Productivity Growth in the Digital Age

Digital transformation represents an opportunity for improving productivity growth by enabling innovation and reducing the costs of a range of business processes. Yet despite the rapid advance of digital technologies, aggregate productivity growth has slowed over the past decade or so, raising the question of how digital technologies can boost productivity. Today, as in the 1980s, when Nobel-prize winner Robert Solow famously quipped: "we see computers everywhere but in the productivity statistics" there is again a paradox of rapid technological change and slow productivity growth.

OECD work shows there is hope for the future. While not yet showing up in the aggregate productivity data, digital transformation is starting to have impacts on productivity in individual firms – and increasingly also in certain industries. Further and larger impacts should emerge as digital transformation evolves and digital technologies, business models and practices diffuse to a greater number of firms and industries, and as digital-intensive firms gain market share. Policy makers can help ensure that these impacts emerge by engaging in supportive policy actions.

Key recommendations

- Strengthen national and international technology and knowledge diffusion. Most technology and knowledge comes from abroad, requiring openness to trade, investment, and international talent. Policies should also strengthen knowledge diffusion within countries, e.g. by a wider use of technology extension services, strengthening of science-industry linkages and greater mobility of talent within the economy.
- Foster investment in tangible and intangible capital, notably skills. Policies to strengthen investment in digital technologies are important, but greater emphasis is needed on investment in complementary knowledge and capabilities, e.g. research and development (R&D), process innovation and other "intangibles". Investment in workers' skills is key.
- Enable small and medium-sized enterprises (SMEs) to harness digital transformation to help boost productivity and ensure growth is inclusive. This includes facilitating access to finance, knowledge networks and skills, SME engagement with competency centres and/or technology extension services, and practical guidance for the adoption of good practices.
- Facilitate the necessary structural change in the economy. Policies often implicitly or explicitly favour incumbents, but should enable experimentation with new ideas, technologies and business models. Policies that constrain the entry and growth of new firms can slow down structural change. Moreover, policy should also avoid trapping resources in inefficient firms.

Laggard firms and stalling diffusion

There are large differences among countries, industries and firms in the state of digital transformation and thus in how digital transformation affects productivity. Recent OECD analysis shows that some sectors are less advanced than others in terms of the pace of digital transformation (Calvino et al, 2018). For example, even if sectors such as agriculture, mining and real estate are using new technologies, they still rank lower than other sectors when it comes to indicators on software investment or use of information and communication technology (ICT) services. In most sectors there are also major differences across firms in their uptake of different digital technologies, raising important questions about why and how firms take up new technologies.

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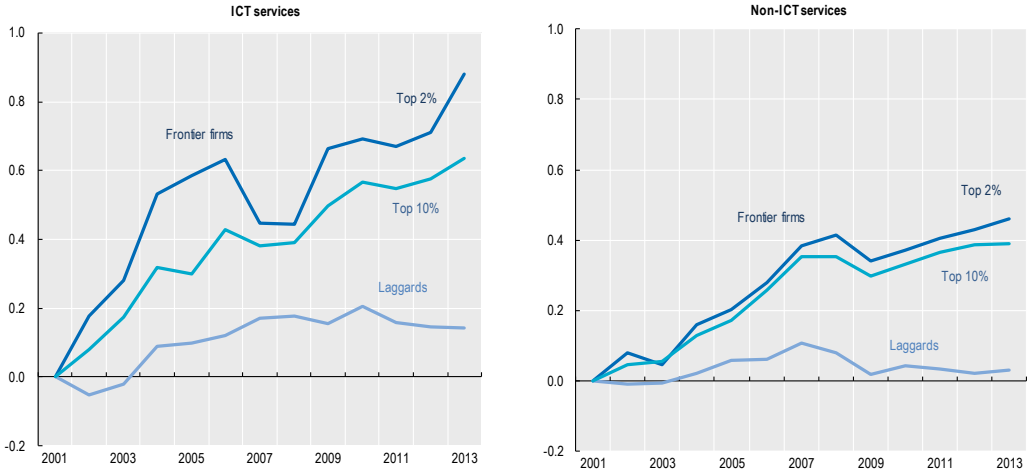
Figure 1. The productivity gap between leading and laggard firms is growing

ICT vs. non-ICT services sector

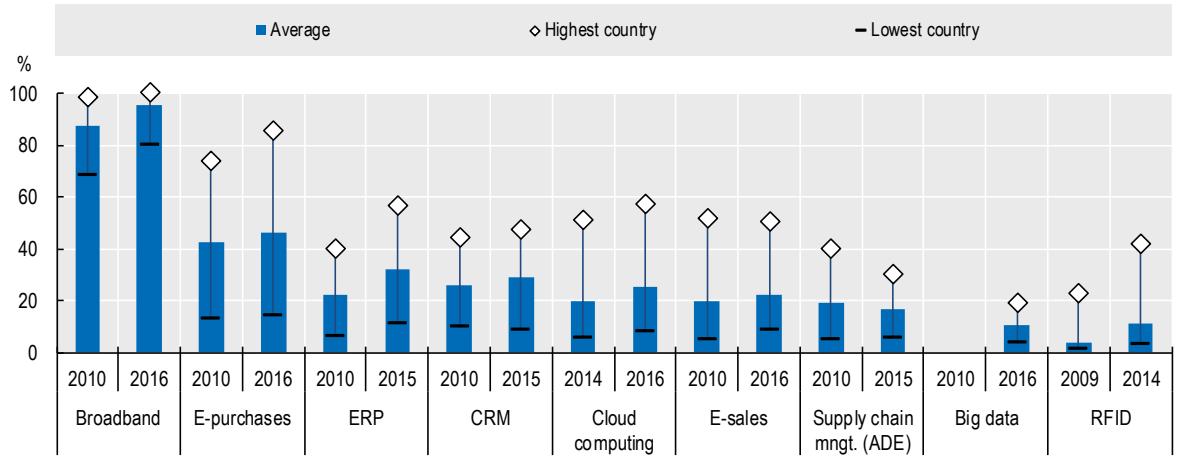


Source: Andrews, D. C. Criscuolo and P. Gal (2016), "The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy", https://doi.org/10.1787/63629cc9-en.

OECD analysis shows that, in fact, uneven uptake and diffusion of digital technologies throughout the economy is an important source of the productivity slowdown. The most advanced firms around the world have not slowed their rate of productivity growth; the aggregate productivity slowdown masks a widening performance gap between more and less productive firms, especially in the ICT services sectors (Andrews, Criscuolo and Gal, 2016) (Figure 1). The resultant divergence in productivity performance is driven both by frontier firms pushing the productivity frontier out, and by the stagnating productivity of laggard firms related to the limited capabilities of, or lack of incentives for, such firms to adopt best practices. Digitalisation may have contributed to this divergence (Gal et al., 2019). This relates to differences in firms' access to skills, as less productive firms can find it harder to attract workers with the right skills to help them adopt digital technologies efficiently.

Figure 2. Diffusion of digital technologies is far from complete

Diffusion of selected ICT tools and activities in firms in OECD countries, 2010 and 2016 (percentage of enterprises with ten or more persons employed)



Notes: The upper and lower bar denote the minimum and maximum average value across countries. ERP = enterprise resource planning; CRM = customer relationship management; RFID = radio frequency identification.

Source: OECD (2017), *OECD Science, Technology and Industry Scoreboard 2017*, https://doi.org/10.1787/9789264268821-en.

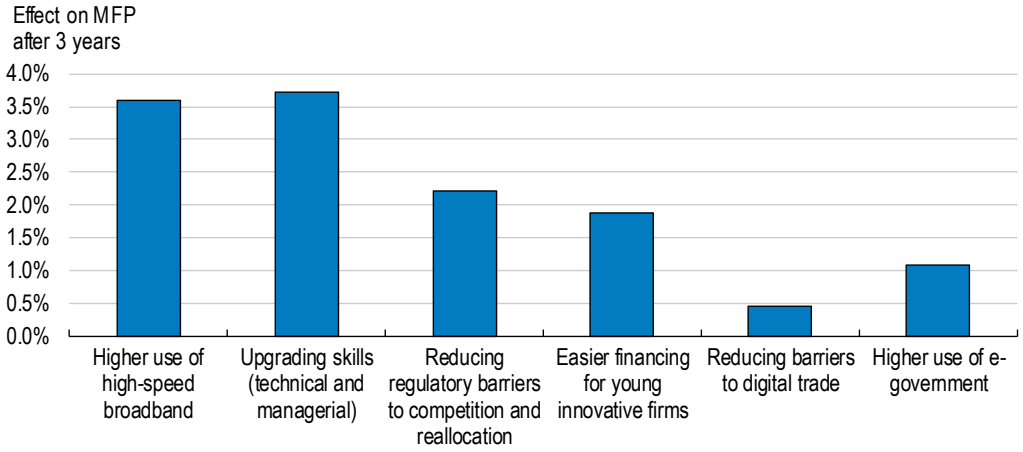
The diffusion of digital technologies across OECD countries is far from complete, even amongst the most advanced economies. While most firms now have access to high-speed broadband networks, more advanced, productivity-enhancing digital tools and applications, such as enterprise resource planning systems or big data analytics, have diffused to far fewer firms in OECD countries (Figure 2).

Digital transformation, as with other technological changes, is not just about the diffusion of technology, but also about the complementary investments that firms need to make in skills, organisational changes, process innovation, new systems and new business models (Haskel and Westlake, 2017). These investments involve much trial and error and take time. Productivity growth may be low and can even turn negative during this process of adjustment and experimentation (Brynjolfsson, Rock and Syverson, 2017). Moreover, the scale of these investments may make digital transformation particularly difficult for non-frontier firms, such as many SMEs (Brynjolfsson, Rock and Syverson, 2017). This implies that the most productive firms have benefitted more from digitalisation than less productive ones (Gal et al., 2019).

More positively, the slow diffusion of digital technologies and related processes across firms and industries in OECD countries suggest that digital transformation's impacts on productivity are likely to emerge in the years to come, as digital intensity in firms and sectors increases. The current business cycle might also affect this; as firms in several OECD countries are starting to incur labour and skills shortages, they will increasingly look for digital tools to help enhance their productivity performance. Policy can make a difference by stimulating productivity-enhancing digital adoption (Figure 3).

Figure 3. Policies can support digital adoption and productivity

Effect on firm productivity (through digital adoption) of closing half of the gap with best performing countries in a range of areas. Average OECD country, effect after 3 years



Note: Detailed assumptions and country-by-country estimates are available in Sorbe et al. (2019).

Source: Sorbe et al. (2019), "Digital dividend: Policies to harness the productivity potential of digital technologies".

Policies to support technology diffusion

Policies should promote successful diffusion to unleash the potential of ICTs and digital tools for firms to increase productivity. Approaches to boost diffusion should take into account not only the individual firm, but also networks of suppliers, users, and customers. Key actors and institutions for technology diffusion include, for example, government technology transfer offices, universities, other non-governmental stakeholders, and test beds which can help to de-risk prospective investments.

Examples of diffusion mechanisms used in different countries include industrial extension programmes, technology transfer, technology-oriented business services, applied technology centres, R&D centres, knowledge exchange and demand-based instruments. In addition, networks, partnerships, and open-source collaborations are increasingly important in orchestrating diffusion.

Support for ICT investment can also strengthen diffusion. Approaches across OECD countries to promote ICT investment include a variety of policy measures:

- Common financial schemes tend to provide monetary support or incentives for the purchase of ICT equipment or towards ICT development. For example, incentives to invest in R&D appear to be associated with greater adoption of customer relationship management and cloud computing (Andrews, Nicoletti and Timiliotis, 2018).

- Non-financial support is often provided through targeted training, mostly focused on the digitalisation of business services, e-commerce, or on the effective use of digital media (OECD, forthcoming).

Other approaches include measures to facilitate data (re)use across organisations and sectors (including by adopting digital government), promotion of e-health applications and e-commerce, digital content creation and diffusion and measures to foster the update of Internet of Things and machine-to-machine communication.

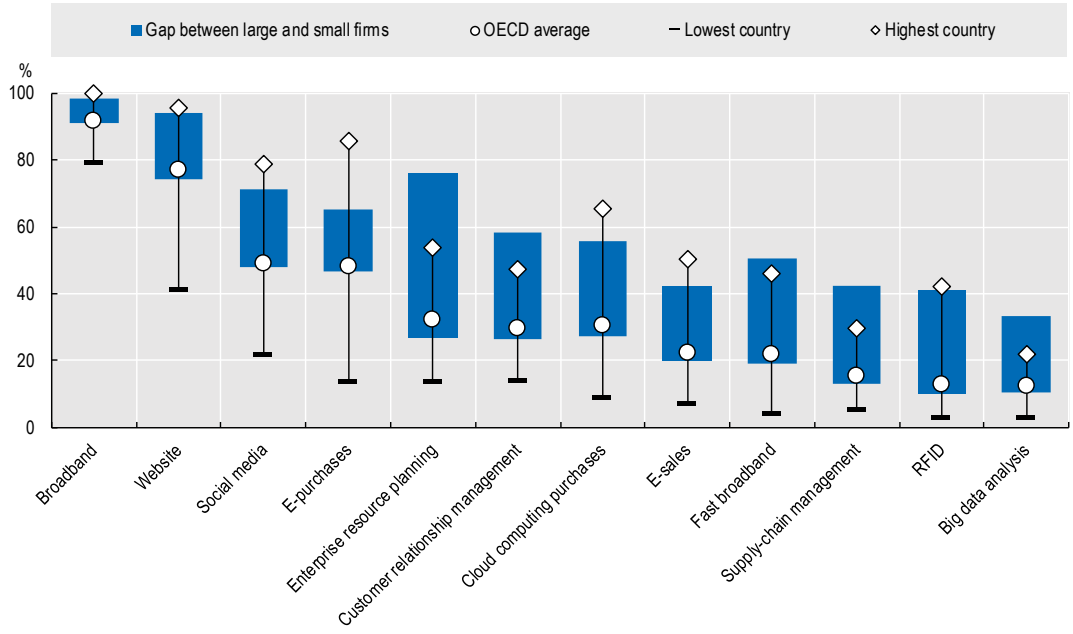
Large potential for SMEs

SMEs face a number of opportunities and challenges in adopting and benefitting from new digital technologies, and so improving their productivity. Digital transformation promotes the emergence of "born global" small firms, which serve customers locally and internationally. These firms' businesses are often underpinned by Internet platforms that facilitate trades that otherwise would not happen and thus increase the supply of products and services for consumers. SMEs can also use digital technologies such as big data and data analytics to better understand the processes within the firm, the needs of their clients and partners, and the overall business environment. They can also take advantage of digital technologies to improve their access to skills and talent, such as through better job recruitment sites, and in the outsourcing of key business functions, all of which can help improve performance. New technologies can also facilitate access to a range of financing instruments. Finally, online platforms can support the productivity of low-tech service firms, for example by providing them with booking facilities and efficient matching algorithms based on consumer review and rating systems (Bailin et al., forthcoming).

Just as diffusion varies across countries and industries, there are also large differences in the uptake of digital tools among firms of different sizes, with large firms on average using digital tools far more than SMEs, even in the same industry. For example, 28% of large firms perform big data analysis, but only 16% of medium-sized and 9% of small firms do so (Figure 4). There are large barriers for SMEs to adopt these new technologies, reflecting challenges such as relative difficulty accessing finance to make the necessary investments, or a lack of key capabilities, such as the requisite human resources and management expertise. Furthermore, SMEs face specific challenges in managing digital security and privacy risks, mainly due to lack of awareness, resources and expertise to assess and manage risk effectively. Finally, the slow adoption of digital technology might also be a reflection of the lower incentives for some SMEs who might not be able to reap the same pay-off from the digitalisation of their production processes as larger businesses.

Figure 4. Large potential remains for diffusion of digital tools in SMEs

Diffusion of selected digital tools among firms, as a percentage of all firms, 2017



Source: OECD (2019, *ICT Access and Usage by Businesses* (database), https://stats.oecd.org/Index.aspx?DataSetCode=ICT_BUS (accessed on 18 February 2019).

Policies to support SMEs

To help SMEs overcome barriers to the use of advanced digital tools, governments can help create favourable conditions for ICT adoption, such as policies that foster ICT investment, skills development and business dynamism, and address specific challenges faced by SMEs through more targeted policies. Examples of policy approaches include:

- Support schemes to facilitate the adoption of tools that are particularly beneficial but new to SMEs. Cloud computing is one example; it requires limited up-front investment when being paid as a service, and offers flexible up- or down-scaling of activities.
- Measures that help SMEs overcome obstacles to better exploit and protect intellectual property and leverage other intangibles. This may include, for example, targeted skills development or measures to overcome hurdles to accessing intellectual property, such as administrative burdens and complex and costly litigation and enforcement mechanisms.
- Exemptions from certain rules for SMEs where these facilitate regulatory compliance. For example, the EU General Data Protection Regulation includes a derogation for organisations with fewer than 250 employees with regards to data record-keeping.
- At the same time, policies targeting firms by size should avoid creating disincentives for SMEs to scale up. For instance, in the case of regulatory simplification for SMEs, efficient firms may choose to remain small to avoid the additional regulatory burden that may come with a certain size threshold.
- Programmes that raise awareness of and create opportunities for linkages and partnerships between SMEs and larger firms, domestically and internationally, which help SMEs exploit their potential in producing intermediate goods and digital services.

These and other policy measures to support SMEs may be taken into account in the context of a national digital strategy in order to ensure coherence and co-ordination across different SME related measures implemented across different policy areas.

Structural factors to encourage digital adoption

Digital transformation of firms involves a process of search and experimentation with new technologies and business models, where some firms succeed and grow and others fail and exit (OECD, 2004). Countries with a business environment that enables this process may be better able to seize the benefits from digital transformation than countries where such changes are more difficult and slow.

The diffusion of selected digital technologies is typically more advanced in sectors where the entry and exit of firms is higher (Calvino and Criscuolo, 2018). This is consistent with the idea that new entrants: 1) possess a comparative advantage in commercialising new technologies (Henderson, 1993); 2) place indirect pressure on incumbent firms to adopt new technologies; and 3) can more fully reach their potential when they have sufficient space to grow, which is accommodated by the exit of inefficient firms.

Moreover, digital adoption will be facilitated by efficient resource allocation, since a firm's incentives to experiment with uncertain/risky digital technologies will be shaped by its perceived ability to rapidly scale-up operations in event of success, and rapidly scale-down operations and potentially exit the market at low cost in the event of failure (Andrews and Criscuolo, 2013).

Recent years have seen declining business dynamism in OECD countries (Criscuolo, Gal and Menon, 2014) and rising resource misallocation (Adalet McGowan, Andrews and Millot, 2017a; Berlingieri, Blanchenay and Criscuolo, 2017) in many OECD countries. The slowdown in business dynamism – e.g. as reflected in a decline in firm entry rates – has had the knock-on effect of slowing down the necessary reallocation of resources across the economy. For example, the share of non-viable old firms has been increasing in many OECD countries, particularly since the financial crisis, while the productivity of the latter group of firms has been falling rapidly relative to "viable" old firms, as well as younger firms in general (Adalet McGowan, Andrews and Millot, 2017a). The growing amount of resources trapped in unproductive "zombie" firms and the slowdown in reform efforts to tackle regulations that impede product market competition (Adalet McGowan, Andrews and Millot, 2017b) have also contributed to the slowdown in structural change.

Research examining the association between business dynamism (measured by the churning rate) and selected measures of digital intensity (Calvino and Criscuolo, 2018) points to the existence of a positive role for digital transformation in encouraging business dynamism. This is in line with the idea that digital transformation lowers barriers to entry and facilitates the reallocation of resources. It also suggests that the more digital-intensive sectors are those that are more dynamic, i.e. with higher rates of entry, higher churning and higher post-entry growth.

Business dynamism is not consistently high across all digital sectors. It is lower in sectors where the automation of tasks and the share of turnover from e-commerce are higher. These findings likely reflect the role of high fixed costs, data and networks of customers and suppliers as a barrier for new firms. They might also reflect that growth of firms in highly automated sectors might not always involve the direct creation of new jobs. Digital technologies are also transforming the way firms produce, scale up and compete. They allow firms to leverage ever larger networks of consumers, access multiple geographical and product markets almost instantaneously, and exploit increasing returns to scale from intangible assets.

The slowdown in business dynamism might be reflecting both changes in production as a consequence of the digital transformation, e.g. stronger reliance on intangibles, and higher fixed costs. It could also be indicative of a shift in the market structure, reflecting lower costs of production, easier penetration of multiple markets and higher intensity in knowledge assets, which allow digital companies to scale up faster and more easily, and generate increasing returns to scale, thus potentially making the entry of new players in the market more difficult.

Policies to foster business dynamism

Harnessing digital transformation for firms places an added premium on policies that foster business dynamism and efficient resource reallocation. A range of policies can incentivise greater digital adoption through experimentation either by increasing competitive pressures or by lowering the costs of reallocation.

- This includes insolvency regimes that do not inhibit corporate restructuring and do not excessively punish entrepreneurial failure, as well as labour market policies that facilitate job transitions and product market policies that do not put excessive administrative burdens on start-ups.
- Access by entrepreneurs to appropriate forms of finance, such as venture capital financing, together with corporate tax regimes that do not excessively favour debt over equity financing, are also associated with higher digital adoption rates.

Firms also need to have access to the right set of capabilities. For example, qualified firm management that takes the decisions to invest and guides the adoption process has been identified as a key capability (see Bloom, Sadun and Van Reenen, 2012; Pellegrino and Zingales, 2014). Firm-level practices related to workers, including their participation in training, or their flexibility in working hours, are also important in this context.

Workers need to have the right skills, so they should be given the chance to continuously develop their skills to keep up to date. Workers should also be in roles where their skills are allocated to their most productive uses. In addition, workers' wages, that can be used as a proxy for their productivity, are positively correlated not only with workers' advanced numeracy skills but also with their management and communication capabilities.

Policy makers also need to examine and take into consideration the changes in business dynamism, in particular in digital-intensive sectors. Even though these changes may be inherent to the nature of digital transformation and not a concern, they do point to important changes in the competitive environment linked to digital transformation.

Further reading

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Digital technologies and large-scale data flows are fundamentally changing how people live and work, interact with one another, participate in the economy, and engage with the government. The OECD's ***Going Digital*** project examines how government policy can help ensure this digital transformation benefits all by increasing growth and improving well-being. Going Digital Policy Notes provide insights into key trends, opportunities and challenges, and the policy directions needed for making the most of digital transformation.

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