Chapter 1

Measuring productivity

Productivity growth has been slowing in advanced economies since the mid-1990s, and more recently also in emerging economies. This decline has occurred at a time of rapid technological change, increasing participation of firms and countries in global value chains, and rising education levels in the labour force, all of which are generally associated with higher productivity growth. These seemingly contradictory facts have raised interest in the "productivity paradox" and whether the productivity slowdown is a transitional phenomenon or a longer-term condition. This chapter presents relevant evidence and discusses different views and explanations about the observed productivity trends. It also describes emerging challenges in measuring productivity and the way forward.

Considerable attention has focused in recent years on the productivity slowdown observed across OECD economies, dating back as far as the mid-1990s and earlier in some cases. More recently the slowdown has begun to be commonly referred to as the *productivity paradox*: a reference to the fact that the current slowdown has occurred at a time of significant technological change.

The advent of new (typically) digital innovations, such as Big Data, was expected to have sparked off a new wave of productivity growth, similar to those seen in the past, e.g. as a result of electrification and the ICT wave in the 1990s. But this has not, at least, yet materialised, raising a number of still largely open questions, ranging from potential lagged effects of these new technologies, to structural versus cyclical factors, right through to measurement.

While the jury remains out on the underlying causes, a growing body of evidence suggests that measurement, or rather "mis-measurement", is not the cause, or at least not the major cause (Syverson, 2016; Byrne, Fernald and Reinsdorf, 2016). This chapter brings together much of the evidence presented in this Compendium to provide, as far as possible, a single narrative on the slowdown story, while also taking the opportunity to present additional insights on the role measurement may play, particularly with regards to the "paradox".

The productivity slowdown and paradox

Until the mid-1990s, labour productivity growth in many OECD countries was relatively high compared with the United States, partly reflecting convergence towards the international productivity frontier (Figure 1.1) with productivity levels rising and, in some cases, surpassing those of the United States (Figure 1.2).

However, in many countries, the catch-up process went into reverse in the following decade (mid-1990s to mid-2000s), as productivity growth in the United States accelerated on the back of ICT led gains, outpacing productivity growth elsewhere. More recently, in the last ten years, productivity growth has slowed significantly, including in the United States, almost flat-lining in some major economies, as the effects of the ICT revolution began to fade.

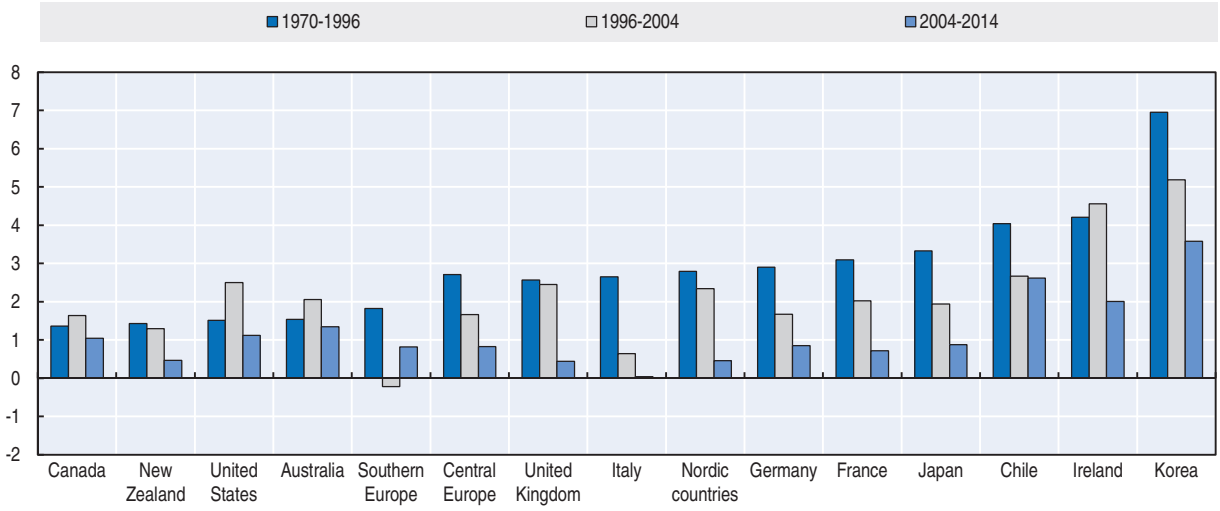
The productivity slowdown observed in recent years has occurred at a time of rapid technological change, increasing participation of firms and countries in global value chains, and rising education levels in the labour force, all of which are generally associated with higher productivity growth. These seemingly contradictory facts have revived the debate on whether the productivity slowdown is a transitional phenomenon or a longer-term condition and a constraint to economic growth (see Box 1.1).

The current slowdown is not a recent affair

As highlighted above, the slowdown in labour productivity growth is a common feature among advanced economies and not a recent phenomenon; indeed underlying long-term trends suggest that the slowdown was underway prior to the crisis (Figure 1.3).

Figure 1.1. **Growth in labour productivity in advanced economies since 1970**

GDP per hour worked, percentage change at annual rate



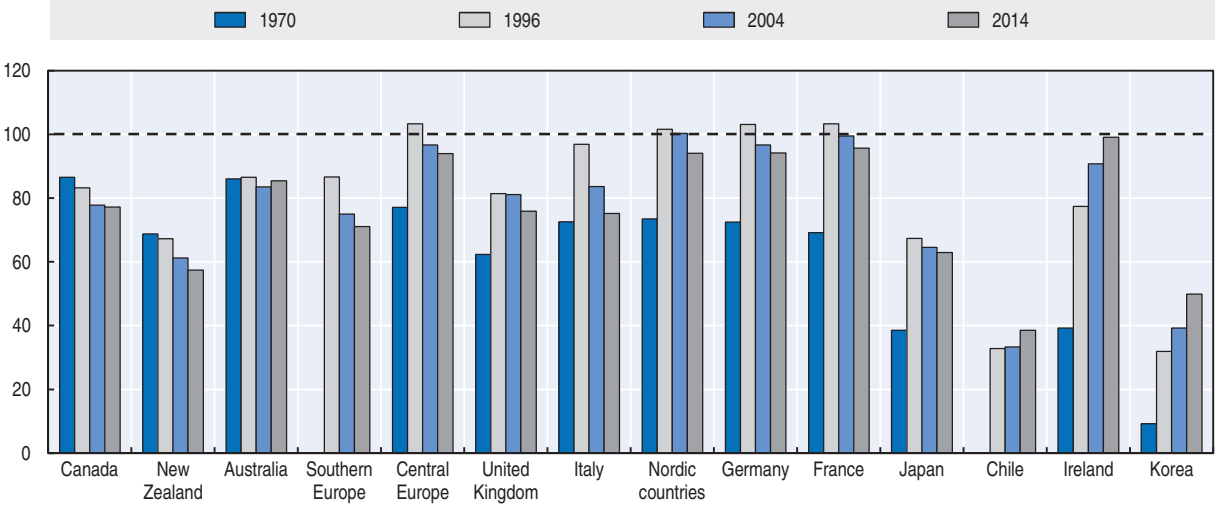
Note: Southern Europe includes Greece, Italy, Portugal and Spain; Central Europe includes: Austria, Belgium, Germany, Luxembourg, the Netherlands and Switzerland; Nordic countries includes: Denmark, Finland, Iceland, Norway and Sweden.

Source: OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, February 2016.

StatLink http://dx.doi.org/10.1787/888933346166

Figure 1.2. **Labour productivity levels in advanced economies**

GDP per hour worked, as percentage of the US, constant 2010 PPPs



Source: OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, February 2016.

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Box 1.1. **Explaining the paradox?**

A number of views have been put forward to address the apparent contradiction or paradox:

i) *The transformative nature and scale of today's technological breakthroughs pale into insignificance compared with those that took place in the last century* (electricity, internal combustion engines, medical breakthroughs, telephone and radio, which took years to fully spread out through the economy). Recent innovations such as ICT, although also revolutionary, saw more rapid adoption and have had a shorter-lived impact on productivity growth (Cowen, 2011; Gordon, 2012).

Box 1.1. **Explaining the paradox?** *(cont.)*

ii) *Structural changes*. One factor that may explain the longer term decline in productivity growth across, particularly developed, economies may be the long term shift from manufacturing to services, including in particular lower productivity personal services. Demographic changes and more service orientated consumption patterns, notably from ageing populations may have exacerbated these impacts.

iii) *The pace of technological progress has not slowed but adoption requires parallel innovation in organisational structures and business models* (Brynjolfsson and McAfee, 2011; Baily, Manyika and Gupta, 2013). In other words, the next wave of productivity growth driven by technology breakthroughs in artificial intelligence, robotics, the Internet of Things, Big Data, 3-D printing, nanotechnology, biotechnology, may lag the innovations.

iv) *A breakdown of the diffusion machine*. Some studies (Andrews, Criscuolo and Gal, 2015; OECD, 2015a) suggest that the main source of the productivity slowdown is not a slowing in the rate of innovation by the most globally advanced firms, but rather a slowing of the pace at which innovations spread throughout the economy. In other words a breakdown of the diffusion machine that previously saw productivity spill-over from frontier firms, a factor behind the paradox.

v) *Rent reducing transformation*. Another possibility is that many of the new technologies, in particular those related to the digital economy such as Big Data and e-commerce, may have a different transformative role than earlier technological innovations. These earlier innovations, including classic ICT innovations such as computers and software, often resulted in profound changes to the production process of goods and services. Many of today's new innovations, notably e-commerce and to a lesser extent some applications of Big Data, on the contrary, are less about transforming (i.e. introducing efficiencies in the production process) and more about expanding markets, where productivity gains are generated through improved economies of scale rather than transformative changes in the production process.

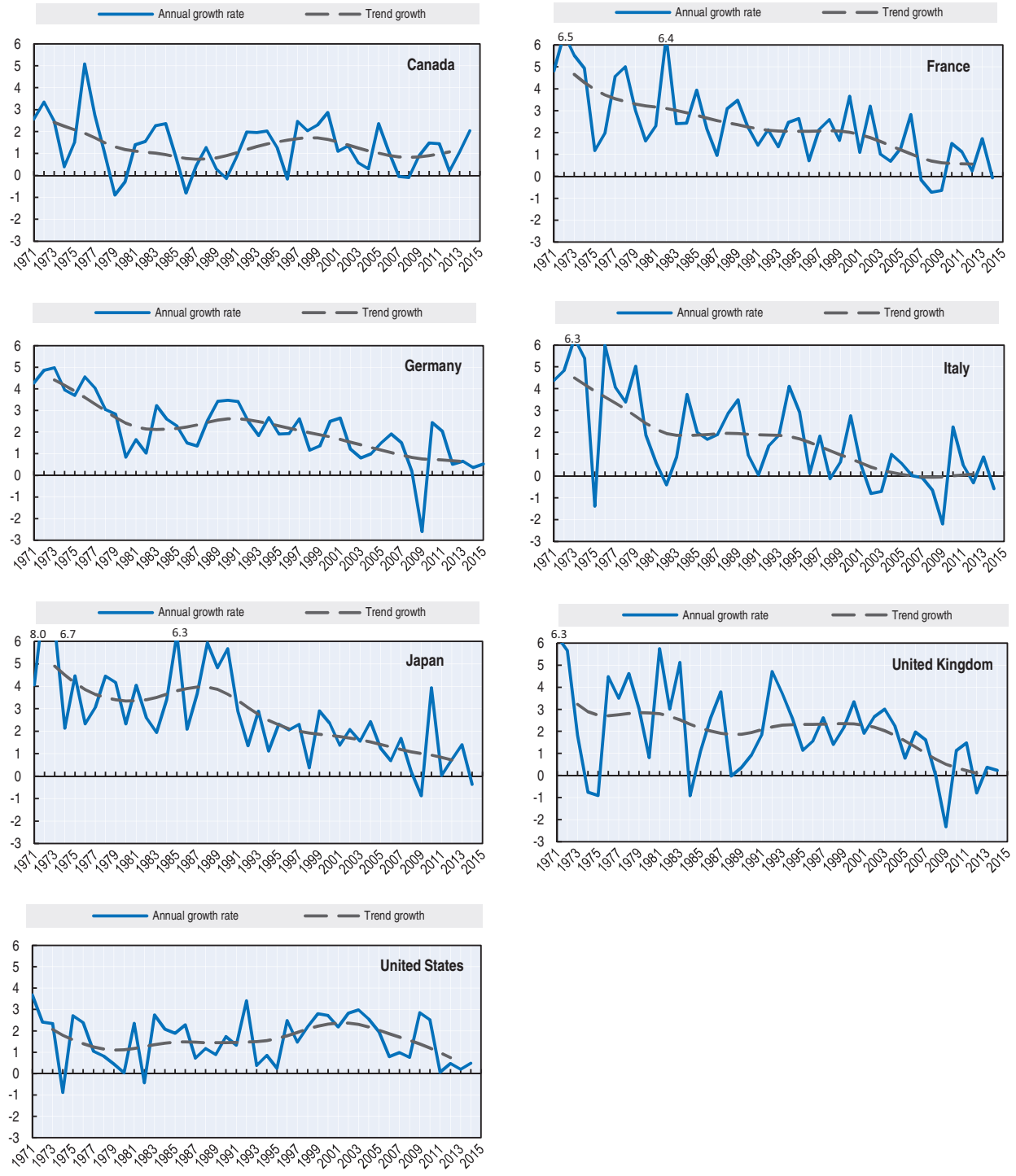
Indeed it is difficult to completely rule out the possibility that the effects may lower labour productivity (but not necessarily multifactor productivity), as competition in relatively high labour cost countries, regions or cities, from lower labour cost areas, either drives wages down in the former, reducing the quality of labour input and dis-incentivising investment, or displaces the activity altogether. In the first case the net effect could result in lower overall labour productivity, even if the competition originates from abroad; and in the second case, where the activity in a certain region is displaced altogether, overall labour productivity could decline at the national level if the competition is driven within the country.

vi) *Measurement*. Several measurement challenges limit the analysis of recent productivity trends and indeed their policy implications. These challenges are of course not all new. Many concern longstanding issues relating to the measurement of factors of production and output, and in particular the distinction between price and volume changes. But new forms of doing business, driven in particular by digitalisation, and the increasing importance of knowledge-based assets that are outside of the System of National Accounts (SNA) production boundary, have added new measurement challenges and exacerbated even the long standing ones. They are also beginning to raise questions about the scope of the SNA production boundary itself as households increasingly engage in activities that once would have been the preserve of intermediaries through the use of free services (e.g. search engines). These have been further complicated by the growing importance of global value chains in the production process. Increased specialisation in tasks within an industry in a given country may complicate simple analyses of value added, and so productivity, at the sectoral level that implicitly assume that a similar activity (or rather task) is being undertaken over comparable periods of time. The increasing importance of multinationals and indeed their ability to engage in profit shifting across affiliates, adds a further layer of complication, particularly for measures of multifactor productivity, as the potential for inconsistencies between where factors of production and output are recorded increases. The last section in this Chapter provides a more thorough assessment of measurement challenges.

One important thing to note from the above is that none of the potential causes is mutually exclusive. All or some could explain the paradox, and so they should be viewed as complementary.

Figure 1.3. **Trend labour productivity growth in G7 countries**

Total economy, percentage change at annual rate



Source: OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, February 2016.

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Declining trends in labour productivity growth are largely characterised by slower growth in multifactor productivity (MFP), lending some weight to the arguments that technological spillovers and diffusions from ICT, and other new technologies may be lower than from earlier technology breakthroughs.

The evidence here is not conclusive. For example, declining trends may, at least in part also reveal other inefficiencies in the combined utilisation of labour and capital inputs, notably from skills mismatches (Box 1.2) but also capital misallocation. Moreover, lower MFP growth has not been the only component driving down labour productivity, in many countries the contribution of capital deepening, particularly in recent years, reflecting weaker investment, has also begun to trend downwards (Figure 1.4).

And the contribution from investment in ICT has slowed significantly

The direct contribution of ICT capital goods to productivity reached its peak in the late 1990s and started to diminish in the early 2000s. Considerable improvements in the price-performance ratio of ICT capital (and Moore's law) saw significant take-up of ICT capital in the mid to late 1990s, with correspondingly significant contributions to overall labour productivity growth. Although investment in ICT remained relatively high at the turn of the 2000s and onwards, and continued to play an important role in driving productivity growth across OECD countries, these contributions began to decline almost across the board, with sizeable declines in many countries (Figure 1.5).

While the shares of ICT investment have held up reasonably well compared with other forms of investment, ICT investment as a share of GDP in recent years remains below previous highs, significantly so in some countries (Figure 1.6).

Although the slowing contribution from ICT may reflect increased investment in other knowledge-based assets

Investment in ICT capital also contributes indirectly to productivity growth, as it supports firms in innovating and improving organisational and managerial practices, including the management of sales, inventories, customers and supply chains. ICT capital investment thus often requires complementary investments in knowledge-based capital (KBC), such as patents, design, firm-specific training, organisational and managerial capabilities and the experimentation with new technologies in the form of research and development. Currently however, with the exception of software and research and development, most of the investment in KBC are outside of the System of National Accounts (SNA) production boundary, and so are not included in the investment and capital figures shown in the Compendium.

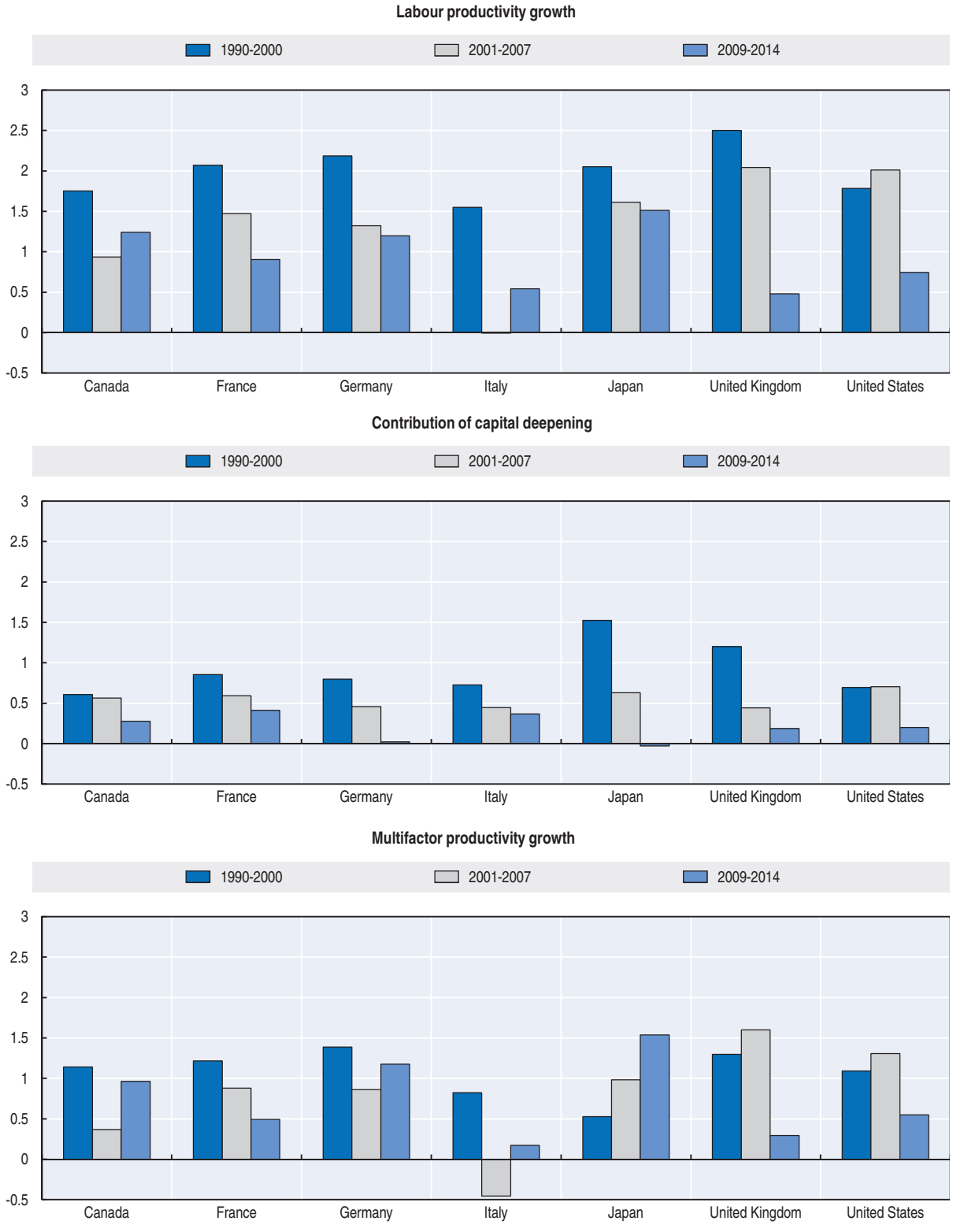
Recent studies show that investment in KBC has been increasing over the past two decades, often at a faster pace than investment in traditional physical capital (OECD, 2015b). In 2013, investment in all types of KBC amounted to around 1.5 times investment in fixed assets in the United States and the United Kingdom, 80% in France, 90% in Germany and just under half in Italy and Spain (Figure 1.7). That being said *The Future of Productivity (OECD, 2015)* pointed to a slowing in the pace of KBC investment that started prior to the crisis, which may have led to lower spillover effects for MFP.

But increased investment in other knowledge-based assets only adds to the paradox

The current exclusion of many knowledge-based assets from the SNA production boundary cannot automatically be used to explain the paradox however, as their exclusion

Figure 1.4. **Labour productivity growth, capital deepening and MFP in G7 countries**

Total economy, percentage change at annual rate



Source: OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, February 2016.

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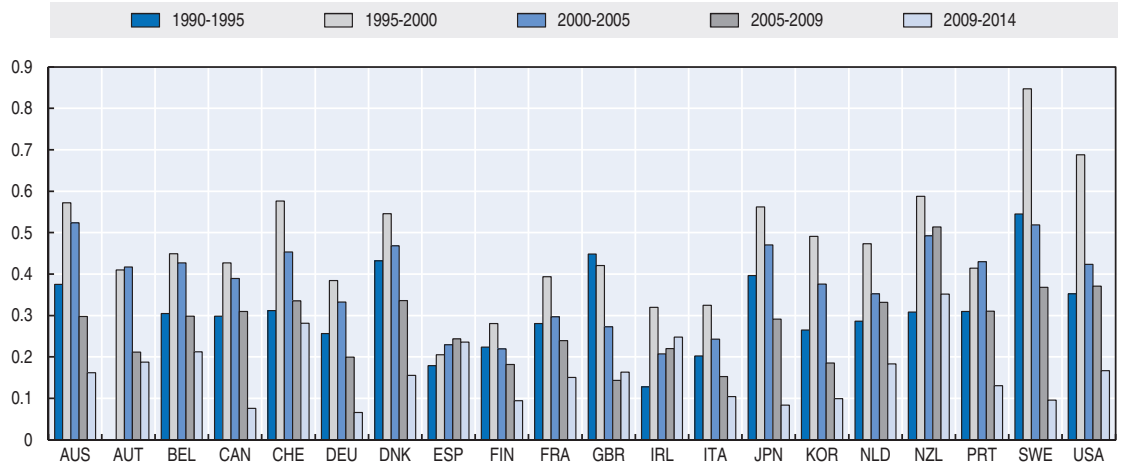
Figure 1.5. **Contribution of ICT capital deepening to labour productivity growth**

Percentage change at annual rate



Source: OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, February 2016.

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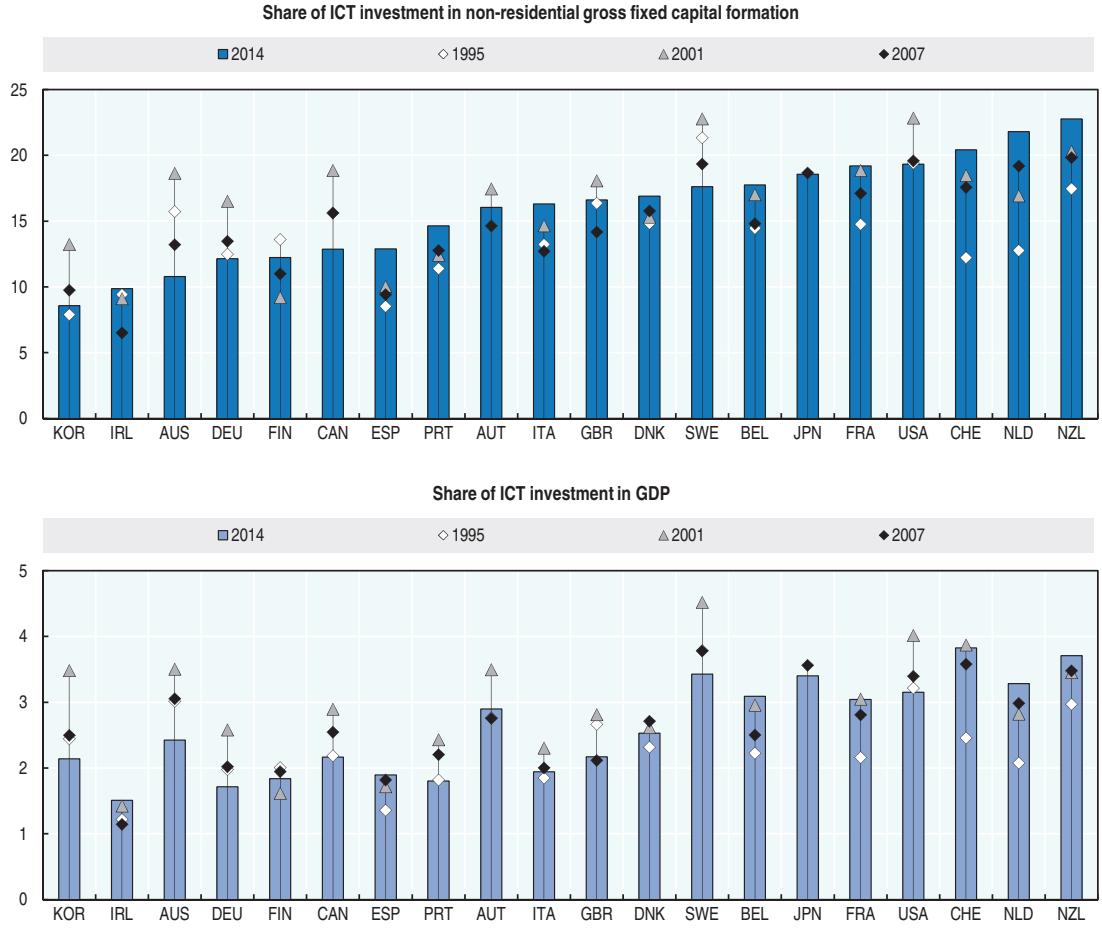
Figure 1.6. **Share of ICT investment**

Percentage of non-residential gross fixed capital formation and percentage of GDP



Source: OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, February 2016.

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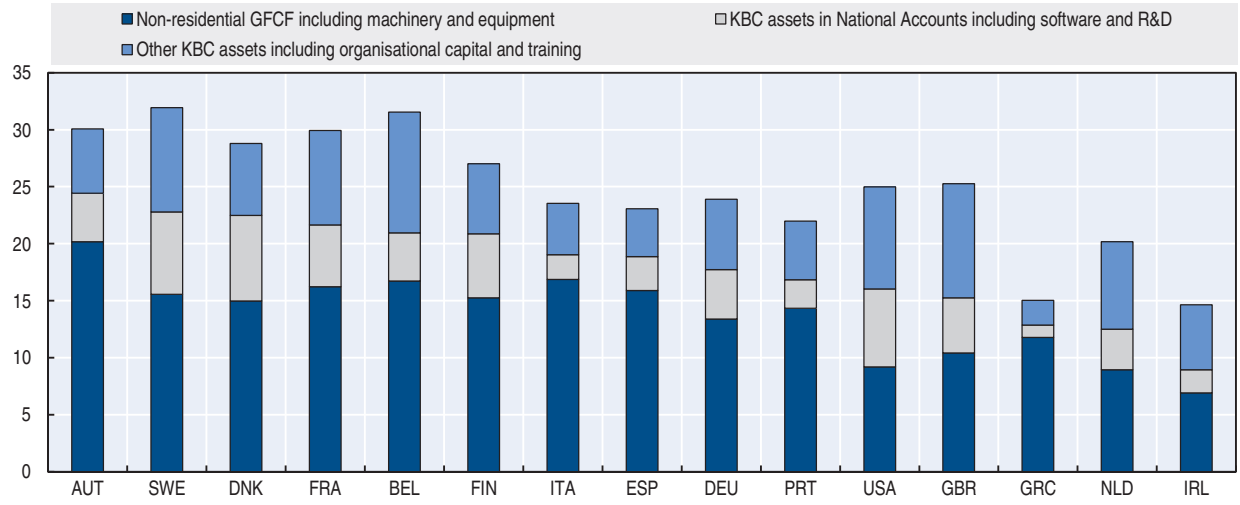
Figure 1.7. **Business investment in fixed and knowledge-based capital, selected economies, 2013**

As percentage of business sectors' gross value added



Source: OECD (2015b), OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society, OECD Publishing, Paris, *http://dx.doi.org/10.1787/sti_scoreboard-2015-en*.

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Box 1.2. **Productivity and skills mismatch**

While the specific knowledge of highly educated workers can directly increase business performance, a skilled workforce can also act indirectly on productivity via improved technologies, business models and organisational practices, reinforcing the benefits of investment in physical and knowledge-based capital (KBC).

However, according to the recent OECD Survey of Adult Skills (PIAAC), there are significant shares of workers in OECD countries that are over or under-qualified for their job, with high shares also reporting a mismatch between their existing skills and those required for their job (OECD, 2013). This implies that there is scope for improving the efficiency of human capital allocation in OECD countries, possibly affecting aggregate productivity.

The links between skills mismatch and labour productivity have been recently explored by OECD work, exploiting data from the PIAAC survey (Andrews and Adalet Mc Gowan, 2015). The existing body of literature already emphasised that under-qualification and under-skilling are associated with lower labour productivity within the affected firm. The important insight of the recent work is that skill and qualification mismatch is associated with lower aggregate labour productivity. In particular, the impact of over-skilling on productivity results from its effects on allocative efficiency: in industries with a higher share of over-skilled workers, more productive firms find it more difficult to attract suitable labour that could allow expanding their operations. The conclusion seems to indicate that the allocation of skills can potentially account for a relevant share of cross-country productivity gaps, complementing recent findings showing that the level of skills can explain 30%-40% of the cross-country variation in aggregate labour productivity (OECD, 2013).

Finally, there is a link between managerial quality and mismatch; a more efficient matching of qualifications and skills is one of the possible channels through which higher managerial quality increases productivity.

Source: Andrews and Adalet Mc Gowan, 2015; OECD, 2013.

means that their indirect impact is currently captured with estimates of MFP, and so the evidence pointing to rising shares of KBC merely serves to reinforce the paradox.

Recent analysis that explores the links between business investment in KBC and productivity performance (Andrews and Westmore, 2013; Andrews and Criscuolo, 2014) provides some possible insights. Preliminary evidence points to two findings: the speed of convergence towards the long-run MFP growth rates seems to be faster in countries with high managerial quality and business R&D and, importantly in the context of the paradox, the returns to investing in KBC appear to be affected by structural factors that influence the ability of economies to reallocate resources to firms that invest in this type of capital.

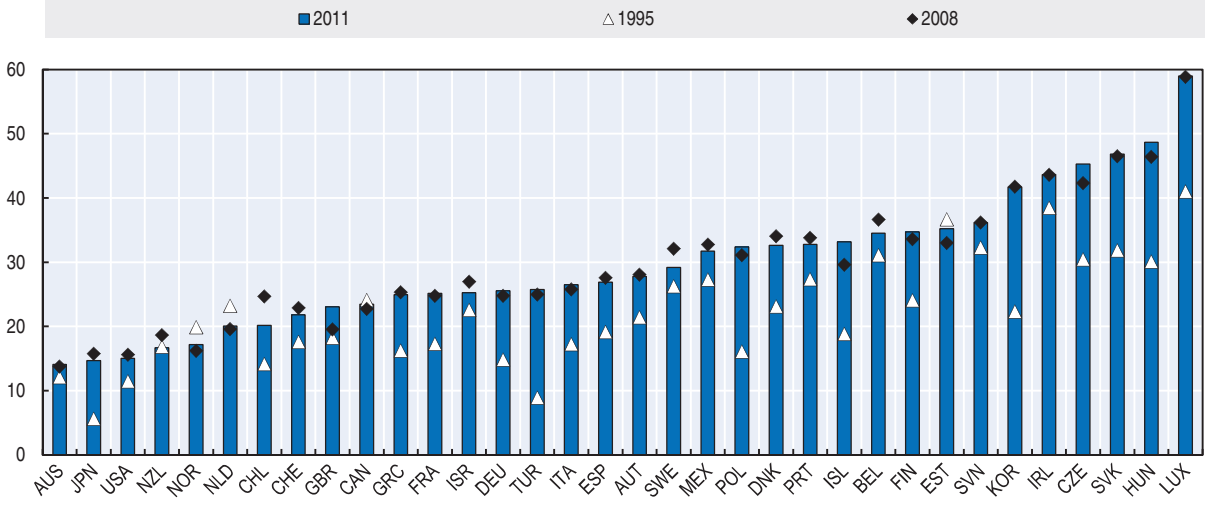
Productivity growth has slowed despite rising participation in global value chains

Participation in global value chains (GVCs) enables firms to specialise in activities or tasks where they have comparative advantages, providing opportunities to benefit from economies of scale as they gain access to new markets, while also benefitting from increased potential technology spillovers. Moreover, by increasing international competition, GVCs put pressure on firms to innovate to succeed.

Measured on the basis of the foreign content of gross exports, the evidence shows that integration in GVCs has increased significantly since the mid-1990s (Figure 1.8). The evidence also indicates a positive, but nuanced, relationship between participation in GVCs and productivity growth (Figure 1.9). While the overwhelming evidence supports the existence of strong positive relationships between GVC integration and growth, integration in GVCs requires indeed a holistic policy approach. In some countries, for example, the evidence points to getting locked in the middle-income trap, and in others, the reallocation of workers in tasks facing competition from lower labour cost countries may be suboptimal, with potential increases in skills mismatches.

Figure 1.8. **Foreign value added share of gross exports**

Percentage



Source: OECD-WTO: Statistics on Trade in Value Added (database), *http://dx.doi.org/10.1787/data-00648-en*.

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Figure 1.9. **Integration in GVCs and productivity**

Total economy

Source: OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, February 2016 and OECD-WTO: Statistics on Trade in Value Added (database), *http://dx.doi.org/10.1787/data-00648-en*.

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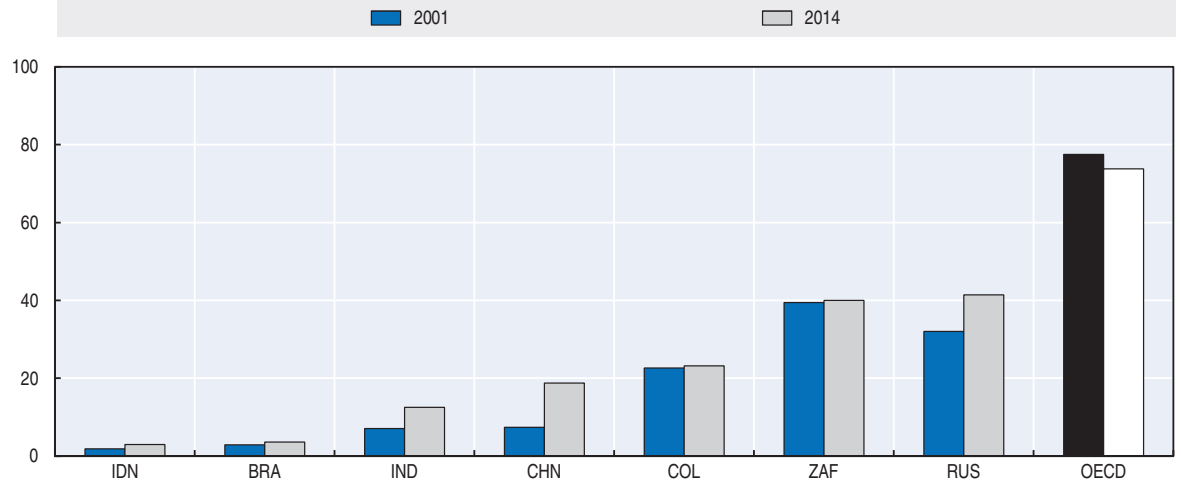
And the slowdown is not confined to developed economies

The evidence supporting the relationship between higher integration in GVCs and higher productivity is particularly strong for developing economies but recently, the slowdown in labour productivity growth has also extended to emerging economies (Figures 1.10 and 1.11).

Figure 1.10. **Labour productivity levels in emerging economies**

GDP per person employed, as percentage of the US, constant 2010 PPPs



Source: OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, February 2016.

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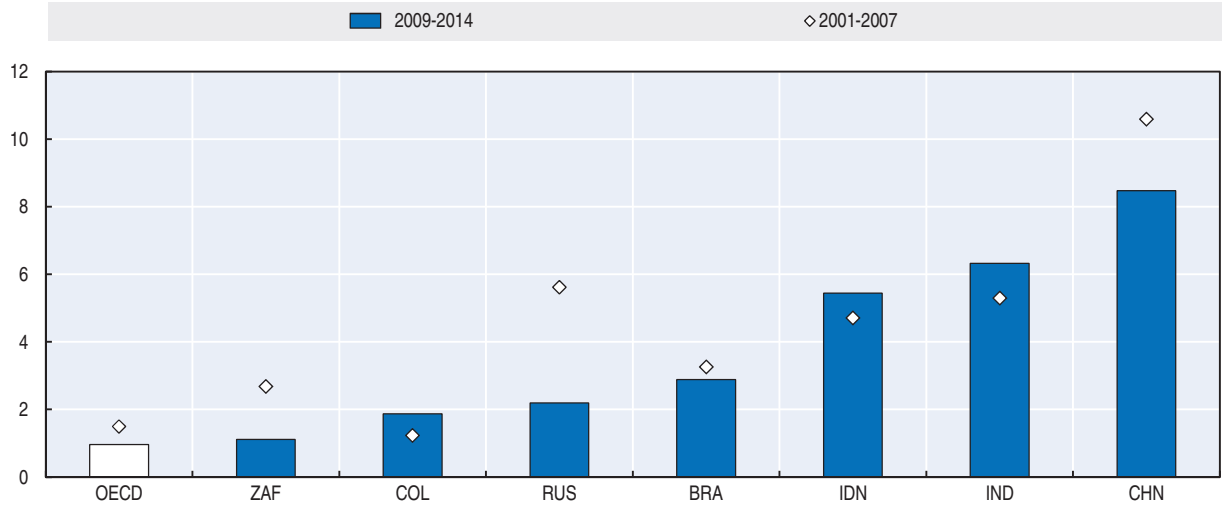
Figure 1.11. **Labour productivity growth in emerging economies**

GDP per person employed, percentage change at annual rate



Source: OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, February 2016.

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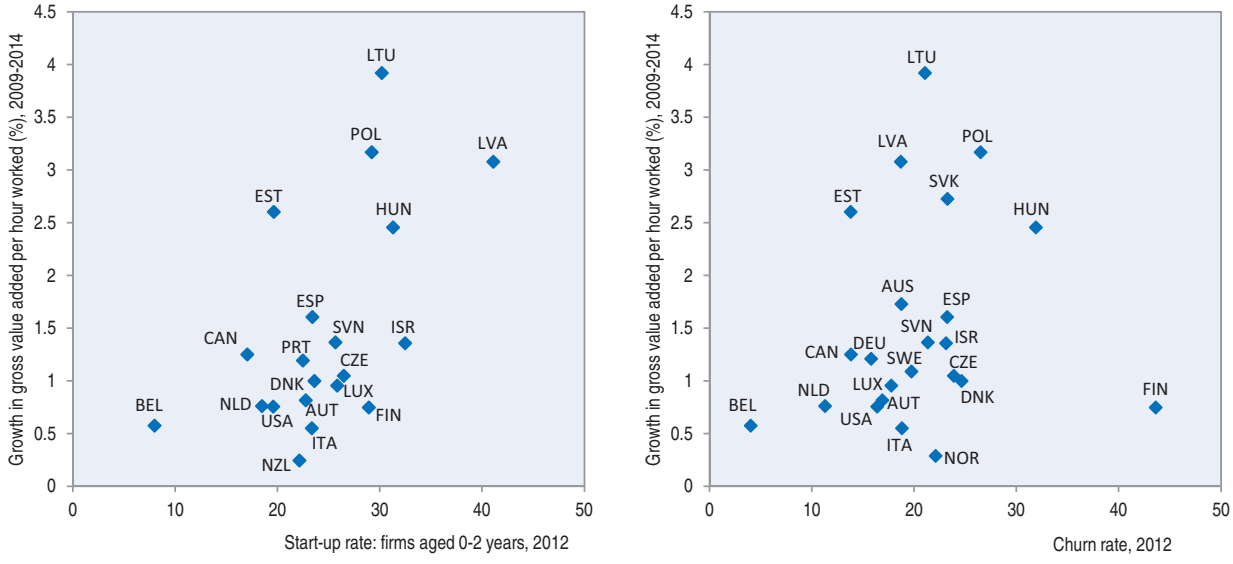
Sluggish business dynamism adds further concerns to productivity growth

In many countries the slowdown of productivity growth, has been coupled with sluggish business dynamism. The evidence shows a strong relationship between labour productivity growth and start-up rates and churn rates, i.e. the sum of birth and death rates (Figure 1.12). New firms contribute to the creation of novel ideas, and competition with incumbent firms stimulates the latter to introduce productivity-enhancing changes (e.g. improved managerial

Figure 1.12. **Labour productivity growth and business dynamism**

Share of employer firms with 0-2 years in total firm population (left) and churn rates (right) on x-axis and GDP per hour worked, percentage change at annual rate on y-axis



Source: OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en* and OECD Structural and Demographic Business Statistics (database), *http://dx.doi.org/10.1787/sdbs-data-en*.

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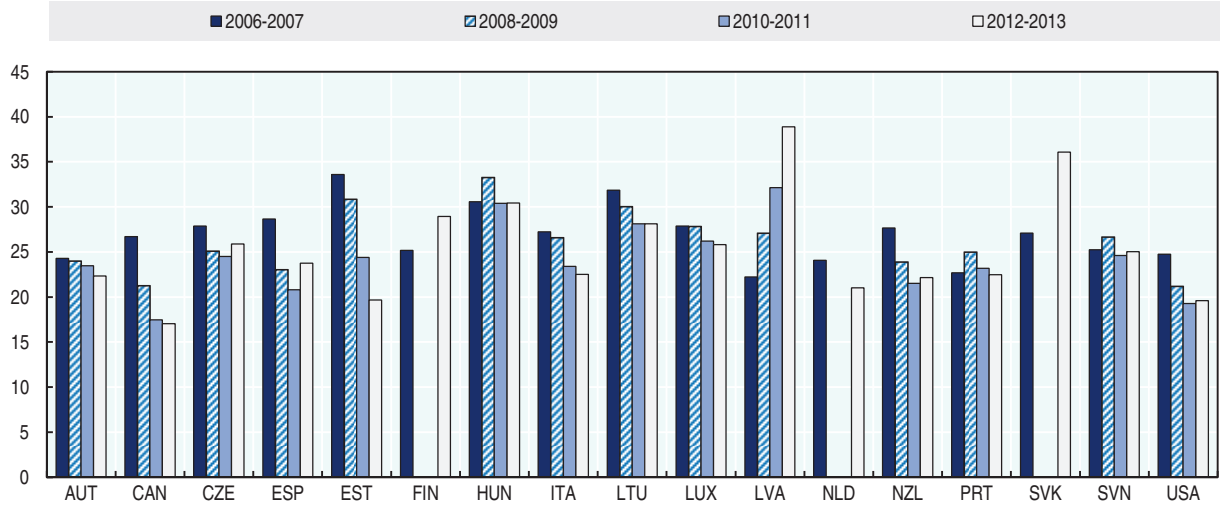
practices, adoption of new technologies, etc.), thus contributing to increase aggregate productivity growth. Churn rates illustrate the creative destruction process, whereby new (innovative) firms enter and expand while displacing less productive firms. This reallocation of resources is expected to increase aggregate productivity.

In recent years, though, the start-up and churn rates have generally declined in OECD countries, with a few exceptions (Figures 1.13 and 1.14). Andrews, Bartelsman and Criscuolo (2015) show that for eight European countries MFP growth over the 2000s was weaker in sectors that recorded larger declines in the share of young firms (under six years), and in particular start-ups (under three years).

Figure 1.13. **Start-up rates, total business economy**

Share of employer firms with 0-2 years in total firm population, average of the period



Source: OECD Structural and Demographic Business Statistics (database), *http://dx.doi.org/10.1787/sdbs-data-en*.

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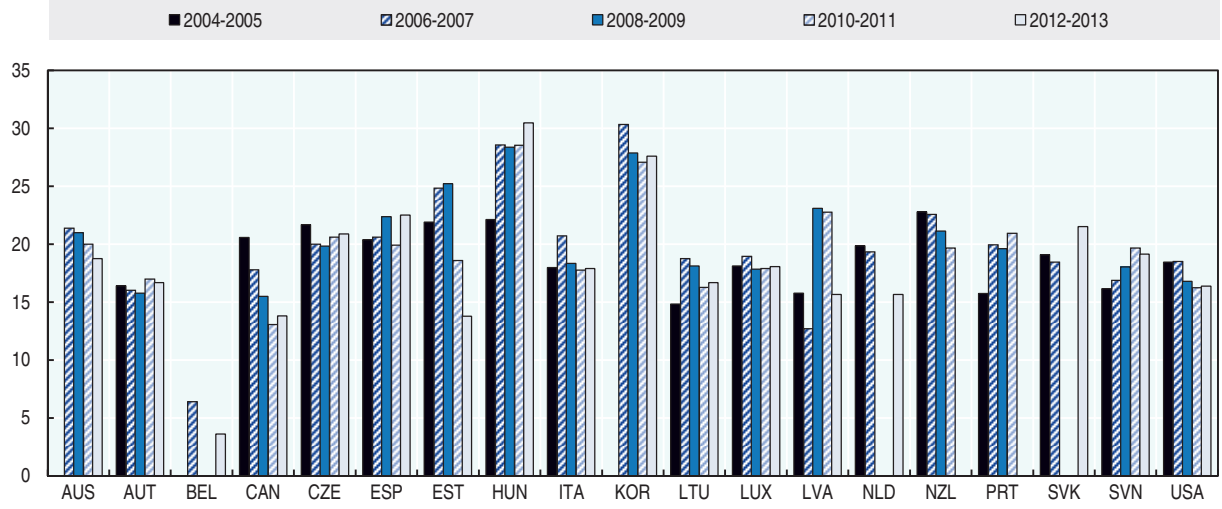
Figure 1.14. **Churn rates, employer enterprises, total business economy**

Percentage



Source: OECD Structural and Demographic Business Statistics (database), *http://dx.doi.org/10.1787/sdbs-data-en*.

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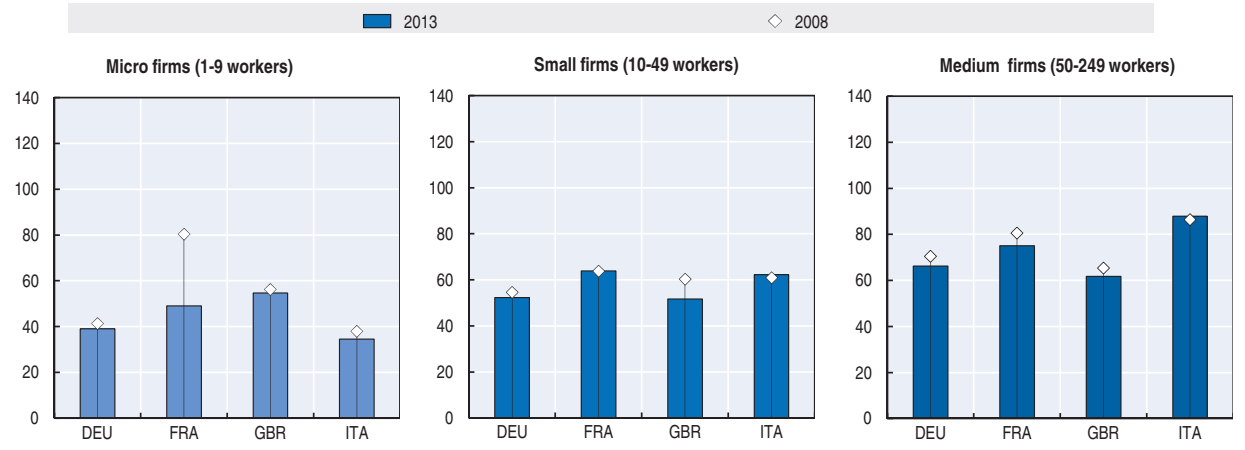
Firm heterogeneity also matters for productivity. To the extent that large firms can exploit increasing returns to scale, productivity typically increases with firm size. In fact, larger firms show almost consistently higher levels of productivity than micro and small enterprises (Figure 1.15). Interestingly, the gap in productivity between firms of different sizes increased in the manufacturing sector from 2008 to 2013, while not always in the services sector.

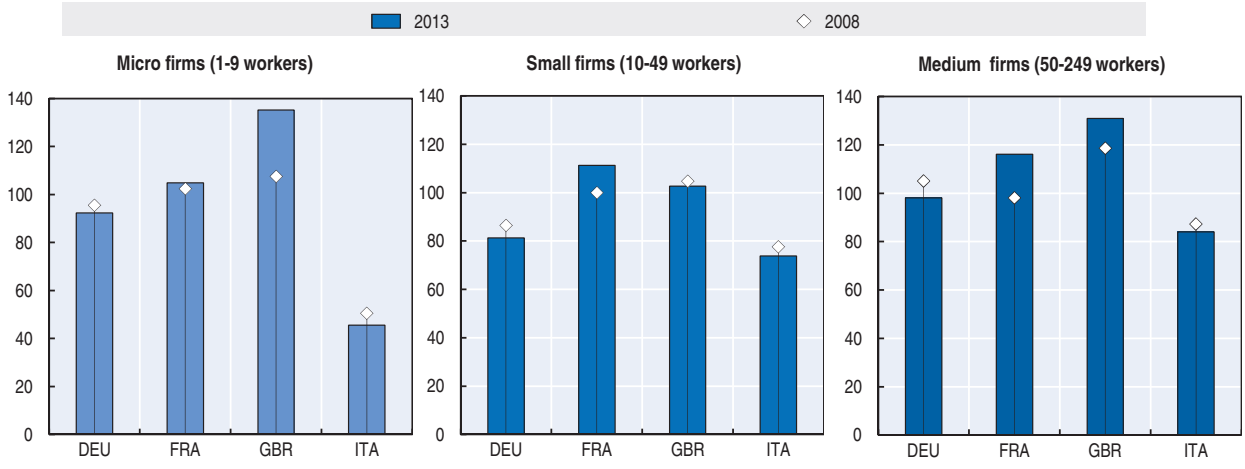
Figure 1.15. **Labour productivity by firm size**

Value added per person employed, large firms (250 workers or more) = 100

Panel A. Manufacturing



Panel B. Services



Source: OECD Structural and Demographic Business Statistics (database), *http://dx.doi.org/10.1787/sdbs-data-en*.

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Current challenges in productivity measurement

Productivity measurement has long been a matter of considerable interest. There are a number of difficulties in accurately measuring productivity that can impact on recorded estimates and, in addition, impair international comparability, calling for a careful interpretation of currently available productivity measures. These difficulties manifest themselves both in the measurement of the factors of production, capital and labour, and in measures of output. The following sections set out these issues and highlight the potential impact that mis-measurement has on recorded estimates of productivity.

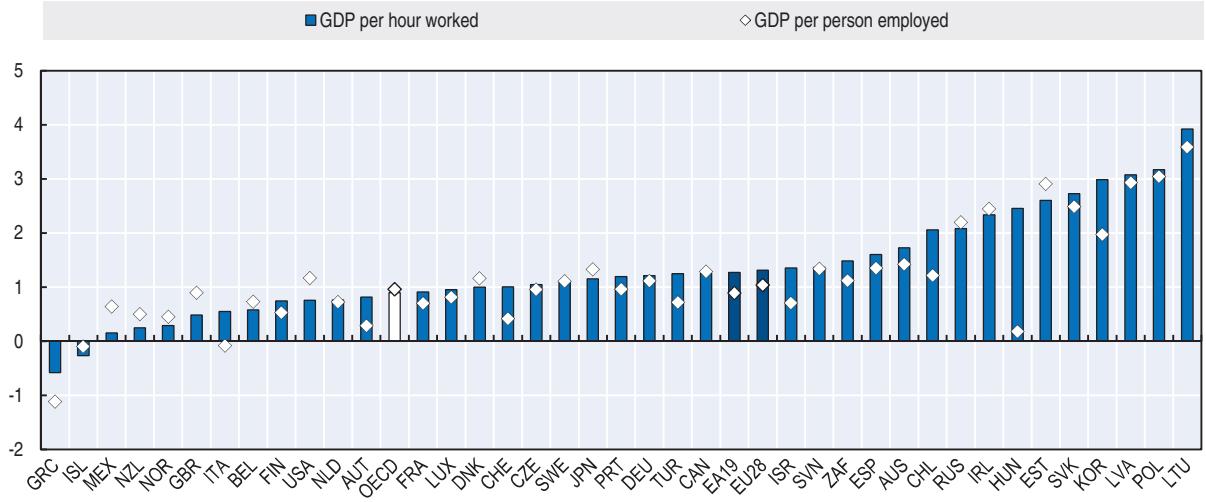
Labour

Hours worked vs head-counts

Conceptually, the volume of labour input reflects the time, effort and skills (quality) of the workforce employed in the production process. Ignoring for now quality differences in labour, labour input should in theory be measured as the total number of hours actually worked. Simple head-counts are not able to fully reflect the actual labour input as they are not able to adjust for differences in the relative shares of part and full-time employment, or indeed shifts in these shares that have marked labour markets in recent years. Nor are head-count figures able to account for other factors such as changes in statutory hours and absences from work, which reveals significant differences in nearly all economies (Figure 1.16).

Figure 1.16. **Labour productivity growth, 2009-14**

Total economy percentage change at annual rate



Source: OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, February 2016.

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Adjusting for quality of labour

The effective quantity of labour depends not only on total hours worked or total number of persons employed but also on the characteristics (notably skills) of those performing the work. Conventional measures of productivity however are rarely able to account for these characteristics, meaning that they treat workers as perfect substitutes. For example, an hour worked by a highly-experienced doctor and an hour worked by student in a fast-food restaurant are treated as equal amounts of labour.

Evaluating skills and their productivity is however non-trivial, for example there would be little reason to expect significant differences in productivity between the doctor and the student if they both worked in the fast-food restaurant. Typically, studies have measured the quality of labour by identifying a number of characteristics such as industry worked in, occupation, educational attainment, or age and weighted them with their relative wage (Jorgenson et al., 1987; Bureau of Labor Statistics, 1993; Schwerdt and Turunen, 2008; O'Mahony et al., 2009). In recent years many national statistical offices have computed estimates of labour quality (e.g. Australia, Canada, New Zealand, the United Kingdom, the United States). All these studies rely on a cross-classification of hours worked by observed worker characteristics weighted with measures of average labour

compensation shares attributable to each worker group. Most studies use predicted wages (based on wage differentials due to the selected labour characteristics and not to other factors) to determine the weights. Growth in labour quality is then estimated as the difference between the growth rate of quality-adjusted labour input and the change in total hours worked.

Accounting for the composition of the work force can alter the measured contributions to economic growth and provides the basis for a better understanding of conventional productivity measures. For example, the evidence points strongly to counter-cyclical movements in conventional measures of labour productivity and economic growth. During periods of strong growth the labour share of low-skilled workers tends to increase as firms reduce their skill requirements to expand production, resulting in downward pressures on labour quality; Figure 1.17 illustrates this for the United Kingdom.

Figure 1.17. **Growth in labour input, United Kingdom**

Total economy, percentage change at annual rate

Source: UK Office for National Statistics.

StatLink http://dx.doi.org/10.1787/888933346329

More subtle questions regarding labour measurement include the treatment of (often increasing) commuting time to work as labour input or the fact that workers with zero hour contracts may be spending time on stand-by.

Capital

Comprehensive productivity estimates require exhaustive coverage of capital assets. But achieving exhaustive coverage in all countries remains elusive, partly by design in the SNA which only recognises as assets certain categories. Where coverage is not exhaustive this will necessarily impact directly on estimates of multifactor productivity.

Non-produced assets

Standard measures of multifactor productivity growth often ignore the contribution of the depletion or use of domestic subsoil assets (e.g. oil, gas, copper, lead) and land. However, income generated by these assets is captured in gross domestic value added.

It has been shown that the direction of the adjustment in traditional measures of multifactor productivity, when accounting for subsoil assets, depends on the change in the rate and value of subsoil asset extraction relative to other factor inputs (Brandt, Schreyer and Zipperer, 2013). Analysis at the industry level demonstrated less pronounced declines in the MFP of the mining sector in Australia when accounting for the contribution of subsoil assets (Argento and Burnell, 2013). MFP measures can also be enhanced on the output side by correcting GDP for undesirable output, i.e. emissions (Brandt, Schreyer and Zipperer, 2014). In a number of cases, this leads to an *upward* adjustment of measured productivity when undesirable outputs grow less quickly (or decline faster) than desirable outputs.

Knowledge-based assets

The SNA recognises a number of intellectual property assets: research and development expenditures, software and databases, mineral exploration costs, and artistic and literary originals. But these are not the only forms of knowledge-based assets that can contribute to growth. It is widely recognised that assets such as organisational capital, brand equity, training, or design can all play an important role (Corrado, Hulten and Sichel, 2005, 2009; OECD, 2013). Their exclusion from the production boundary of the SNA is not based on conceptual grounds but rather on the very practical difficulties involved in measuring them in a comparable and meaningful way across countries.

Indeed, measurement of intellectual property products already included in the SNA is far from trivial. New international measurement guidance (for instance, OECD 2010) has greatly improved international comparability, although scope for continued improvement remains, noticeably in measuring price changes, which struggle to capture changes in quality, in no small part reflecting the often unique nature of the assets, but also in determining depreciation rates for different categories of assets (see also "Output" below).

A number of studies, including at the OECD, have conducted analysis that complements the SNA asset boundary through the inclusion of additional knowledge-based assets. Despite important measurement challenges there remains strong appetite among the international statistical community to develop improved and comparable methods that can have near universal (global) application. The effects on productivity growth of extending capital measurement to these assets are hard to predict as both capital input and output are altered by their inclusion.

Also, for multinational firms in particular, the benefits from these assets, especially organisational capital, design, brand, can accrue to any or all of the affiliates. But the methods that are used to estimate the value of these assets typically allocate all value to the country where the asset creation occurred (such as R&D departments in headquarters). However, from a standpoint of measuring productivity, capital services should be measured where they enter the production process. The correct accounting approach would necessarily need to adjust value added in all parties, a difficult venture for which data are presently lacking.

Profit shifting and globalisation

The potential disconnect between capital on one side and recorded output and value added on the other, referred to above, 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, and R&D, generating that production.

The international statistics community, starting with the OECD Task Force on Research and Development and subsequently UNECE Task Forces on Globalisation in the National Accounts and Global Production, have for a number of years strived to introduce clarity, with a key focus on attempting to ensure alignment with the principles of economic ownership (i.e. who runs the risks and receives the rewards) but the current situation remains a work-in-progress with all Task Forces calling for further work to be conducted.

Unlike many of the issues raised above and below, the question is not necessarily that the related flows (payments and receipts) from the use of the assets are not recorded in the accounts, but whether the flows align with national accounts concepts of *economic ownership*, rather than *legal ownership*. This means that current estimates, and comparability, of GDP across countries will be affected as too will be productivity.

Output

As a general remark, any mis-measurement of output will have direct consequences on measures of productivity. It is well known that the measurement of the volume of output is particularly challenging in the area of services, where price indices that can capture quality changes, are crucial but often elusive, particularly for services. Significant efforts are however being made to improve this situation, for instance by OECD and Eurostat (2014). The following sections list specific areas that warrant special attention.

Non-market activities

The lack of information on market prices and the difficulties of measuring the output volume of health, education and public administration services constitute an important challenge for productivity measurement. In many OECD countries, these activities account for over 20% of total GDP. Any shortcomings in sector productivity measurement thus affect aggregate productivity measures. In some countries, the volume of these services is often estimated on the basis of inputs, meaning that output and input volumes are not independent of one another and implying zero productivity growth. That said, progress has been made in the development of output-based measures for health and education services that are independent of inputs (Schreyer, 2010). For activities of the general administration (e.g., providing security or delivering quality regulation for business or integrity in procurement), on the other hand, it is much harder to develop sound measures of output, for conceptual and empirical reasons.

For all non-market producers, the SNA specifically rules out the addition of an imputation for the cost of capital services in arriving at the total value of output, adding only a component for depreciation and not the opportunity costs or financing costs of capital. The main reason for this convention lies in the fact that any such imputation directly affects GDP and national income and that there is a broad spectrum of possible imputations. That said, few studies show alternatives for dealing with this complication (Jorgenson and Landefeld, 2006; OECD, 2009). From the perspective of productivity measurement, the asymmetric treatment of assets used in market and non-market production results in an incomplete estimate of capital inputs and an asymmetric treatment of the same asset, depending on the sector affiliation of the asset owner (Jorgenson and Schreyer, 2013). For analytical applications it may therefore be useful to deviate from the national accounts convention.

Financial services

A particular challenge concerning financial services relates to the imputed item, referred to in the System of National Accounts 2008 (2008 SNA) as Financial Intermediation Services Indirectly Measured (FISIM), which reflects the implicit service provided by banks for intermediation services (e.g. liquidity transformation, teller machines, etc.) where explicit charges are not typically made, and instead are recouped as the difference between a risk free reference rate and deposit rates, for depositors, and the difference between lending rates and the reference rate for borrowers. Significant efforts have been made in recent years to improve international comparability and estimation methods (ISWGNA, 2013), but challenges, particularly for prices, remain.

Digitalisation

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 have argued that this output is missing from GDP statistics, implying an under-estimation of production and possibly productivity. This is certainly an issue that impacts on notions of consumer surplus, and although it is clear that a more substantive investigation of the issue is warranted, at least to provide further guidance on how the accounting framework deals with these flows and whether the activities are correctly estimated in practice, the emerging consensus is that the conceptual accounting framework for GDP is not deficient in this respect (Ahmad and Schreyer, 2016).

One area where there has been considerable debate in recent years relates to the digital revolution, characterised in large part by new players such as AirBnB and UberPop and their new business models, creating new Business to Customer (B2C) and Customer to Customer (C2C) activities. These new models are clearly disruptive and some commentators have argued that they put in question traditional productivity measures by ignoring production and transactions among households.

However, apart from cases where new C2C models may create opportunities for fiscal evasion (and so under-declaration of output and indeed employment), there is no reason to believe that the arrival of these new models has necessarily caused new and significant systemic measurement problems per se. Certainly the output (fees, commissions, etc.) of the new coordinating players should be recorded in the national accounts.

Concerning C2C transactions, which resemble bartering transactions, such as house swapping, again there will be a disruptive impact on economic activity (e.g. on the hotel sector), with a potential impact on the related output recorded in the national accounts as the activity is not picked up, but this can be tempered by the fact that the accounts already impute an estimate of output for dwelling services where owners occupy their own dwellings. Moreover, for productivity estimates, the lack of recorded output will be further tempered by the fact that there will also be no recorded labour input.

That being said, digitalisation is beginning to raise more profound questions about the scope of the accounting framework. Models like UberPop and Cashierless tills are dependent on greater participation (labour input) on the part of the consumer, but the consumer's activity remains outside of the GDP production boundary. In effect, the new business models imply a partial shifting of a service activity to the final consumer. Indeed questions are also being raised about the participative role that consumers play in receiving free services (e.g. media) financed through advertising revenues (Nakamura and Soloveichik, 2015). The overall

effect on welfare from a societal perspective remains to be fully explored: to the extent that consumers provide unpaid labour services, there may be some negative welfare effects. But new technologies and service agreements also greatly enhance consumer convenience, they permit quick and costless access to information and entertainment, and they improve individuals' search capacity and so generate positive welfare effects.

Prices

Adequately capturing price changes, and differentiating between pure price change and quality (volume) change remains a long-standing challenge. And with products, in particular services but increasingly also goods, becoming more unique via customisation, price comparisons that control for quality differences are more complicated. The *Eurostat-OECD Methodological Guide for Developing Producer Price Indices for Services* (OECD and Eurostat, 2014) provides detailed advice on this issue by product, highlighting a number of approaches that could be used for measuring price changes in specialised products (contract pricing, model pricing, component pricing, hedonic methods), but accurately measuring quality changes remains challenging. However, it is perhaps important to put the issue of "customisation" into its appropriate context when considering volume measures of GDP. The objective is to measure price *changes*, not the price *level* of the product. Consequently, proxy estimates that employ comparable price changes over comparable (non-customised) products may limit the scope of potential errors on volume and productivity estimates.

One characteristic of globalisation has been the significant increase in outsourcing strategies that have brought with them significant substitution between domestically produced goods and imports. In many countries, however, it is not possible to accurately capture the corresponding price changes, impacting on volume estimates of GDP and hence productivity (Reinsdorf and Yuskavage, 2014).

Going forward

From the above it is clear that a significant number of challenges remain both in improving our understanding of the drivers of productivity and in improving measurement of those drivers. These include, but are not restricted to, the measurement of human capital, skills, knowledge-based assets, the use of natural resources, and the digital economy, in particular the new business models, all of which form important strands of the OECD's statistical work programme. But, notwithstanding progress in these areas, the current indications are that measurement, or rather mis-measurement, is unlikely to fully explain the recent productivity slowdown and paradox. Trends in productivity growth across advanced economies suggest that the slowdown has been underway for decades, and only accentuated by the crisis, reflecting a mixture of structural and cyclical factors. Inefficiencies in the allocation of resources, such as skills mismatches, sluggish investment, lower growth in international trade and a decline in business dynamism all feature as possible suspects. But there is also concern that there may be more than just a casual relationship with the increase in income and wealth inequalities that have also been observed in recent decades across OECD economies. Indeed there is concern that the relationship may be causal, with inequalities creating unequal opportunities, trapping individuals in lower skilled and lower productivity activities, with lower earnings, higher job insecurity and poorer working conditions.

Addressing these issues and challenges, and in particular the links between productivity and inequalities, is at the heart of the 2016 OECD Ministerial Council Meeting,

which recognises that promoting productivity growth while sharing productivity gains more evenly can create a virtuous circle to tackle inclusion gaps and foster in turn higher productivity.

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