THE NEXT PRODUCTION REVOLUTION

MAKING THE DIGITAL TRANSFORMATION WORK FOR SPAIN

Report prepared for the OECD-Fundación Ramón Areces seminar

MADRID, SPAIN
14 MARCH 2017

OECD
BETTER POLICIES FOR BETTER LIVES

This background paper was prepared for the OECD-Fundación Ramón Areces seminar, Madrid, 14 March 2017.

It draws on recent OECD work on the digital transformation and the next production revolution, including the 2016 *Science, Technology and Innovation Outlook* (OECD, 2016a), the OECD *Digital Economy Outlook 2015* (OECD, 2015a), the G20 report *Key Issues for Digital Transformation in the G20* (OECD, 2017a), the interim report on OECD work on the *Next Production Revolution* (OECD, 2016b), and the OECD *Better Policies Series – From Bricks to Brains* brochure for Spain (OECD, 2017b). More details on many of the issues discussed in this paper are available in those studies.

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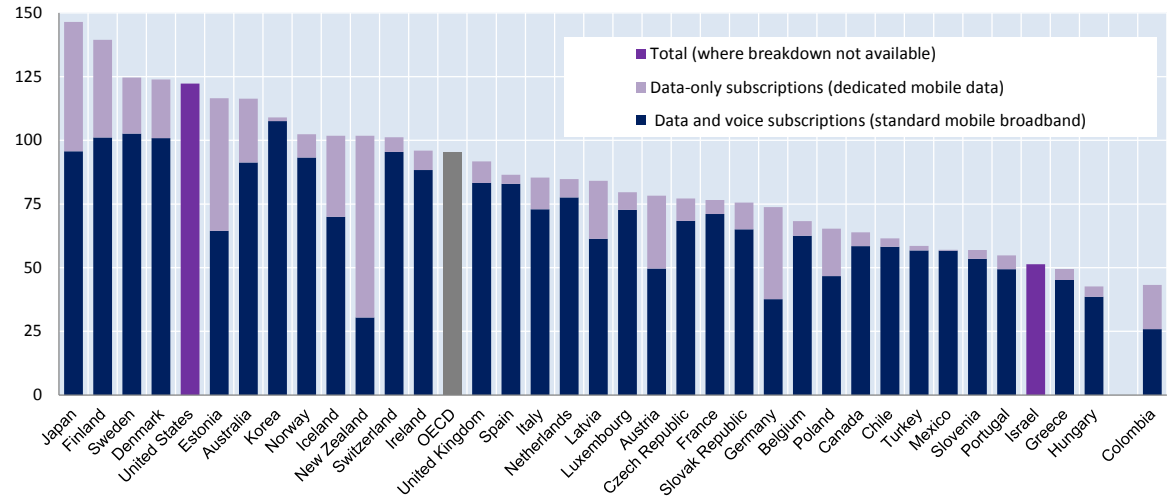
1. Digitalisation and the next production revolution

We are in the midst of the transition towards a digital economy and society. Although underway for nearly half-a-century, the pace of change has quickened in recent years. Digital infrastructures are now nearly fully deployed across OECD countries and growing quickly beyond (Figure 1), and powerful devices like smart phones provide ubiquitous computing to many. Access has grown, from 4% to 40% of the world's population in 20 years and emerging and developing economies are increasingly using digital technologies to leapfrog ahead in areas like e-commerce, banking and health. In Spain, 80% of all individuals used the Internet in 2015, up from just under 50% in 2005. Much of this growing use is related to the rapid penetration of mobile broadband (Figure 1), where Spain stands just below the OECD average.

Figure 1. OECD mobile broadband subscriptions per 100 inhabitants, by technology, June 2016



Notes: Israel, Switzerland and United States: data for June 2016 are estimates. Colombia is in the process of accession to the OECD.

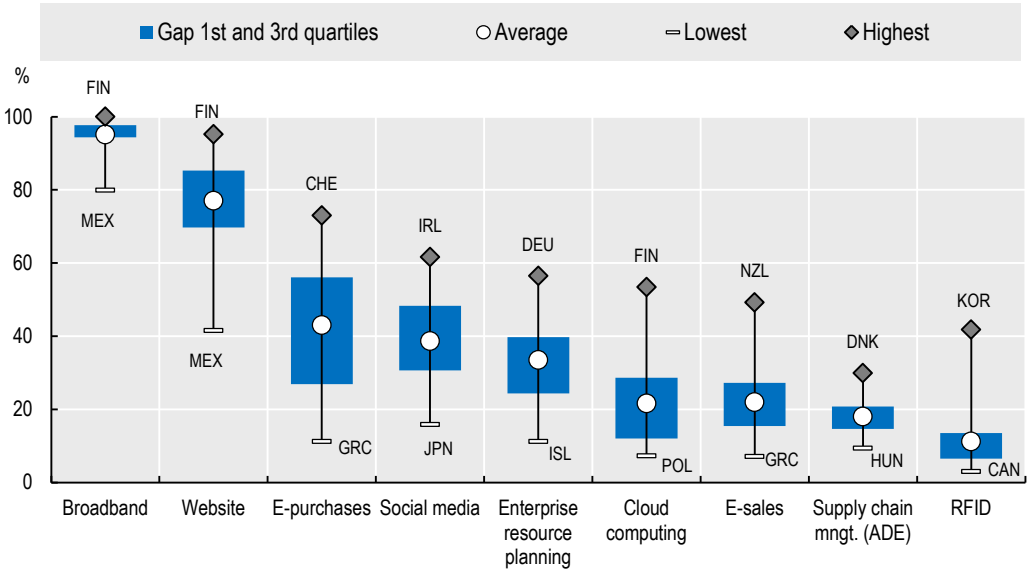
Source: *OECD Broadband Portal*, www.oecd.org/sti/broadband/oecdbroadbandportal.htm.

As more people and things become connected to networks, torrents of data are generated, new technologies such as block chain emerge and breakthroughs occur in artificial intelligence, **it is clear that the digital transformation is still only at an early stage**. While many firms now have access to digital technologies, the use of digital tools still differs greatly across countries, even among the most advanced economies (Figure 2). The access of Spanish firms to broadband networks, for example, is now close to that of leading countries in the OECD, but Spanish firms still lag considerably in the use of specific digital technologies, e.g. for e-purchases or e-sales, or for cloud computing. Small and medium-sized enterprises (SMEs), in particular, lag behind in Spain (as in many other OECD countries), even though digital technologies also offer many new opportunities for such firms.

The digital transformation is key to a **broader production revolution** that is underway, which entails a confluence of technologies ranging from digital technologies (e.g. 3D printing, Internet of Things, advanced robotics) to new materials (e.g. bio- or nano-based) to new processes (e.g. data-driven production, artificial intelligence, synthetic biology).

Figure 2. The diffusion of selected ICT tools and activities in enterprises, 2015

Percentage of enterprises with 10 or more persons employed



Sources: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database* and national sources, April 2016.

The digital transformation and the next production revolution that are underway promise to spur innovation, increase productivity across a wide range of activities, enhance the delivery of many public and private services, e.g. health and education, and improve well-being as information and knowledge become more widely available and democratised.

But these benefits go hand-in-hand with challenges to the nature and structure of organisations, markets, and social interactions. The digital transformation raises challenges for skills, employment, market entry, and competition, and also invites rethinking on how to preserve fundamentals such as privacy, security, property, and on how to ensure inclusiveness.

A number of key challenges affect the digital transformation. These range from ensuring access to all individuals and firms, including SMEs, to facilitating its effective use, to helping workers deal with the disruption, to research and innovation, and to a wide range of other questions around competition and regulation, and also privacy and security. This section briefly touches on each of these and points to some key policy issues for Spain.

2. Enhancing access and use of digital technologies

Digital technologies have spread rapidly over the past 20 years, with a large share of the population in OECD countries now having access to fixed or mobile broadband networks, and firms often using several digital applications throughout their businesses. Developments in mobile technologies have also enabled people to conduct daily personal computing and communications activities on-the-go. Nevertheless, there is still considerable variation across and within OECD countries in the access of people and firms to digital technologies and services.

The variation within OECD countries across different population groups appears largely linked to incomes, levels of education, age, and region, with gender differences typically playing a more limited role. Many lagging OECD countries have made strong progress in reducing these gaps in the past decade, in large part due to advances in mobile broadband availability. Data on Internet access by income quartiles also show that the diffusion process has also advanced substantially for low-income households in many countries (OECD, 2016c). As the benefits of digital technologies increase with the number of people and firms connected, increasing access and ensuring that all are able to benefit from these technologies and their many applications and services is an important challenge for policy makers.

Over the past few years, access to mobile Internet has increased rapidly among the Spanish population (OECD, 2017b). In 2016, 71% of adults accessed the Internet through a mobile phone, against 17% in 2011. This share is 11 percentage points above the EU15 average (60% in 2016). Access to fixed broadband has increased as well, but at a lower speed: In 2016, 71% of Spanish households had access to fixed broadband, against 58% in 2011. This share remains below the EU15 average (76% in 2016).

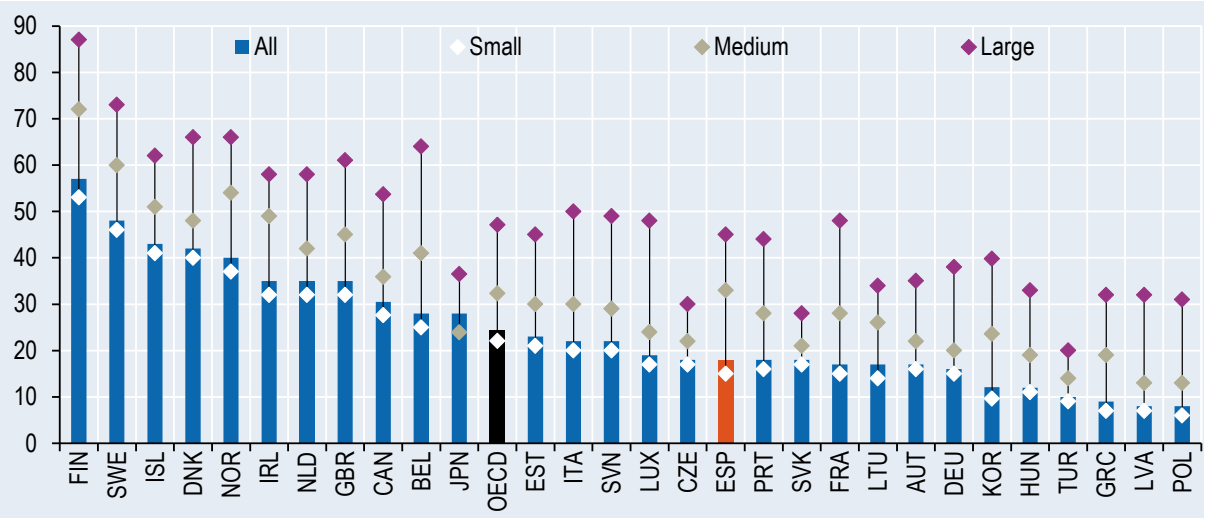
In Spain, the growth in fibre connections – the fastest broadband technology – has been one of the highest in OECD countries. By June 2016, fibre connections accounted for 29.7% of all fixed broadband connections, well above the OECD average of 20.1%. While Spain is among the top countries in terms of fibre subscriptions, the overall access to fixed broadband infrastructure can be further extended. In this context, it is important for policy makers and regulators to assess competition, especially in the light of convergence and an increasing amount of bundled services.

In 2016, 67% of Spanish adults used the Internet daily (OECD, 2017b). This share amounts to a 20 percentage point increase since 2011 but is 5 percentage points below the EU15 average. The gap is mainly accounted for by low usage among the elderly (65-74 year-olds), low-education and low-income individuals. In addition, the diffusion of e-commerce remains limited, with only 44% of Spanish people having purchased online at least once in 2016 against 61% for the EU15 average. Policies targeting these three groups are the key to improving access to online services for all, e.g. health, education and government services, and to reducing the digital divide. The digital revolution will backfire if it widens the gap between haves and have-nots and erodes trust between governments, companies and citizens. Making the digital transformation inclusive will not only contribute to social stability but also increase the size of digital markets and create new business opportunities.

For firms, differences in the uptake of information and communication technologies (ICTs) across OECD countries appear mainly linked to firm size, but they are also affected by the sectoral composition of the economy. Moreover, while broadband access and basic applications such as websites are common among most firms, more advanced applications, such as cloud computing are used by a much smaller share of firms, in particular by SMEs (Figure 3), perhaps in part because a lack of workers with the skills to use these technologies effectively, but also as these applications require a much greater transformation of business processes and attention to security and risk management (discussed further below). In Spain, for example, some 45% of large firms used cloud computing services in 2016, but only 15% of small firms.

Figure 3. Enterprises using cloud computing services, by size, 2016

As a percentage of enterprises in each employment size class



Sources: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database* and national sources, January 2017.

The diffusion of digital technologies among Spanish firms has occurred rapidly in recent years (OECD, 2017b). In 2016, 97% of all Spanish businesses with at least 10 employed persons had broadband access (2 percentage points above the EU15 average) and 75% of all Spanish businesses had a website or a home page, an increase by 11 percentage points from 2011 (though still lower than in the EU15 of 80%. The share of Spanish SMEs with broadband access (fixed or mobile) and whose businesses processes are automatically linked to those of their suppliers or/and customers is above the EU15 average (95 % and 14%). More broadly, Spanish firms are around the EU15 average in their use of business-enhancing digital technologies and above that average in their use of Electronic Resource Planning software (36% against 33% for EU15), although they make less use of cloud computing than their peers in other EU states and OECD countries.

However, automation of production, a process that had occurred at a very fast rate over 1993-2000, seems to have significantly slowed down since, as shown by the stagnation in the gross stock of operational robots over 2010-14. Overall, ICT accounted for only 10% of total investment (gross fixed capital formation) in Spain over 2011-15. Providing incentives for investment in ICTs is important to increase productivity and speed up the economic recovery in Spain. Targeting SMEs will be critical, to ensure that this process is inclusive and that the gains are spread widely across society.

The slow uptake of some digital technologies is an important challenge for policy, as these technologies offer valuable opportunities for firms, including in lowering important barriers to entry. For example, digital technologies can facilitate cross-border e-commerce and participation in global value chains (e.g. Skype for communications, Google and Dropbox for file sharing, LinkedIn for finding talent, PayPal for transactions, and Alibaba and Amazon for sales). Enhancing access to networks and enabling SMEs to engage in e-commerce can be an effective way for small firms to go global and even grow across borders where they can become competitors in niche markets. For example, M-Pesa, a Kenyan mobile-money service, is now active across Africa as well as in South Asia and Eastern Europe.

Despite the rapid spread and uptake of digital technologies, adoption and use vary among economies by demographic categories, industries and firm size. Barriers to the access and effective use of digital technologies typically include some combination of a lack of high-quality and affordable infrastructure; a lack of trust in digital technologies and activities; a shortage of the skills needed to succeed in the digital economy; services

trade barriers; high costs and poor access to financing for smaller firms; and barriers to the reallocation of resources across firms and sectors.

These barriers can be ameliorated by developing and implementing comprehensive national digital strategies that would encompass actions to enhance competition in telecommunication markets and improve Internet access for disadvantaged groups, SMEs and regions; elevate the importance and clarify the objectives of policies and practices to address digital security and privacy risks; reduce firm-level barriers and enable complementary investments; ensure life-long learning mechanisms to improve workers' skills; and foster firm dynamics within the economy.

It is also essential that countries continue to invest in the development of digital infrastructures to meet existing and future demand. They provide the foundation for many new services, applications and business models. They are also crucial in underpinning and enabling the digital innovations that are transforming production. Key barriers to the deployment of high-speed networks and services include the nature of the infrastructure itself (often characterised by monopolies and duopolies), which can give rise to high barriers to entry. In addition, geography, administrative barriers, regulatory uncertainty, and high capital expenditure, access to spectrum, and in some countries, a lack of basic infrastructure (e.g. electricity) particularly in rural areas, can be stumbling blocks. An important area for policy action therefore involves establishing national broadband plans with well-defined targets and reviewing them regularly. These plans should ideally address the key barriers to the deployment of high-speed networks and services and include measurable targets to address the policy challenges associated with ensuring competition and investment. It is also important that these plans include targets associated with the important technical enablers, such as access to Internet exchange points and spectrum, among others.

As noted above, important differences in ICT adoption and usage exist between large and small firms, with SMEs facing several barriers to adopting ICTs and digital technologies in their operational activities, in particular in having the resources to acquire the necessary complementary knowledge-based assets, such as organisational and human capital. It is essential to help promote adoption of these digital technologies among SMEs because they can help overcome some of the traditional barriers to investing in digital technologies, including the often high, upfront sunk costs of these investments, and allow them to switch more rapidly from one technology to another to avoid being locked in.

Comprehensive national digital strategies that take into account SMEs, policies that facilitate access to finance, and SME engagement with competency centres and/or technology diffusion extension services, can be helpful in this regard.

Building on these issues, recent OECD work points to a number of recommendations for Spain that can help strengthen uptake of digital technologies, notably (OECD, 2017b):

- **Further improve access to fixed and mobile communication networks and extend high-speed broadband coverage as much as possible.**
- **Increase use of digital technologies by the elderly and people with lower education and income levels, through provision of user-friendly interfaces for digital government services and ensuring early exposure to digital technologies at school.**
- **Promote incentives for investment in ICTs through the further implementation of Spain's Digital Agenda, focusing especially on SMEs.**

3. Skills and talent for the digital transformation

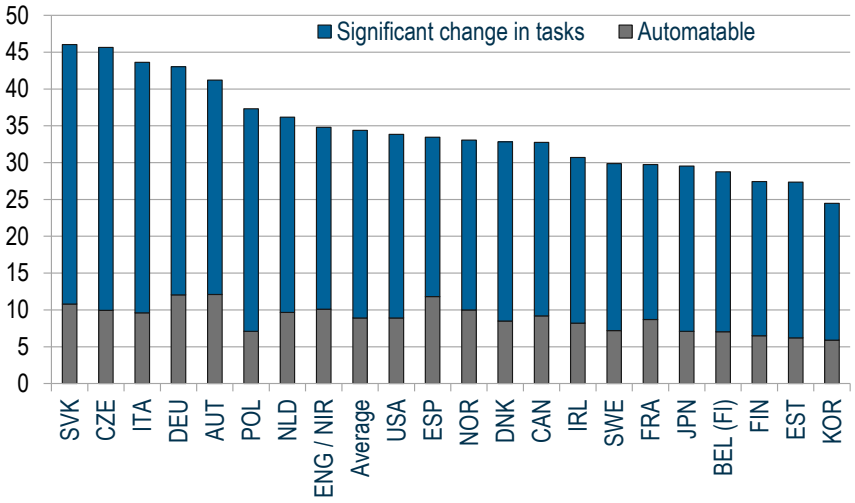
The second major challenge for policy concerns jobs and skills. The digital transformation is already affecting individuals not only by changing the demand for skills but also by disrupting entire industries. However, recent OECD findings suggest that so far, while leading to restructuring and reallocation, ICTs have not led to greater unemployment over time. If adopted successfully, i.e. if combined with organisational changes and good managerial practices (OECD, 2004), ICTs can contribute to increased productivity, which progressively translates into lower prices and/or new products, higher final demand and higher employment, thus compensating for the initial job displacement.

However, the digital transformation is being accompanied by a process of skill-biased technological change. Most new technologies have required higher levels of skill to use than those they displace. This is a long-standing trend. While skills-biased technological change helps explain the rise in the employment share of workers in high-skill jobs over the past three decades, it does not explain the simultaneous rising in the share of low-skilled jobs. This phenomenon, known as job polarisation, may be linked to ongoing technological changes. Developments in technologies such as artificial intelligence, robotics, the Internet of Things and big data analytics, may be changing the nature of the link between technology and jobs. Those jobs relying on a high proportion of automatable tasks are at high risk of being substituted for by new technologies. Computers and algorithms mainly substitute for jobs with tasks that can be easily codified on the highly skilled end of the skill distribution, or manual jobs at the bottom end of the skill distribution, leading to job polarisation or "hollowing-out".

The extent and permanence of this hollowing-out remains controversial. Some studies suggest that digitalisation may make it possible that, in the near future, a large proportion of tasks or even entire occupations currently carried out by workers could be performed by machines (Frey and Osborne, 2013) enhancing the fear that computers and many are bound to lose (Brynjolfsson and McAfee, 2011). Recent OECD analysis suggests that on average across countries, 9% of jobs are at high risk of being automated, while for another 25% more jobs, 50% of the tasks will change significantly because of automation (Arntz, Gregory and Zierahn, 2016; Figure 4). For Spain, some 12% of jobs are currently considered to be at high risk of automation, and another 20% of jobs are expected to change significantly due to automation.

Figure 4. Jobs with high and medium potential for automation

Percentage of jobs with 70 % and between 50 % and 70 % of substitutable tasks



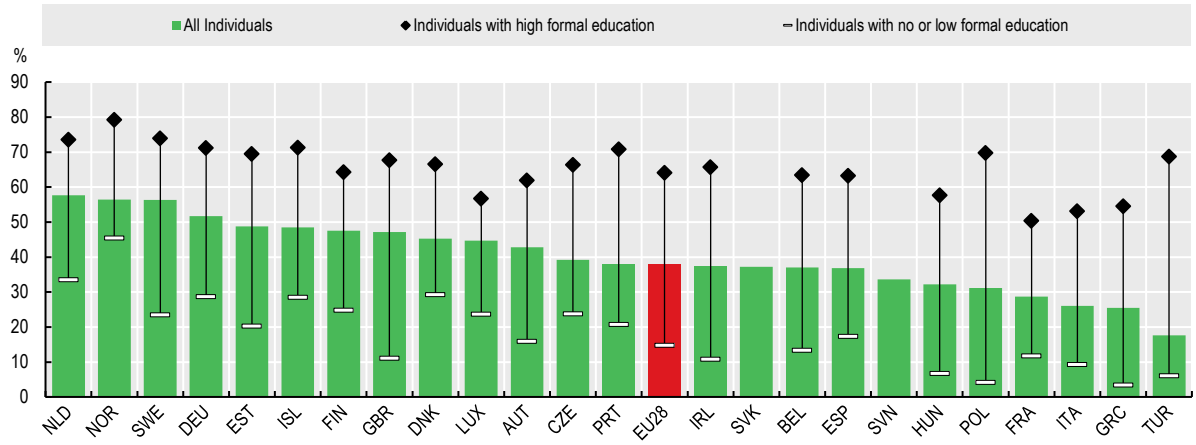
Sources: OECD *Survey of Adult Skills* (PIAAC); Arntz et al. (2016).

A key question remains whether digitalisation increases the pace or nature of hollowing-out, with implications on jobs. Estimates such as Frey and Osborne (2013) have been criticised on the basis that rather than occupations it is specific tasks that are at risk of automation, while occupations are more likely to evolve to accommodate the penetration of technology rather than face complete substitution (Bessen, 2015). Workers with the skills to adapt to changes in the workplace are less at risk of being left behind. Also, with the productivity gains and the adoption of technology, new and complementary jobs are likely to be created (Autor, 2015). Overall, however, these studies find evidence that the share of middle wage jobs, characterised by routine tasks, has declined and the wage share of the middle-skilled has also contracted, which has contributed to increased inequality. Evidence of temporary job polarisation is also supported by OECD findings (OECD, 2015b) which suggest that in periods where labour demand decreases due to ICT, the decrease is stronger for medium-skilled workers than for their high- and low-skilled counterparts.

Regardless of the precise number of jobs at risk of automation, continued hollowing-out will continue to disrupt the labour market. Workers will need different skills, not just more skills. Data from the OECD *Survey of Adult Skills* show that on average across the 22 countries that implemented the survey, 55% of workers lack basic problem-solving skills in technology-rich environments, suggesting weak prospects for capitalising on the opportunities offered by the digital economy (OECD, 2013a). Moreover, in many countries, including Spain, many individuals do not judge their computer skills to be sufficient if they were to apply for a new job within a year. This is particularly the case for people with no or low levels of formal education (Figure 5).

Figure 5. Individuals who judge their computer skills to be sufficient if they were to apply for a new job within a year, 2013

As a percentage of all individuals



Source: OECD (2014), *Measuring the Digital Economy: A New Perspective*, http://dx.doi.org/10.1787/888933148354.

Properly educating young people and adults and preparing them for life-long learning must therefore be a priority in a world where knowledge assets are critical. Higher levels of education and skills will be increasingly important for success in the labour market of tomorrow, also in Spain. While the majority of jobs (71% in 2012) continue to be in occupations that typically require only upper secondary education or less, almost all growth between 2006 and 2014 in the shares of employment in Spain was in occupations that typically require a university degree.

There has been a substantial improvement in tertiary attainment rates in Spain, with the country now ranking at the OECD average. In 2012, the share of Spanish 25-34 year-olds with tertiary education was 39%, compared with 19% among 55-64 year-olds. This improvement of 20 percentage points was surpassed in only six OECD countries. However, Spanish tertiary graduates rank near the bottom of the OECD in terms of their performance

in reading and numeracy. Comparatively few tertiary graduates are high performers. They also perform worse than their peers in other countries when it comes to computer experience. The problem seems to start in school. While dropout rates have fallen significantly in recent years (from 26.3% in 2011 to 19.9% by 2015), Spain still has the highest incidence of early school leaving in the European Union (OECD, 2015c). Since most dropouts (70%) do not obtain a high school diploma, levels of skills remain unknown, due to the lack of external evaluations, but can be presumed to be very low. Early school leavers are often unemployed and also contribute to the high rate of "Not in Education, Employment, or Training" (NEETs) in Spain.

According to the OECD's Programme for International Student Assessment (PISA) study, the 15 year-olds who remain in school now rank alongside their peers in most other OECD countries in reading, mathematics and science, but this reflects more a fall in the OECD average than an improvement in Spain's performance. In fact, the performance of Spanish students has stagnated over time. Comparatively few students perform at the highest levels of proficiency in literacy (6% in Spain compared to the OECD average of 8%). 16% (22%) of 15 year old students perform below Level 2 in the PISA assessment of literacy (numeracy), considered the baseline level of proficiency. While this is better than the OECD averages of respectively 20% and 23%, it is still no reason for complacency as these students lack the basic level of skills needed to succeed in the labour market. Similarly, 27.5% of working age adults score less than Level 2 in literacy and/or numeracy (on a scale up to Level 5) in the OECD *Survey of Adult Skills*, this is a pressing problem for the country. The initial education system needs to do a better job of ensuring that all students develop strong literacy, numeracy and problem-solving skills. In the same vein, efforts to raise the basic skills of the lowest skilled adults need to be strengthened. This is crucial for making Spain a more knowledge-based economy and for ensuring that everyone has the opportunity to thrive in such an economy.

Finally, it is important to note that digitalisation is also changing the way work is organised. The "platform economy" (referring broadly to the "gig", "sharing", and "on-demand" economies), though still small in scale, is growing quickly across many sectors since it lowers the transaction costs of businesses accessing a larger pool of potential workers and suppliers, with workers increasingly engaged as independent contract workers. This has benefits for some workers, providing them with greater flexibility, and allowing people to earn additional income and access work, sometimes for the first time. At the same time, these jobs rely mostly on non-standard work arrangements (e.g. self-employment) that may limit access to regular jobs; it may also offer less promising employment trajectories and lower access to social protection or training opportunities; and it could also limit worker's access to union representation and wage-setting mechanisms. Attention to these issues will be important for the future.

Recent OECD work provides a number of recommendations for Spain that can help strengthen skills and talent. A number of those are particularly important for the challenges offered by the digital transformation, notably (OECD, 2017b):

- **Expand strong work-based vocational programmes, to continue to decrease early school leaving and raise youth employment rates.**
- **Improve student performance in compulsory and upper secondary education through a more competency-based instructional system, higher curricula standards, and evaluation and assessment frameworks for teachers.**
- **Provide greater support for teacher training, selection, and professional development to drive improved completion rates and skills (including digital skills) acquisition in compulsory and upper secondary education.**
- **Improve and expand access to high-quality labour-market information to support informed choices in education and careers.**

4. Science and innovation

Benefiting from the digital transformation also depends on the capabilities of an economy for research and innovation, as this supports the generation of new knowledge, products, services and business models. In terms of science, technology and innovation, Spain's significant progress in increasing research and development (R&D) as a share of gross domestic product (GDP) in the 1990s and 2000s was curtailed and even reversed following the economic crisis (OECD, 2016a). In particular, public R&D investment decreased steadily over the period 2009-14 at an annual growth rate of 3.4%. The trend has been reversed in 2015 with an increase of 2.1%. Spain's GERD intensity (relative to GDP) remains low, however, and stands at about half the OECD average. Some of the key STI policy priorities are: strengthening business innovation, reinforcing the public research system, and improving commercialisation and technology transfer.

Encouraging business R&D and innovation

A critical challenge for improving competitiveness and economic growth in Spain is improving the innovation capacity of the business sector. The innovation performance of the Spanish business sector still lags behind the OECD median in several dimensions (see Figure 6[a,d,e,f,g]). The gap is particularly important in terms of R&D activity and patenting. Few Spanish firms appear in the top 500 corporate R&D investors. The structural features of BERD remain pretty much the same as in 2007. As in most OECD countries, R&D is mostly concentrated in the manufacturing sector accounting for 60% of BERD, whereas services represent around 35%. Foreign affiliates account for 40%. The share of SMEs and large firms in BERD is almost even. Venture capital remains under-developed (Figure 6[h,i,j]) and the number of young patenting firms ranks at the bottom of OECD indicators. Business start-ups are smaller and with a lower survival rate than most of their Euro-area counterparts. The ease of entrepreneurship index ranks at the bottom-half group of OECD countries.

Spain needs to reassess its support for business innovation and balance the different instruments at its disposal, attuning them better to businesses' incentives and evidence on their economic impact. While the R&D tax credit regime provides what appears to be one of the most generous tax treatments of business R&D (in 2016, the R&D tax subsidy rate was USD 0.36 per USD of R&D outlays for profitable firms), the actual magnitude of tax expenditure is small relative to other OECD countries and other major partner economies, even after accounting for Spain's low business R&D intensity. Spain is among the lower quarter of OECD countries and partner economies in terms of R&D tax support as share of GDP, down to 0.02% in 2014 from 0.03% in 2002. Stringent documentation requirements and the limited profitability of firms during the financial crisis reportedly have led to a historically low uptake of R&D tax incentives by firms in Spain (OECD, 2015d). The government has recently adopted measures to streamline the process and make the scheme more attractive for less profitable firms (e.g. young firms) by allowing the credits to be partly refundable. These measures, combined with claims on credits previously carried forward, are expected to nearly triple tax expenditures to reach EUR 693 million (0.05% of GDP).

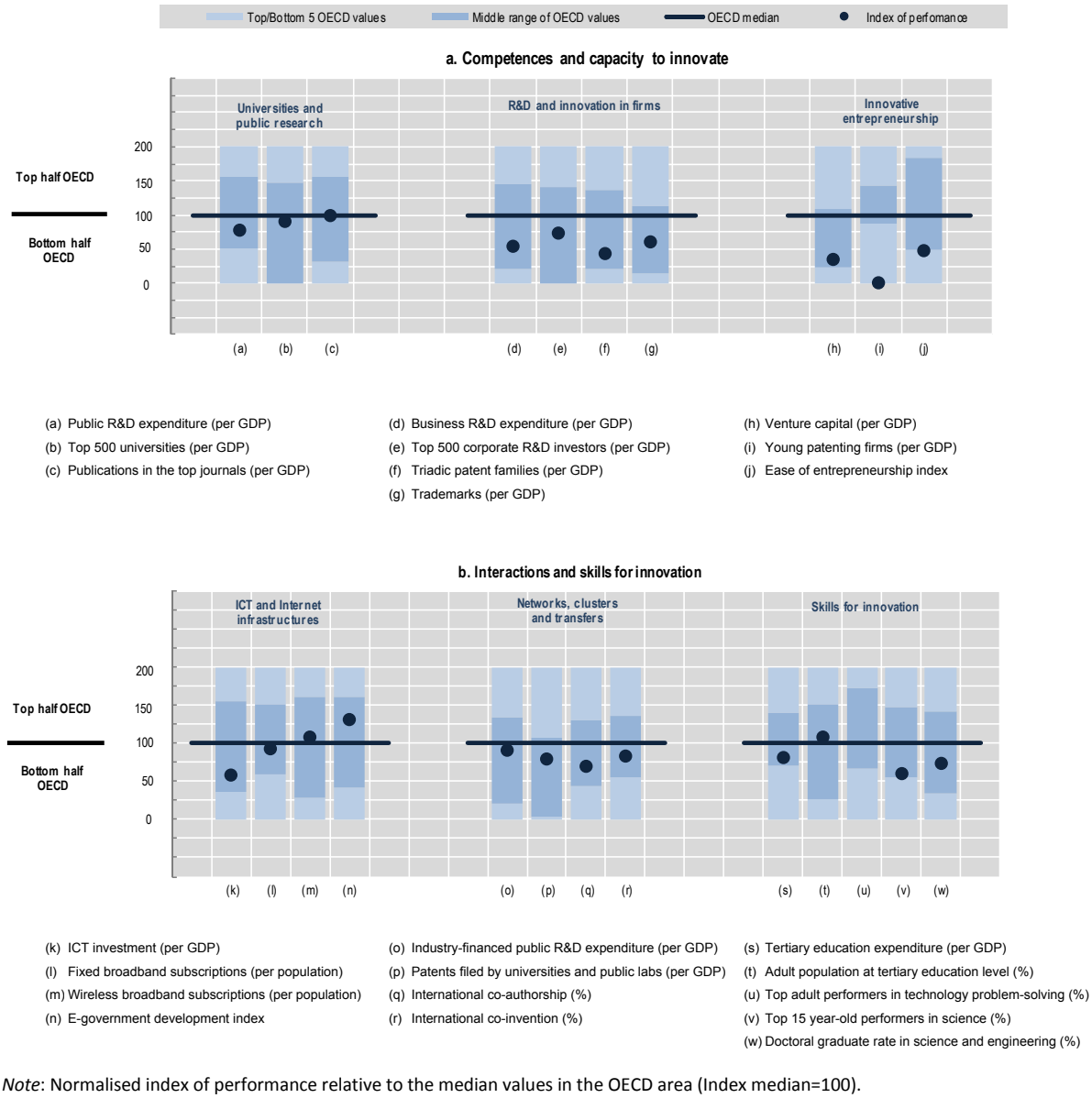
Budgeted funds for loans and advances to support business innovation have similarly experienced very low levels of business take-up. This indicates scope for making business support for research and innovation more grounded on independent evaluation evidence. In addition to putting in place better designed fiscal incentives, grants and loans, authorities should also consider making better use of other instruments such as procurement for knowledge-intensive solutions, as well as strengthened collaboration and linkages with public research organisations (PROs) and universities.

Strengthening the public research system

The government aims to reinforce public research capabilities and to foster research excellence and infrastructures in order to increase the international impact of universities and research centres. Spain's performance in scientific publications is at the OECD median, although the ratio of public R&D expenditures to GDP and the density of global 500 universities are slightly below (Figure 6[a,b,c]). A major challenge for the public research system is to continue improving the quality of outputs, now in the OECD average, and to better contribute to industrial competitiveness and solving societal challenges commensurate with national strategic plans. Between 2010 and 2014, government appropriation for R&D decreased by 30% and this has limited has limited strengthening of the STI system and consequently, Spain's growth potential. The central government's budget for public expenditure on R&D in 2014, 2015 and 2016 indicates that the decreasing trend has been reversed.

Figure 6. Science and Innovation in Spain

Comparative performance of national science and innovation systems, 2016



Note: Normalised index of performance relative to the median values in the OECD area (Index median=100).

Source: OECD (2016a), *Science, Technology and Innovation Outlook*, http://dx.doi.org/10.1787/sti_in_outlook-2016-en.

Spain has made good progress in increasing its excellence focus, for example, by means of the *Agencia Estatal de Investigación* (an autonomous funding body with ex ante and ex post evaluation of funded projects) and the *Severo Ochoa* programme (competitive accreditation and financial support for high-impact institutions). However, some measures adopted to support budgetary consolidation have added major uncertainty to research in the publicly funded science and research base. For example, calls for competitive research projects are bearing a disproportionate share of budget cuts and are approved only late in the year, making it very difficult to commit the amounts in time. At the same time, claw-back practices add major burden and uncertainty to planning within PROs.

More generally, Spanish PROs typically lack the means to be financially and strategically autonomous and fully and directly accountable for their own research and administrative practices, leaving them poorly equipped and incentivised to adapt to changing conditions and exploit other opportunities such as increasing collaboration with business. Despite significant progress in developing an ecosystem to foster interactions between public research and business, the low demand for research and low absorptive capacity in the business sector remains another obstacle, particularly for SMEs.

Technology transfer and commercialisation

As in other OECD countries, enhancing the contribution of public research to the economy and society is a great challenge. In terms of industry-science linkages and the commercialisation of public research, Spain has made significant progress in developing an ecosystem to foster interactions between public research and business but low demand for research and low absorptive capacity in the business sector remains an obstacle, particularly for SMEs. As a consequence, Spain scores below OECD in several indicators (Figure 6[b,o,p]) such as the share of industry-financed public R&D (as a share of GDP). In spite of an increased in university patenting in recent years, its intensity (relative to the size of the economy) scores at the bottom half of OECD.

Globalisation

Spain's public research base is well connected internationally judging by co-authorship data but more is needed to deepen the integration of the overall innovation system into international networks, especially by business firms (Figure 6[q,r]). The government's "Strategy for the Internationalisation of Spanish Universities 2015-2020" therefore seeks to expand Spain's participation in international programmes and international networks of research and innovation. Spain has improved its participation in Horizon 2020. Spain obtained EUR 553.3 million in the first 73 recorded calls of the European research and innovation program, which placed it as the fifth recipient of funding. According to interim results, for the period 2014-15, Spain improved its position and now ranks 4th, behind Germany, United Kingdom and France.

In regards to the business sector, the internationalisation of firms remains an area of concern. Through the competitive programme, *Empresa Nacional de Innovación* (ENISA) finances SMEs in their internationalisation process. According to aggregated results of Horizon 2020 competitive funding calls, Spanish SMEs are performing quite well.

Recent OECD work provides a number of recommendations for Spain that can help strengthen science and innovation, including (OECD, 2017b):

- **Ensure budget statements on research and innovation become more realistic, transparent and aligned to funding plans.**
- **Focus support for long-term research on solutions to societal challenges and areas of demonstrated excellence.**

- **Facilitate reform in PROs and in their governance by reducing unnecessary bureaucracy, and enhancing their autonomy and synergies with universities.**
- **Strengthen evaluation of innovation support programmes and deepen links between PROs and the business sector through private-public collaborations.**
- **Keep under review recent adjustments to the system of public support for business research and innovation, including R&D tax credits, to better evaluate the policy mix.**
- **Use procurement more effectively for knowledge-intensive solutions.**

5. Other key issues

Many other policy areas are important to consider in the context of the next production revolution and the ongoing digital transformation. Two of these are briefly discussed below, namely 1) competition and regulatory frameworks; and 2) privacy and security.

Competition and regulatory frameworks

Digital technologies can be disruptive, enabling new market entrants while challenging incumbents and existing business models. Digital technologies also pose new challenges for regulators. The ability to deliver digital products instantaneously with almost zero marginal costs anywhere and anytime in the world has propelled firms and platforms to global scale and challenged legacy regulatory and competition frameworks. A review of existing policies and regulations may be needed to ensure they continue to facilitate innovation, trade and investment, structural change, job creation and productivity growth across the economy.

More generally, digitalisation is changing the world faster than many laws have evolved. OECD countries should therefore develop mechanisms to periodically review their legal frameworks and, where appropriate, update them to ensure that they are well-suited to the increasingly digitalised world. Designing and implementing a whole-of-government approach to digitalisation is crucial in this regard because advances in one area can be mitigated by retaining the status quo in another.

One important legal area that is being affected by digitalisation is competition, which may need to undergo some adjustments in the digitalised context, such as a shift towards looking at data as the most vital competitive asset in some markets, different approaches to market definition and market power, and a greater focus on international co-operation and co-ordination. Countries may wish to develop new tools for assessing the particular complexities of competition in the digital era.

Online platforms create new markets and opportunities, but also raise a range of economic and social challenges. Governments should consider updating laws to address factors that unnecessarily make working through online platforms less attractive, the lack of clarity in certain regulations, tax issues that emerge with the proliferation of small revenues earned via platforms, and consumer and privacy protection of online market participants.

Security and privacy

The opportunities presented by the digital economy will not be realised in the absence of trust. Digital security incidents are growing in both number and sophistication each year. These incidents can lead to significant economic and social consequences for public and private organisations. Examples include disruption of operations, direct financial loss, lawsuits, reputational damage, loss of competitiveness (e.g. in case of theft of trade secret), as well as loss of trust. Today's digital environment also challenges existing frameworks for personal data protection with potential adverse consequences on individual privacy and individual trust.

Robust strategies to manage digital security risk are essential to establish the trust needed for economic and social activities to fully benefit from digital innovation. The OECD's *Recommendation on Digital Security Risk Management for Economic and Social Prosperity* (Security Risk Recommendation [OECD, 2015d]) sets out a risk management policy framework to address digital security issues with three messages:

- **It is impossible to entirely eliminate digital security risk when carrying out activities that rely on the digital environment. However, the risk can be managed, that is, can be reduced to an acceptable level in light of the interests and benefits at stake, and the context.**
- **Leaders and decision makers should focus on the digital security risk to economic and social activities rather than only on the risk to the digital infrastructure.**
- **Organisations should integrate digital security risk management into their economic and social decision making processes and overall risk management framework rather than treating it solely as a technical problem.**

The OECD 2013 Guidelines Governing the Protection of Privacy and Transborder Data Flows (the 2013 OECD Privacy Guidelines [OECD, 2013b]) also recommend taking a risk-based approach to implement the privacy principles and enhance privacy protection. Furthermore, privacy risk management can contribute to global interoperability of privacy protection frameworks. However, while the concept of risk management is well established in the digital security space, more work is needed to determine how it can be applied to privacy protection and there is debate about how to implement a comprehensive risk management approach to strengthen the application of the well-established OECD Privacy Guidelines' principles.

The Security Risk Recommendation and the Privacy Guidelines both call for the development of flexible and technology-neutral whole-of-society national strategies supported at the highest level of government to address digital security and privacy risk. The openness and interconnectedness of the digital ecosystem produces many economic and social benefits; it also makes devices, systems and networks more vulnerable to attacks, and can create privacy risk. Creating a risk-free environment without threatening these benefits is impossible. Therefore, all stakeholders need to work together to create an environment that promotes effective digital security and privacy risk management.

National strategies developed in concert with all stakeholders can create the conditions for greater stakeholder collaboration in relation to risk management at both policy and operational levels, for example, by promoting the sharing of knowledge, know-how, and experience on successful practices. Such strategies can foster international co-operation and help guide cross-border efforts to address digital security risk, strengthen privacy protection and lessen uncertainty for transborder personal data flows.

SMEs, and early-stage start-ups in particular, are critical to economic growth; they drive competition and innovation, and contribute to job creation. They also face distinct challenges in managing digital security and privacy risk. A digital security incident that can result in a loss of consumer trust, damage to reputation, or a drop in revenue, may be more damaging for SMEs than for larger companies because they are more likely to find it difficult to weather a temporary loss of customers or revenue. As well, they may not have the resources or expertise to effectively assess and manage risk. On the positive side, SMEs that are aware of the risk and can demonstrate that they have robust digital security and privacy practices may have a competitive advantage when seeking partnership opportunities with larger organisations. In order to help SMEs realise these opportunities, it is essential to increase SMEs awareness and promote adoption of good practice. Useful approaches could include the development of SME-specific risk management guidance tools and incentives, for example, by leveraging digital risk insurance.

6. Concluding remarks

The digital transformation affects all corners of the economy, society, and government activities. To realise its full benefits, governments need to reach across traditional policy silos and across different levels of government and develop a whole-of-government approach to policymaking. This means more co-ordination when making decisions and implementing policy measures across ministries and levels of government as well as actively involving all key stakeholders, including the business community, trade-unions, civil society and Internet technical community, in the policymaking process as well as implementation and monitoring. By identifying the key policy areas affected by the digital transformation, it will be easier to link up the relevant ministries and government bodies that need to be connected and co-ordinated to ensure that all policies are mutually reinforcing and aligned with one coherent and strategic national digital agenda.

The next production revolution and ongoing digitalisation of our economies and societies will only expand and deepen; Spain, like other OECD countries, must be ready to make the most of it. This report has touched on a number of key elements that may help chart an innovative, ambitious, and pro-active policy agenda. Only by taking a pro-active, 21st-century approach to the next production revolution and digital economy will countries maximise the enormous potential the digital economy holds for our economies and well-being.

The challenge for policy makers is to identify the policy mix that will enable their economies to best maximise the benefits of an increasingly digitalised global economy and adequately address the resulting challenges. To do so, it is essential to ensure access to, and participation in, the digital economy for everyone in all countries; maximise the contribution of technological and ICT innovations to productivity and inclusive growth, job creation and well-being; and build trust and resiliency for networks and users. Given the inherently global nature of the Internet, and the strengthened interconnections it has created, collaboration among and within OECD countries across a wide range of policy areas is critical. The OECD's work to build such a comprehensive agenda has just started and will continue over the years to come.[1]

Notes

1. Details on the OECD's Going Digital project are available at the OECD website: http://oe.cd/goingdigital.

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