CHAPTER II

CHAPTER II.1

SLOW AND DIVIDED: WHAT POLICIES CAN LIFT ECONOMIES AND RESTART ENGINES OF GROWTH FOR ALL?

Chiara Criscuolo

OECD, Department of Science, Technology and Innovation

1. Introduction

Over the last decade, developed economies in Europe and elsewhere have faced two major trends with important implications for the well-being of their societies: a slowdown in productivity growth and increasing inequality. These trends are already affecting countries in many areas, ranging from earnings growth and inequality to the ability of governments to make good on promises to their citizens. The two trends have been mainly studied separately and from an aggregate perspective. The debate around the slowdown in global productivity tends to focus on the ability of recent technological developments, particularly in the information and communications technology (ICT) industries, to generate broad and sustained economic growth, and on measurement issues. At the same time, the debate about the potential causes of rising inequality tends to emphasise structural trends, like skill-biased technological change and offshoring, and institutional factors, such as education, unionisation, the minimum wage and top income taxation.

However, recent research points to important interconnectedness between the two types of trends and attracts attention to the need to look behind the aggregate figures (Andrews et al., 2016; Berlingieri et al., 2017). Specifically, it emphasises the role of individual firms in driving aggregate outcomes and the huge differences that exist among firms, even within the same country and narrowly defined industries. It documents a growing divergence between high-productivity firms and those lagging behind. This divergence could at least partially explain productivity slowdown and hints at some of its potentially deeper causes, namely insufficient technological diffusion to laggard firms and an insufficiently dynamic process of ‘creative destruction’, whereby inefficient firms exit the market and resources are reallocated to innovative new firms. In addition, the divergence in productivity is found to be linked to a divergence in wages, which means that the same company-level patterns can also explain a significant part of the growing inequality in earnings (Berlingieri et al., 2017). Importantly, this implies that policy responses which can tackle the increasing productivity divergence could potentially produce a ‘double dividend’ in terms of both greater productivity growth and reduced income inequality.

The aim of this chapter is to provide an overview of this research and use it as an evidence base for designing policies that ensure productivity growth for all. It is organised as follows: Section 2 provides a brief overview of the global productivity slowdown and increasing inequality and the discussions around them. Sections 3 and 4 focus on the role of productivity differences across firms in driving these trends. Section 3 takes a global perspective and summarises evidence on the widening gap between the global frontier and the rest of the business population, and explores the potential role of policies in closing this gap. Section 4 takes a closer look at the sources of these divergences, exploring variations within countries and industries. Section 5 links productivity divergence to wage inequality and investigates the role of structural factors such as globalisation, digitalisation and labour market features on both wage inequality and its links to productivity dispersion. Section 6 concludes this chapter.

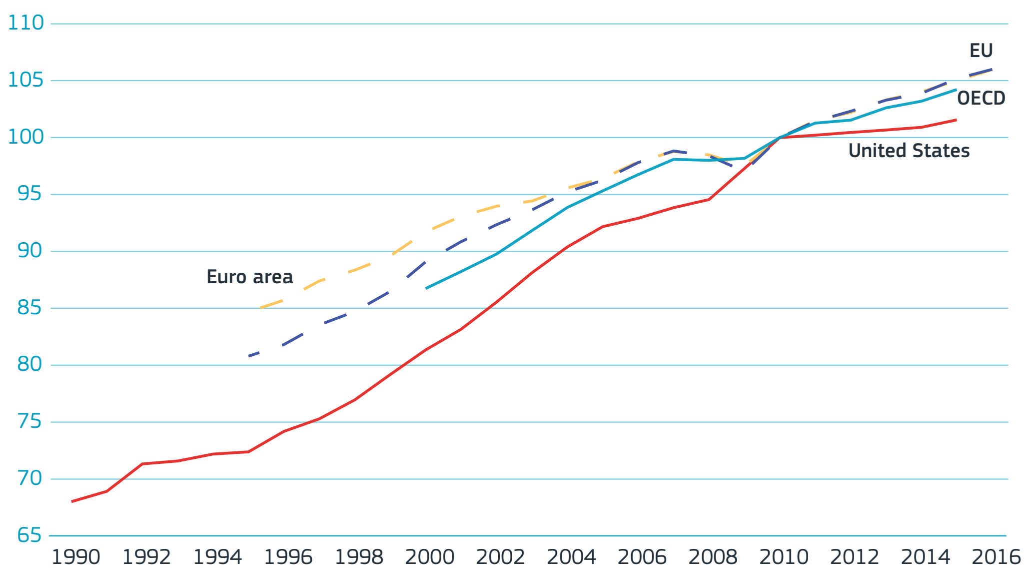
2. The two trends

2.1 Global productivity slowdown

OECD and European economies have witnessed a global productivity slowdown that started well before the great recession and has worsened ever since. What is even more worrying is that the main culprit behind the pre-recession productivity slowdown is a decline in the contribution to growth by multi factor productivity (MFP), an index which measures how efficiently inputs are combined to produce output. MFP can be considered a proxy for innovation, smart organisation, good management and, more broadly, a high level of knowledge-based capital (KBC). The slowdown in MFP growth is of concern because, in the long run, it is the main driver of economic and income growth, governments' capacity to respect their obligations vis-à-vis societies and, ultimately, people's well-being.

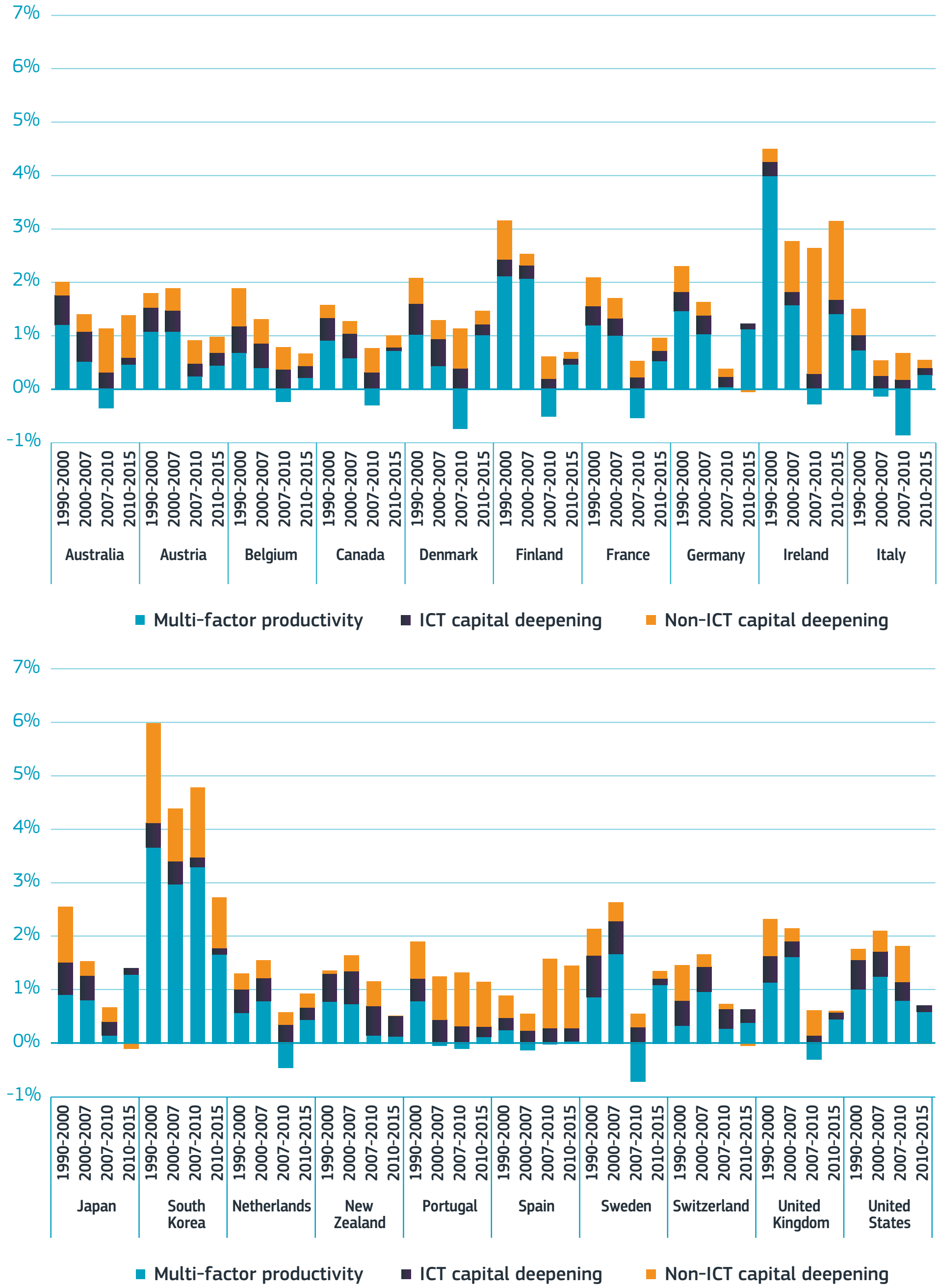
This slowdown in aggregate productivity and the decline in the contribution from MFP growth characterises many countries across the OECD, including Europe and the United States (Figures II.1.1 and II.1.2).

Figure II.1.1 Real growth in GDP per hour worked[1], 1990-2016
Index 2010 = 100



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies.
Data: OECD, Productivity database
Note: [1]GDP per hour worked in PPP$ at 2010 prices and exchange rates.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_1.xlsx

Figure II.1.2 Decomposition of labour productivity growth - percentage point contribution to labour productivity growth (annual), 1990-2000, 2000-2007, 2007-2010, 2010-2015



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies.
Data: OECD, Productivity database
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_2.xlsx

Given the importance of productivity and innovation for long-term well-being, the slowdown has sparked a lively debate in the academic arena among those who see it as a permanent feature of a new economic era – the so-called techno-pessimists – and those who see it as a temporary phenomenon, the so-called techno-optimists. Yet other researchers have investigated the role of mismeasurement to explain these patterns.

The techno-pessimists, such as Robert Gordon, argue that the recent slowdown is a permanent phenomenon. Innovations such as electrification, internal combustion and plumbing, which took place during the Second Industrial Revolution, between the second half of the 19th and the first half of the 20th centuries, and their spin-off inventions – aeroplanes, air-conditioning and interstate highways – were the main drivers of rapid productivity growth at the frontier, i.e. in the United States of America, until the 1970s. In contrast, innovations from the Third Industrial Revolution, especially in ICT, have only led to a short-lived spurt of productivity (Gordon, 2012). In addition, current and future innovations and their potential impact onUnited States economic growth will be dwarfed, according to techno-pessimists, by 'headwinds' related to demography, education, inequality, globalisation, environment and the debt overhang.

At the opposing end of the debate, techno-optimists justify the current slowdown as the cost of the transition from an economy based on the production of goods to one based on the production of ideas. This temporary slowdown masks the underlying dramatic speed of technological progress led by the IT and digital revolutions, which will continue to transform the global economy (Brynjolfsson and McAfee, 2011). In their view, science and technology's main function in history is "to make taller and taller ladders to get to the higher-hanging fruits and to plant new and possibly improved trees" (Mokyr, 2014) and to achieve new frontiers that remain unimaginable today.

Finally, some have argued that the slowdown is not real but is an artefact due to the mismeasurement of productivity growth. Economists such as Hal Varian dispute the use of GDP as the relevant measure of output in today's digitalised economies (Varian, 2016)[1]. More recently, evidence suggests that we might have been missing growth because of mismeasurement of growth from "creative destruction" and subsequently of inflation rates (Aghion et al., 2017). However, others have suggested that mismeasurement, although an issue, can only explain too small a fraction of the productivity slowdown, given its magnitude and timing (see for example Groshen et al., 2017; Syverson, 2016[2]; Byrne, Fernald and Reinsdorf, 2016) to be considered the main explanation of this phenomenon.

1 The main argument considers the measurement problem related to the fact that a lot of what originates from the digital revolution (e.g. apps; improved search engines) is (nearly) free. For example, Google's search engine contribution to GDP is measured by the advertising Google manages to sell on it while no value is ascribed to what a user can do on the engine: https://www.brookings.edu/wp-content/uploads/2016/08/varian.pdf

2 For example, Syverson (2016) provides various pieces of evidence against the mismeasurement hypothesis. Amongst those, he shows that across different countries the size of the productivity slowdown is unrelated to measures of the countries' consumption or production intensities of ICTs, often cited as sources of mismeasurement. Second, existing estimates of the surplus created by internet-linked digital technologies are well below the volume of "missing output" due to productivity slowdown.

Both the techno-optimists versus techno-pessimist debate and the measurement hypothesis focus on aggregate and sectoral productivity growth. However, a country's productivity growth performance is driven by the performance of firms in the economy. In addition, there is overwhelming evidence that firms are heterogeneous even within narrowly defined sectors (e.g. Syverson, 2004 and references therein). Thus, aggregate productivity growth will depend both on each firm's growth performance as well as on the extent to which resources are allocated to the most efficient firms. In the long term, the capacity of economies to ensure a productivity enhancing reallocation of resources and a Schumpeterian creative destruction process are also key. The following two sections explore these issues.

2.2 Rising inequality

The second key feature of recent decades has been an increase within countries in inequality in income between the rich and the poor (OECD, 2015; Piketty, 2014) and in earnings among different types of workers, for instance between high- and low-skilled workers (Autor et al., 2003) and between those employed in large versus small businesses (Song et al., 2015). Evidence suggests that most of this growing inequality is driven by an increase in wage inequality among workers.

A significant part of the growing inequality in income can be attributed to increasing inequality in earnings driven by a rise in the wage differentials between firms, as found in Brazil (Helpman et al., 2017), Denmark (Bagger et al., 2013), Germany (Baumgarten, 2013; Card et al., 2013; Goldschmidt and Schmieder, 2015), Italy (Card et al., 2014), Portugal (Card et al., 2016), Sweden (e.g. Häkanson et al., 2015), the UK (Faggio et al., 2010), and in theUnited States (Dunne et al., 2004; Barth et al., 2014; Song et al., 2015).

Productivity has been identified as an important element of the "between-firm" component (Davis and Haltiwanger, 1992; Mortensen, 2003; Dunne et al., 2004; Faggio et al., 2010; Christensen and Bagger, 2014). Berlingieri et al. (2017) show that this growing divergence in between-firm wages is strongly correlated with the within-country-sector divergence of productivity documented over the last decade in 16 countries. This link is explored in Section 5.

3. Productivity slowdown from a company perspective: the gap between the global frontier and the rest

As mentioned earlier, most of the debate surrounding the global slowdown in productivity growth has focused on aggregate measures and is abstracted from much of the complexity that characterises today's economies. However, aggregate productivity growth figures are the result of two underlying micro processes: 1) the heterogeneous productivity growth performance of firms; and 2) the processes of creative destruction which enable new firms to enter the market and replace old ones, and resources to be reallocated to higher-productivity businesses.

New OECD research (Andrews et al., 2016) contributes to the ongoing debate on the productivity slowdown precisely by looking into each of these trends, taking into account the significant heterogeneity in productivity performance that exists across firms within sectors at the global level. Distinguishing between companies at the productivity frontier and laggards, the analysis suggests that the latter have experienced a significant slowdown in the rate of catch-up with the frontier (i.e. a slowing down of their productivity growth performance, worsening of process 1), and that business dynamism and the reallocation of resources have deteriorated significantly over time (worsening of process 2).

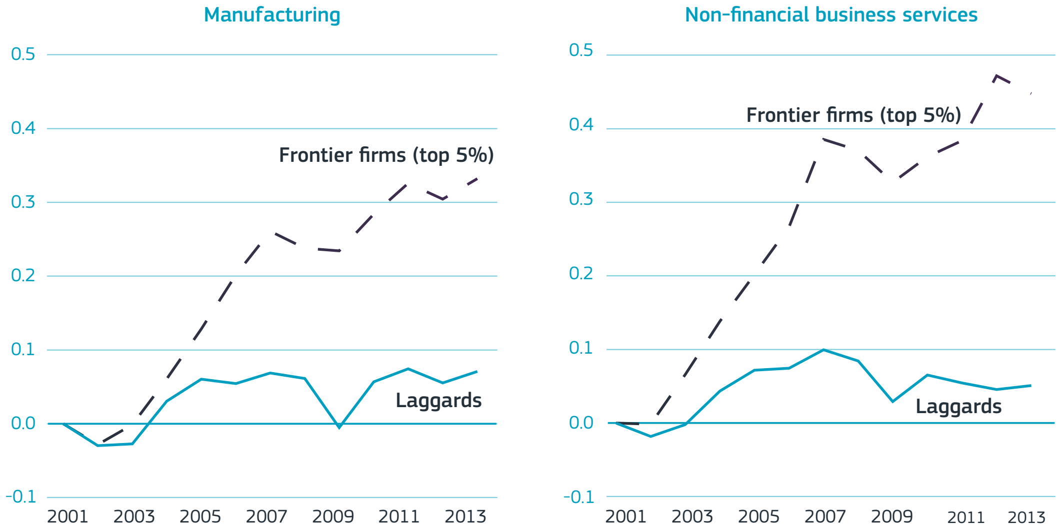
3.1 Breakdown in the diffusion machine

Using a harmonised cross-country firm-level database covering businesses with more than 20 employees across 24 countries, Andrews et al. start by distinguishing firms according to their relative performance. They define global frontier firms as the top 5% in terms of labour productivity levels within each 2-digit sector, in each year, across all countries since the early 2000s.

Isolating this group of firms clearly shows that, contrary to techno-pessimists' narrative (Gordon, 2012), over the first decade of the 21st century productivity slowdown is not a reflection of a slowdown in productivity growth at the global frontier. Rather, it is a reflection of an increasing productivity gap between the global frontier, which experiences robust growth over the period, and the rest of the companies, with a labour-productivity wedge growing at an average annual rate of 2.2% in manufacturing and 5% in non-financial business services (Figure II.1.3).

Repeating this exercise using multi-factor productivity (MFP) estimates suggests that this productivity divergence remains even after controlling for differences in capital deepening and mark-ups. This suggests that the rising MFP gap between global frontier and laggard firms may reflect divergence in innovation between the two groups of firms.

Figure II.1.3 The widening labour productivity gap between global frontier firms and other firms[1]



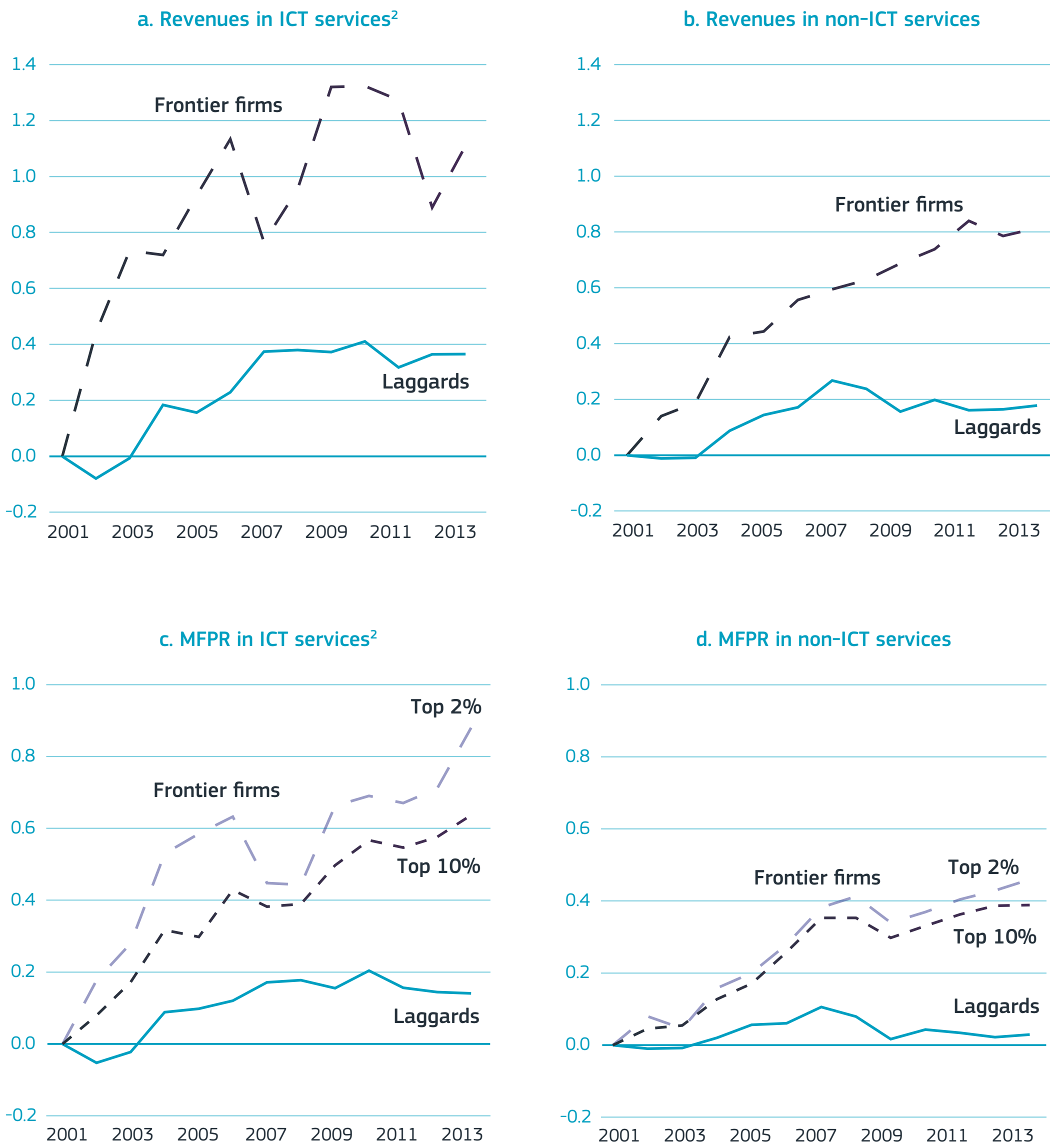
Science, Research and Innovation performance of the EU 2018
Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: Andrews, Criscuolo and Gal, 2016
Note: [1]The global frontier is measured by the average of log labour productivity for the top 5% of companies with the highest productivity levels within each 2-digit industry. Laggards capture the average log productivity of all the other firms. Unweighted averages across 2-digit industries are shown for manufacturing and services, normalised to 0 in the starting year. The vertical axes represent log differences from the starting year: for instance, the frontier in manufacturing has a value of about 0.3 in the final year, which corresponds to approximately 30% higher in productivity in 2013 compared to 2001.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_3.xlsx

The next question is what is driving this increasing wedge between frontier and non-frontier firms. The analysis explores this in two directions. First, it looks at the performance of firms at the frontier and those lagging behind. Secondly, it looks at the dynamics of creative destruction and reallocation over the period.

Looking at the performance of frontier firms, the study explores the potential role of digital technologies to create global winner-takes-most dynamics (Brynjolfsson and McAfee, 2011), focusing on the relative performance of frontier firms in ICT services (computer programming, software engineering, data storage and so on) vis-à-vis other sectors. The analysis confirms that global frontier firms increased their market share and had a significantly larger MFP gap, not only vis-à-vis non-frontier firms but even within the group of global frontier firms, between the very top firms (top 2%) and other frontier firms (Figure II.1.4).

Looking at the relative performance of non-frontier firms, econometric analysis based on a neo-Shumpeterian model of convergence shows that these firms' catch-up rate has slowed significantly since early 2000 (Figure II.1.5).

Figure II.1.4 Winner takes most dynamics[1]



Science, Research and Innovation performance of the EU 2018

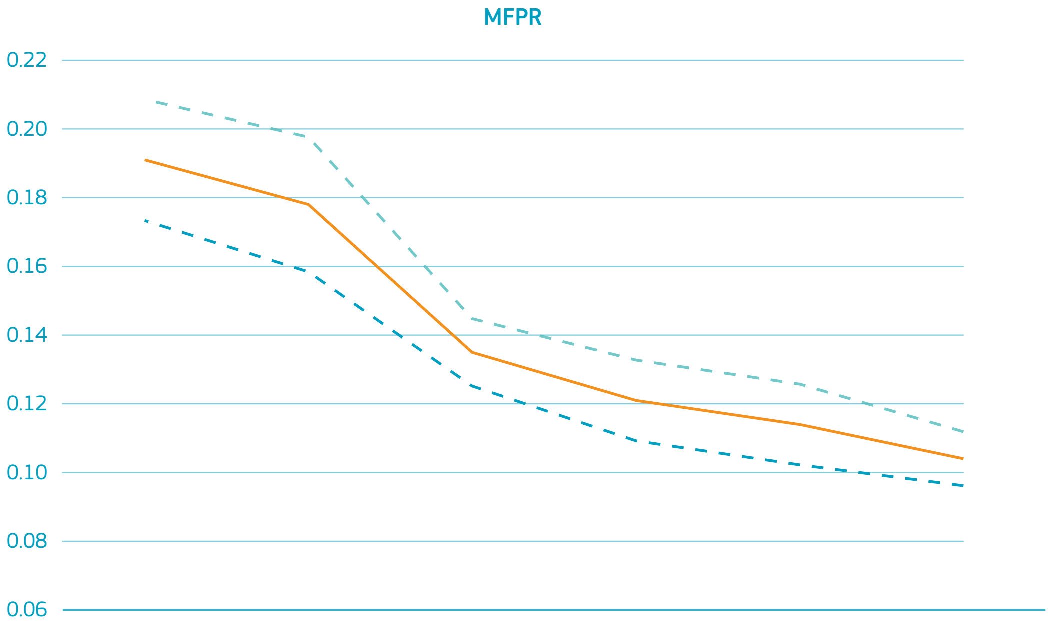
Source: DG Research and Innovation – Unit for the Analysis and Monitoring of National Research and innovation Policies

Data: Andrews, Criscuolo and Gal, 2016

Notes: [1]The global frontier is measured by the average of log labour productivity for the top 5% of companies with the highest productivity levels within each 2-digit industry. Laggards capture the average log productivity of all the other firms. Unweighted averages across 2-digit industries are shown for manufacturing and services, normalised to 0 in the starting year. The vertical axes represent log differences from the starting year: for instance, the frontier in manufacturing has a value of about 0.3 in the final year, which corresponds to approximately 30% higher in productivity in 2013 compared to 2001. [2]ICT services includes information and communication sector (NACE Rev. 2.0 section J) and postal and courier activities (NACE Rev. 2.0 sector 53).

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_4.xlsx

Figure II.1.5 Convergence towards the frontier has slowed down
Estimated convergence parameters by time period[1]



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: Andrews, Criscuolo and Gal, 2016
Note: [1]The solid line shows the period specific coefficients δ_2^j in the convergence equation:

$$\Delta MFP_{it} = \delta_1 GAP_{i,t-1} + \sum_j \delta_2^j GAP_{i,t-1} * D_t^j + \delta_3 \Delta MFP_{F_s,t} + \sum_m \delta_4^m X_{it}^m + \mu_{ct} + \eta_j + \varepsilon_{it}$$

where the periods j are, as reported in the Figure, 1997-2000; 2000-2002; 2002-2005; 2005-2007; 2007-2010 and 2010-2014.
The dashed lines show the estimated 95% confidence interval.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_5.xlsx

Further symptoms of the stalling technological diffusion and slowing dynamism among laggards are found in the declining rate of laggard firms outside the top quintile of productivity distribution that subsequently make it to the global productivity frontier. These patterns are particularly evident among private business services where intangibles and tacit knowledge are important. This suggests that these patterns may reflect the increasing costs incurred by laggard firms of moving from an economy based on production to one based on ideas, as discussed by techno-optimists such as Brynjolffson. On average over 2001-2003, 50 % of firms at the global frontier in terms of MFPR in the services sector were either classified two years earlier as frontier firms (i.e. 33 % of firms were in the top 5 %), or resided outside the frontier grouping but were in the top decile (10 % of firms) or top quintile (7 % of firms). By 2011-2013, however, this Figure had risen to 63 %, driven by a significant increase in the proportion of incumbent firms retaining their position in the frontier (43 %) with a more modest increase in entry to the frontier by firms residing just outside the frontier but in the top decile (13 %) some two years earlier.

3.2 Declining business dynamism and "creative destruction"

This rising entrenchment at the frontier is consistent with the broader decline in business dynamism observed across OECD countries using different measures of business dynamism (Figure II.1.16). This, in turn, implies declining incentives among laggard incumbent firms to adopt the latest technologies and business practices (Bartelsman et al., 2013).

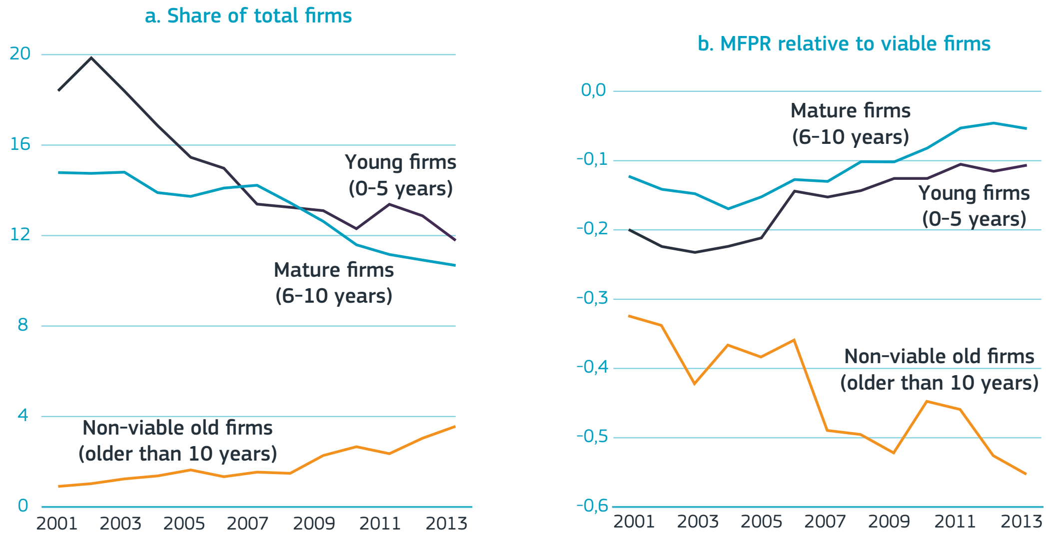
This declining entry rate translates into a declining share of young firms and a higher share of non-viable old firms. In addition, it seems to have become relatively easier for weak firms that do not adopt best practices to survive while, at the same time, the average productivity of young firms has increased, suggesting that entry barriers might have risen, making it more difficult for low-productivity firms to enter the market.

These patterns seem to point to the role of market contestability as a potential policy area to be explored to understand these patterns. Econometric analysis at the industry level confirms the link between stronger productivity divergence between the best firms and the rest and slow pro-competition market reforms. Sectors that saw a very slow pace of product market reforms, such as retail trade and professional services, could have seen their productivity divergence up to 50% lower had they undergone reforms at the same pace as the telecommunications sector, where they were most extensive.

Figure II.1.6 Declining business dynamism[1] across countries - increased earning inequality and increased between-firms wage dispersion, 2001-2011

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: OECD
Note: [1]Entry rate is defined using number of units with positive employment (number of entering units with positive employment over total number of units with positive employment). Churning rate is defined as the sum of gross job creation rate and gross job destruction rate. Excess job reallocation rate is defined as churning rate less the absolute value of net employment growth for the period. Excess job reallocation thus reflects the job reallocation that occurs over and above the minimum necessary to accommodate the net employment changes. Figure II.1.6 reports regression coefficients of within-sector country regressions of the relevant variable on year dummies with 2001 being the reference year. Years before 2001 and after 2011 are excluded due to the limited data coverage. Estimates are based on 20 countries (AT, BE, BR, CR, DK, ES, FI, FR, HU, IT, JP, LU, NL, NO, NZ, PT, SE, TR, UK, US).
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_6.xlsx

Figure II.1.7 Indicators of declining market dynamism amongst laggard firms[1]



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: Andrews, Criscuolo and Gal, 2016
Note: [1]Figure II.1.7 shows the frequency and relative productivity of three groups of firms: firms aged 5 years or less (young firms), firms aged 6 to 10 years (mature firms) and firms older than 10 years that record negative profits over at least two consecutive years (non-viable old firms). The omitted group are firms older than 10 years that do not record negative profits over at least two consecutive years (viable old firms).The age of the firm is inferred from the incorporation date. The estimates are unweighted averages across industries in the non-farm non-financial business sector.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_7.xlsx

4. Zooming in on productivity divergence within countries and sectors

In the previous section, we have shown that over the last decade there has been a steady increase in productivity dispersion between firms at the global frontier and the rest of companies in the same sectors. We will now consider whether the observed global pattern is paralleled by a divergence in productivity within country-sectors during the same period.

4.1 The data challenge

One limitation of the sample data used in the study by Andrews et al. (2016) is that it is restricted to covering businesses with at least 20 employees. Whilst this sample restriction does not impact on the conclusion of their study – extending the analysis to businesses with less than 20 employees would likely make their conclusions even stronger – it does mean that they cannot bring their analysis from the global to the country level because the sample size becomes too small for many country-sectors pairs. As shown by previous OECD work, in most OECD and EU countries, firms with fewer than 20 employees represent a large majority of businesses (Figure 8), with companies with fewer than 10 employees accounting for 80 % of firms on average.

This means that if we want to analyse productivity dispersion and productivity divergence within countries and sectors, we need to use a different data source which either covers the whole distribution of businesses, such as business registers, administrative records and tax data, or a sample that is designed to be representative of the business population, e.g. stratified random samples often used by statistical offices to run their production surveys.

Unfortunately, while considerable progress has been made in recent years in providing researchers with secure access to official microdata on firms at the country level, significant obstacles remain, especially in terms of transnational access. The challenges of transnational access are many, beginning with locating and documenting information on available sources and their content (i.e. coverage, variables, classifications, etc.) and on accreditation procedures (i.e. eligibility, rules, costs, timing). Finally, data-access systems differ across countries, implying that while remote access or execution could be possible in some countries, in other countries only access on-site is allowed, while non-nationals are not granted access to national data in others. As a result, multi-country studies requiring the exploitation of micro-data are very difficult to conduct.

In the last few years, the OECD Directorate for Science, Technology and Innovation has produced new evidence on employment dynamics and productivity across countries exploiting official and confidential firm-level data within two projects: DynEmp and MultiProd. The projects have relied on countries' confidential microdata to conduct comparable cross-country analysis on employment dynamics and productivity, respectively[3], via the formation and coordination of networks of national researchers, with each team having access to their respective national microdata. The two OECD projects collect and analyse harmonised cross-country micro-aggregated data from administrative data or official representative surveys, such as business registers, social security and corporate tax records or national statistical offices' surveys of production, ensuring comparability of the country-level results via the use of a commonly specified protocol for data collection

3 See also www.oecd.org/sti/DynEmp.htm and www.oecd.org/sti/ind/MultiProd.htm

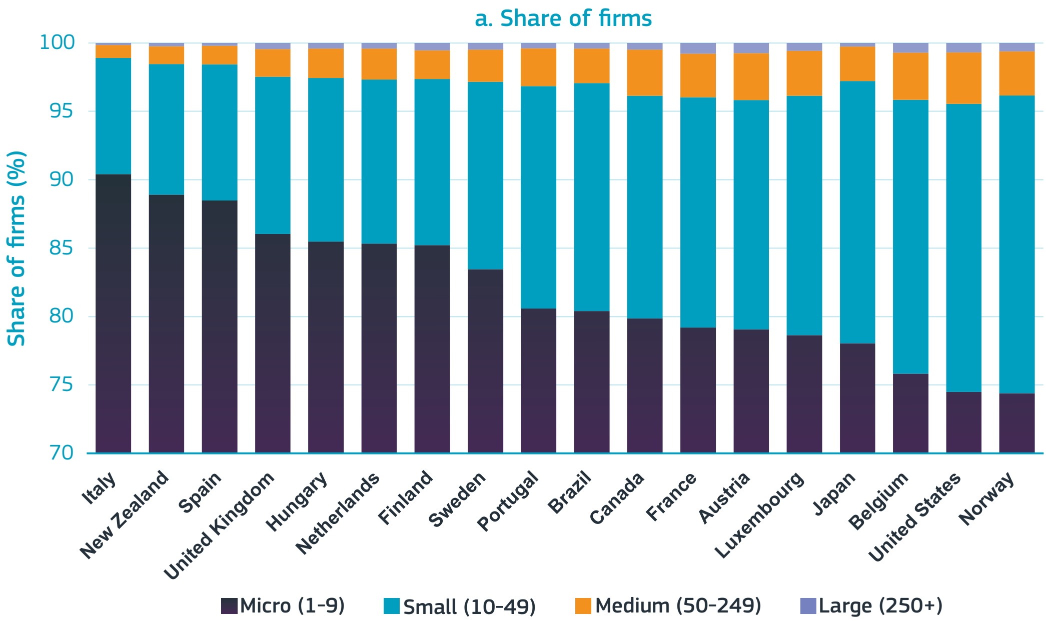
and aggregation and a commonly specified model for the econometric analysis. The methodology followed in the DynEmp and MultiProd projects – a distributed microdata analysis – involves the OECD writing a computer code then running this code in a decentralised manner by representatives in national statistical agencies or experts in public institutions who have access to the national micro-level data. The micro-aggregated data generated are then sent back to the OECD for comparative cross-country analysis. These data reduce confidentiality concerns as they aggregate information at a sufficiently high level and achieve a high degree of harmonisation[4].

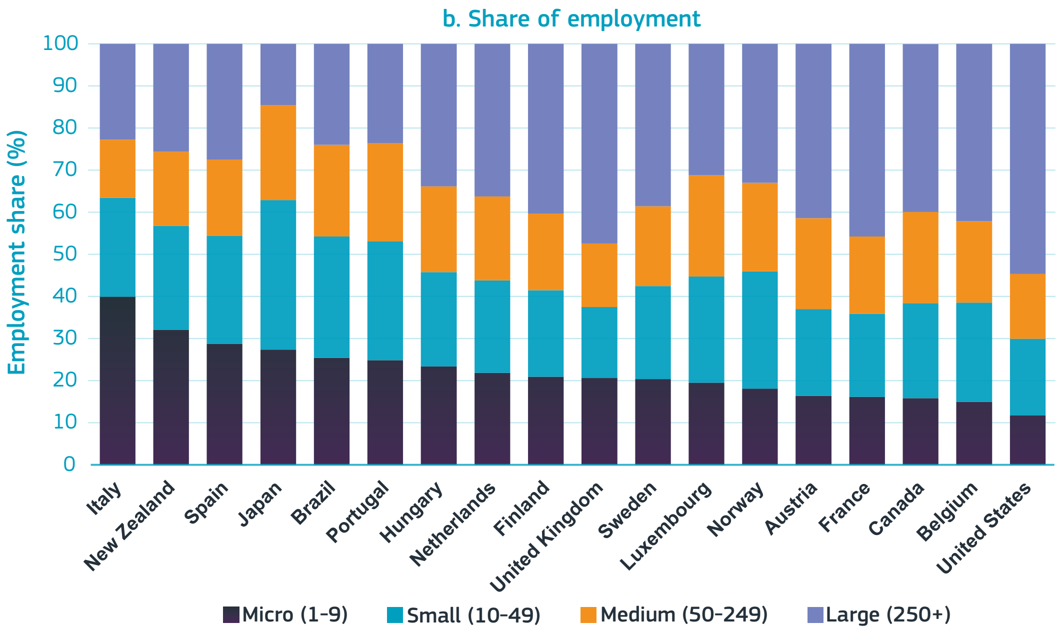
When analysing productivity, being able to use official survey data covering the whole business population, or a random sample of firms that can be made representative by re-weighting using business registers, allows for a reliable and comparable analysis of productivity distributions, the description of trends in productivity dispersion over time, estimation of entry and exit contribution to growth, and many other types of analysis.

Thus, although difficult, the use of these confidential data provides a unique source of information for analysing productivity dispersion within countries and sectors and its trend over time.

4 Apart from a few previous instances when a similar approach was used – in academic circles and within the OECD, the World Bank and more recently the European Central Bank – this procedure is still not widely applied when collecting statistical information. This may have to do with the time required to set up and manage the network as well as developing a well-functioning, 'error-free' program code which is able to both accommodate potential differences across national micro-level databases and minimise the burden on those who have access to the data and run the code.

Figure II.1.8 Firms and employment - % share by size of firm[1]





Science, Research and Innovation performance of the EU 2018

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: Andrews, Criscuolo and Gal, 2016
Note: [1]The period covered is 2001-2011 for BE, CA, FI, HU, NL, UK and US; 2001-2010 for AT, BR, ES, IT, LU, NO and SE; 2001-2009 for JP and NZ; 2001-2007 for FR; and 2006-2011 for PT. Sectors covered: manufacturing, construction, and non-financial business services. Owing to methodological differences, figures may deviate from officially published national statistics. For JP data are at the establishment level, for other countries at the firm level. Average across all available years.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_8.xlsx

4.2 Cross-country evidence on productivity divergence

The large dispersion in productivity even within narrowly defined industries is an established fact in the literature (e.g. Syverson, 2004). This fact is evident for several countries, as shown in Figure II.1.9 which provides a descriptive account of the dispersion in productivity, measured as the difference between the 90th and 10th percentiles of the log productivity distribution. The table shows a significant dispersion in both manufacturing and services between the top and the bottom performing firms in terms of labour productivity (LP) and multi-factor productivity (MFP): on average across countries, firms in the top decile of the distribution can produce almost five times as much value added per worker as firms in the bottom decile in the same country's manufacturing sector, and more than seven times as much in services; similar ratio hold for MFP.

Figure II.1.9 90-10 log productivity differences[1] in 2001

	Log-LP 90-10 diff.		Log-MFP 90-10 diff.	
	Manuf.	Services	Manuf.	Services
Denmark	1.31	1.90	1.19	1.73
Finland	1.19	1.34	1.14	1.22
France	1.30	1.64	1.33	1.62
Hungary	2.45	3.09	2.38	2.83
Italy	1.71	1.93	1.65	1.77
Japan	1.13	1.25	1.02	1.21
Netherlands	1.86	2.69	2.34	2.89
New Zealand	1.93	2.15	1.94	2.00
Norway	1.52	1.96	1.67	1.94

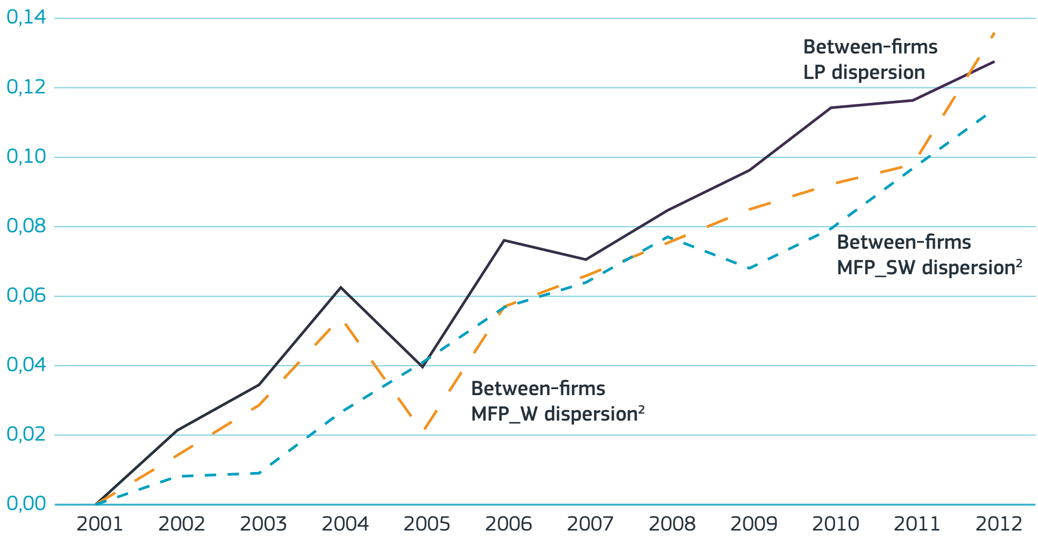
Science, Research and Innovation performance of the EU 2018

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: Berlingieri, Blanchenay and Criscuolo, 2017.
Note: [1]90-10 percentiles log productivity differences, averaged across two-digit sectors using employment and log value-added as weights for labour productivity and MFP respectively.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_9.xlsx

When looking at how the dispersion has evolved over time, the data confirms that even within countries and sectors, productivity dispersion has actually increased substantially. Indeed, the gap between firms in the top 10% by productivity and those in the bottom 10% increased by approximately 14% between 2001 and 2012. Figure II.1.10 shows that within-sector dispersion has increased for both labour and multi-factor productivity, with a remarkably similar pattern across all productivity measures.

Figures included in the appendix illustrate the trend in log-productivity dispersion, which is increasing both in manufacturing and in services within the countries in the sample. For the majority of countries, dispersion in 2012 is higher than in 2001: in services, this is the case for all countries except New Zealand in terms of labour productivity; and in manufacturing, for all but Italy and New Zealand – both in terms of labour and multi-factor productivity.

Figure II.1.10 The 'great divergence' in productivity[1], 2001-2012
90-10 difference in log productivity



Science, Research and Innovation performance of the EU 2018
Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: Berlingieri, Blanchenay and Criscuolo, 2017.
Note: [1]Figure II.1.10 plots the year dummy estimates βt of a regression of log-productivity dispersion (measured as the difference between the 90th and 10th percentiles of log-productivity) within country-sector pairs: $(\log P90 - \log P10)cjt = \alpha + \Sigma t\, \beta t\, yt + zcj + \varepsilon c\, jt$, with reference year y equals to 2001, for a given productivity measure P, and where c denotes countries, j sectors and t years, using data from the following countries: AU, AT, BE, CH, DK, FI, FR, HU, IT, JP, NL, NO, NZ, SE.
[2]Two measures of MFP are provided: an index-based measure (MFP_SW: Solow residuals using cross-country industry-specific labour shares) and the semi-parametric measure à la Wooldridge (2009) (MFP_W).
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_10.xlsx

4.3 Divergence at the top and bottom

An interesting question is whether productivity divergence is driven by an acceleration of frontier firms or by a slowing down of productivity at the bottom relative to the median firm[5]. To answer this question, Berlingieri et al. (2017) estimate the yearly average productivity dispersion within countries and sectors, separately for the top 90-50 and bottom 50-10, differences in the log-productivity distribution.

The estimates suggest that the divergence has happened both at the top and at the bottom of the distribution. The trend highlights that at the beginning of the 2000s, this divide was mainly driven by the bottom performers not keeping up with the median firms. Since the mid-2000s – and especially in the services sector – it has also increasingly been the case that the top performers have left the median firms behind.

In services, the dispersion at the top starts growing after 2005, flattens out slightly during the crisis years before increasing again from 2010. The gap between the median firm and firms in the bottom decile of the distribution has been growing steadily since 2000 and, especially when focusing on trends in MFP dispersion, the crisis has widened the gap even further. In the manufacturing sector, the dispersion at the top declines until 2005, and this pattern contributes significantly to the flat dispersion found in the aggregate economy. After 2005, the dispersion peaks but to a lesser extent compared to services. The dispersion at the bottom still displays higher growth over the period, but is more volatile, especially for MFP.

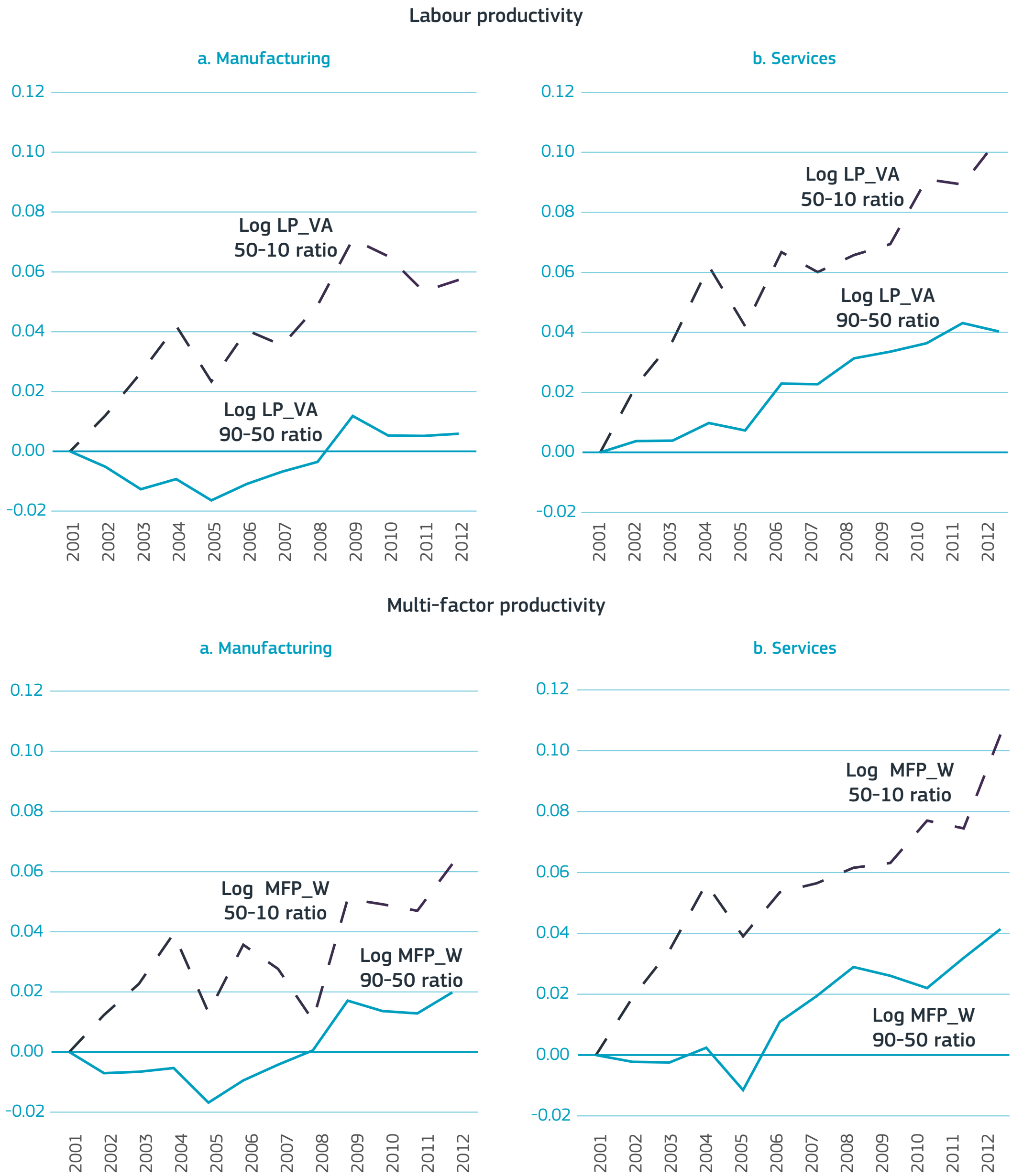
What drives the divergence at the bottom? Two forces could be at work: an increasing gap between the median and the worst-performing firms might reflect faster growth at the median relative to the bottom firms. However, it could also reflect a worsening of the selection effect at the bottom of the distribution, with unproductive firms managing to remain in the market despite their low productivity. This would mean that the process of productivity enhancing resource reallocation has deteriorated since the early 2000s.

Figures II.1.11 and II.1.12 plot the productivity of the 10th, 50th and 90th percentile of the productivity distribution, normalising the year 2001 to 0. In each figure, the left panel represents productivity dispersion in manufacturing and the right panel represents productivity dispersion in (non-financial) market services. The patterns differ markedly between manufacturing and services. In manufacturing, with the exception of the Great Recession, productivity has increased for all quantiles of the productivity distribution, although the increase is smaller for the least productive firms. This is in line with the hypothesis of accelerating growth for the median firms. In contrast, in services, productivity has largely remained flat for the median firms but has actually declined substantially for the least productive firms, suggesting a break down in the process of 'creative destruction'.

Figures a and B in the appendix show the same results for individual countries. They suggest that both forces – the improved performance by median firms and the deteriorated selection at the bottom – might have been at work but to a different extent in different countries.

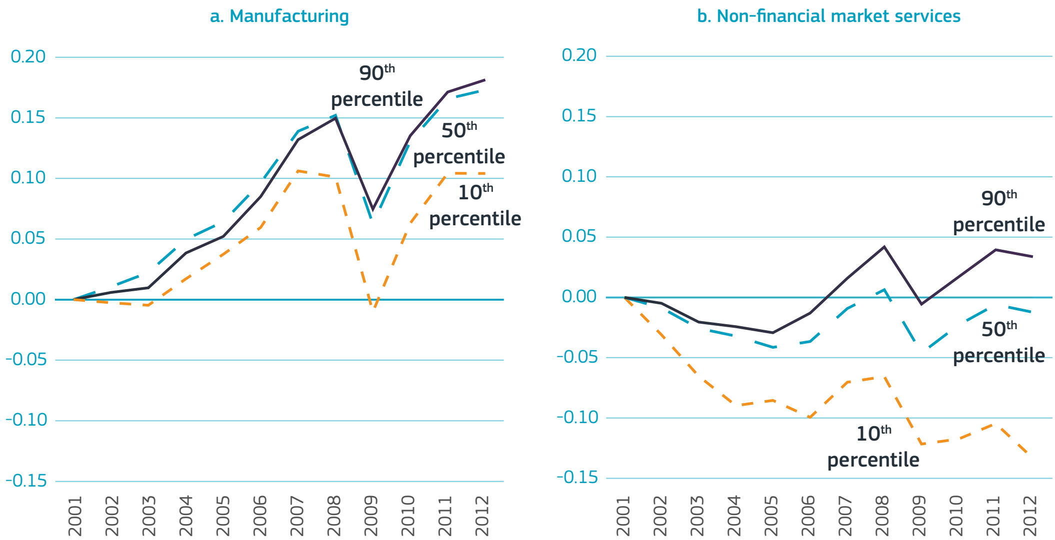
5 Given the limitation of the data used in Andrews et al., 2016, discussed above, and heterogeneous changes in data coverage across countries, especially among small businesses, this analysis was not possible there.

Figure II.1.11 Labour productivity dispersion - top versus bottom of the labour and MFP productivity distribution, for manufacturing and services[1], 2001-2012



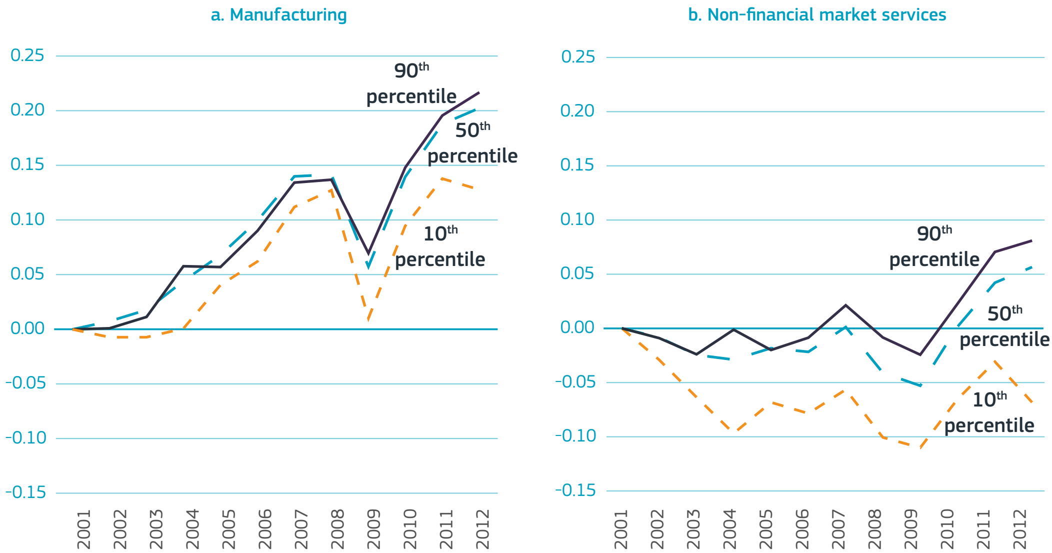
Source: DG Research and Innovation – Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: Berlingieri, Blanchenay and Criscuolo, 2017.
Note: [1]Figure II.1.11 plots the year dummy estimates of a regression of log-productivity dispersion at the top (90th and 50th percentiles difference, solid line) and at the bottom (50th and 10th percentiles difference, dashed line) within country-sector pairs, separately for manufacturing and services. Countries: AU, AT, BE, CL, DK, FI, FR, HU, IT, JP, NL, NO, NZ, SE.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_11.xlsx

Figure II.1.12 Trends for top, median and bottom decile of the (log) LP distribution[1], 2001-2012



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: Berlingieri, G., et al. (2017), "The Multiprod project: a comprehensive overview", OECD Science, Technology and Industry Working Papers, No.2017/04, OECD Publishing, Paris. http://dx.doi.org/10.1787/2069b6a3-en
Note: [1]Log labour productivity in the 10th, 50th and 90th percentile of the productivity distribution, for manufacturing (left panel) and non-financial market services (right panel) since 2001. The countries included are: AU, AT, BE, CH, DK, FI, FR, HU, IT, JP, NL, NO, NZ, SE. The graphs can be interpreted as the cumulated growth rates of LP within each country and sector over the period. For instance, in 2012 in manufacturing the 90th quantile of productivity is roughly 19% higher than in 2001. The estimates reported in the graph are those of year dummies in a cross-country regression of log-productivity in the 90th, 50th and 10th percentile of the distribution.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_12.xlsx

Figure II.1.13 Trends for top, median and bottom decile of the (log) MFP distribution[1], 2001-2012



Science, Research and Innovation performance of the EU 2018

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies

Data: Berlingieri, G., et al. (2017), "The Multiprod project: a comprehensive overview", OECD Science, Technology and Industry Working Papers, No. 2017/04, OECD Publishing, Paris. http://dx.doi.org/10.1787/2069b6a3-en

Note: [1]Log-MFP (Wooldridge) in the 10th, 50th and 90th percentile of the productivity distribution, for manufacturing (left panel) and non-financial market services (right panel) since 2000. The countries included are: AU, AT, BE, CH, DK, FI, FR, HU, IT, JP, NL, NO, NZ. The graphs can be interpreted as the cumulated growth rates of MFP within each country and sector over the period. For instance, in 2012 in manufacturing the 90th quantile of productivity is roughly 24% higher than in 2001. The estimates reported in the graph are those of year dummies in a cross-country regression of log-productivity in the 90th, 50th and 10th percentile of the distribution.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_13.xlsx

5. The link between productivity divergence and greater wage inequality

As discussed in Section 2.2, a large part of the overall increase in wage inequality is due to greater differences in average wages across firms. This section explores between-firm wage inequality, its link with productivity dispersion, and the effect of policies on both types of dispersion and the link between them over time.

5.1 Between-firm wage inequality and its link to productivity divergence

Figure II.1.13 describes the 90-10 log-wage ratio (solid line) which compares wages in firms in the top 10% of the wage distribution with wages in those at the bottom 10%. It shows an upward trend indicating an increase in wage differentials between firms within the same sectors: by 2012, the 90-10 wage ratio is 12.3% higher than in 2001. The increase in between-firm wage dispersion is in the same ballpark as the increase in overall earnings inequality (the broken line in Figure II.1.13). Hence, by analysing wage inequality between firms, we can go a long way in understanding what drives overall wage inequality.

Thus, the divergence in firms' productivity within country-sector pairs is matched by a divergence in wages across both firms and workers in the overall economy. Interestingly, the trends for wages are also similar to those for productivity divergence when analysing separately the upper tail wage inequality – the wage at the 90th percentile (the wage paid by a firm in the top 10% of wage distribution) relative to the 50th percentile (the firm right in the middle) and lower tail wage inequality. Berlingieri et al. (2017) show that the gap in the average wage between the bottom decile and the median grew faster between 2001 and 2012 than the gap between the median and the top decile – i.e. lower-tail inequality grew faster than upper-tail inequality. In the latter, there is even evidence of a small degree of convergence in the early 2000s, which then disappears in the second half of the decade when there is also divergence at the top.

These parallel trends in dispersion both at the bottom and the top (Figure II.1.14) suggest that the distribution of wages and productivity are linked. Econometric estimates of the correlation between the divergence in wages and divergence in productivity do indeed show a significant positive correlation, even after accounting for a sector's workforce or firm-age composition. An increase of one standard deviation in the dispersion of logged labour productivity (MFP respectively) correlates with an increase of 25.5% in logged wage dispersion (19.5% respectively).

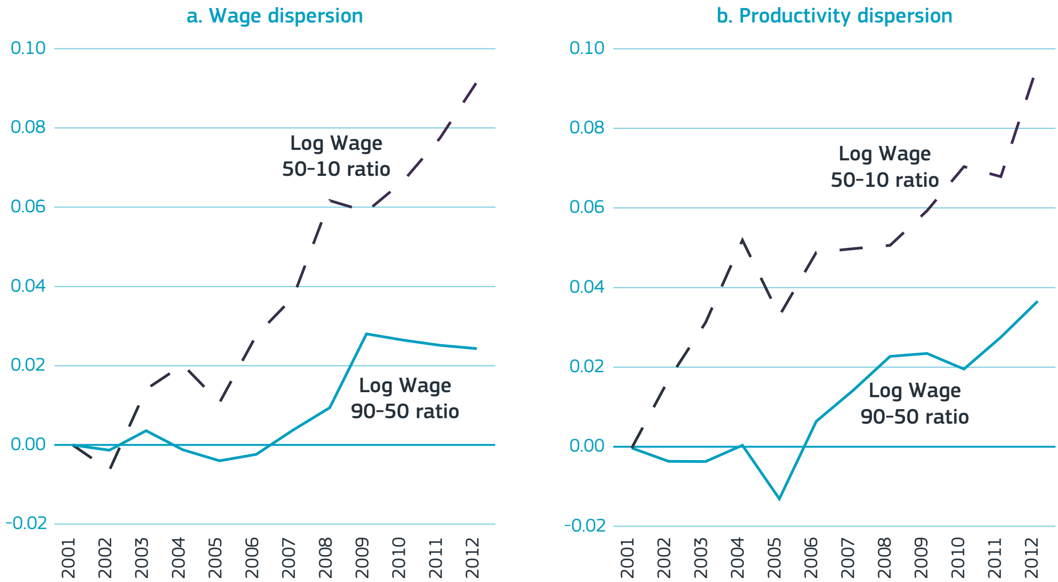
A different way of looking at the link between wages and productivity along their distribution is to analyse the wage distribution conditional on the productivity distribution: i.e. looking at the evolution of wage productivity deciles. Figure II.1.15 indicates the average wages in the top, bottom and the 4th to 6th decile of the labour productivity distribution. The evidence suggests that wage inequality between firms with different productivity performance has increased, in a very similar way to how productivity dispersion has increased. There are, nonetheless, some important cross-sectoral differences in the magnitude of the gap between wages in the most productive firms and those in the worst performing firms. Among the most productive firms, wages have increased more in the service sector than in manufacturing. Again, there are significant differences across countries (see Figures E and F in the appendix) suggesting that structural differences across countries, institutions and policies may play an important role.

Figure II.1.14 Increased earning inequality and increased between-firms wage dispersion[1], 2001-2012

Science, Research and Innovation performance of the EU 2018

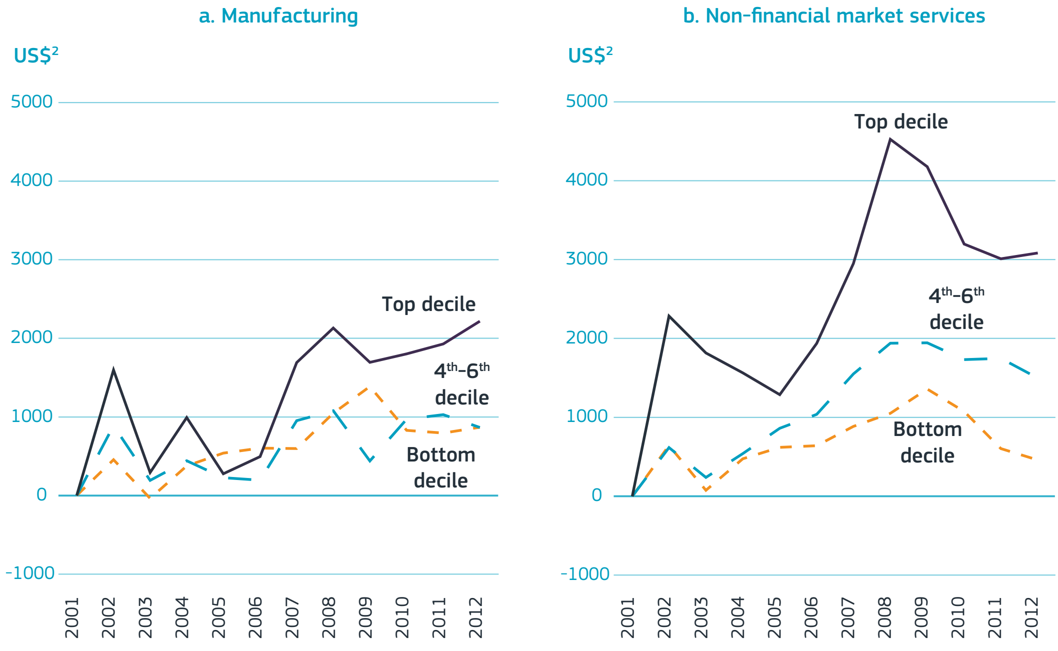
Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: Berlingieri, Blanchenay and Criscuolo, 2017.
Note: [1]Figure II.1.14 plots the estimated year dummies of a regression of log-wage dispersion (90th and 10th percentiles ratio) within country-sector pairs, using data from the following countries: AU, AT, BE, CL, DK, FI, FR, HU, IT, JP, NL, NO, NZ, SE. The line referring to overall earnings inequality plots the estimated year dummies of a similar regression using the dispersion in earnings from the OECD Earnings Distribution database within each country. The data on overall earnings inequality are only available at the country level and for a more limited set of countries: FI, FR, HU, JP, NO, NZ for the whole period; AU, IT, SE from 2002; and NL between 2002 and 2010.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_14.xlsx

Figure II.1.15 Upper-tail and lower-tail wage and productivity divergence[1]



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: Berlingieri, Blanchenay and Criscuolo, 2017.
Note: [1]The figure in panel a [resp. b] plots the estimated year dummies of a regression of log-wage [resp. log-MFP] dispersion at the top (90th to 50th percentiles ratio, solid line) and at the bottom (50th to 10th percentiles ratio, dashed line) within country-sector pairs, using data from the following countries: AU, AT, BE, CL, DK, FI, FR, HU, IT, JP, NL, NO, NZ, SE.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_15.xlsx

Figure II.1.16 Change in real wages in different parts of the productivity distribution of firms[1], 2001-2012



Science, Research and Innovation performance of the EU 2018

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies
Data: Berlingieri, Blanchenay and Criscuolo, 2017.
Notes: [1]The countries included are: AT, BE, CH, DK, FI, HU, IT, JP, NL, NO. The graphs can be interpreted as the cumulated increase of average wages within each country and sector over the period. For instance, in 2012 in manufacturing the average wage paid by the 10% most productive firms is on average roughly 2,000 US dollars higher than in 2001. The estimates reported in the graph are those of year dummies in a cross-country regression of the average wage in the bottom, top and 4th to 6th decile of the productivity distribution. [2]PPP$ at constant 2005 prices and exchange rates.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_ii_1_16.xlsx

5.2 Effect of policies

While it is expected that in well-functioning markets wages reflect labour productivity, so that dispersion in wages could be linked to dispersion in productivity, the literature has suggested that this could be further strengthened by the fact that the most productive workers increasingly work for the most productive firms. For example, there is evidence of a clustering of highly skilled workers in high-paying firms (Bagger et al., 2013), as well as more use of the outsourcing of non-core, low-value-added, low-pay activities (Goldschmidt and Schmieder, 2015). Rent sharing – i.e. workers in high-profit/high-productivity firms enjoying a share of the firms' rents – also plays a role in explaining this trend (Card et al., 2014; Card et al., 2013). Therefore, it is important to understand whether structural changes, such as globalisation, and digitalisation, and policies, in particular labour market institutions and policies affect the link between productivity and wages.

Berlingieri et al. (2017) find that globalisation and digitalisation are not only associated with a rise in between-firm wage inequality, but they also reinforce the link between wages and productivity dispersion. In sectors where firms increase the use of information and communications technologies (ICT) over time, wage dispersion grows faster, which suggests that ICT affects firms heterogeneously. In sectors that become more open to trade through either imports or exports, not only has wage dispersion risen but its link with productivity dispersion has also been strengthened (see also Helpman et al., 2017).

Country-specific policies and institutions also play a role in shaping the evolution of wage and productivity dispersions and the link between them. a significant amount of evidence has been gathered on the role of policy and institutions for explaining the observed increase in wage dispersion, in particular the decline in real minimum wage and, for the UK and the US, the decline in unionisation. For continental European economies, the focus has been on the degree of centralisation of wage bargaining, and where greater decentralisation is typically associated with higher wage dispersion. Berlingieri et al. focus on the role of wage-setting institutions and labour market features: minimum wages (in terms of both the hourly real minimum wage and the minimum relative to average wages of full-time workers); employment protection legislation (strictness of employment protection for both individual and collective dismissals); trade union density; and the coordination of wage setting.

The results of their analysis suggest that all these policies have the intended consequence of reducing wage dispersion and hence overall inequality. At the same time, they affect the link between wage and productivity dispersion. For example, more centralised bargaining is associated with a weaker link between productivity and wage dispersion, while this is not the case for changes in employment protection legislation and union density, the effects of which are significant only in the cross-section but not over time. Although more centralised bargaining can thus help to limit wage dispersion, at the same time it weakens the link between wages and productivity dispersion, which might be detrimental for long-term growth. Conversely, minimum wage policies, while also reducing wage dispersion, are associated with a stronger link between wage and productivity dispersion over time, which could benefit long-term growth.

6 Conclusions

Productivity growth plays a central role in shaping the welfare of societies and the competitiveness of countries. Productivity differences, for instance, explain a large share of the differences in income per capita across countries. But as firm-level productivity can vary widely, even within narrowly defined industries, analysing aggregate or even industry-average productivity data cannot provide the evidence needed to understand the complex dynamics that characterise our economies.

Aggregate productivity performance is the result of the productivity performance of heterogeneous firms as well as the process of resource reallocation among those firms, and of creative destruction enabling new companies to enter the market and inefficient firms to exit it.

Ongoing OECD research is using firm-level data to explore three main features of OECD and European economies over recent decades: global productivity slowdown, greater divergence in productivity performance across firms, and an increase in earnings inequality.

Recent research has shown that the within-firm productivity growth of laggards has worsened during the last decade leading to a slowdown in the convergence towards the best performing firms, the frontier, and also that the process of reallocation has worsened. The two may be closely linked as a weakening in the reallocation process might translate into fewer incentives for incumbents to innovate and improve their productivity. The rise in productivity dispersion, which is evident not only globally within sectors but also within countries, is significantly related to the observed increase in earnings inequality. This is yet another reason to search for policies that include productivity divergence as they may carry a double dividend for inclusiveness to the extent that the observed rise in wage inequality is closely related to the rising dispersion in average wages paid across firms (Card et al., 2013; Song et al., 2016). This is particularly evident in sectors that are more open to trade and are more ICT-intensive. As expected, wage-setting institutions affect the distribution of wages, although recent OECD research shows that they also have an indirect effect by impacting the link between productivity and wage dispersion.

To promote productivity growth, it is important to provide incentives for advancing the productivity frontier, helping laggards to catch up, and facilitating the reallocation of resources to their most productive use.

Effective innovation policies are crucial for extending the global frontier. They must provide the right incentives for researchers to continue investing in basic research and breakthrough innovations. In addition, given the increasingly key role of transnational corporations, they should coordinate investment efforts across the globe, both in basic and applied research, via policies such as R&D tax incentives, corporate taxation and IPR regimes.

The ability of laggards to catch up with more innovative firms depends on greater domestic and international competition and the international mobility of skilled workers who will facilitate the diffusion of existing technologies to the lagging firms. Once again, this is an area where policy has a significant role to play.

Finally, an effective reallocation process requires well-functioning product, labour and risk capital markets as well as the implementation of policies that do not result in resources being ‘trapped’ in inefficient firms. This includes efficient judicial systems and bankruptcy laws that do not excessively penalise failure. The latter are particularly important as recent evidence suggests that they affect disproportionally more start-ups in high-risk sectors (Calvino et al., 2016). Framework policies that reduce barriers to firm entry and exit have also been found to improve reallocation and productivity performance.

Finally, given the important role of different policies, coordination across different policy areas within countries as well as greater collaboration in the analysis of productivity and the effective sharing of good practices across countries are needed for productivity to become the driver of strong and inclusive growth.

References:

Aghion, P. and P. Howitt, (1992). a Model of Growth Through Creative Destruction, *Econometrica* 60, no. 2: 323-351.

Aghion, P., Bergeaud, A., Boppart, T., Klenow, P. and Li, H. (2017). Missing Growth from Creative Destruction, Mimeo, http://www.klenow.com/missing-growth.pdf

Andrews, D., C. Criscuolo and Gal, P. (2017). The Best vs the Rest: The Global Productivity Slowdown Hides an Increasing Performance Gap across Firms, VoxEU.org, 27 March.

Autor, D.H., F. Levy and Murnane, R.J. (2003). The Skill Content of Recent Technological Change: An Empirical Exploration, *The Quarterly Journal of Economics*, Vol. 118, No. 4, pp. 1279-1333.

Bagger, J., K.L. Sørensen and Vejlin, R. (2013), Wage Sorting Trends, Economics Letters 118(1): 63-67.

Bartelsman, E., J. Haltiwanger and Scarpetta, S. (2013). Cross-Country Differences in Productivity: The Role of Allocation and Selection, *American Economic Review*, 103(1): 305-34.

Barth, E., Bryson, A., J.C. Davis and Freeman, R. (2014). It's Where You Work: Increases in Earnings Dispersion across Establishments and Individuals in the U.S., *NBER Working Paper* No. 20447, National Bureau of Economic Research.

Baumgarten, D. (2013). Exporters and the Rise in Wage Inequality: Evidence from German Linked Employer-Employee Data, *Journal of International Economics*, Vol. 90, No. 1, pp. 201-217.

Berlingieri, G., P. Blanchenay and Criscuolo, C. (2017). The Great Divergence(s), OECD Science, Technology and Industry Policy Papers No. 39, OECD Publishing, Paris: http://dx.doi.org/10.1787/953f3853-en

Brynjolfsson, E. and McAfee, A. (2011). Race Against The Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy, Digital Frontier Press.

Byrne, D., J. Fernald and Reinsdorf, M. (2016). Does the United States have a productivity slowdown or a measurement problem? Brookings Papers on Economic Activity Conference Draft, March 10-11, 2016.

Card, D., A.R. Cardoso and Kline, P. (2016b). Bargaining, Sorting, and the Gender Wage Gap: Quantifying the Impact of Firms on the Relative Pay of Women, *The Quarterly Journal of Economics*, Vol. 131, No. 2, pp. 633-686.

Card, D., F. Devicienti and Maida, A. (2014). Rent-Sharing, Holdup, and Wages: Evidence from Matched Panel Data, *Review of Economic Studies* 81(1): 84-111.

Card, D., J. Heining and Kline, P. (2013). Workplace Heterogeneity and the Rise of West German Wage Inequality, *Quarterly Journal of Economics* 128(3): 967-1015.

Christensen, B. and Bagger, J. (2014). Wage and Productivity Dispersion: The Roles of Rent Sharing, Labor Quality and Capital Intensity, *2014 Meeting Papers* No. 473, Society for Economic Dynamics.

Criscuolo, C., Gal, P. and Menon, C. (2014). The Dynamics of Employment Growth: New Evidence from 17 Countries, OECD STI Policy Papers No. 14.

Davis, S.J. and Haltiwanger, J. (1992). Gross Job Creation, Gross Job Destruction, and Employment Reallocation, *The Quarterly Journal of Economics*, Vol. 107, No. 3, pp. 819-863.

Decker, R., Haltiwanger, J., Jarmin, R.S. and Miranda, J. (2014). The role of entrepreneurship in U.S. job creation and economic dynamism, *Journal of Economic Perspectives* (28), pp. 3-24.

Decker, R., Haltiwanger, J., Jarmin, R.S. and Miranda, J. (2016). Where Has All the Skewness Gone? The Decline in High-Growth (Young) Firms in the U.S, *European Economic Review* 86 (July): 4-23.

Dunne, T., Foster, L., Haltiwanger, J. and Troske, K.R. (2004). Wage and Productivity Dispersion in United States Manufacturing: The Role of Computer Investment, *Journal of Labor Economics*, Vol. 22, No. 2, pp. 397-430.

Faggio, G., Salvanes, K.G. and Van Reenen, J. (2010). The Evolution of Inequality in Productivity and Wages: Panel Data Evidence, *Industrial and Corporate Change*, Vol. 19, No. 6, pp. 1919-1951.

Goldschmidt, D. and Schmieder, J.F. (2015). The Rise of Domestic Outsourcing and the Evolution of the German Wage Structure, NBER Working Paper No. 21366, National Bureau of Economic Research.

Gordon, R. (2012). Is U.S. Economic Growth Over? Faltering Innovation Confronts the Six Headwinds, NBER Working Papers, No. 18315.

Groshen, E.L., Moyer, B.C., Aizcorbe, A.M., Bradley, R. and Friedman, D.M. (2017). How Government Statistics Adjust for Potential Biases from Quality Change and New Goods in an Age of Digital Technologies: a View from the Trenches, *Journal of Economic Perspectives*, 31(2): 187-210.

Håkanson, C., Lindqvist, E. and Vlachos, J. (2015). Firms and skills: the evolution of worker sorting, *Working Paper Series* No. 9, IFAU - Institute for Evaluation of Labour Market and Education Policy.

Helpman, E., Itskhoki, O., Muendler, M.A. and Redding, S. (2017). Trade and Inequality: From Theory to Estimation, *Review of Economic Studies* 84(1): 357-405.

Mokyr, J. (2014). The Next Age of Invention: Technology's future is brighter than pessimists allow, in Brian C. Anderson ed., *City Journal*, Manhattan Institute, Winter 2014, pp. 14-20.

Mortensen, D. (2003). *Wage Dispersion: Why are Similar Workers Paid Differently*?, Zeuthen lecture book series, MIT Press, Cambridge, Massachusetts.

OECD (2015). *The Future of Productivity*, OECD Publishing, Paris.

OECD (2016). *The Productivity-Inclusiveness Nexus*, OECD Publishing, Paris.

Piketty, T. (2014). *Capital in the 21st Century*, Harvard University Press, Cambridge, Massachusetts.

Song, J., Price, D.J., Guvenen, F., Bloom, N. and von Wachter, T. (2015). Firming up Inequality, NBER Working Papers, No. 21199.

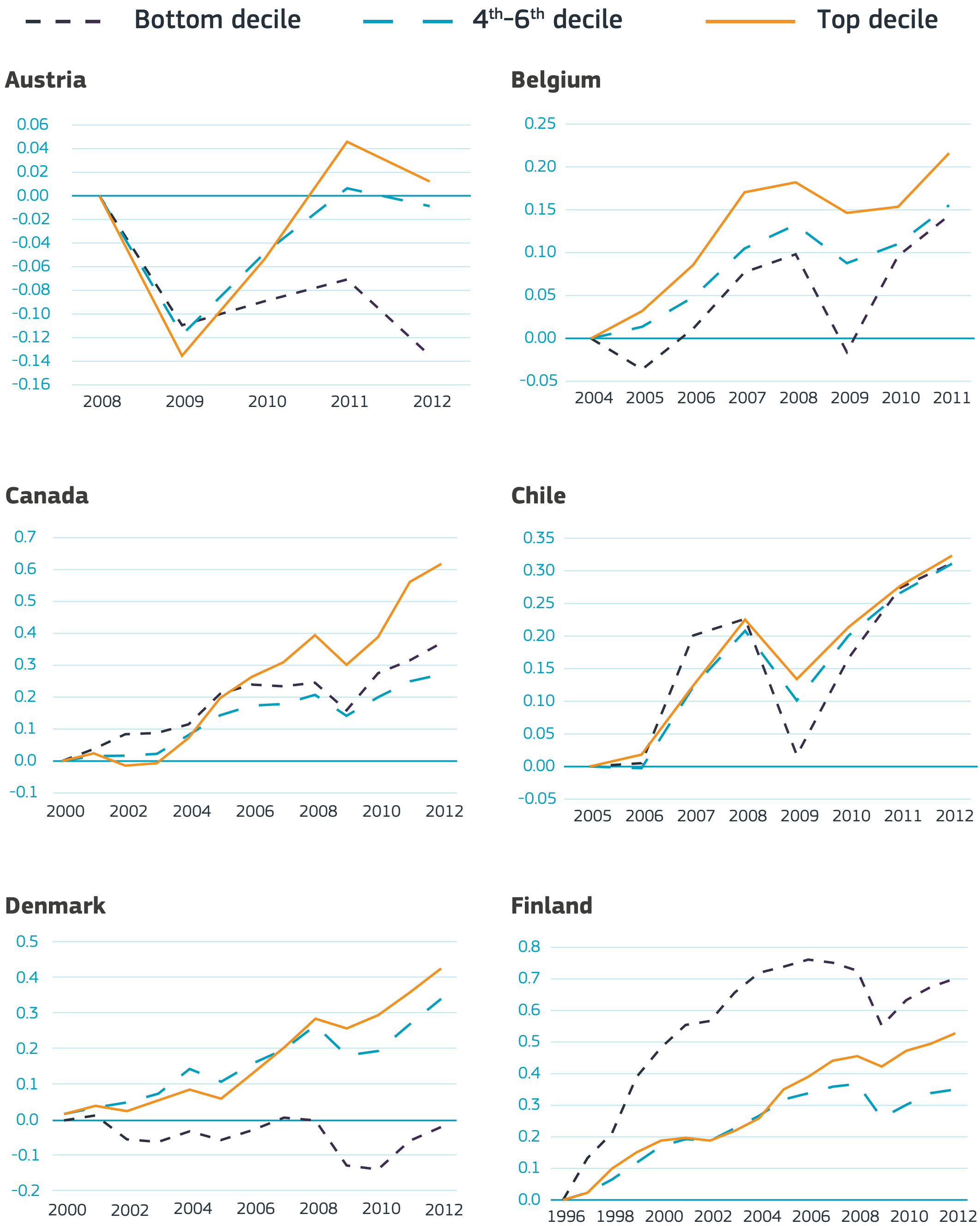
Syverson, C. (2004). Product Substitutability and Productivity Dispersion, *Review of Economics and Statistics*, May 2004.

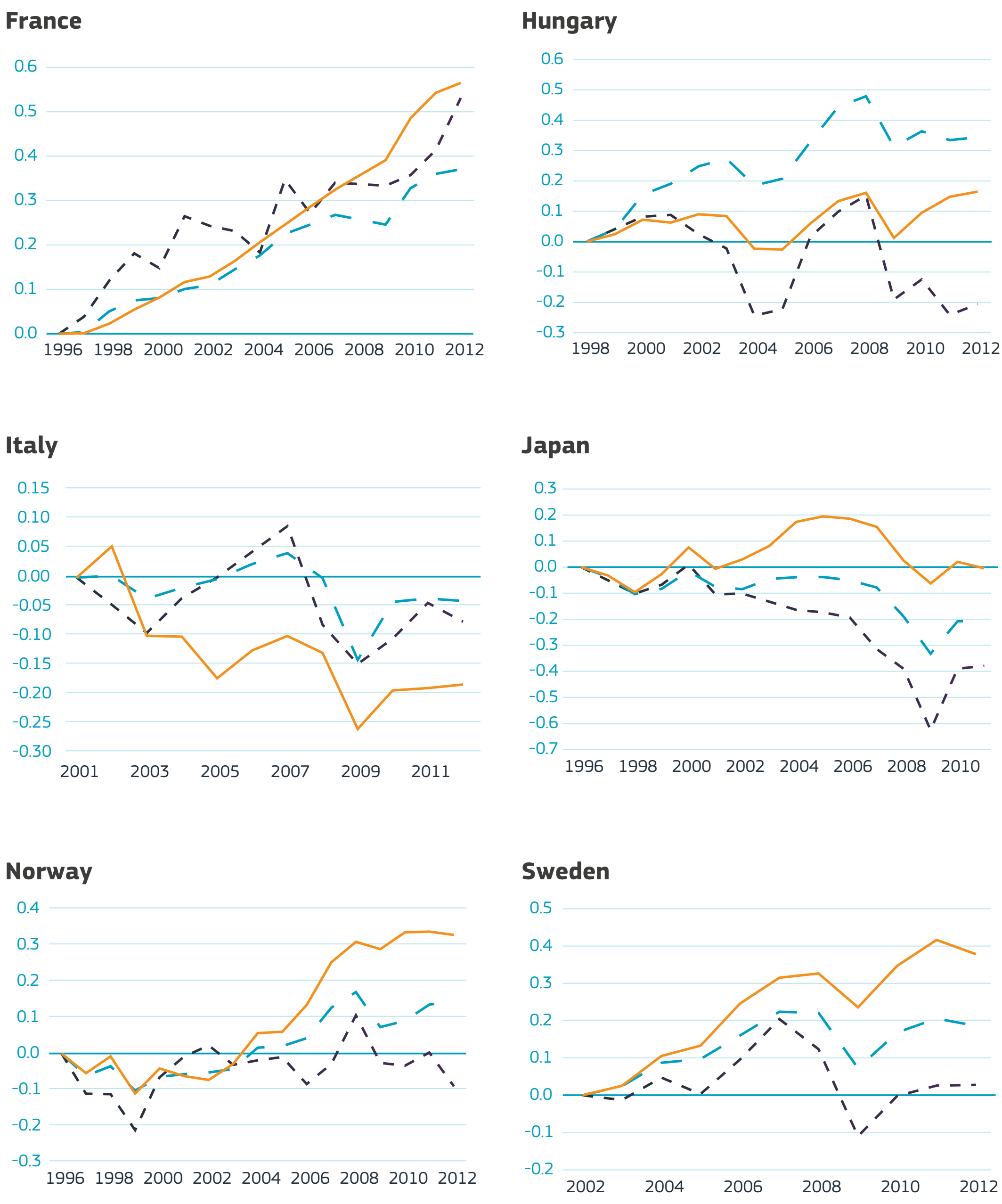
Syverson, C. (2016). Challenges to Mismeasurement Explanations for the U.S. Productivity Slowdown, NBER Working Paper No. 21974.

Varian, H. (2016). a microeconomist looks at productivity: a view from the Valley, presentation at "Slow growth in productivity: Causes, consequences, and policies", 8 September 2016, Brookings, Washington DC: https://www.brookings.edu/wp-content/uploads/2016/08/varian.pdf.

Appendix

Figure a Divergence in labour productivity performance[1] in the manufacturing sector



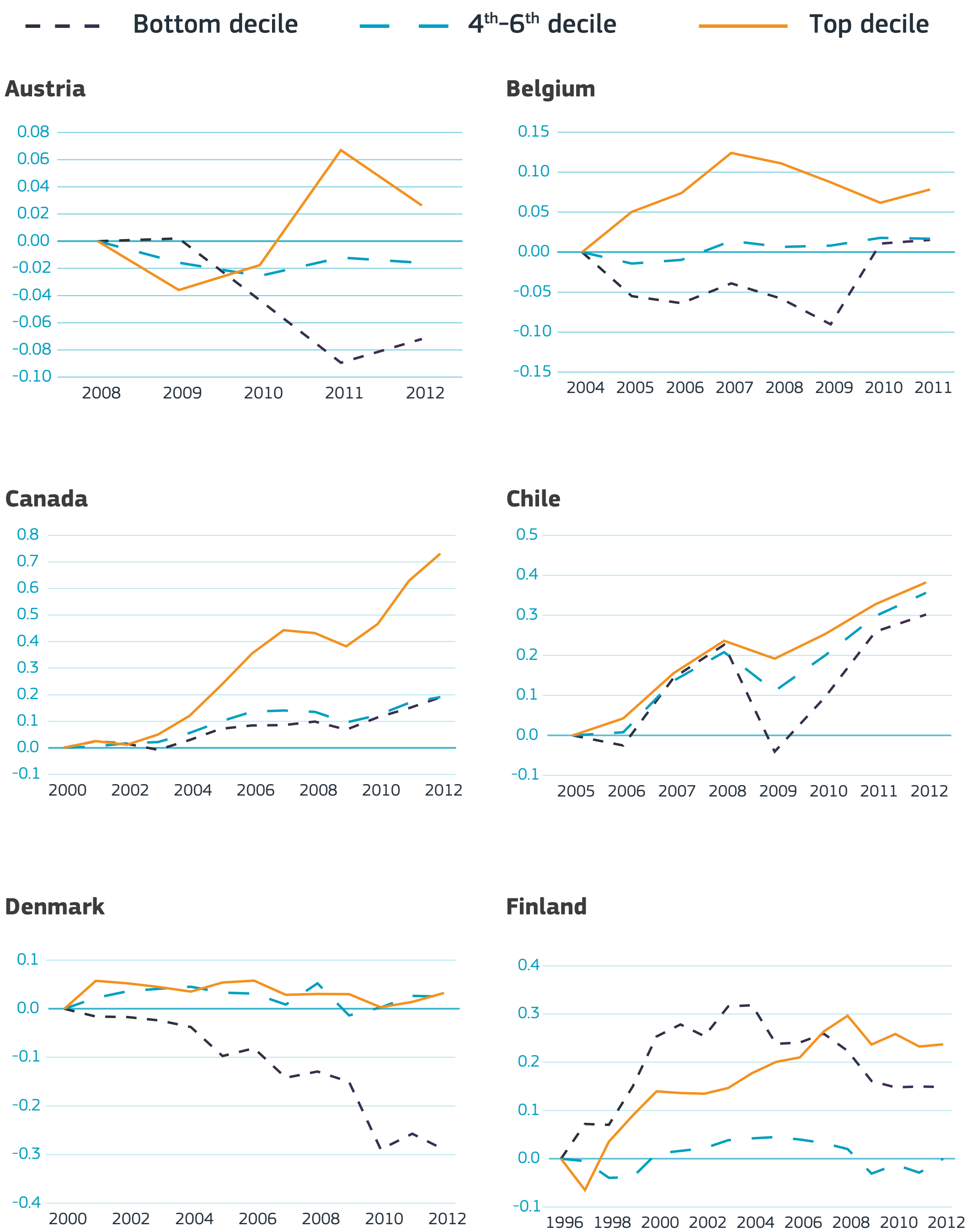


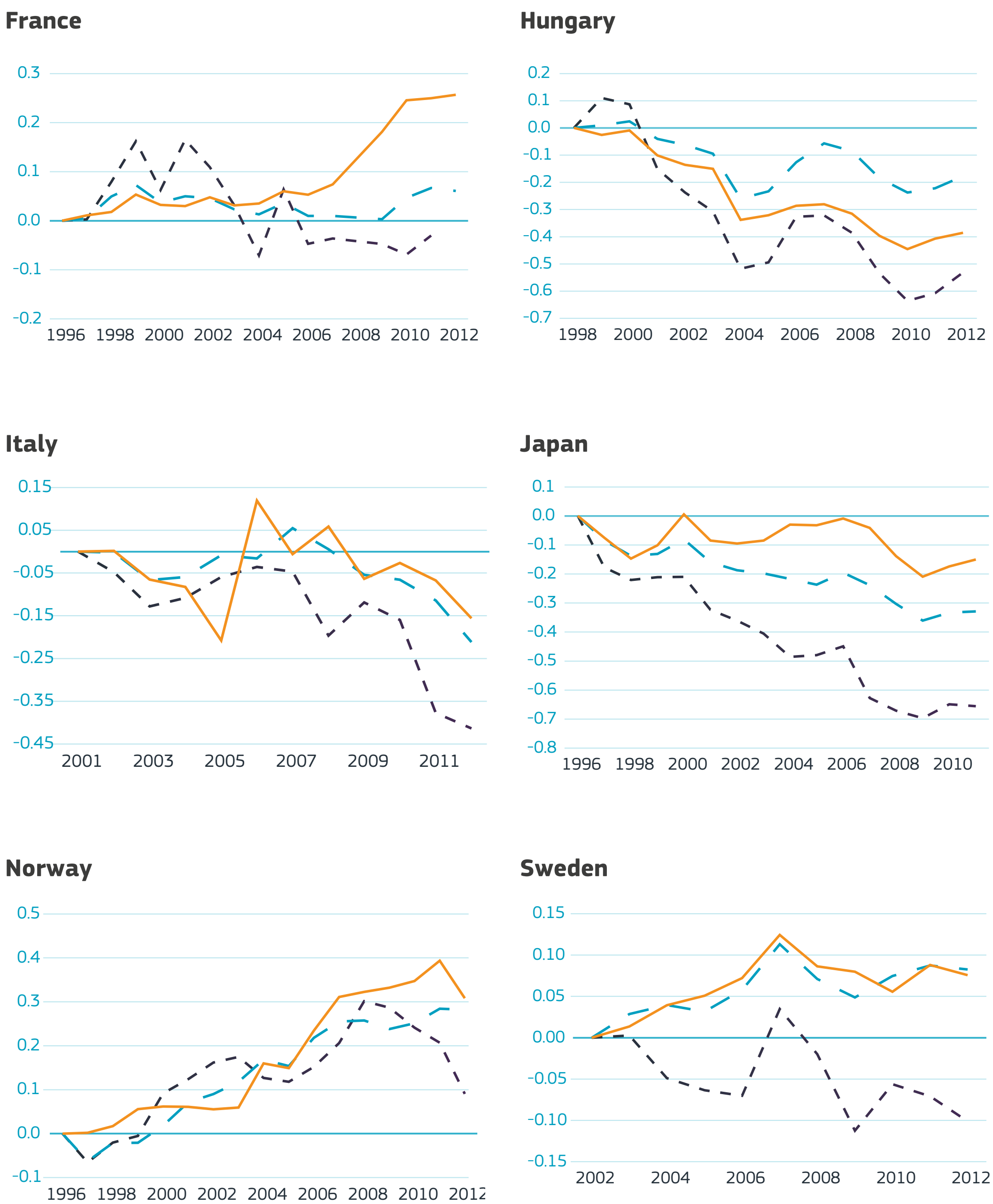
Source: Data from the OECD Multiprod project, preliminary results, April 2016.

Note: [1]Figure a 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.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_a_1_.xlsx

Figure B Divergence in labour productivity performance[1] in the services sector



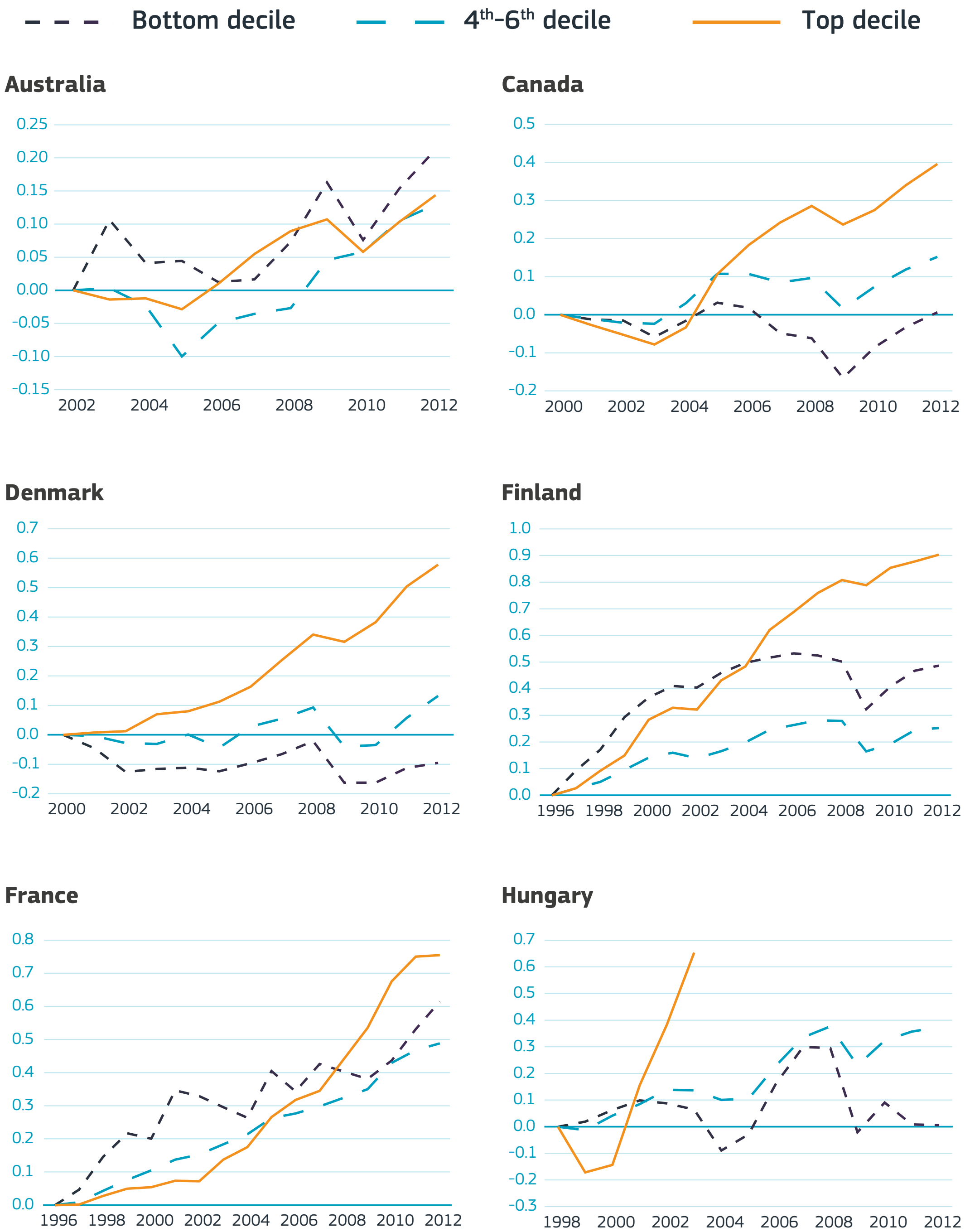


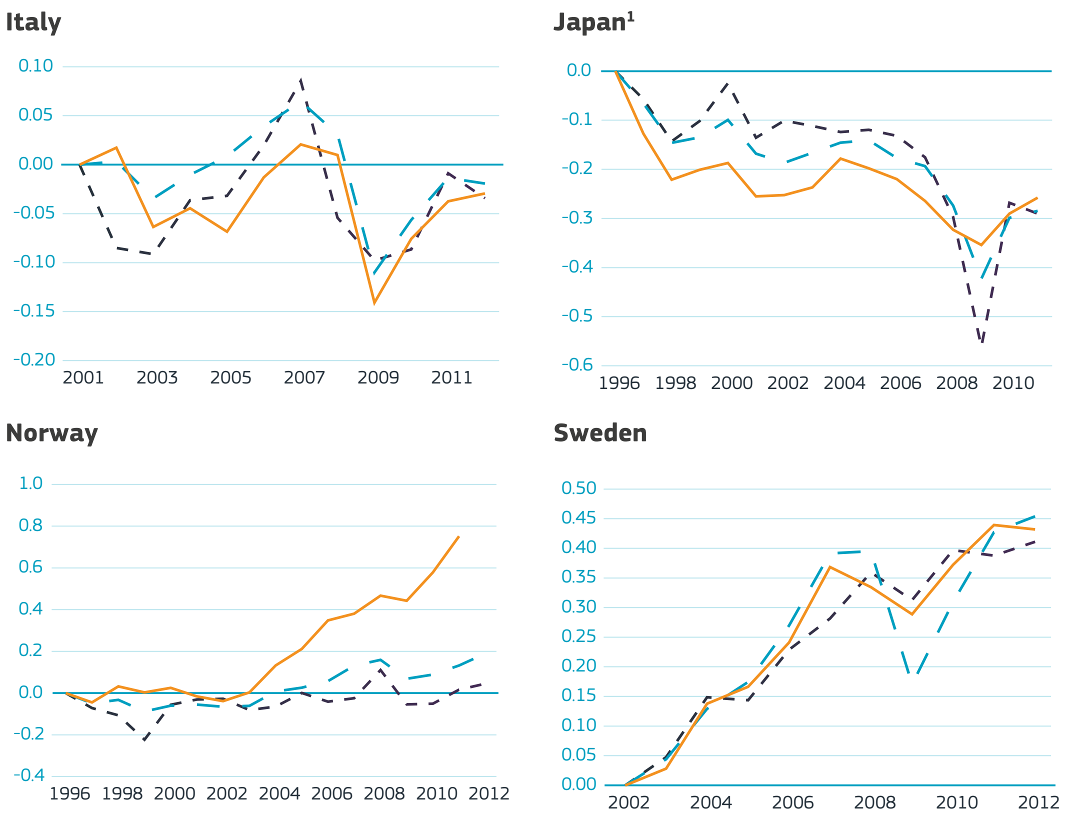
Source: Data from the OECD Multiprod project, preliminary results, April 2016.

Note: [1]Figure B 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.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_a_2.xlsx

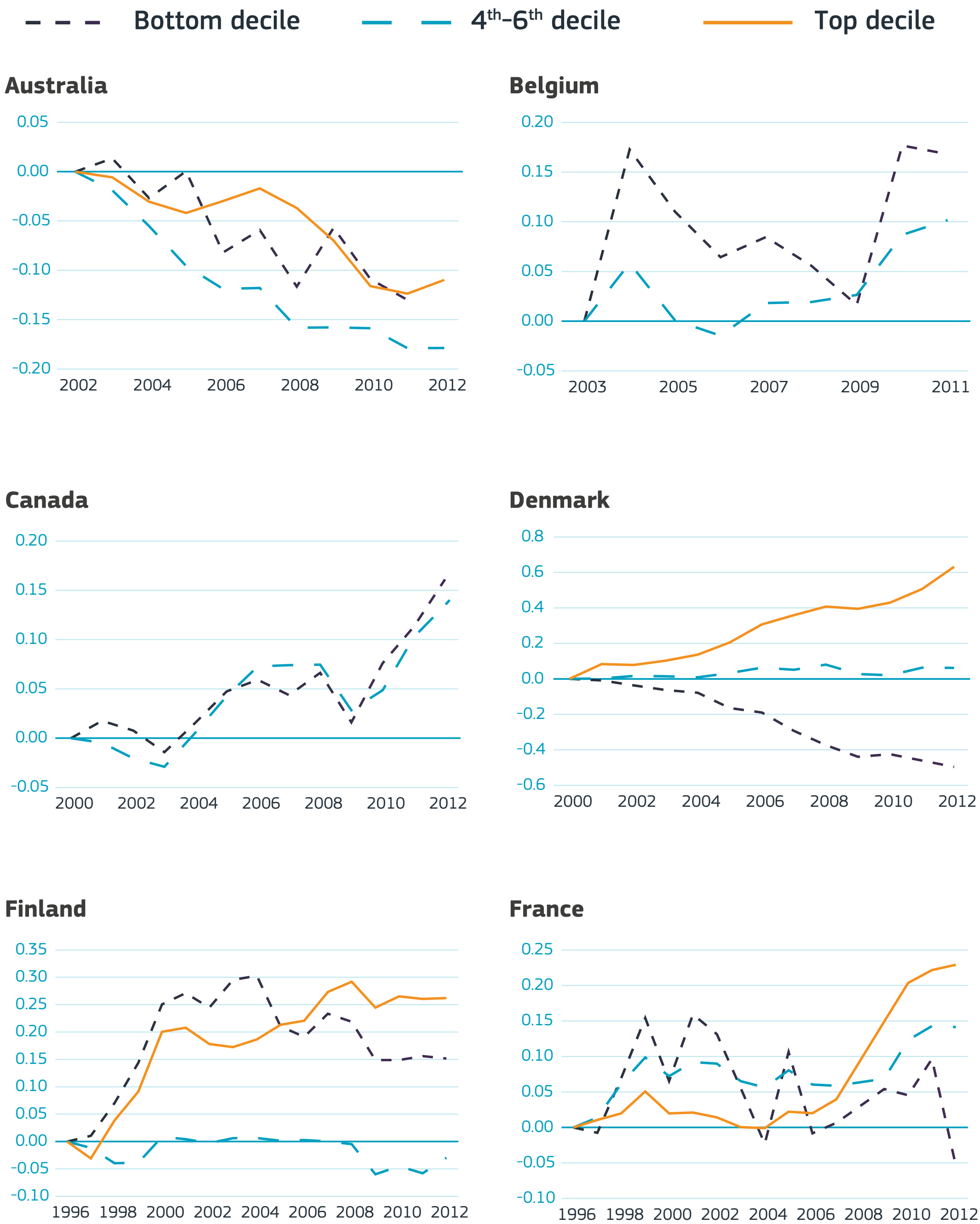
Figure C Polarisation of MFP-Wooldridge in the manufacturing sector





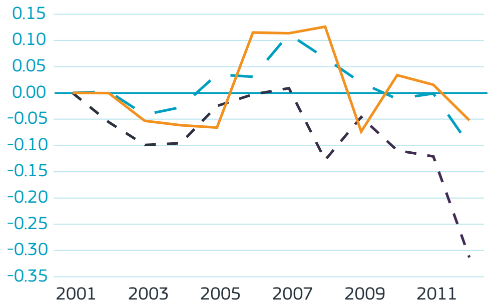
Source: Data from the OECD Multiprod project, preliminary results, February 2016.
Note: [1]Data for Japan only includes firms above 50 employees.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_a_3.xlsx

Figure D Polarisation of MFP-Wooldridge in the services sector

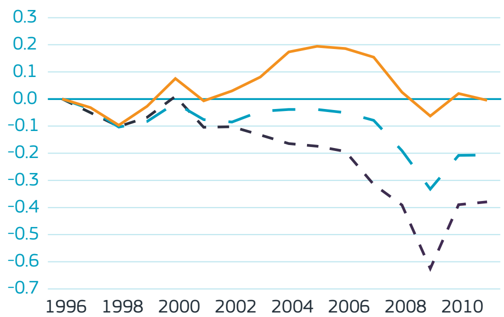


Hungary

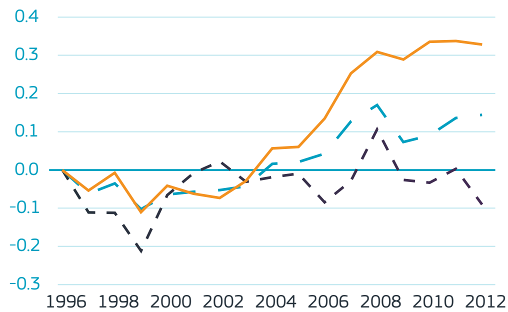
Italy



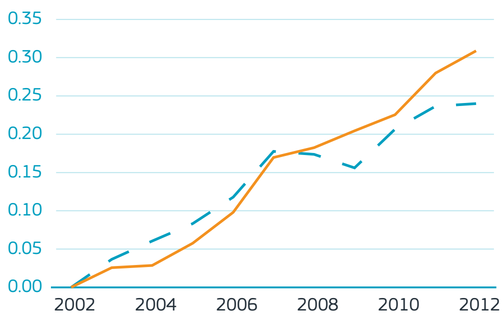
Japan[1]



Norway

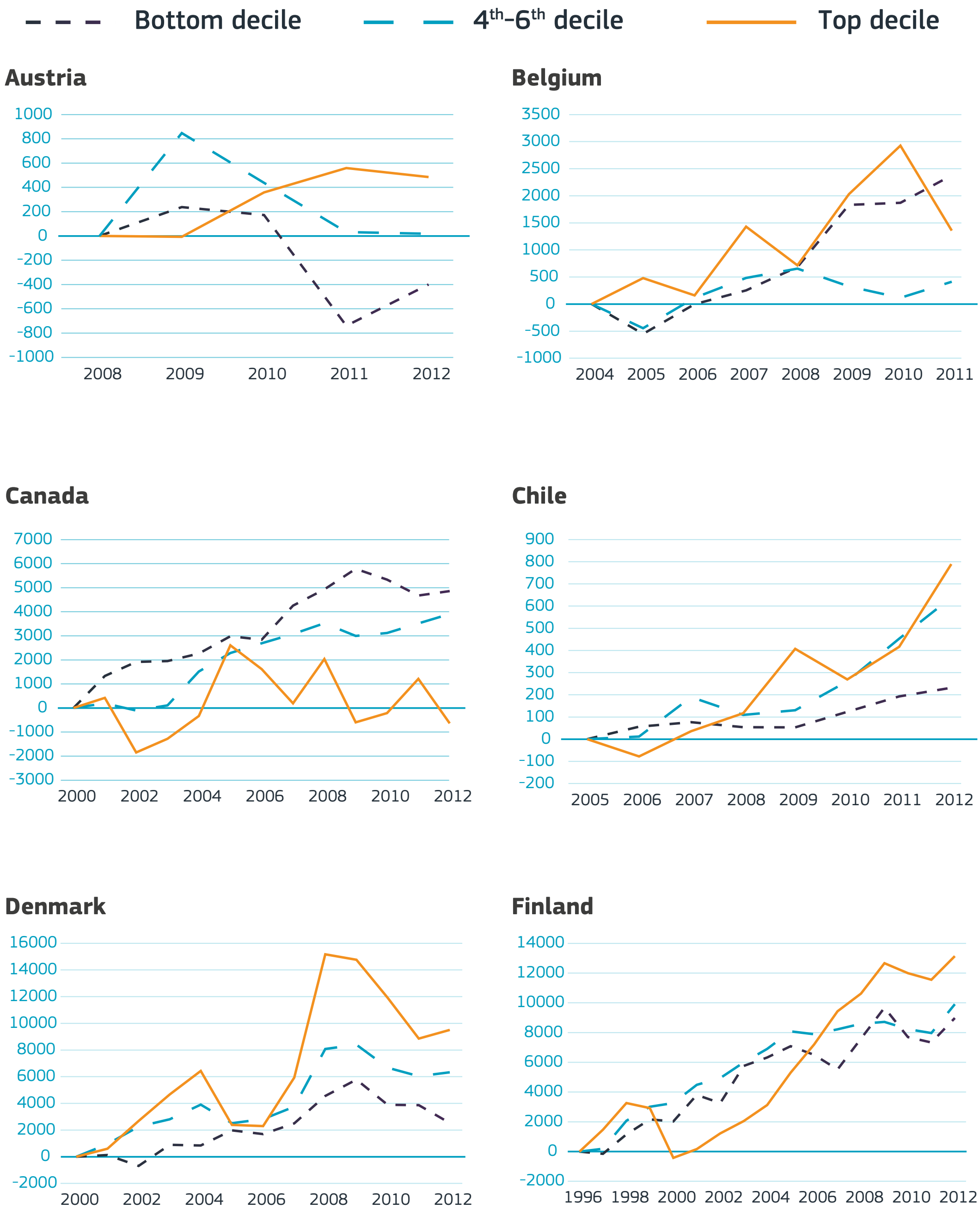


Sweden

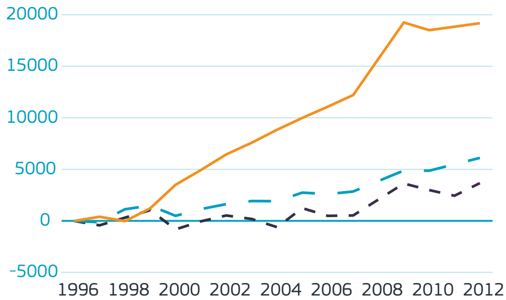


Source: Data from the OECD Multiprod project, preliminary results, February 2016.
Note: [1]Data for Japan only includes firms above 50 employees.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_a_4.xlsx

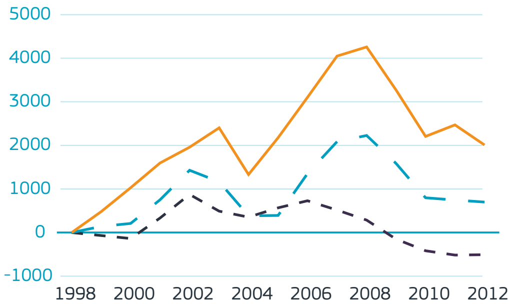
Figure E Change in real wages in different parts of the productivity distribution of firms[1] in the manufacturing sector



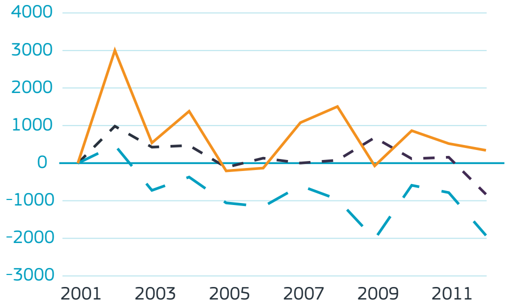
France



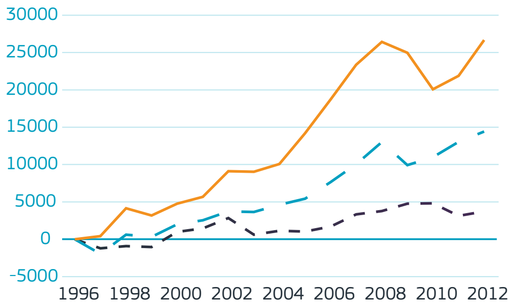
Hungary



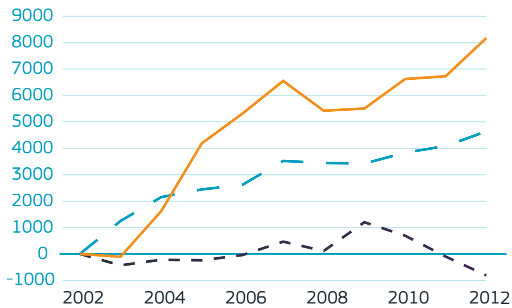
Italy



Norway



Sweden

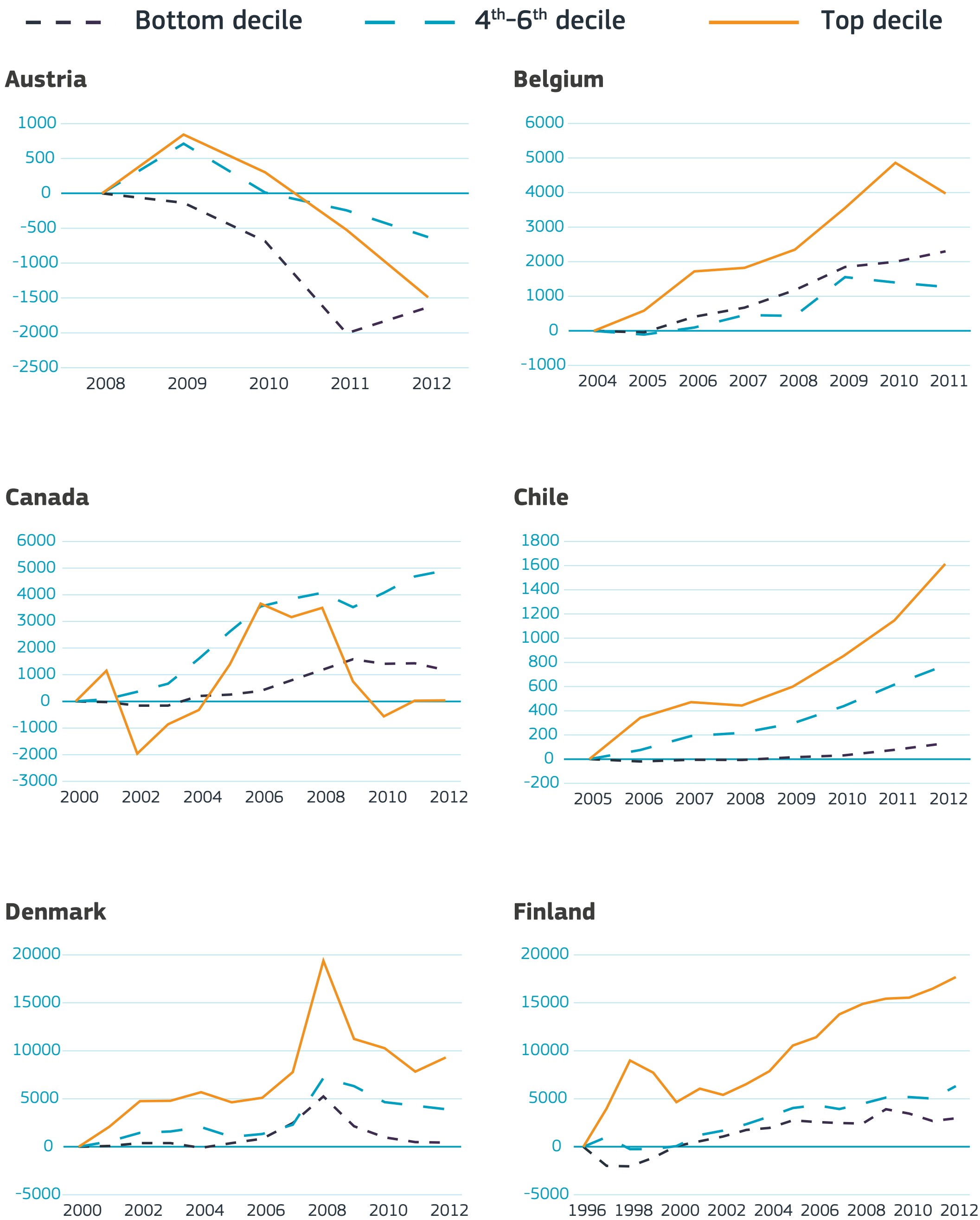


Source: Data from the OECD Multiprod project, preliminary results, April 2016.

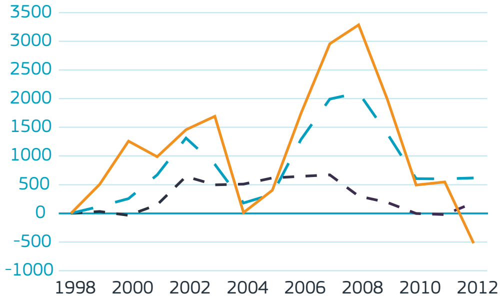
Note: [1]Each line represents the unweighted average of real wages across firms in a given part (bottom decile, 4th to 6th deciles, and top decile) of the productivity distribution in each year. Thus, "Top decile" represents the evolution of the average wage among the 10% most productive firms of a given year. Within each part of the distribution, wage levels are normalised at 0 in the first available year: in 1996 for Finland, France 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. Wages are expressed in 2005 US dollars.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_a_5_.xlsx

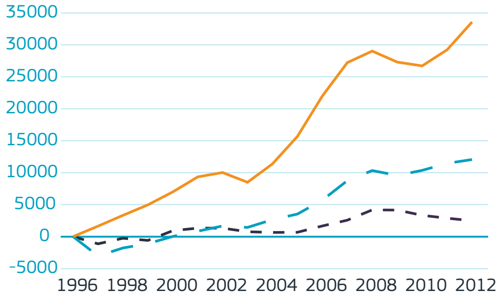
Figure F Change in real wages in different parts of the productivity distribution of firms[1] in the services sector



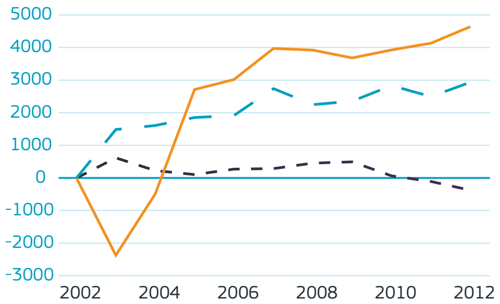
Hungary



Norway



Sweden



Source: Data from the OECD Multiprod project, preliminary results, April 2016.
Note: [1]Each line represents the unweighted average of real wages across firms in a given part (bottom decile, 4th to 6th deciles, and top decile) of the productivity distribution in each year. Thus, “Top decile” represents the evolution of the average wage among the 10% most productive firms of a given year. Within each part of the distribution, wage levels are normalised at 0 in the first available year: in 1996 for Finland and Norway, 1998 for Hungary, 2000 for Canada and Denmark, 2002 for Sweden, 2004 for Belgium, 2005 for Chile and 2008 for Austria. Wages are expressed in 2005 US dollars.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/partii/partii_1/figure_a_6.xlsx