efficient allocation of resources both across and within sectors and firms. In industry, productivity growth is generally higher than in the services sectors. Hence, strengthening the production sector would also support productivity advancement in Europe. Furthermore, empirical evidence shows that openness to foreign trade and to foreign direct investment is supportive to productivity growth.

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