Chapter 1

The Productivity Paradox

Why has aggregate productivity growth slowed across OECD countries and emerging economies over recent years? What was the relative importance of structural and cyclical factors in driving this trend? This chapter sets out to answer these questions by examining the evolution of the great productivity slowdown that has taken place in OECD countries since the turn of the millennium, and subsequently spread to prominent emerging markets. It highlights the paradox of slowing aggregate productivity at a time of fast technological change before going on to consider possible causes of this phenomenon. In particular, it looks in greater depth at the role played by the divergence in productivity performance between global frontier firms and poorer-performing non-frontier firms, and at the pronounced discrepancies between the productivity growth rates of different regions. The chapter suggests that structural policy settings limiting competition may have been an important contributor to the trends described.

Recent decades have seen a persistent and worrying slowdown in productivity growth. Productivity gains, which are a central driver of long-term improvements in living standards, have slowed in many advanced economies over recent decades. More recently, this slowdown has extended to emerging economies. This *slower* productivity growth is fuelling concerns of persistently low global growth with population ageing in several economies leaving productivity and investment as the main potential sources of income growth in the decades to come. The on-going debate on the future of productivity often pits a pessimistic view against a more optimistic view.

The pessimistic view holds that the recent slowdown is a permanent phenomenon. According to this perspective, the types of innovations that took place in the first half of the 20th century (e.g. electrification etc.) are far more significant than anything that has taken place since then (e.g. ICT), or indeed, likely to transpire in the future (Gordon, 2012; Cowen, 2011). These arguments are bolstered by evidence of the slowdown in business dynamism observed in frontier economies such as the United States. Gordon (2012) also argues that there are a number of strong headwinds on the horizon that will cause productivity growth in the US to slow further, including ageing populations, a deterioration of education, growing inequality, globalisation, sustainability, and the overhang of consumer and government debt.

Conversely, technological optimists argue that the underlying rate of technological progress has not slowed and that the IT revolution will continue to dramatically transform frontier economies. According to Brynjolfsson and McAfee (2011), the increasing digitalisation of economic activities has unleashed four main innovative trends: i) improved real-time measurement of business activities; ii) faster and cheaper business experimentation; iii) more widespread and easier sharing of ideas; and iv) the ability to replicate innovations with greater speed and fidelity (scaling-up). While each of these trends is important in isolation, their impacts are amplified when applied in unison.

Drawing on recent OECD analysis of productivity trends this chapter shows that:

- The slowdown in productivity growth reflects a mix of cyclical and structural factors, which have – thus far – prevented rapid technological change from propelling aggregate productivity growth as it has done in the past. One factor has been persistently weak investment in physical capital (machines and equipment, physical infrastructure). In most advanced countries, the recovery in non-residential investment is lagging behind that of GDP, and this is particularly the case among European countries (OECD, 2016).

- Behind the slowdown in aggregate productivity growth, there has been a growing dispersion of productivity performance within countries between firms and regions, with some of them enjoying fast productivity gains enabled by rapid technological progress, and others lagging behind. In other words, while the productivity frontier keeps advancing, these gains have not diffused throughout the rest of the economy.

- Boosting productivity growth will require policy actions to address the obstacles to knowledge and technology diffusion, while continuing to support technological progress and innovation at the frontier.

This chapter is organised as follows. It first reviews the aggregate productivity trends in advanced and emerging economies and highlights the paradox of slowing aggregate productivity at a time of fast technological change (Section 1). It then reviews the role played by the divergence in productivity performance between firms (Section 2) and between regions (Section 3).

1.1 Trends in aggregate labour productivity

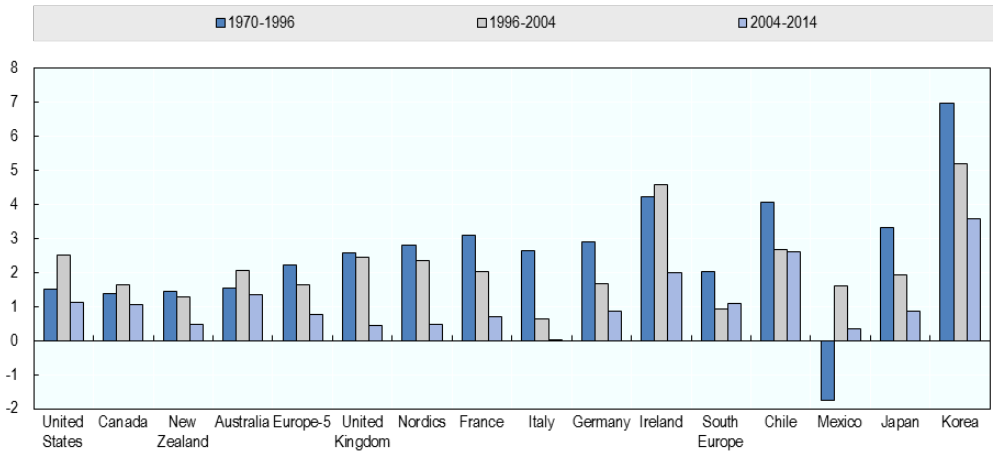
Productivity is about "working smarter", rather than "working harder". It reflects firms' ability to produce more output by better combining inputs, a process that is made possible by new ideas, technological innovations, as well as process and organisational innovations, such as new business models. Labour productivity is defined here as GDP per hour worked, which can be decomposed into the contributions of capital deepening (i.e. higher capital per unit of labour) and a residual, total factor productivity (TFP).

1.1.1 Productivity gains have been decelerating over recent decades in most advanced economies.

Until the mid-1990s aggregate labour productivity growth in advanced economies was driven by convergence towards the productivity frontier. Those economies whose productivity levels started furthest behind the US saw relatively faster productivity growth (Figure 1.1). While for some economies, this phenomenon partly reflected the rebuilding of war-ravaged capital stocks, it was also the result of technology and knowledge spill-overs from the global productivity frontier, which facilitated the adoption of more advanced technologies and better practices (Aghion and Howitt, 2006).

Figure 1.1. Labour productivity performance in advanced economies had been converging with that of the US until the mid-1990s.

GDP per hour worked; annual average growth

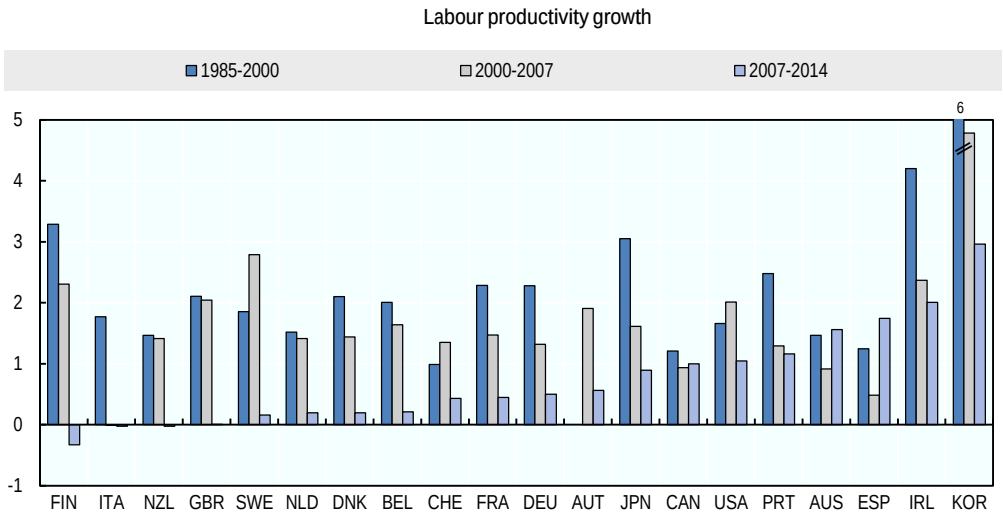


Notes: Europe-5 includes Austria, Belgium, Luxembourg, the Netherlands and Switzerland; Nordics includes: Denmark, Finland, Iceland, Norway and Sweden; Southern Europe includes Greece, Portugal and Spain. For 1970-96, Europe-5 excludes Austria.

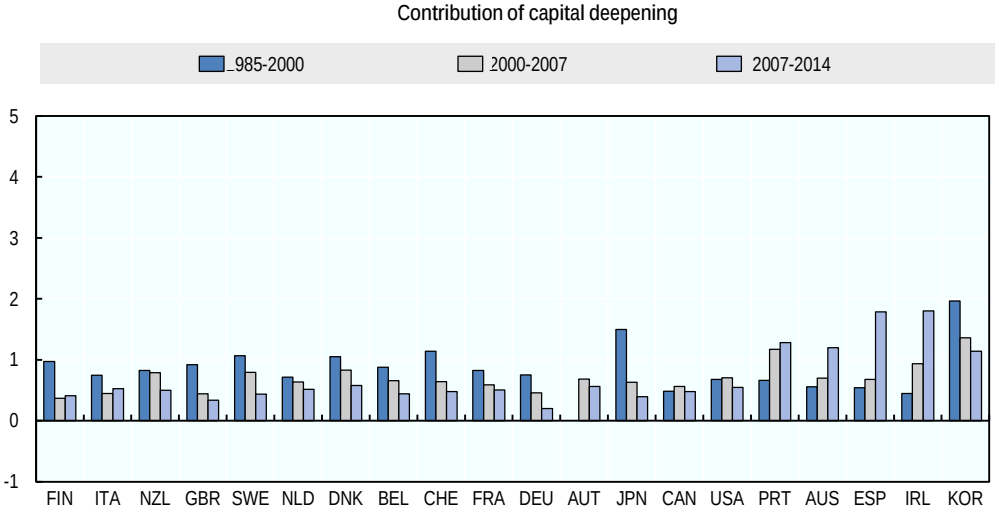
Source: OECD Productivity database, January 2016.

Yet the convergence process faded in the mid-1990s, and aggregate labour productivity growth slowed in many OECD countries. While properly measuring productivity and assessing its trends has always been a challenge – and is even more so today, due to the changing nature of many economic activities (**Box 1.1**) - there are clear signs of a slowdown. From the mid-1990s, many countries, particularly in Europe, did not keep pace with the acceleration of productivity growth associated with rapid diffusion in ICT in the United States, and gaps in productivity levels between the US and other advanced economies started to widen again. However, from 2004 the benefits from the ICT revolution on labour productivity began to wane in the US too. Many OECD countries experienced a slowdown in labour productivity growth between 2000 and 2007 (see **Figure 1.2, Panel A**). This slowdown mainly reflected slowing total-factor productivity (TFP) growth (**Figure 1.2, Panel C**).

Figure 1.2. From the early 2000s labour productivity growth was hit by a weakened contribution from TFP and by a fall in the contribution from capital deepening

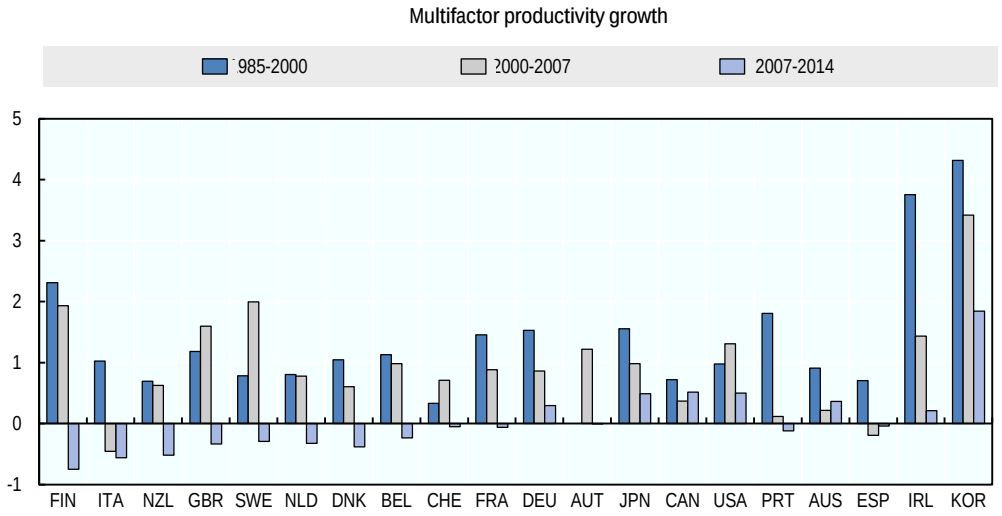


Notes: Data for 1985-2000 for Switzerland correspond to 1992-2000; Data for 2007-2014 for Australia,



Ireland, Japan, Portugal, Spain and Switzerland correspond to 2007-2013.

Source: OECD Productivity Database, March 2016.



Since the crisis, a further slowdown in labour productivity growth in the OECD was driven by a decline in the contribution of capital per worker. In the aftermath of the great recession that followed the 2007-08 global financial crisis, labour productivity has been curbed by a stark weakness in capital deepening (Figure 1.2, Panel B). The recovery in investment since 2009 has been sluggish compared with previous cycles (OECD 2015a). In 2014, for 40% of OECD countries, the estimated contribution of capital per worker to trend labour productivity growth was less than ¼ per cent per annum, while this was true for only two OECD countries in 2000 and 2007. Moreover, the under-investment in assets with high spill-over effects, such as physical and digital infrastructure and network sectors, has been particularly damaging for productivity performance. This post-crisis weakness in investment reflects both structural and cyclical factors, including weak aggregate demand, which affected capital accumulation through the typical accelerator mechanism. Weak product market competition, impaired financial systems, and elevated levels of uncertainty also played a role. Consequently, more balanced and robust global demand, improved market conditions, and reduced uncertainty are key to propelling investment to a higher growth rate. Another possible explanation for the decline in the contribution of capital per worker to trend labour productivity growth is growing business investment in knowledge-based capital, which was more resilient than tangible capital during and following the crisis, but which cannot contribute much to productivity performance in a context of weak demand.

Box 1.1. The challenge of accurately measuring productivity

There are a number of difficulties in accurately measuring productivity, calling for a careful interpretation of available measures and international comparisons. These difficulties concern both the measurement of the factors of production, labour and capital, and the measurement of output. They have been exacerbated by ongoing changes in the labour market, rapid technological change and digitalisation.

Labour

The volume of labour input should reflect the time, effort and skills (quality) of the workforce employed in the production process. This volume should in theory be measured as the total number of hours effectively worked. This requires going beyond simple head-counts of employed people, to adjust for differences in the relative shares of part and full-time employment --which have changed substantially in recent years-- and changes in hours worked, accounting for example for vacation time, holidays or paternal leave. The effective quantity of labour also depends on the characteristics (notably skills) of those performing the work, which are difficult to measure. Existing measures of labour characteristics usually rely on the identification of workers' industry of employment, occupation, educational attainment, age, etc., weighting these characteristics with the average labour compensation shares attributable to each type of workers.[a] Some countries also face issues with the measurement of the hours of foreign workers. Another recurring challenge is measuring productivity at the sub-national level. For instance, price indices are typically only available for the entire economy and regional GDP is sometimes difficult to delineate. More subtle questions regarding labour measurement include the treatment of the (often increasing) commuting time to work (i.e. whether this time should be counted as labour input) and of the time workers with zero hour contracts may be spending on stand-by.

Capital

Comprehensive productivity estimates require **exhaustive coverage of capital assets** (including the capital services provided by natural, non-produced assets). Broad coverage, however, remains elusive. This is partly by design, as the System of National Accounts (SNA) only recognises as capital certain categories of assets. In particular, standard measures of multifactor productivity growth often ignore the contribution of the depletion or use of **natural resources**, such as subsoil mineral assets (e.g. oil, gas, copper, lead), land and soils, freshwater, wild fisheries and natural forests, while the income generated by these assets is captured in GDP. Increased productivity can therefore sometimes reflect higher natural resource use.

While the SNA recognises a number of **intellectual property assets** (research and development expenditures, software and databases, mineral exploration costs, and artistic and literary originals) as capital, other knowledge-based items such as organisational capital, brand equity, training, or design are not included in the SNA, mostly because of the practical difficulties involved in measuring them in a comparable and meaningful way across countries. New international measurement guidance (for instance OECD, 2010) has greatly improved international comparability, but scope for further improvement remains, noticeably in measuring price changes[b] (capturing changes in quality is a challenge because of the often unique nature of the assets, as well as the difficulty is determining depreciation rates for different categories of assets). Another challenge is measuring productivity for **multinational**

enterprises (MNEs), as the benefits from their assets — especially organisational capital, design, brand — can accrue to any or all of the affiliates, while the methods used to estimate their value typically allocate it to the country where the asset creation occurred (such as R&D departments in headquarters); from a standpoint of measuring productivity, capital services should be measured where they enter the production process. The potential disconnect between capital on one side and recorded output and value-added on the other carries even greater weight in the light of tax optimisation by MNEs as profits are shifted between jurisdictions without any recorded transfer or shifting of the assets, such as brands, R&D etc., generating that production.

Output

Any mis-measurement of output has direct consequences on measures of productivity. This is particularly true in the area of services where good price indices that can capture qualitative changes are often elusive.[c] The lack of information on market prices and the difficulties of measuring the volume of **health, education and public administration services** constitute another important challenge for productivity measurement. In some countries, the volume of these services is estimated on the basis of inputs, meaning that output and input volumes are not independent and implying zero productivity growth. While progress has been made in the development of output-based measures for health and education services (Schreyer, 2010), implementing the same approach for other activities of the general administration (e.g. security) remains a challenge for conceptual and empirical reasons.

More generally measuring how the public sector contributes to overall productivity is particularly complex. On the one hand, the National Accounts do not capture the full range of inputs and outputs necessary to measure appropriately the efficiency of government operations. On the other, it is difficult to assess empirically the direct and indirect effects of government interventions on broader outcomes, such as the education and health status of the population, which are the ultimate objectives of policy.

Moreover, output measures could be enhanced by correcting GDP for undesirable output (i.e. emissions) (see Brandt, Schreyer and Zipperer, 2014). While the costs of investment in pollution abatement are fully captured in traditional measures of productivity growth (in terms of factor inputs including labour and produced capital), the benefits of such investments are not taken into account, as pollution is not considered an output of the production process. In a number of cases, **accounting for environment-related outputs** can lead to an *upward* adjustment of measured productivity when undesirable outputs grow less quickly (or decline faster) than desirable outputs.

Some implications of digitalisation and the collaborative or 'sharing' economy

One area of considerable debate in recent years has been the **digital revolution and the collaborative or 'sharing' economy along with new business models**, with new players such as AirBnB and Uber. It has been argued that these business models, enabled through digital platforms ('business to consumer', B2C; and peer to peer (P2P)) call into question traditional productivity measures by ignoring production and transactions among households. However, apart from cases where new P2P models create opportunities for tax evasion (and so under-declaration of output and employment), it is unlikely that these new models necessarily cause new significant systemic measurement problems. P2P transactions, some of which resemble

bartering transactions (e.g. house swapping), may have a disruptive impact on economic activity (e.g. on the hotel sector), with a potential impact on the output recorded in the national accounts as the P2P activity is not picked up; but this effect is tempered by the fact that the accounts already include an estimate of output for dwelling services where owners occupy their own dwellings. Moreover, for productivity estimates, any lack of recorded output may be further tempered by the likelihood that under-declarations of recorded income may also be matched by under-declarations of recorded labour input.

Where new forms of activity do raise philosophical questions is with the accounting framework itself. Business models like Cashierless tills are dependent on greater participation (labour input) on the part of the consumer, but the consumer's activity here remains outside of the GDP production boundary. This implies at least a partial shifting of a service activity to the final consumer, in many cases for the ultimate benefit of the same consumer. These changes increase measured productivity in the business sector but do not necessarily constitute welfare-enhancing innovations from a societal perspective, although consumers may benefit from greater choice. The digitalisation of the economy has brought with it the provision of free services such as internet search capacity or contents available for free. Some authors[d] have argued that this increases consumer welfare so that GDP, where such welfare gains are not reflected, may have to be adjusted accordingly. However, GDP is not designed as a measure of consumer welfare, but as a measure of production and, rather than changing its nature, the emergence of free products calls for complementing GDP with appropriate measures of welfare and well-being.

[a] See Jorgenson et al 1987, BLS 1993, Schwerdt et al 2007, O'Mahony et al 2009 as well recent measures of labour quality by Australia, Canada, New Zealand, United Kingdom, United States.

[b] See for example 'Changes to National Accounts for Blue Book 2015: the deflation of investment in software' UK Office for National Statistics.

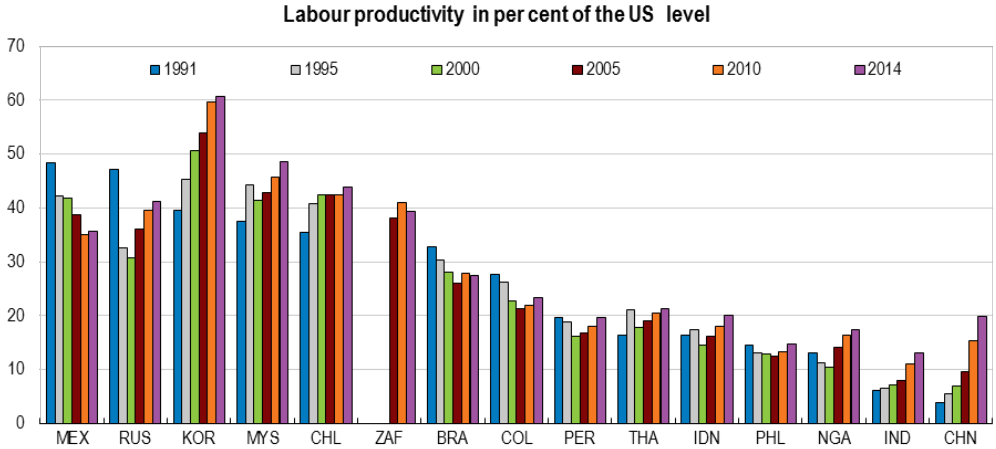
[c] Significant efforts are however being made to improve this situation, for instance Eurostat and OECD (2014).

[d] Brynjolfsson and McAfee (2014); *The Second Machine Age*, New York

1.1.2 Emerging and developing countries have not caught up with their OECD counterparts fast enough and are now also experiencing a slowdown in productivity.

Despite some catch-up, labour productivity levels in emerging and developing countries continue to be well below those in advanced countries. There has been some convergence in the level of labour productivity in emerging and developing economies. However this convergence has often been slower than expected and the gap with advanced economies remains large due to the comparatively very low starting points. For instance, labour productivity in China, India, and Indonesia has at least doubled between 1990 and 2015. However, labour productivity levels in China and Indonesia remained five times lower than in the United States in 2014, while in India they remained eight times lower (Figure 1.3).

Figure 1.3. In many emerging economies, the productivity catch-up vis-à-vis the United States has been limited over the past 25 years

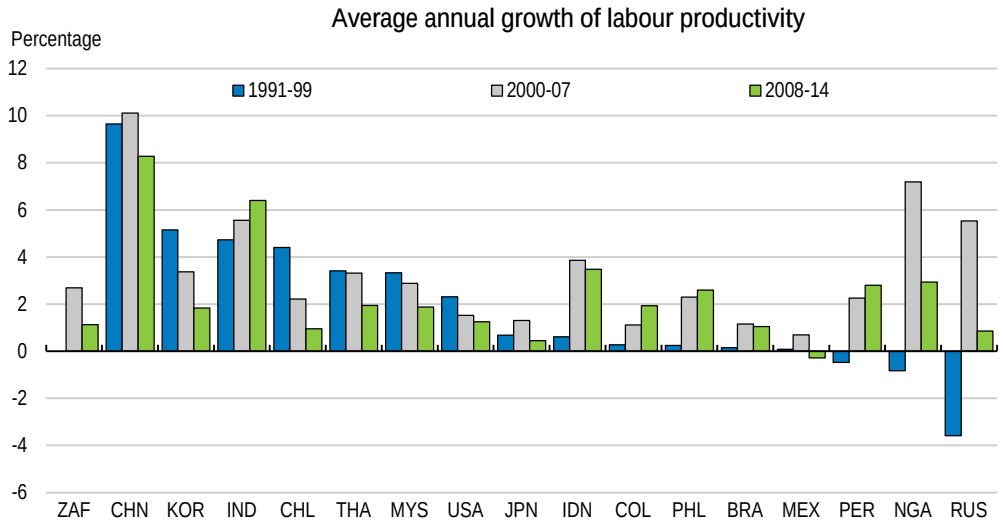


Notes: Labour productivity levels is defined as GDP per person employed, based on 2010 PPPs.

Source: OECD calculations based on World Bank and ILO KILM data

Moreover since the crisis, emerging countries have experienced a slowdown in total factor productivity. Recent data shows that many developing economies have recently experienced slower labour productivity growth when compared to the 2000s. In contrast with advanced economies, the slowdown largely reflects slower TFP rather than weaker capital deepening (e.g. China, Malaysia, and Thailand). In some emerging and developing countries, productivity growth has even turned negative (e.g. Mexico, Chile, Viet Nam and Peru). In these countries too this slowdown reflects both cyclical factors, including the end of the commodity boom, and structural factors (**Figure 1.4**).

Figure 1.4. Labour productivity growth has slowed in many emerging market economies since the crisis



Source: OECD calculations based on World Bank and ILO KILM data.

1.1.3 The full effects of rapid technological change have yet to filter into labour productivity growth.

There is a paradoxical element to the aggregate labour productivity growth slowdown. This slowdown has been taking place against a background of ongoing technological change. Historically, periods of rapid technological change have often provided fresh impetus to productivity growth - albeit with several years, even decades, of delay - e.g. the steam engine and electrification or, more recently, the digital technologies that affected productivity growth in a range on ICT-using industries in the 1990s.

This suggests that the full effects of rapid technological progress may not yet be visible in aggregate productivity measures. From the late 1950s, when "information technology" was first established as a proper category in the US national accounts, to the mid-2000s, relentless progress in micro-chips, processing power and software algorithms has allowed for computer power to double no less than 32 times (i.e. a doubling every 18 months or so, "Moore's Law"). This has contributed to a very rapid fall in the price of computer technologies, making them cheap and increasingly applicable throughout all sectors of the economy. The resulting digitalisation of the economy has not only led to the development of new goods and

services but also unleashed several new innovative trends.. Yet, despite all these effects, labour productivity growth has slowed down. This implies that either these favourable effects have not yet fully materialised and are therefore likely still to come, or that they are being off-set by countervailing forces elsewhere. So, there may be another story - that the aggregate productivity measures mask important divergences between frontier innovators and other firms.

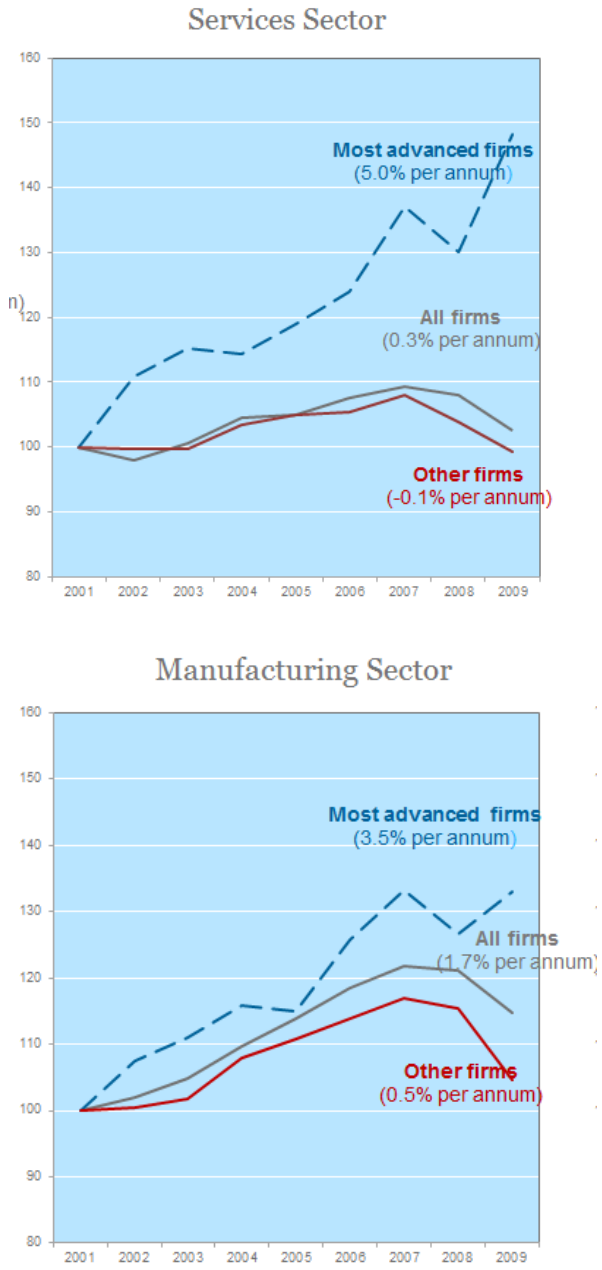
1.2 A breakdown of the diffusion machine

1.2.1 Increased between-firm divergence in productivity performance is a factor behind the paradox of slow aggregate labour productivity growth occurring concurrently with fast technological improvement.

Behind the aggregate slowdown of productivity performance since the early 2000s, there has been a marked divergence between the productivity performance of global frontier firms and others. Productivity growth of the global frontier firms - a category comprised of firms from different countries, reflecting varying patterns of comparative advantage and natural endowments (Andrews, Criscuolo and Gal, 2015) - remained robust, at an average annual rate of 3.5% in the manufacturing sector over 2000s, while it slowed sharply in non-frontier firms, which registered only 0.5% productivity growth over the same period (**Figure 1.5**).[1] This gap in productivity performance was even more pronounced in market services, where the labour productivity of frontier firms grew at an annual rate of 5%, but remained flat for other firms.

[1] Figure 1.5 is based on firm-level data available only from the late 1990s. While it is possible that the divergence started earlier than shown on the figure, it cannot be verified from these data.

Figure 1.5. Marked between-firm divergence has been observed from the early 2000s



Labour productivity; index 2001=100

Notes: "Frontier firms" corresponds to the 100 globally most productive firms in each 2-digit sector. "Non-frontier firms" is the average of all other firms. "All firms" is the sector total. The average annual growth rate of average labour productivity (value added per worker) is shown in parentheses. The broad patterns depicted in this figure are robust to: *i*) using different measures of productivity (e.g. TFP based on the Solow residual from a value added production function containing tangible capital and employment, using uniform factor shares across countries and over time for comparability); *ii*) following a fixed group of frontier firms over time; and *iii*) excluding firms that are part of a multi-national group (i.e. headquarters or subsidiaries) where profit shifting activity may be relevant.

Source: Andrews, Criscuolo and Gal (2015).

Emerging evidence from official micro data – that covers a longer period for some countries – also points to a divergence in productivity growth across different firms in the productivity distribution within countries (Figure 1.6). This data – currently available for twelve OECD countries – shows that in recent years the productivity gap between the "national frontier"[2] and the worst performing firms[3] has increased in the manufacturing sectors of a number of countries such as Austria, Belgium, Canada, Denmark, Japan, Norway and Sweden. In most countries, the gap increased significantly at the beginning of the 2000s, and in some it further increased during the crisis. Aside from the case of Finland and Italy, there has not been a consistent catch-up by the worst performing firms with the national frontier throughout the period. In some countries, the worst performing firms have caught up with the "median firm" (i.e. in the manufacturing sector in Canada), while in others the catch up was interrupted by the financial crisis (e.g. Chile and France). For the services sector, the results are broadly similar, although for several countries such as Canada, Chile, France, Italy, Japan and Sweden, the divergence has grown larger in services than in manufacturing.

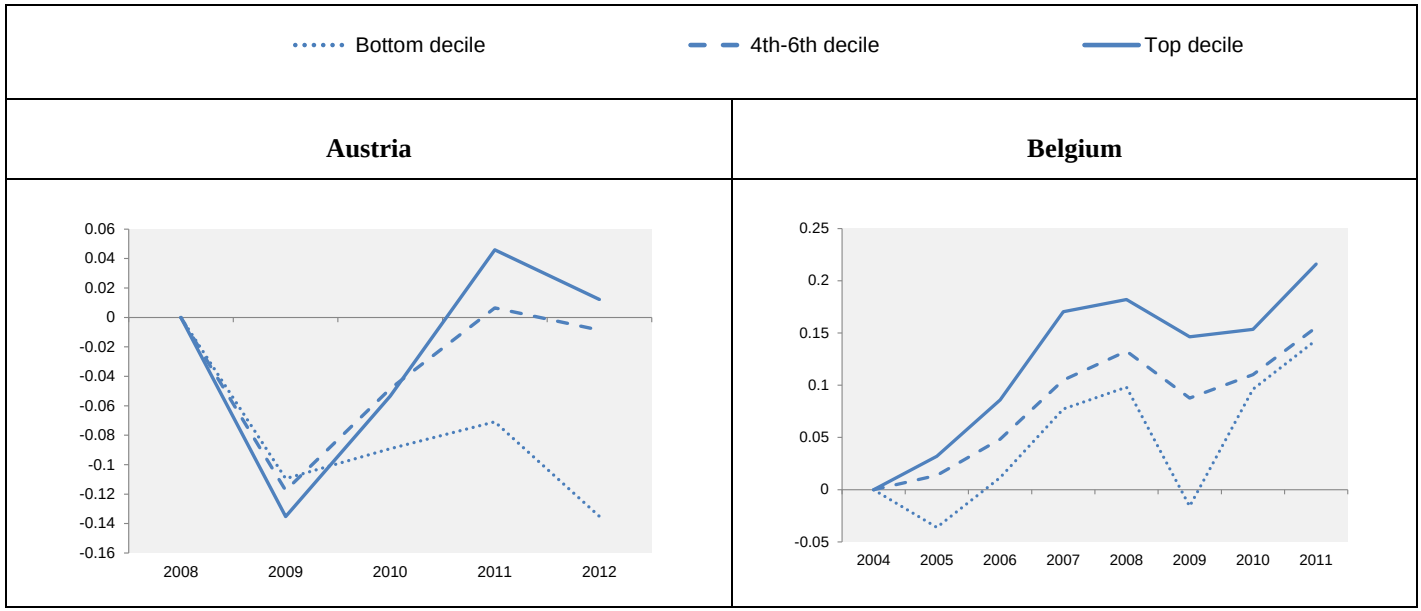
Despite the prevalence of similar trends, it is important to note that the sources of the productivity divergence differ across countries. In Canada, the divergence is mainly driven by the take-off of the productivity frontier at the beginning of the 2000s. In contrast, in manufacturing and services in Denmark, and in Swedish services divergence is not so much a question of productivity at the frontier "taking off", but rather of laggard firms decoupling from the rest of the distribution. In most cases divergence comes from a combination of the two: take-off at the top and the worsening of performance at the bottom. This was the case for manufacturing in Japan, Norway and Sweden and for services in France and Japan.

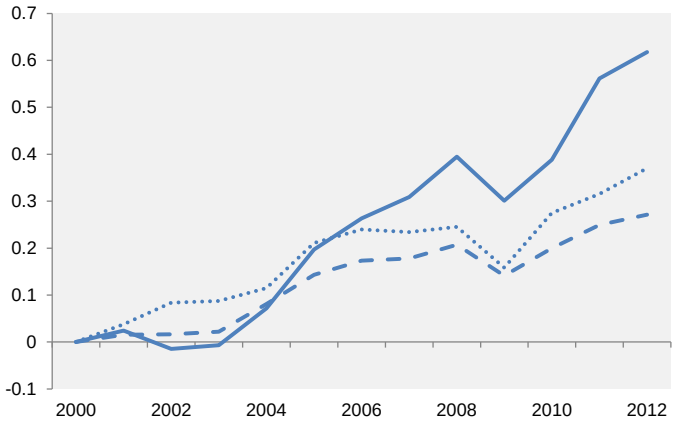
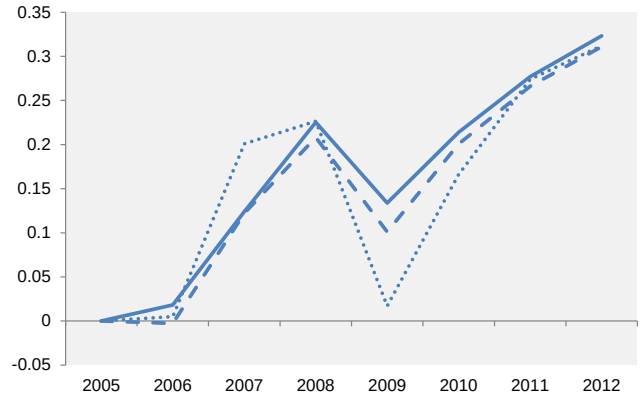
2 i.e. the best performing firms in the country defined as the top 10% in terms of labour productivity.

3 i.e. the bottom 10%.

Figure 1.6. Increasing divergence in Labour Productivity Performance in many OECD countries

A. Manufacturing



Canada	Chile
	

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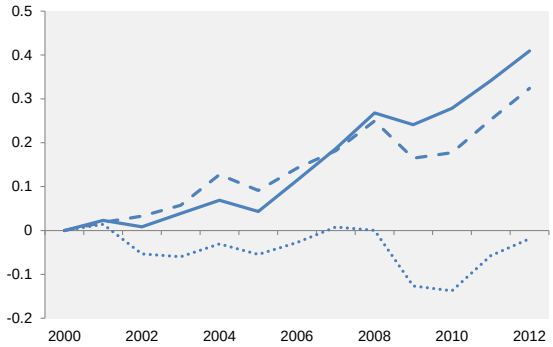
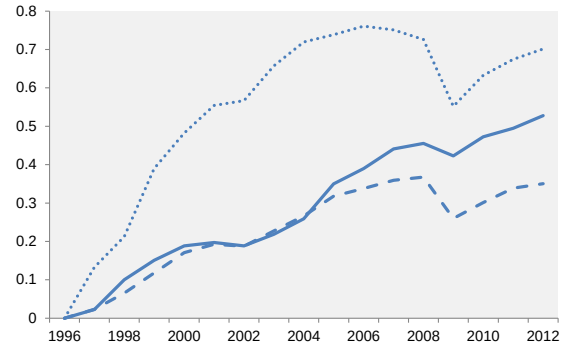
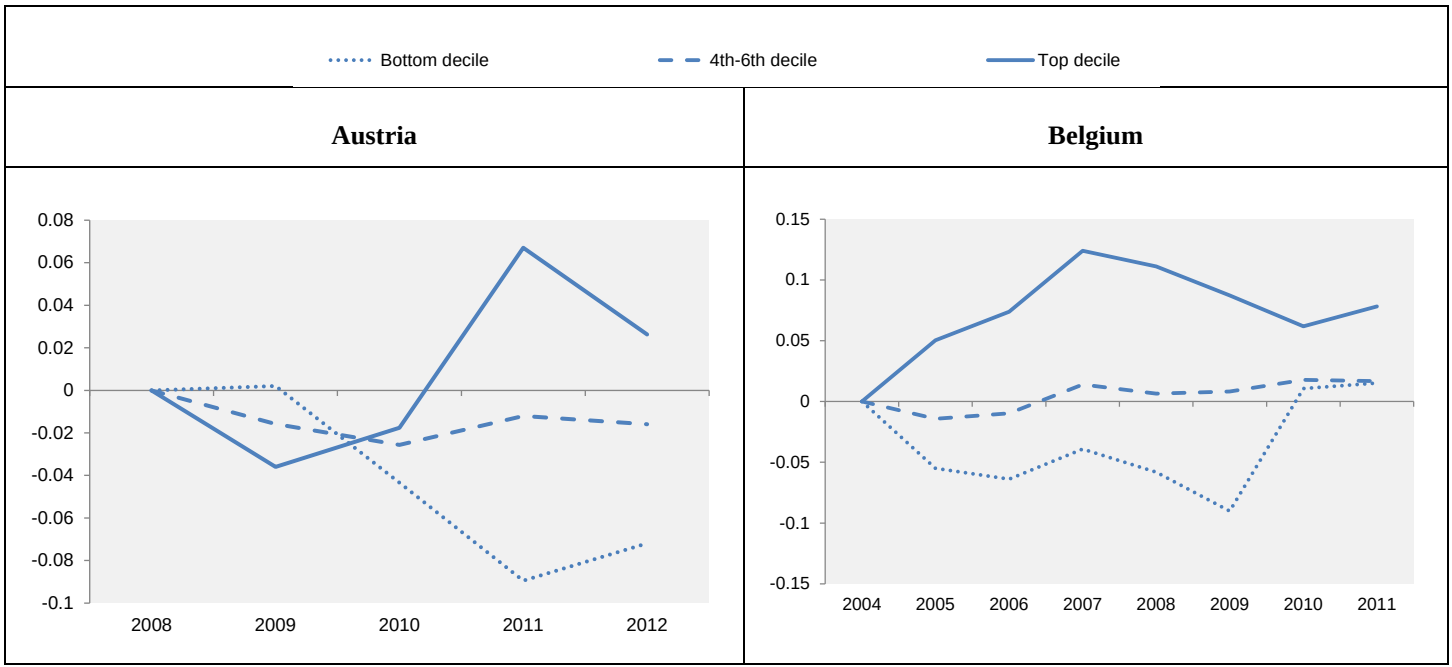
	

Notes: The graph reports the unweighted average of real labour productivity (defined as real value added per employee) expressed in 2005 US dollars for firms in the bottom decile, between the 4th and 6th deciles, and in the top decile of the labour productivity distribution in any given year. The values are normalised at their initial values in 1996 for Finland, France, Japan and Norway, 1998 for Hungary, 2000 for Canada and Denmark, 2001 for Italy, 2002 for Sweden, 2004 for Belgium, 2005 for Chile and 2008 for Austria. Data for Japan only includes firms above 50 employees.

Source: Data from the OECD Multiprod project, preliminary results, April 2016, see: http://www.oecd.org/sti/ind/multiprod.htm and Berlingieri, Blanchenay and Criscuolo (2016) for more details.

Disclaimer: estimates are based on micro-aggregated data and might differ from official national statistics.

B. Non-Financial Services



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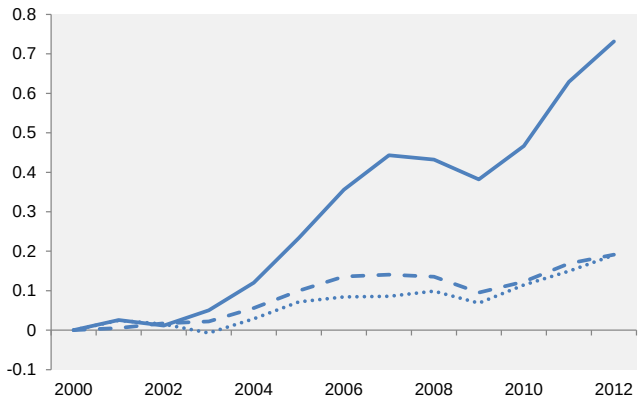	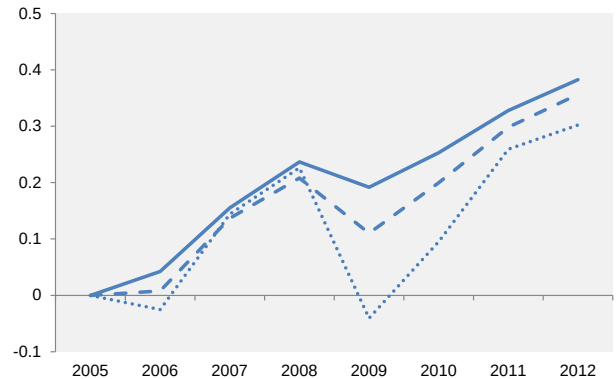

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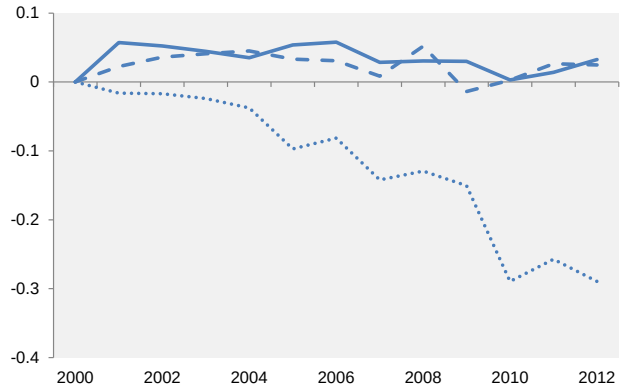
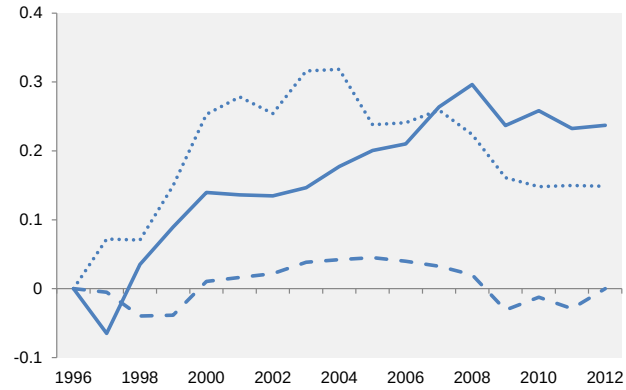
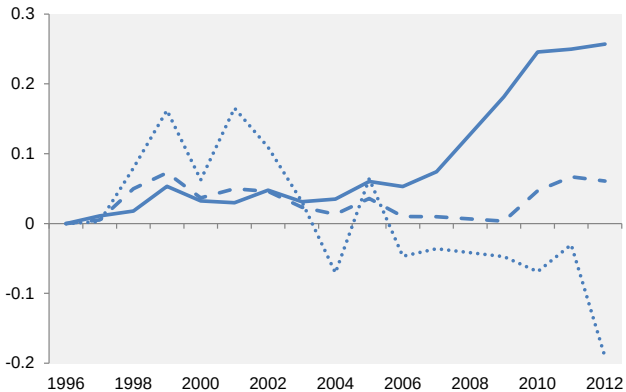
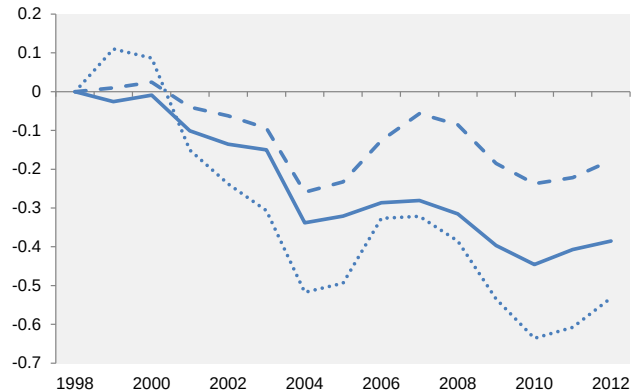
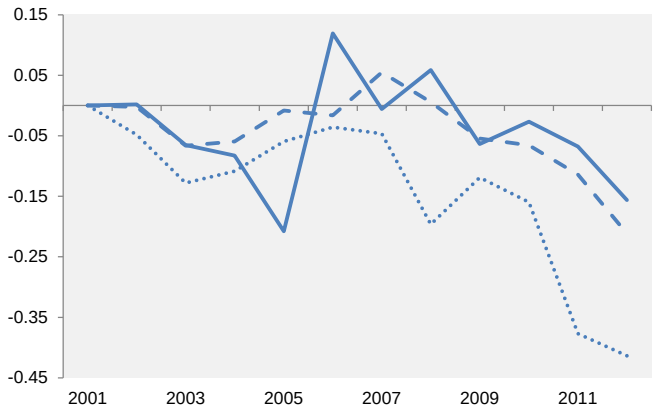
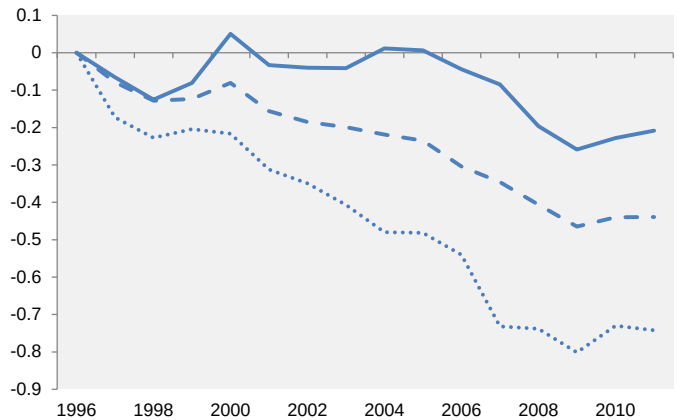
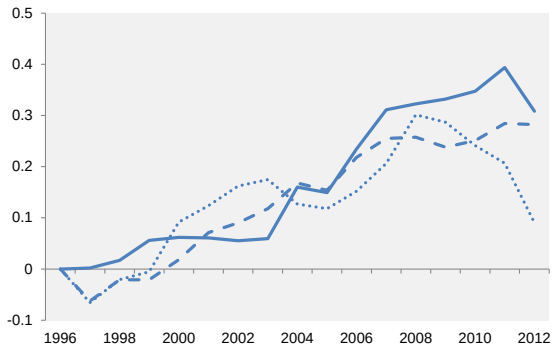
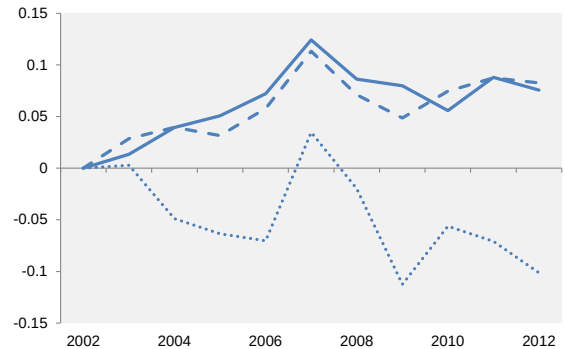
	

France	Hungary
	

Italy	Japan
	

Norway	Sweden
	

Notes: The graph reports the unweighted average of real labour productivity (defined as real value added per employee) expressed in 2005 US dollars for firms in the bottom decile, between the 4th and 6th deciles, and in the top decile of the labour productivity distribution in any given year. The values are normalised at their initial values in 1996 for Finland, France, Japan and Norway, 1998 for Hungary, 2000 for Canada and Denmark, 2001 for Italy, 2002 for Sweden, 2004 for Belgium, 2005 for Chile and 2008 for Austria. Data for Japan only includes firms above 50 employees.

Source: Data from the OECD Multiprod project, preliminary results, April 2016, see: http://www.oecd.org/sti/ind/multiprod.htm and Berlingieri, Blanchenay and Criscuolo (2016) for more details.

Disclaimer: estimates are based on micro-aggregated data and might differ from official national statistics.

1.2.2 There are several interpretations to the increased between-firm divergence.

There are several ways to interpret this growing dispersion in productivity growth, with one plausible explanation stressing the possible breakdown of the diffusion machine. One possible explanation suggests that the main source of the productivity slowdown is not the slowing of the rate of innovation by the most globally advanced firms, but rather a slowing of the pace at which innovations spread throughout the economy: a breakdown of the diffusion machine (Andrews, Criscuolo and Gal, 2015).[4]

Both the rate of innovation and productivity gains at the frontier seem to have remained strong. Firms on the global productivity frontier are typically larger, more profitable and more likely to apply for patents than other firms. Moreover, they are on average younger than other firms. They are also typically "global firms" in the sense that they operate in different countries (often as part of a MNE group), and are interconnected with suppliers/customers from different countries along global value chains (GVCs). This makes them better placed than other firms to enhance productivity, using their capacity to innovate, which increasingly requires not only investment in R&D and advanced technologies, but also a combination of technological, organisational and human capital in production processes throughout global value chains (GVCs). Global frontier firms may also be in a better position to harness the power of digitalisation to rapidly diffuse and replicate cutting-edge ideas, technologies and business models.

Corporate strategies also play an important role in achieving high productivity gains. Recent analysis of financial data for 11,000 large global companies shows that two groups of high level productivity firms can be identified: incumbent firms, with high but slowing productivity growth; and fast growing, high-productivity firms. Three aspects of the corporate strategies of the fast growing productivity firms appear to play a major role: i) an increase in R&D spending; ii) a preference for equity financing, while declining companies favoured debt financing;[5] and iii) previous high M&A activity.

4 Andrews, Criscuolo and Gal (2015) show that these trends are robust for a range of measurement issues.

5 Weaker firms might borrow excessively to compete with more successful firms to carry out mergers and acquisitions (M&As), to remunerate shareholders or to garner takeover defences, which in turn undermines their ability to have a longer-

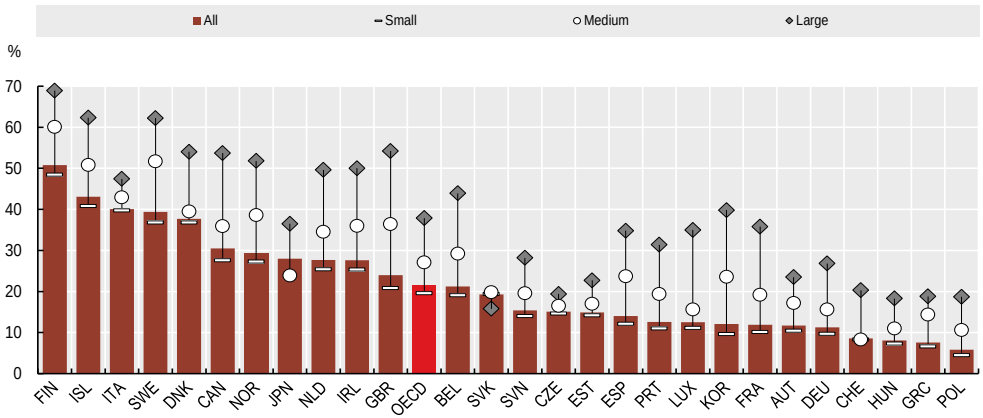
At the same time, the capacity of other firms in the economy to learn from the frontier may have diminished. The rising gap in productivity growth between firms at the global frontier and other firms since the beginning of the century suggests that non-frontier firms face increased difficulties in learning from the frontier. This is consistent with: i) longer run evidence on the penetration rates of new technologies (e.g. Comin and Mestieri, 2013); ii) possible winner takes all dynamics (Gabaix and Landier, 2008); and iii) the rising importance of tacit knowledge.

Many firms have also failed to successfully adopt new technologies and best practices. The main obstacle to stronger productivity growth has not been the unavailability of advanced technology, but rather the lack of successful adoption by many firms. There are many possible factors that could explain this, including access to finance or talent, which can prevent smaller firms from making the necessary investments and turning them into better business performance. In addition, as discussed in more detail below, many characteristics of the policy environment, ranging from product market competition to labour market policies, to financial structures are key reasons for why smaller and/or national firms do not take advantage of technological progress. The difficulty of making the complementary changes and investments that underpins the success of frontier firms, e.g. investments in the necessary skills, organisational practices, process innovation and management, may have also contributed. For example, new OECD evidence shows that, contrary to common belief, the uptake of cloud computing remains very low among small firms, despite the fact that small firms can disproportionately benefit from this technology (**Figure 1.7**).

term focus because debt must be serviced and the company is forced to shorter-term cash generating activities.

Figure 1.7. The uptake of cloud computing is comparatively low amongst small firms

Uptake of cloud computing service by size, 2014 as a percentage of enterprises in each employment size class



Source: OECD, ICT Database; Eurostat, Information Society Statistics Database, July 2015. See STI Scoreboard 2015, http://dx.doi.org/10.1787/888933274459.

A complementary explanation for the divergence in productivity performance involves growing rents for global frontier firms, leading to higher measured firm-level productivity.[6] The growing importance of knowledge-based capital in total business investment (Andrews and de Serres, 2012; OECD, 2013a; 2015b) may to some extent have favoured market concentration and in some instances may have contributed to rent seeking behaviour. The non-rivalrous nature of knowledge means that the initial cost incurred in developing new ideas – typically through R&D – does not need to be re-incurred as those ideas are combined with other inputs in the production of goods or services. This gives rise to increasing returns to scale.

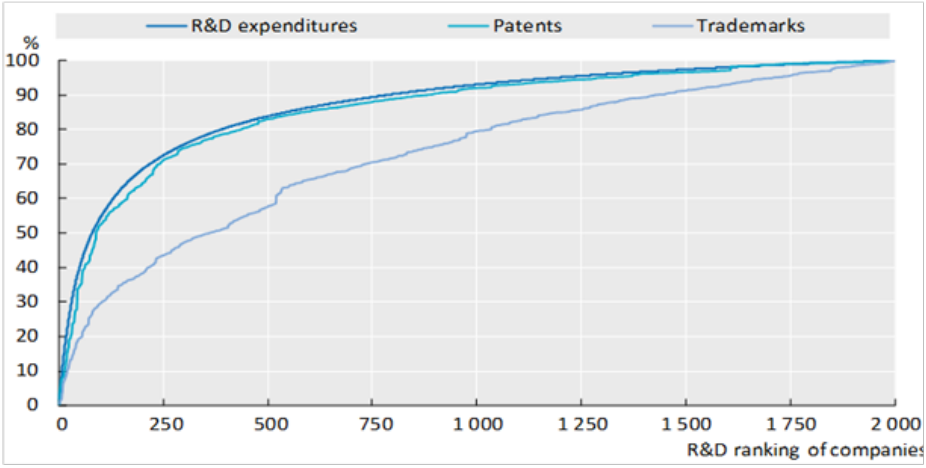
Several structural settings may favour the creation of rents for global frontier firms. First rent seeking can be reinforced by network externalities (*i.e.* the benefit from the network rises with the square of the number of users), which are particularly prevalent in some industries, such as those

6 Analysis at the firm level makes use of industry level price indices to compute productivity growth. Differences in measured productivity levels between firms can reflect either actual differences in productivity performance or differences in price levels, where the latter may result from market rents. The two components are difficult to separate with the available data.

involving digital platforms. This process can lead to growing concentration in certain markets, and can contribute to winner-take-all dynamics in these markets. Winner-take-all dynamics may not lead to growing rents if the resulting market dominance is temporary and rents are eroded by competition, including from other platforms and new business models (OECD, 2013a). However, if combined with a lack of competition, winner-take-all dynamics can lead to greater rent-seeking behaviour, which would benefit certain firms over others. They could also lead to a higher capital share in the economy, unless such rents are also shared with workers through higher wages. Further work is needed to assess empirically whether rents are growing in certain markets, and how these are being shared across investors and workers. In the end, attention to policies related to competition and innovation are key.

Policy settings which favour incumbents can reinforce the process of market concentration and rent seeking. Market concentration and rent seeking that result from the interaction between digital technologies, tacit knowledge and globalisation can be reinforced by policies that favour incumbents and slow the growth of challenger firms. For instance, intellectual property rights are important in an economy that is increasingly based on knowledge, but may lead to excessive concentration, unless coupled with pro-competition policies (OECD, 2013b). Similarly, poorly designed R&D tax credits may prevent challengers from competing on an equal basis in existing and emerging markets. There is also some evidence pointing to a slowdown in business dynamics; the average age of global frontier firms has been increasing since 2001, which could reflect a slowdown in the entry of new firms to the global frontier. Recent OECD evidence also shows that R&D and invention are highly concentrated. For instance, OECD work finds that the top 5% of the world's 2000 largest corporate investors in R&D account for 55% of their joint R&D expenditure, 53% of patents and 30% of trademarks (**Figure 1.8**).

Figure 1.8. Cumulative shares of R&D expenditures and the IP bundle within top 2000 R&D companies, 2012



Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, June 2015.

A third complementary explanation for the growing divergence in productivity growth is related to those firms furthest behind. As shown in Figure 1.6, the median firm (50th percentile) in several countries, e.g. Denmark and Norway, has not experienced much slower productivity growth than the most productive firms (90th percentile). Rather, it is the poorest performing firms (10th percentile) in some countries that have strongly negative productivity growth, bringing down aggregate performance. While poor productivity is not always a problem, as it can reflect the performance of new firms faced with high start-up costs, persistently poor performance points to lack of market selection (Andrews and Criscuolo, 2013), in particular when poorly-performing firms continue to exist in the market, rather than closing down. The relative importance on aggregate productivity growth of inadequate diffusion from the frontier on the one hand, and/or weak selection of the laggards on the other hand, is an important open research question.

1.2.3 There are major obstacles to stronger productivity growth.

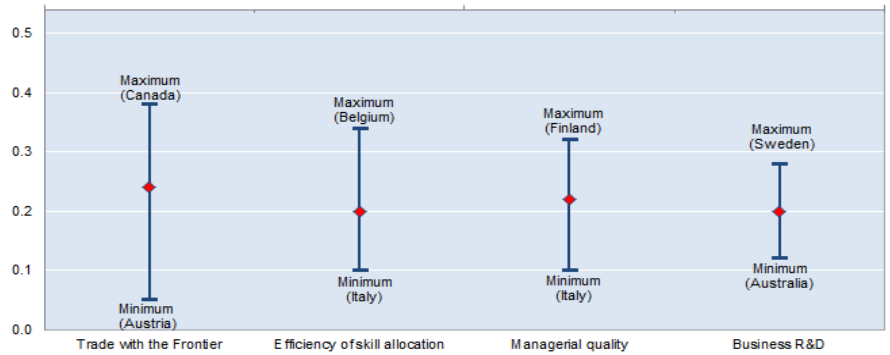
Future productivity growth will benefit from the revival of the diffusion machine. The rising gap between high productivity firms and the rest raises key questions about the obstacles that prevent all firms from successfully adopting well-known and replicable innovations. Future growth will benefit from harnessing the forces of knowledge diffusion. This is particularly vital

in the services sector that accounts for an increasing share of economic activity, and in particular logistics, finance, business services and communications that are needed for firms to compete in the global market place. OECD analysis has identified five key factors that shape the diffusion process: i) global connections via trade, FDI, participation in GVCs and the international mobility of skilled labour; ii) connections and knowledge exchange within the national economy, e.g. the interaction between scientific and higher education institutions and businesses; iii) scope for experimentation by firms – especially new entrants – with new technologies and business models; iv) synergistic investments in R&D, skills, organisational know-how (i.e. managerial capabilities) and other forms of knowledge-based capital efficient reallocation of scarce resources.

There are significant differences between OECD countries with respect to the structural factors that shape the diffusion process. Figure 1.9 presents estimates of how the benefits of a 2% acceleration in productivity growth at the global frontier – roughly equivalent to that observed in the United States during the late 1990s ICT boom – diffuse across economies, depending on some different structural factors. For example, countries that trade very intensively with the frontier economy (e.g. Canada) realise 0.35 percentage points higher productivity growth per annum, compared to countries with fewer such trade linkages (e.g. Austria). Higher efficiency of skill allocation - notably a reduction in the degree of over-skilling in the economy - business investment in R&D and managerial quality have similar effects on the diffusion process, and these gains are economically significant, particularly given an average MFP growth of only ½ per cent per annum over the period of analysis.

Figure 1.9. Different structural factors shape productivity diffusion from the global frontier across OECD countries

Estimated frontier spill-overs (% per annum) associated with 2% point increase in MFP growth at the global frontier



Notes: The chart shows how the sensitivity of MFP growth to changes in the frontier leader growth varies with different levels of policy variables. The diamond refers to the estimated frontier spill-over effect associated with a 2% MFP growth at the frontier around the average level of the policy. The label "Minimum" (Maximum) indicates the country with the lowest (highest) value for the given structural indicator in a given reference year.

Source: Saia, A., D. Andrews, and S. Abrizio (2015), "Productivity Spillovers from the Global Frontier and Public Policy Industry-Level Evidence", OECD Economics Department Working Papers, No. 1238, OECD Publishing, Paris.

Barriers to exit and skills mismatch play an important role in trapping valuable resources in low productive activities. Coexistence of poorly performing firms with star performers could result from a number of factors, but barriers to exit and skill mismatch clearly play a role. The opportunity cost of such barriers and mismatch can be large as – at least in the short to medium-run – firms' innovation activities draw from a scarce and fixed pool of contestable resources, particularly skilled labour. Thus, trapping resources in relatively small and low productivity firms can hinder the growth prospects of more innovative firms (Acemoglu, et al., 2013).

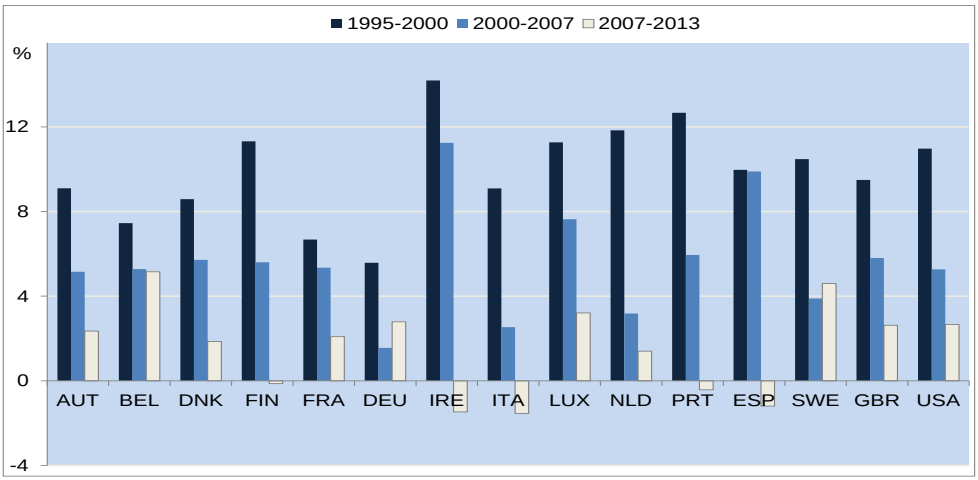
Similarly, the incidence of skill mismatch might be harmful to aggregate productivity because it constrains the growth of the most productive firms. These frictions may explain why national frontier firms are undersized in some economies, greatly diminishing their aggregate impact (OECD, 2015b). The probability of skill mismatch is related to many of the framework conditions already noted – product market competition and labour market policies - which affect the ability of workers to move from

job to job. It is also worsened by transportation and housing costs, which make it difficult for workers to move to a better matched job.

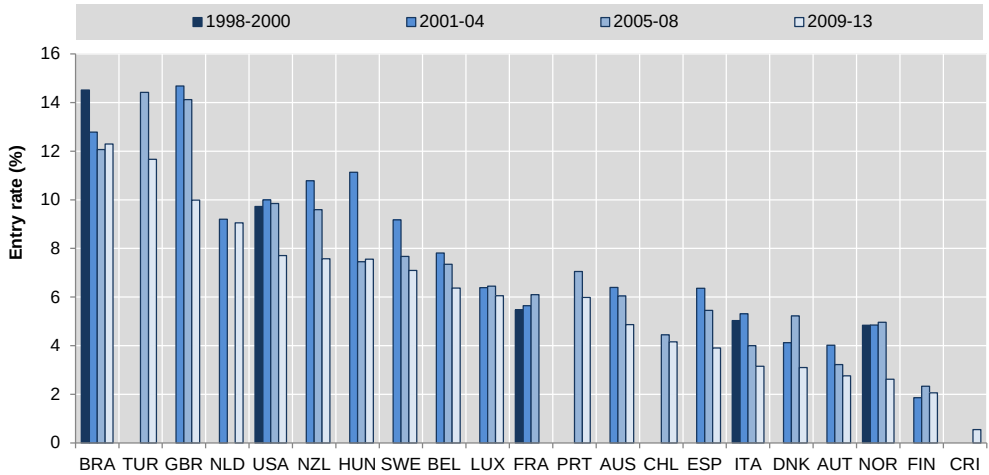
More generally, productivity growth would benefit from continuous resource allocation in the economy. The decline in business dynamism from the early 2000s may result in both slower diffusion and weaker dynamism at the frontier. A decline in business dynamism has been observed since the early 2000s (Criscuolo, et al., 2014). In particular, this is reflected in a slowdown in knowledge-based capital accumulation, which usually underpins innovations and their subsequent adoption, and in a decline in business start-ups, which are a key source of innovations and put pressure on incumbents to innovate (**Figure 1.10)**. This decline consequently raises concerns about a structural slowdown in productivity growth and may foreshadow a possible slowdown in the arrival of breakthrough innovations. A satisfactory explanation for these developments remains elusive. A possible important factor could be the persistence of small, old firms that have very low productivity. Costly delays and slow exit of poorly performing firms, sometimes supported by government guarantees, and compounded by financial institutions that do not want to realise non-performing loans on their balance sheets, creates a particularly unfavourable environment for productivity growth.

Figure 1.10. The pre-crisis slowdown in TFP growth coincided with a decline in business dynamism

A: Investment in Knowledge-Based Capital; annual average growth



B: The role of start-ups by country over time



Notes: Panel A reports the average annual growth in nominal KBC investment within each time period. Panel B reports entry rates (calculated as number of entrants with positive employment over total number of units with positive employment). Figures report averages for the periods 1998 – 2000; 2001 – 2004; 2005 – 2008 and 2009 – 2013 conditional on availability. Sectors covered are: manufacturing, construction, and non-financial business services. The first available year for which the database has been validated is: 1998 for Brazil; 1999 for Norway, France and the United States; 2000 for Italy; 2001 for Austria, Denmark, Luxembourg and the Netherlands; 2002 for Belgium, Finland, Hungary, New Zealand and Sweden; 2003 for Australia and the U.K.; 2004 for Spain; 2006 for Chile; 2007 for Portugal and Turkey; 2010 for Costa Rica. The last available year for which the database has been validated is: 2013 for Spain, Turkey and the United States; 2012 for Austria, Australia, Brazil, Chile, Costa Rica, Denmark, Luxembourg, the Netherlands, Portugal and Sweden; 2011 for Belgium, Finland, Hungary and New Zealand; 2010 for the U.K. and Italy; 2009 for Norway; 2007 for France. The period between 2005 and 2008 has been excluded for the Netherlands due to a redesign of the business register in 2006. Figures for Chile are preliminary. Owing to methodological differences, figures may deviate from officially published national statistics reports start-up rates (defined as the fraction of firms which are from 0 to 2 years old among all firms) averaged across three-year periods for the manufacturing, construction, and non-financial business services sectors. Data refer to 2001-2010 for AUT, BRA, ITA, LUX, NOR, ESP and SWE; 2001-2009 for JPN and NZL; 2001-2007 for FRA; and 2006-2011 for PRT. Owing to methodological differences, figures may deviate from officially published national statistics. For Japan, data are at the establishment level. Data for Canada refer only to organic employment changes and abstract from M&A activity.

Source: Panel A is sourced from Corrado et al., (2013); Panel B is sourced from OECD DynEmp v.2 database. Data for some countries are still preliminary.

1.3 Increased divergence between the most and least productive regions within a country

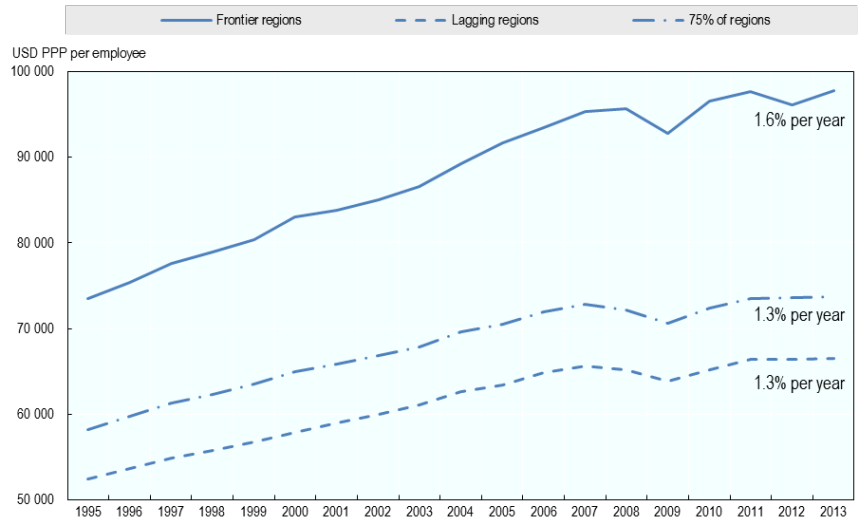
1.3.1 The widening gap in productivity growth between regions at the productivity frontier and lagging regions may have contributed to the labour productivity slowdown.

Between 1995 and 2013, disparities in productivity performance between regions within countries have also increased. From 1995 to 2013, labour productivity (measured by GDP per worker[7]) increased on average by 1.6% for the frontier regions, as opposed to only 1.3% per year in the majority of regions (the lowest 75%) as well as the lagging regions (the lowest 10%). This growth differential, when cumulated over the same period, generates an increase of the gap between the frontier and the most lagging regions of approximately 50% (from around USD 21 000 to 31 000 PPP per worker) (Figure 1.11). These inter-regional divergences largely stabilised after the crisis, but mainly as a result of a slowdown in the most advanced regions, rather than of catching up by lagging regions.

7 The best measure of labour productivity available at the regional level, which suffers from the lack of accurate price deflators at the regional level. A new OECD project has just begun that will seek to measure regional level price differences.

Figure 1.11. The gap between frontier and lagging regions was widening even before the crisis

Averages of highest top 10% (frontier), lowest 75% and lowest 10% (lagging) regional GDP per worker, TL2 regions

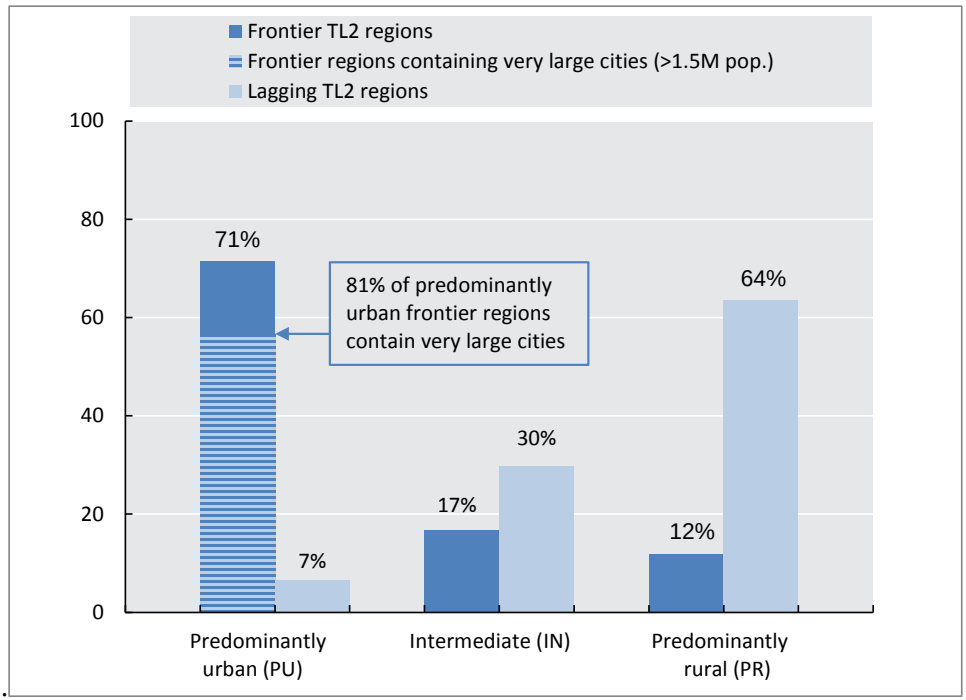


Note: Average of top 10% and bottom 10% TL2 regions, selected for each year. Top and bottom regions are the aggregation of regions with the highest and lowest GDP per worker and representing 10% of national employment. The bottom 75% regions account for 75% of national employment. Due to lack of regional data over the period, only 20 countries are included in the averages.

Source: Calculations based on the OECD Regional Database.

Frontier regions are predominantly urban, whereas lagging regions are predominantly rural. The frontier is dominated by predominantly urban regions, in particular those containing very large cities (Figure 1.12). Conversely, two-thirds of the lagging regions are predominantly rural. The large and persistent gaps between frontier and lagging regions are to a great extent the result of agglomeration forces that increase productivity in regions that contain large cities. Furthermore, the rising importance of tacit knowledge as a source of frontier productivity developments could lead to increased disparities between urban and rural areas insofar as tacit knowledge is more difficult to diffuse across firms than other forms of productivity enhancement.

Figure 1.12. Frontier regions are predominantly urban, whereas lagging regions are predominantly rural



Note: Share of frontier/lagging regions distributed by typology over the period 2003-2013. TL2 region typology defined by their degree of rurality using the following thresholds: PR>50%, PU<30%, other=IN, plus upgrade PR->IN and IN->PU if contain a city >1.5M pop.

Source: Calculations based on the OECD Regional Database.

Even if it is to be expected that economic activities concentrate spatially, lagging and less populated regions should also be expected to see some catch-up. As with countries, productivity is the main determinant of regional growth. It spreads from large cities to the regions around them, even to a distance of 200-300 km, driven by their economic and demographic linkages with urban areas. Moreover, smaller cities can reap productivity gains by being closely linked to other cities using connectivity as a substitute for size (OECD, 2014). Other factors driving regional per capita growth vary with the level of productivity they have already achieved. For example, R&D investment appears to be more important for growth among regions that were already at the highest levels of GDP per capita, than for regions well below the national average (OECD, 2012).

The fact that lagging regions are not currently benefiting from catch-up dynamics may be due to several factors. First, the breakdown of the "diffusion machine" across firms may have had a particularly negative impact on lagging regions disconnected from global frontier firms. Also, in an increasingly knowledge-intensive economy, regions with a large share of low-skilled workers (e.g., those that have only completed primary education), may be increasingly penalised. Evidence shows they are a bigger drag on regional growth than the lack of high-skilled workers (OECD, 2012). In addition, remote rural areas have a greater dependence on local assets and tradable sectors, and thus growth may be more vulnerable to shocks in general or in their sectors of specialisation, including fluctuations in commodity prices (OECD, 2014). Finally, governance challenges such as low levels of institutional capacity at subnational level, lack of a well-designed and implemented regional strategy, and a piece-meal policy approach can also help to explain why certain regions with catch-up potential do not succeed in fulfilling that potential (OECD, 2012).

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