CHAPTER 3.1

PRODUCTIVITY PUZZLE AND INNOVATION DIFFUSION

KEY FIGURES

1.0 %
the rate of productivity growth in Europe between 2010 and 2018

65.7 %
the contribution of R&I to total productivity growth in a sample of EU countries

12 %
the gap in real labour productivity between the EU and the United States in 2018

0.5 %
the annual growth rate of Total Factor Productivity in the EU after the crisis

What can we learn?

- **R&I are at the core of the productivity and competitiveness** of our economy.
- **Productivity growth and sustainability can reinforce each other**. Productivity can help overcome the trade-off between environmental policy and long-term growth.
- Despite the rise in digital technologies in the past decade promising large productivity gains, **productivity growth has been sluggish**, holding back more robust economic growth in Europe and other advanced economies.
- **The gap in productivity performance** between highly productive economies and firms at the frontier and the rest points, among other factors, to a **lack of innovation diffusion** in Europe.

What does it mean for policy?

- **R&I policy that aims to enhance productivity** will reinforce companies' ability to be competitive at the global level, benefitting jobs and creating value.
- **R&I policy plays an important role for catching-up** of laggard companies and regions by improving the conditions to speed up knowledge creation and diffusion (investment, regulation, science-business links, framework conditions, and capacity and quality of national R&I systems).

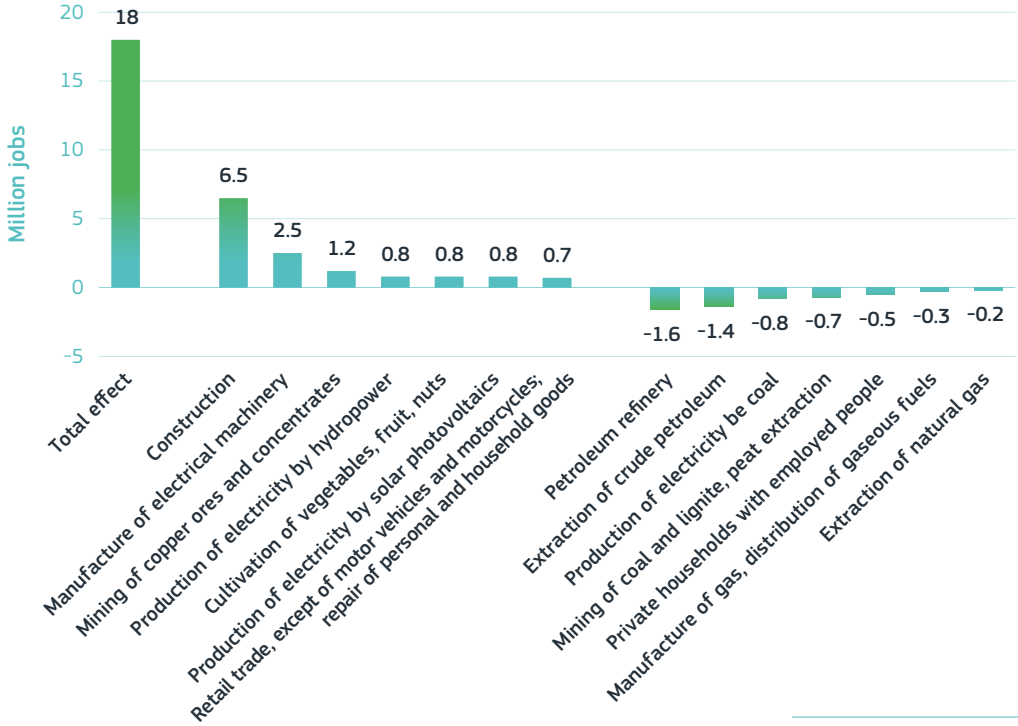
1. Productivity, competitiveness and innovation are closely related

Higher productivity means stronger competitiveness, which is crucial for EU companies in a globalised economy. This is even more true as the EU risks gradually losing its competitiveness, with slow innovation, adoption of technologies and productivity growth in a context where technology is changing fast and new global players are emerging rapidly (European Investment Bank, 2019). Higher productivity will also be essential in the future in the light of ageing societies to compensate for a declining share of the workforce in the population. In this context, productivity will be a key determinant of Europe's future prosperity.

Competitiveness, productivity and innovation are separate concepts but are very closely interrelated. In the global context, it would be a mistake to ignore the fact that innovation can drive the EU's competitiveness through productivity growth. Spurring innovation has a direct effect on what is produced, making goods better and cheaper whilst also ensuring that the production process is efficient. This improvement in the ratio of production output to input is referred to as productivity. Hence, it is a measure of efficiency. Enterprises are competitive when their productivity grows consistently and enables them to reduce the unit costs of their outputs. In turn, if this happens in traded sectors it can allow EU companies to compete on global markets without relying on government support.

Productivity growth and sustainability can reinforce each other. Productivity can also help overcome the trade-off between environmental policy and long-term growth when coupled with appropriate action, such as investment in pollution abatement (Basu and Jamasb, 2019). Boosting productivity growth needs refocusing the use of available resources and investments on more efficient production activities and systems, which must also be environmentally friendly in order to ensure a sustainable growth path (Kalff et al., 2019). Hence, increasing the efficiency of the production process can be compatible with sustainable production and support the sustainable transition. This raises the issue of ensuring a proper decoupling between economic activity and the negative externalities related to the production process. R&I can play a key role here. Productivity gains, and the related economic benefits in terms of value added and jobs, can also be directly generated by more competitive sustainable activities. For example, in Europe, the value added and employment of the environmental sector has increased rapidly compared to the rest of the economy, together with a steady increase in labour productivity (Box 3.1-1). The International Labour Organization (2018) shows an overall positive employment impact from the action taken in the energy transport and construction sectors to limit global warming to 2 °C. By 2030, the estimated job creation, driven by the high demand for labour from renewable energy sources, is around 18 million jobs globally. Under the same logic, it can be shown that the stringency of environmental policies is accompanied by higher levels of eco-innovation and economic competitiveness (European Environment Agency, 2020).

Figure 3.1-1 Sectors most affected by the transition to sustainability in the energy sector (in million jobs)



Science, research and innovation performance of the EU 2020

Source: ILO (2018). World Employment and Social Outlook 2018 – Greening with jobs

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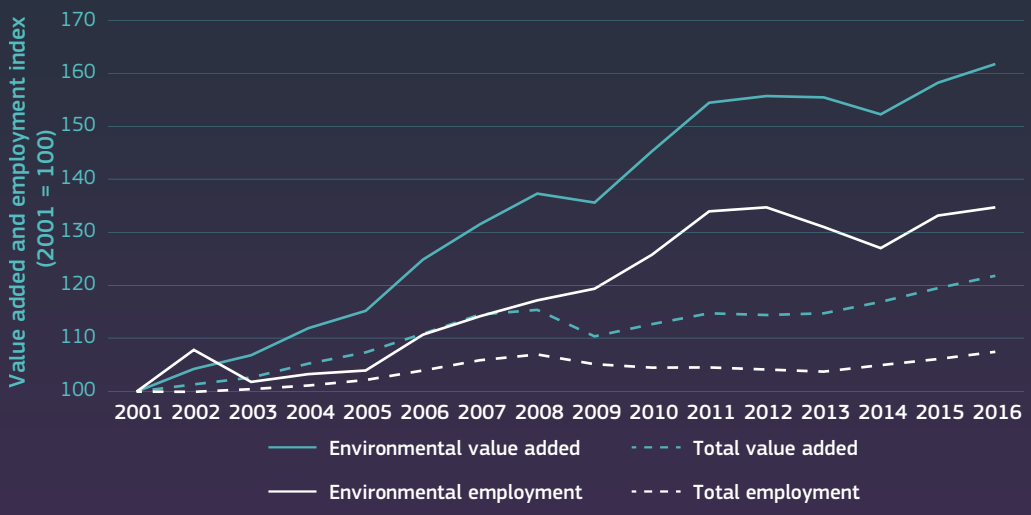
BOX 3.1-1 A sustainable transition

Europe has engaged in a transition towards a sustainable growth model, in line with the 2030 Agenda for Sustainable Development. Among the multifaceted dimensions of a sustainable development path, the creation of an economic and social model within the natural limits of our planet plays a key role, calling for a better use of resources and a transition towards a low-carbon and climate-nature Europe (European Commission, 2019).

Such a transition also requires a change in the way the production process takes place, including greater relevance and weight for those activities aimed at the prevention and maintenance of the stock of natural resources and a reduction in environmental degradation. Figure 3.1-2 presents the growth of employment and gross value added in activities devoted to environmental protection – the prevention, reduction and elimination of environmental degradation – and resource management – the preservation and maintenance of the natural resources stock. The trend reveals that **the EU has embarked on a sustainable development path, with a steady increase in the weight of the 'environmental sector' in terms of both employment and gross value added, as well as productivity**. Indeed, these activities are growing faster than the overall economy, with a steady and positive trend being in place since 2001.

Figure 3.1-2 Growth of the environmental sector in the EU28[(1)], 2001-2016



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Eurostat (online data code: env_ac_egss2 and env_ac_egss1)

Note: Data are normalised to 100 in 2001.

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Furthermore, productivity growth brings benefits to consumers through higher wages for workers. At the same time, businesses become more profitable, which also benefits investment and jobs. The question is to what extent these (technological/digital) productivity gains benefit society as a whole and what share is captured by a small number of dominant firms. This deserves further investigation, although the dominant market power of a few extremely productive large players could raise distributional questions (ILO, 2018).

R&I is crucial for the EU's productivity. For a long time, economic theory has highlighted the role of technical progress in productivity growth and the key role innovation systems play in this (Solow, 1957; Romer, 1986; Romer, 1990). Innovation has two roles in stimulating productivity (Hall, 2011). First, R&I can increase firms' efficiency through process innovation and improve the goods and services they produce. This raises their demand and reduces production costs. Second, firms that innovate are also likely to grow more, and new entrants with better products should displace existing inefficient firms. Overall, this contributes to increasing aggregate productivity: new ideas help to generate greater (or the same) output with the same (or less) input, for both companies and the whole economy. This, in turn, should positively affect wages and business profitability. Similarly, once a new technology is produced, its diffusion throughout the economy is a key productivity driver: higher adoption rates reduce the gap between leaders and laggard companies (and regions) and eventually positively affect aggregate performance (Andrews et al., 2016; Anzoategui et al., 2019).

BOX 3.1-2 Investments in intangible assets, innovation and productivity performance

Cincera, M. (ULB), Delanote, J. (EIB), Mohnen, P. (UNU-MERIT), Santos, A. (ULB) and Weiss, C. (EIB)

Investment in intangible assets has increased rapidly over the past few decades, mainly driven by changes in industrial market structure, with several important implications for how firms operate[1]. While the manufacturing sector is becoming more oriented towards services and customers, an increasing number of tasks in the services sector are automated thanks to artificial intelligence and robotisation. In this context, information and communications technologies (ICT) affect firms' organisational structure and commercial strategies by providing them with new ways of selling products and services (e.g. e-commerce) or giving fast and easy access to data (e.g., information about customers). Technological change is also affecting the structure of the labour market, creating a need for new jobs in the ICT sector and changes in the demand for workers' skills.

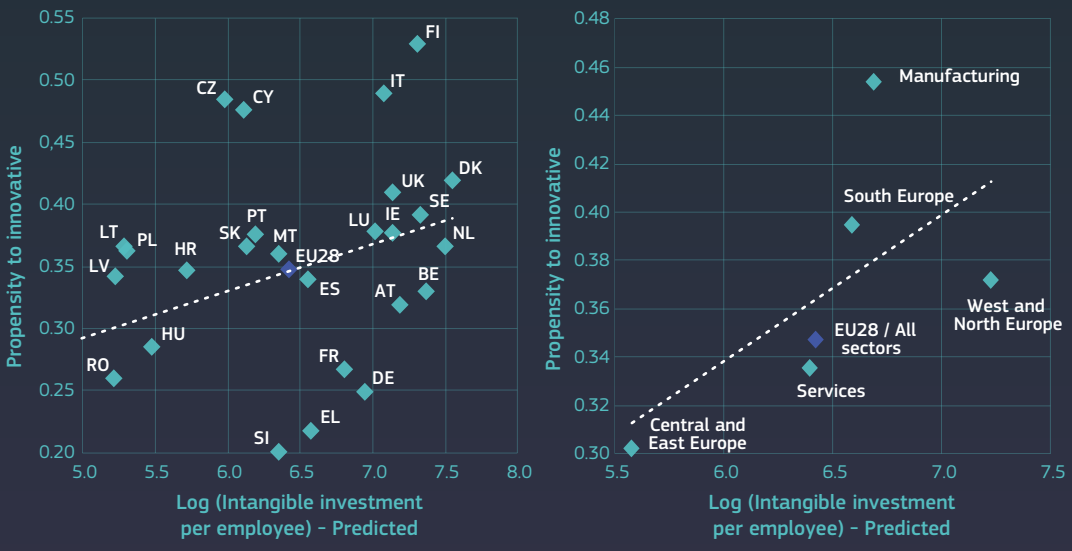
EU firms are facing new challenges. Digitalisation and globalisation are putting pressure on existing market positions competition. Investment in intangible assets – such as R&D, intellectual property rights (patents, trademarks, and design), software and data, and staff training – has gained relevance in overcoming these market pressures. Intangible investment has a positive effect on the propensity to innovate (Figure 3.1-3) and firm productivity (Figure 3.1-4).

Firms located in central and eastern Europe tend to invest less in intangible assets, have a lower propensity to innovate and are less productive. In contrast, firms in west and north Europe have higher levels of intangible investment and productivity.

Manufacturing firms have a higher propensity to innovate than services – for a similar level of intangible investment, they are more likely to introduce new products, processes or services. At the same time, firms in the manufacturing sector tend to be less productive, even though they display a higher average intangible investment intensity than those operating in the services sector.

1 Haskel, J. and Westlake, S. (2017), Capitalism without capital: The rise of the intangible economy, Princeton, NJ: Princeton University Press.

Figure 3.1-3 Intangible investment and innovation



Science, research and innovation performance of the EU 2020

Source: EIB Investment Survey (EIBIS waves 2016 to 2018)

Note: The log of intangible investment per employee was estimated using an OLS regression, controlling for selection bias (decision to invest), obstacles to investment activities, competition index in the sector, firm production capacity utilisation and firm characteristics. Intangible investments include R&D expenditures (including the acquisition of intellectual property); software, data, IT networks, and website activities; acquisition of new skills through the training of employees; organisation and business process improvements (such as restructuring and streamlining).

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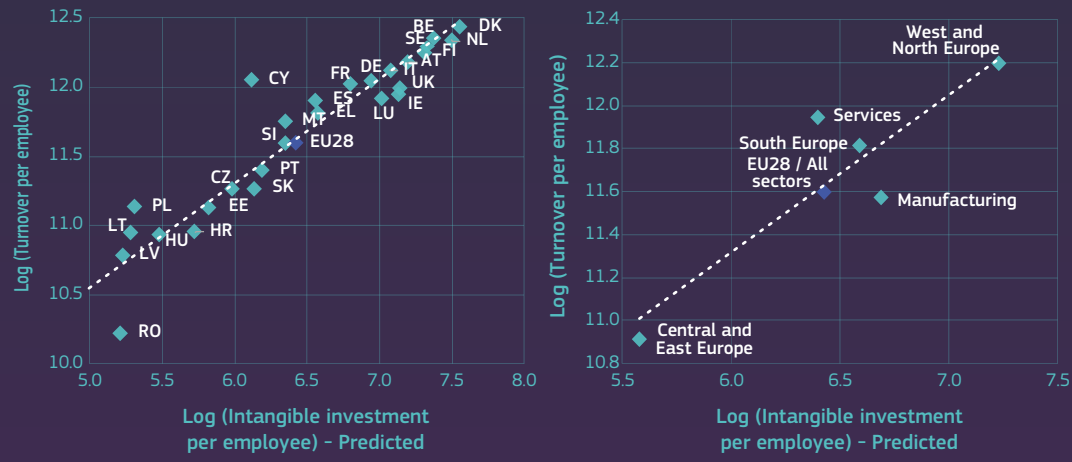
Figure 3.1-4 Intangible investment and productivity relationship



Science, research and innovation performance of the EU 2020

Source: Based on the EIB Investment Survey (EIBIS waves 2016 to 2018)

Note: The log of intangible investment per employee was estimated using an OLS regression, controlling for selection bias (decision to invest), obstacles to investment activities, competition index in the sector, firm production capacity utilisation and firm characteristics. Intangible investments include R&D expenditures (including the acquisition of intellectual property); software, data, IT networks, and website activities; acquisition of new skills through the training of employees; organisation and business process improvements (such as restructuring and streamlining).

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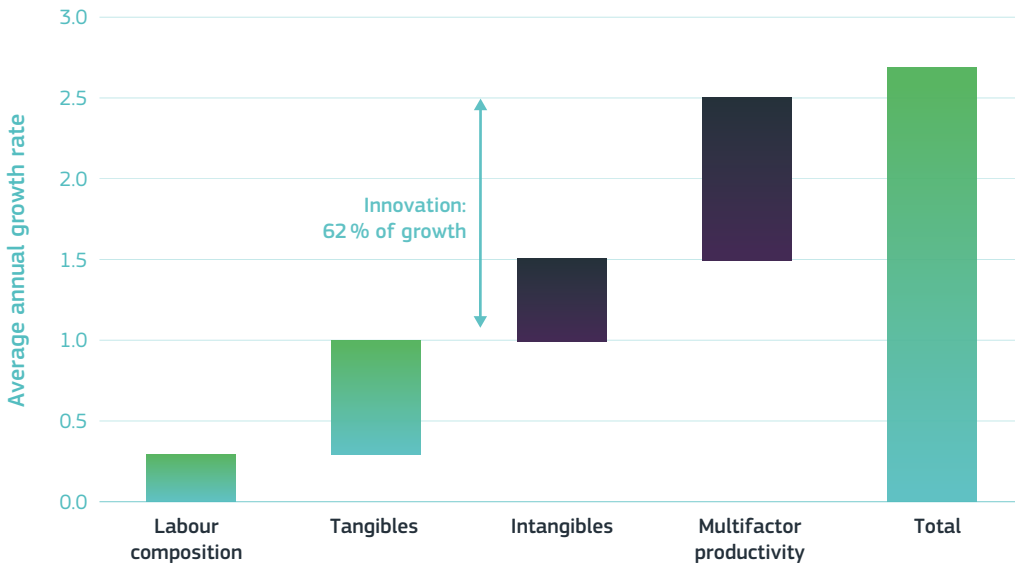
The positive relationship between R&I (and other intangible assets) and productivity has been observed and studied extensively in the literature (see Box 3.1-2 for a recent illustration). While the estimated impacts of R&I on productivity and economic growth vary depending on the methodology used and the period, countries and industries analysed, typical findings confirm the above economic rationale, revealing that R&I and intangible investments do explain a relevant share of productivity performance. Recent evidence also suggests that the decline in R&D and adoption investments contribute to explaining the productivity slowdown preceding the last economic crisis and in its aftermath, respectively (Anzoategui et al., 2019). To quantify the contribution of R&I and intangible investments to productivity and economic growth, the most notable findings suggest that[2]:

- **Before the crisis, almost two thirds of economic growth in Europe from 1995 to 2007 were derived from R&I**, broadly defined as TFP and intangible investments, including R&D, as reported in Figure 3.1-5 (Bravo-Biosca et al., 2013).

Figure 3.1-5 Contribution to European economic growth – percentage per annum (1995-2007)



Science, research and innovation performance of the EU 2020

Source: Bravo-Biosca et al. (2013)

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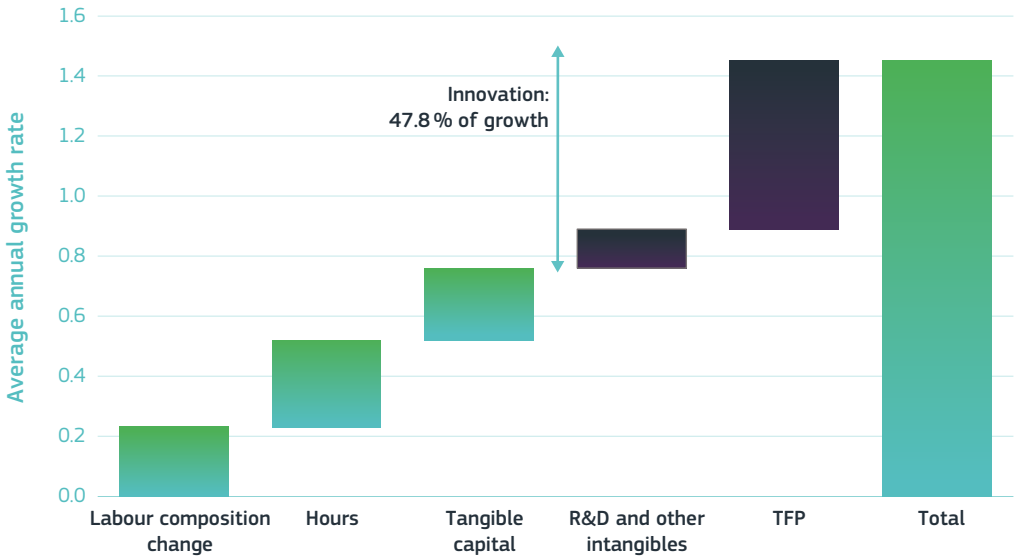
2 Growth accounting is a standard approach to estimating the contribution of capital, R&D and other intangible (and tangible) components to labour productivity growth, following the seminal work by Solow (1957). TFP is usually considered as the proxy of technological change, while different specifications of the estimation model allow the role of specific factors to be traced back, such as, for instance, ICT capital, R&D, economic competences, etc. The search for the contribution by intangibles has increased in recent years due to the increasing availability of reliable data.

- **After the crisis, from 2010 to 2016, almost half of the economic growth in Europe derived from R&I**, still defined as TFP and intangible investments, including R&D, obtained using the most recent EU KLEMS data 2019 (Figure 3.1-6). Unlike the precrisis estimates by Bravo-Biosca et al. (2013), the contribution of R&I declined slightly due to the significant increase in the role of hours worked, which had been rather minimal in the previous period.

Figure 3.1-6 Contribution to European economic growth (value added) – percentage per annum (2010-2016)

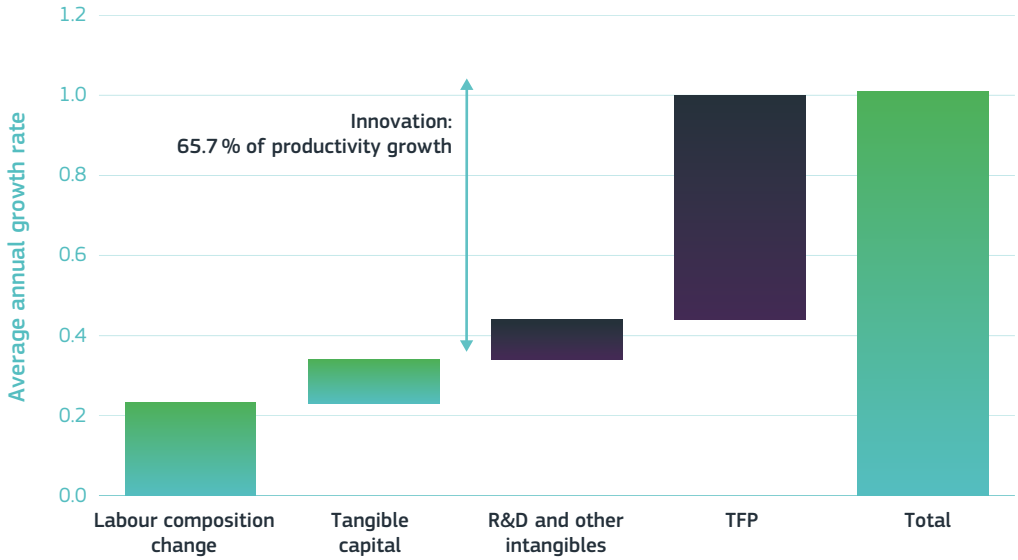


Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on EU KLEMS 2019 (Analytical Database)
Note: Data covers 19 EU Member States: BE, CZ, DE, DK, EE, ES, FR, IT, LV, LT, LU, HU, NL, AT, RO, SI, SK, FI and SE.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter31/figure-31-6.xlsx

- **R&I contributed to nearly two thirds of labour productivity growth in Europe from 2010 to 2016**. If the focus is on labour productivity growth, then the contribution of R&I, as defined above, is equal to about 65.7 % of total productivity growth, signalling its key role as productive-enhancing investments even in the aftermath of the crisis. The results are shown in Figure 3.1-7, presenting the same growth-accounting exercise replacing value-added growth with labour productivity growth.

Figure 3.1-7 Contribution to European labour productivity growth – percentage per annum (2010-2016)



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on EU KLEMS 2019 (Analytical Database)

Note: Data covers 19 EU Member States: BE, CZ, DE, DK, EE, ES, FR, IT, LV, LT, LU, HU, NL, AT, RO, SI, SK, FI and SE.

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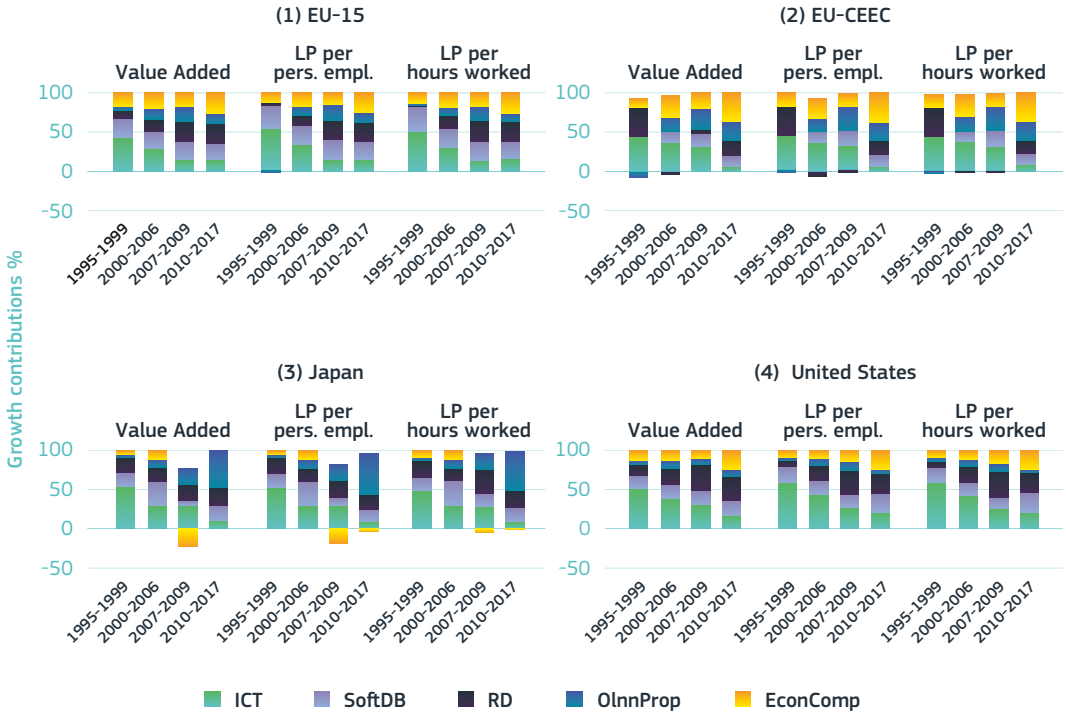
- **The significance of economic competences and intellectual property products has increased in the last two decades**, becoming key intangible assets together with R&D and software and database. While R&D has been and continues to be a relevant factor for economic and productivity growth, economic competences and intellectual property products (including design) have become key drivers of growth across the globe, including in the EU. It is worth noting the decline over time of the contribution of ICT capital (Figure 3.1-8).

- An increase in 10% in R&D investment is associated with gains in productivity between 1.1% and 1.4%, as shown in the meta-analysis by Donselaar and Koopmans (2016)[3].

3 It should be noted that a 10 % increase in R&D investment corresponds to a 0.2 % increase in GDP terms (i.e. R&D investment over GDP). This implies that, assuming no change in the number of hours worked, an increase in R&D investment of 0.2 % of GDP would result in an increase of 1.1 % of GDP, five times larger.

Figure 3.1-8 Contribution of ICT capital and intangible to value added and productivity growth



Science, research and innovation performance of the EU 2020

Source: EU KLEMS 2019

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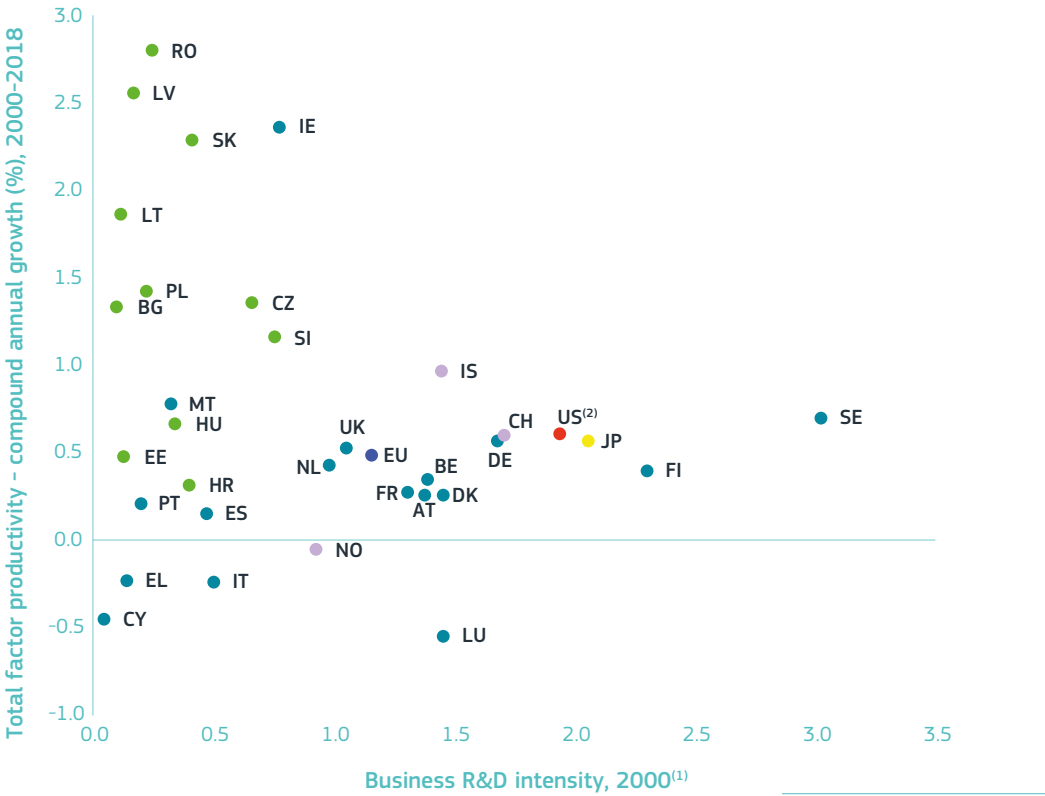
BOX 3.1-3 Total factor productivity and labour productivity

Labour productivity measures the amount of value added produced per work hour and is very often considered to be a good measure of the economy's overall efficiency. Increasing labour productivity can traditionally be associated with the ability to raise the returns to the production factors, notably capital, labour and technology.

Total factor productivity is a measure of the efficiency in the combination of production factors such as labour and capital to generate economic output.

Productivity growth is closely associated with the ability to foster innovation creation and diffusion in high-prosperity countries, but not in lower-performing countries (Figure 3.1-9). There are many factors explaining productivity growth, including well-functioning institutions, better infrastructure and high levels of education. However, and despite the intrinsic difficulties to map the contribution of all these factors, countries with high-income show a strong and positive correlation between TFP growth and business R&D (BERD), as their ability to innovate and technological advancement are main drivers for productivity growth. However, this is not true for lower- and middle-income EU countries where other factors can drive productivity growth, such as improvements in the business environment. In order to avoid a middle-income trap and ensure a long-term virtuous path, central, eastern and south-eastern (CESEE) countries in Europe need to move towards a more innovation-driven model (not just relying on foreign direct investment and technology uptake). The current situation in these countries does not favour the creation of high-skill jobs in the economy and reduces opportunities for high-skilled labour, which is reflected in low unemployment and high job-vacancy rates in the area (Correia et al., 2018).

Figure 3.1-9 Total factor productivity – compound annual growth, 2000-2018 and business R&D intensity, 2000



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Eurostat (online data code: rd_e_gerdtot) and European Commission - DG Economic and Financial Affairs

Notes: (1)SE, NO: 2001; HR, AT: 2002; MT: 2004. (2)US: Business expenditure on R&D (BERD) does not include most or all capital expenditure. (3)Countries in green correspond to CESEE countries.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter31/figure-31-9.xlsx

2. Productivity slowdown: a productivity paradox

Despite the rise in digital technologies over the last decade, promising large productivity gains, productivity growth has been sluggish, holding back more robust economic growth in Europe and other advanced economies. This is referred to as a **productivity paradox** which flags long-term risks for the competitiveness of European economies. The rise in digital technologies and their convergence with the physical world, in what some have called the Fourth Industrial Revolution, is transforming our economies and societies. Automation, big data, the Internet of Things and artificial intelligence are all digital technologies that are coming of age, promising new and more efficient business processes and products, which would bring significant gains in productivity growth in our economy. However, economic growth in Europe, and in other advanced economies, has been held back by very low levels of productivity growth that have remained almost flat for over a decade.

While the slowdown is also true in other major economies, over the last decade, productivity growth in the EU has been particularly poor compared to global competitors (Figure 3.1-10). From 2008-2018, TFP growth in the EU was less than half what it was over the period 1995-2007. While it was also low in other advanced economies, such as the United States and Japan, which only managed growth rates below 1%, the slowdown in productivity growth was particularly acute in the EU. Labour productivity growth rates in the EU also tend to decline over time. While labour productivity per working hour in the EU increased on average by 2.1% (1.9% per worker) per year in the period 1995-2000, in the decade 2000-2010 this fell to 1.2% (0.9%) per year then decelerated further to 1.0% (0.8%) from 2010 to 2018[4]. Box 3.1-4 explores TFP dynamics at the sectoral level for a few Member States.

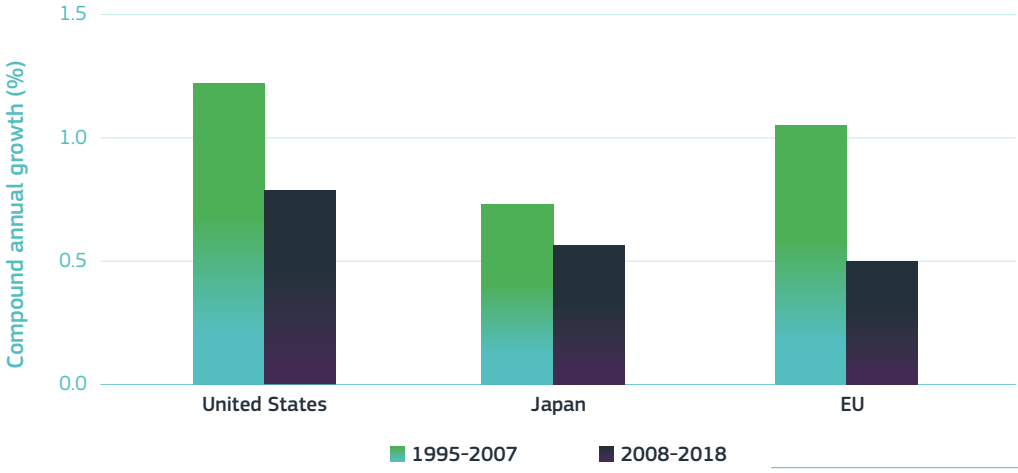
This productivity slowdown is also observed systematically at Member-State level[5] (Figure 3.1-11). Over the last decade, low EU growth was mainly driven by declines in Greece, Luxembourg and other Member States with values close to -1%. On the other hand, Ireland, Slovakia, Latvia and Poland presented the highest TFP growth rates over the last decade.

Compared to the United States, almost all EU countries present lower labour productivity. Only Ireland, Luxembourg, Belgium and Denmark report similar or higher labour productivity. Central and eastern countries show the lowest performances in terms of labour productivity. Overall, the gap in labour productivity growth between the EU and the United States is about 12% (see Figure 3.1-12).

4 Source: DG Regio.

5 Except for Ireland, although productivity growth levels in Ireland should be analysed with caution due to a statistical break following a revision in the calculation of GDP that led to a GDP growth rate of 26% in 2015.

Figure 3.1-10 Total factor productivity – compound annual growth, 1995-2007 and 2008-2018



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit, based on Eurostat and European Commission - DG Economic and Financial Affairs

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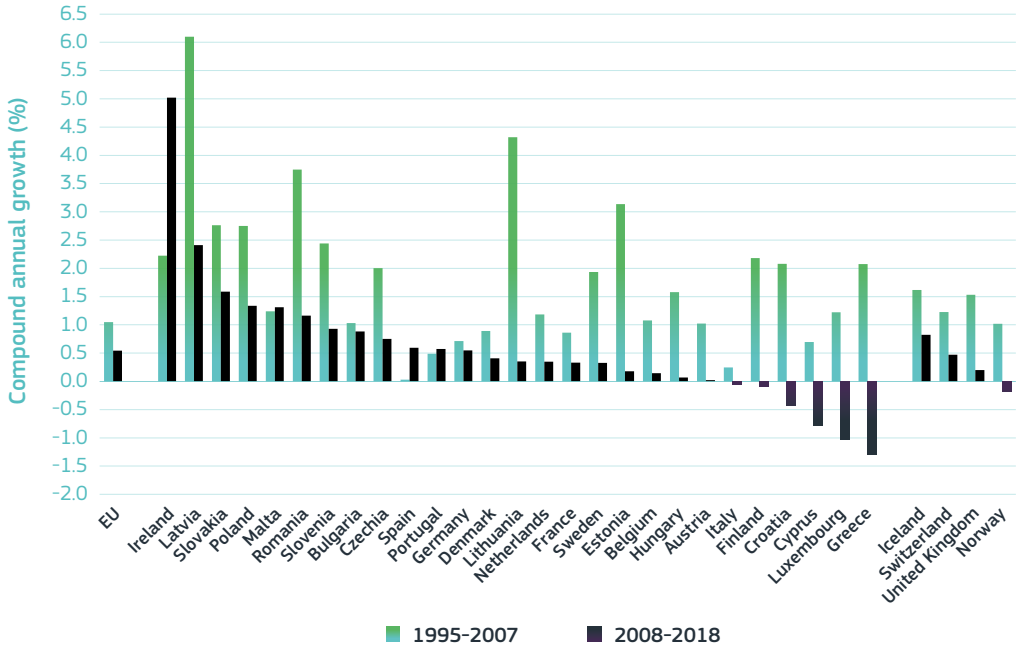
Figure 3.1-11 Total factor productivity – compound annual growth, 1995-2007 and 2008-2018



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Eurostat and European Commission - DG Economic and Financial Affairs

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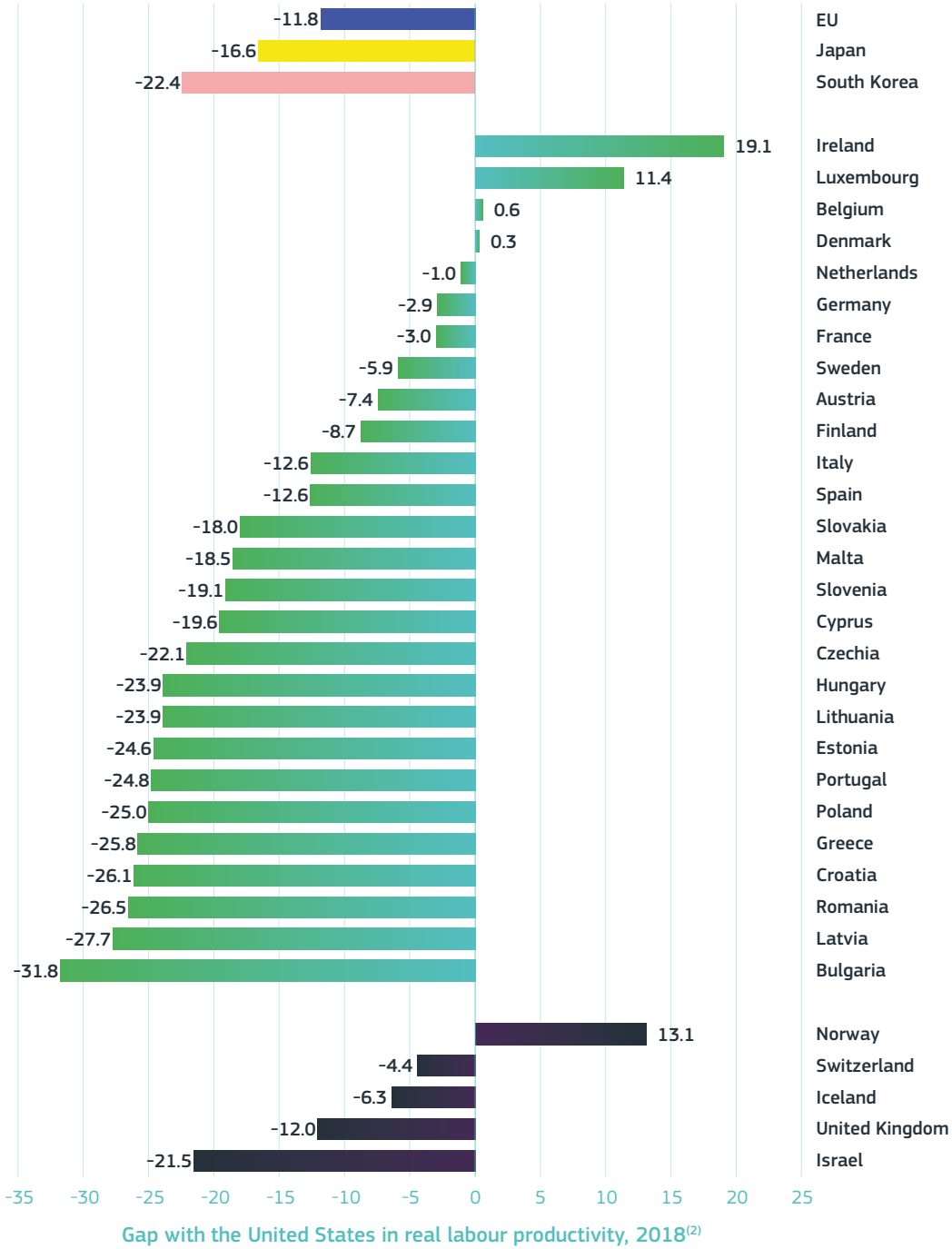
Figure 3.1-12 The gap in real labour productivity (GDP per hour worked[(1)]) between each country and the United States, 2018



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on European Commission - DG Economic and Financial Affairs, OECD

Notes: [(1)]GDP per hour worked in PPS€ at 2010 prices and exchange rates. [(2)]IS, NO, CH, IL, JP, KR: 2017.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter31/figure-31-12.xlsx

BOX 3.1-4 TFP trends at the sectoral level

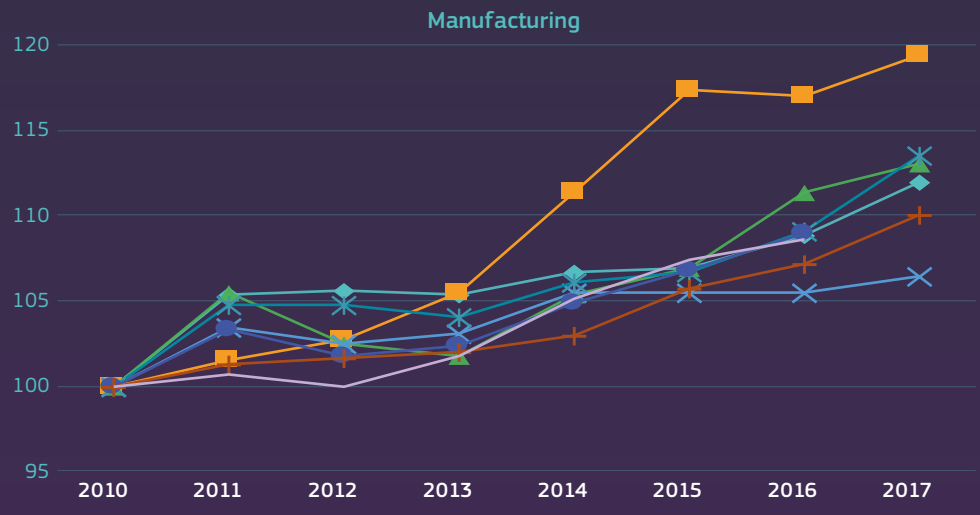
Jeoffrey Malek Mansour - Belgian Science Policy Office (Belspo)

Higher labour productivity can be achieved if more or better capital is used (capital deepening), or if the combined efficiency with which labour and capital are used (i.e. TFP) is improved. As such, TFP is thus a fundamental driver of global productivity and is linked to technological progress in an economy. Figure 3.1-13 shows the evolution of TFP over the post-crisis period (2010-2017) for the EU19[6] and a number of reference countries and across three aggregate sectors: manufacturing, market services[7] and non-market services[8].

It appears that, on average for EU19 countries, TFP has known divergent evolutions across these 3 macro-sectors: while it increased steadily in the manufacturing industries (+9 %), its progression was more moderate in market services (+4 %) and even declined slightly in non-market services (-1 %).

With respect to these averages, individual countries have evolved differently and a variety of trends can be observed. In the manufacturing sector, TFP growth has proved particularly vigorous in Belgium but rather sluggish in France and Italy. Germany, the Netherlands and Austria have remained close to the EU19 average. On the contrary, Germany and the Netherlands have performed particularly well in the market-services sector while France, Belgium and Italy have stagnated and have proved to be the worst-performing economies in our sample. Concerning the non-market-services sector, countries' performance is even more adverse, in particular for Italy and Austria (-2 %), Belgium (-3 %) and more spectacularly Spain (-7 %). Conversely, TFP in Germany, France and the Netherlands has increased by 1 to 1.5 % over the same period in non-market services.

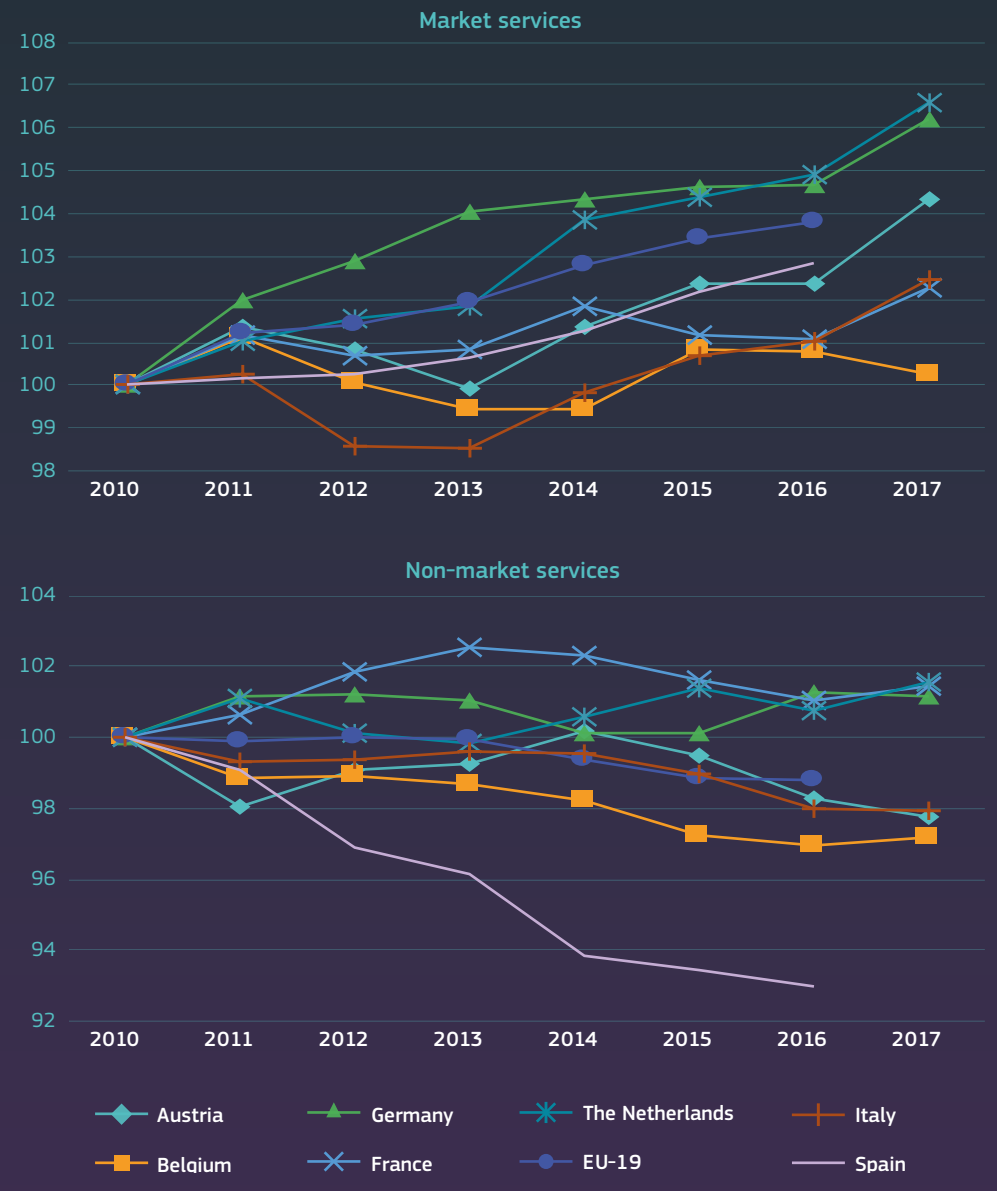
Figure 3.1-13 Total factor productivity by sector and selected EU countries, 2010-2017



6 AT, BE, CZ, DE, DK, EE, ES, FI, FR, HU, IT, LT, LU, LV, NL, RO, SE, SI, SK.

7 Market services are proxied by NACE sectors (sections) G to N: wholesale and retail trade; Transportation and storage; Accommodation and food service activities; Information and communication; Financial and insurance activities; Real estate activities; and Professional, scientific, technical, administrative and support service activities.

8 Non-market services are proxied by NACE sections (sections) O to Q, i.e. public administration, defence, education, human health and social work activities.



Science, research and innovation performance of the EU 2020

Source: Authors' own computations based on EUKLEMS, 2019 release

Note: TFP is set at 100 in 2010.

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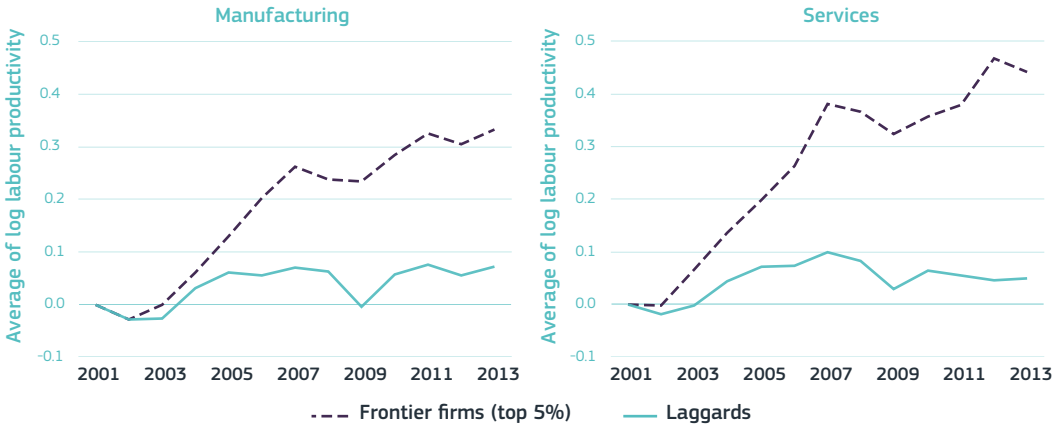
3. A growing productivity gap and a lack innovation diffusion

The productivity paradox points to deep changes in innovation dynamics. These changes relate to the rise of several breakthrough innovations led by **new global technological champions that are creating and shaping entirely new markets**. However, they are also linked to the **slowdown in innovation diffusion**, which is holding back a stronger uptake of innovations across companies, sectors and regions. The convergence of digital technologies with the physical world has enabled the rise of many important breakthrough innovations. At the same time, it has rendered the innovation process more complex as companies need to master different technologies and new business models. This, coupled with the rise in network effects, has led to a slowdown in innovation diffusion across firms, regions and sectors, preventing the benefits of innovation from being disseminated fully across the economy.

This slowdown in innovation diffusion has been observed since the beginning of the 2000s. A small number of leading firms (in particular, platform-economy companies, see Box 3.1-5) have championed strong productivity growth rates, while a 'fat tail' of laggard firms have depicted disappointing productivity growth rates that translate into low aggregate productivity growth. These differences are found across sectors, although there are some intra-sectoral differences, notably with lower overall growth rates in the business service sector. This widening of the productivity gap may explain why a rapid technological change and productivity slowdown can be observed at the same time. This has strong implications not only for productivity growth but also for rising inequality patterns. Wage inequality has increased both within and between firms, suggesting that increasing between-firm inequality does not simply reflect the flow of similar workers into similar firms but that the ones at the top of the wage distribution are seeing even higher rewards (OECD, 2019).

Figure 3.1-14 Labour productivity gap between global frontier firms and other firms, 2001-2013



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Source: Andrews et al. (2016)

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter31/figure-31-14.xlsx

BOX 3.1-5 The rise of platform-economy companies

In the past two decades or so, digital technologies have enabled some of the most impressive breakthrough innovations in our economy, which have revolutionised entire industries and markets. The rise of the so-called platform-economy companies, such as Alphabet, Facebook, Amazon, Alibaba, Uber or Netflix, has deeply transformed how we search for things, communicate with each other, buy products, move within cities or consume entertainment. Many of these firms have been able to grow at an unprecedented pace to become global economic behemoths by market capitalisation, transforming entire industries and markets. At the same time, these companies do not seem to improve the quality of employment as they tend to offer less-stable contracts and fewer prospectives for career development (EPSC, 2019).

One sign of this lack of innovation diffusion is the increasing industry concentration (see also Chapter 2 - Changing innovation dynamics in the age of digital transformation). This is one development that indicates that technological change or globalisation is enabling the most productive firms to expand (Autor et al., 2017), although it has recently also raised questions about the lack of competition and the formation of quasi monopolies. Evidence shows that, between 2000 and 2014, three quarters of European industries saw a **concentration increase in market performance** in the order of 4 percentage points for the average European industry (Bajgar et al., 2019).

In parallel, as a result of persisting rigidities that affect the well-functioning of the markets, 'zombie' firms[9] **continue to 'capture' capital and labour resources** that could otherwise be redirected towards innovative, more productive activities, thereby hindering Europe's innovation performance (see also Chapter 3.3 - Business Dynamics and its contribution to structural change and productivity growth). The misallocation of resources, including credit, barriers to entry and inefficient product and labour markets ease the survival of less-productive firms which would otherwise have exited the market. Consequently, the economy is characterised by a wider distribution of productivity among firms, with a larger gap between the laggards and the most-productive companies. This also means that a more efficient allocation of resources across companies, allowing less productive firms to exit and productive firms to grow, would enable significant growth.

Inequalities between firms are also driven by sectoral dynamics, with the uptake of digital technologies over the past two decades varying significantly across different sectors of the economy. Some sectors have benefited more from the uptake of advanced digital technologies and have adapted their products, services and business models accordingly. On the other hand, other sectors seem to have lagged behind. These disparities could be broadened with the rising applications of artificial intelligence. Promising developments in artificial intelligence can go far beyond labour

9 Zombie firms are defined as those companies with a low ratio of operating income to interest expenses (less than one third for three consecutive years in McGowan et al., 2017), suggesting that they do not make enough profit to pay debt obligations on bank loans.

BOX 3.1-6 Chapter 10 – The bottom also matters: policies for productivity catch-up in the digital economy

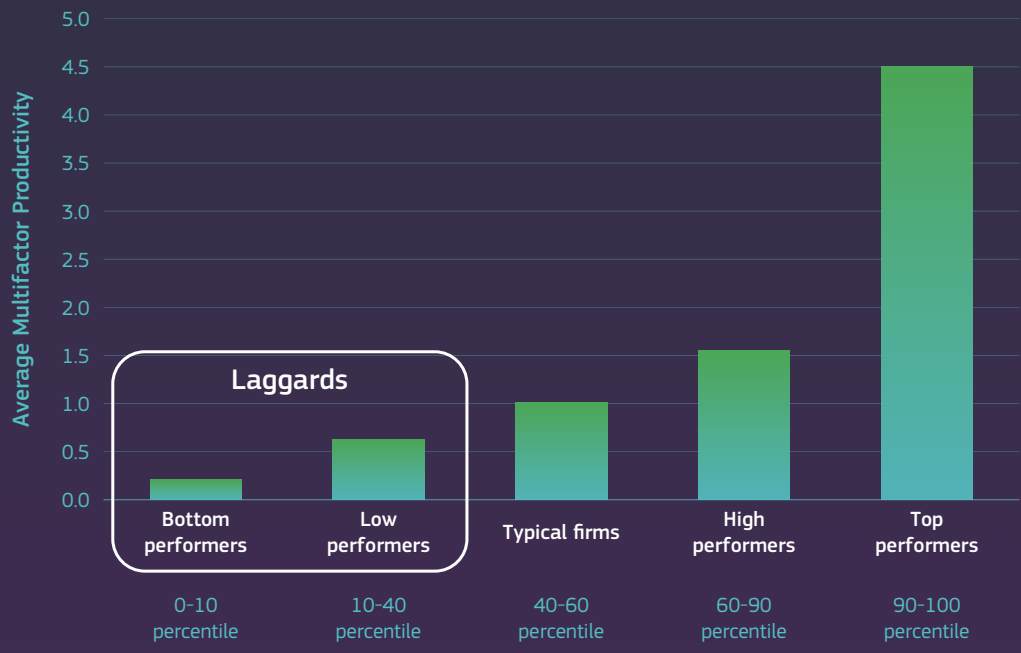
This chapter provides an overview of recent and ongoing analysis of these issues and discusses **policies that affect the catch-up of laggards in the context of digital transformation**.

First, the chapter introduces **productivity divergence** in the context of the global phenomenon linked to digital transformation and the knowledge economy. Then, it examines **trends in productivity divergence and business dynamism**, respectively, with a **focus on the bottom of the productivity distribution**. Beyond common trends, a few examples highlight **cross-country and cross-sector heterogeneity**. The descriptive sections conclude with company and sector characteristics and discussions about the possible explanations behind the documented trends at the bottom, including the role of openness.

The final analytical section provides a framework and summarises the main results of the analysis on the **role of policies on the speed of laggards catching up**.

Read more in Chapter 10.

Figure 3.1-15 Average productivity by performance group relative to the 'typical firms' group multifactor productivity



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Source: Authors' own computations based on the EIB Investment Survey (EIBIS waves 2016 to 2018)

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter31/figure-31-15.xlsx

automation with impacts on business models and innovation activity. The differences observed between firms with strong digital capability and a well-designed AI adoption strategy could reinforce the differences in uptake, enabling these companies to raise profit margins or increase the efficiency of their R&D operations. Overcoming that gap requires, among others, policies to improve the conditions to speed up knowledge creation and diffusion via more investments in intangible assets and skills, and innovation-friendly regulation that supports transformative technological change across sectors.

Ensuring the EU's competitiveness and prosperity will require a boost in productivity. The gap in productivity performance between highly productive firms at the frontier and the rest points to a clear lack of innovation diffusion in Europe. As Member States approach higher levels of prosperity, the adoption of an innovation-based model is crucial to avoid the middle-income trap that this lack of diffusion can exacerbate, especially for Member States in the CESEE. Overcoming that gap requires policies to improve the conditions to speed up knowledge creation and diffusion via increased investments in intangible assets and skills, innovation-friendly regulation that supports transformative technological change across sectors, stronger science-business links, adequate conditions for the creation, scaleup and orderly exit of firms, access to risk capital, and efforts to raise the capacity and quality of national research and innovation systems.

4. Conclusions

R&I are key engines for Europe's productivity growth, driving long-term competitiveness and economic performance. Innovative investments make the production process more efficient and improve produced goods and services. Provided supportive framework conditions are in place, innovative companies can flourish and the process of creative destruction will make room for new entrants with better products, displacing existing inefficient and less-innovative companies.

After the last economic crisis, from 2010 to 2016, nearly two thirds of labour productivity growth in Europe derived from R&I, broadly defined. The contribution of different intangible investments has changed over time, reflecting the evolving innovation dynamics, including the increasing role of digitisation and AI and the rise of global technological champions creating and shaping entire markets. In particular, economic competences and intellectual property products have emerged as key intangible assets, together with R&D, software and databases.

In this context, the increasing concentration of R&I activities highlights the need to foster the diffusion of innovation creation and its uptake in order to spread the benefits across countries, regions and companies. This is particularly important for economies in the southern periphery of the EU, which have been unable to keep pace with the innovation leaders, and for the CESEE countries in order to ensure a continued (and sustainable) growth model in the long term. Innovation diffusion and knowledge absorption are also crucial to close the gap between a few leading top companies and the rest.

Productivity growth can and needs to drive the sustainability transition. As productivity growth entails more (equal) output with the same (fewer) resources, such an improvement in the efficiency of production systems is necessary to reduce the impact of production on the planetary boundaries. Similarly, innovation diffusion and its uptake can ensure that the benefits of productivity growth are widespread across companies, sectors and places, contributing to meeting the social dimension of the sustainability transition.

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