DIGITALIZATION IN KOREA: A PATH TO BETTER SHARED PROSPERITY?

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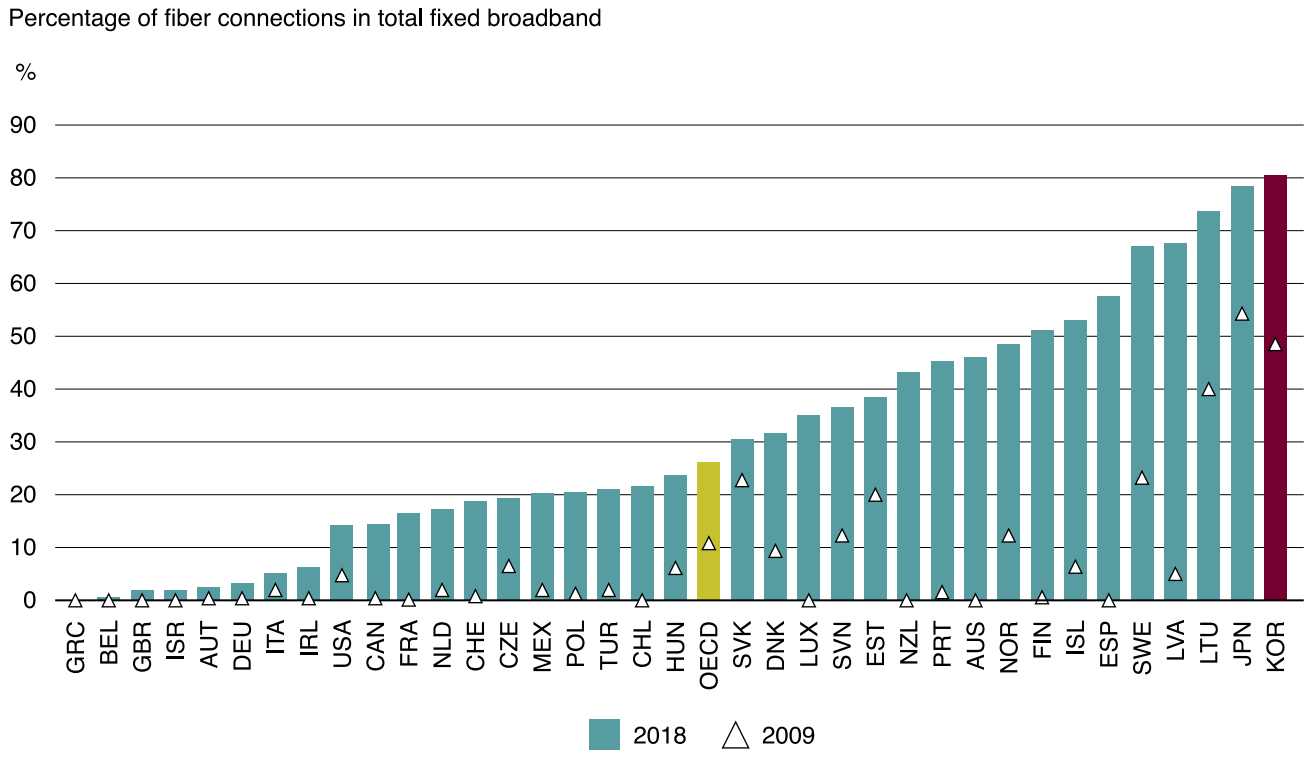
Digitalization could open a new era of growth for Korea. Previous expansion waves, based on traditional industries, have fostered export-led growth and placed Korea among the world's top ten economies. However, divides between industry and services, large and small firms, and regular and non-regular workers have widened. The economy was losing steam even before the COVID-19 crisis, as the working-age population started to decline, and productivity growth slowed. Digitalization offers huge opportunities to raise productivity economy-wide and to tackle inequality, but optimizing it for all requires appropriate policies, notably to enhance skills, adapt regulations, and create networks for technology diffusion and innovation.

Information and communications technology (ICT) has become one of Korea's main economic engines. The acceleration of digitalization during the COVID-19 pandemic increased demand for semiconductors (which account for a fifth of Korea's total exports), Samsung is among the world's smartphone market leaders, Coupang, "the Korean Amazon," made a resounding debut on Wall Street in March 2021, and digital tools greatly contribute to the diffusion of Korean culture (*Hallyu*), as epitomized by the K-Pop group BTS. But beyond these successes, which echo earlier successes of Korean industry, digitalization, including fourth industrial revolution technologies, offers a path to better shared prosperity if small and mid-size enterprises (SMEs) can take advantage of the highest coverage of high-speed broadband in the Organisation for Economic Co-operation and Development (OECD) (Figure 1) to adopt digital technologies and increase their productivity. Indeed, productivity gaps between Korean industries are wide. While productivity is high in manufacturing, and especially ICT, it remains lackluster in business services (excluding ICT), which employ over 40% of the workforce (Figure 2).

Widespread diffusion of technology requires not only infrastructure and entrepreneurship, but also appropriate policies. The Korean New Deal, launched in response to the COVID-19 pandemic, aims to accelerate the transition towards a digital economy, along with greening the economy and reinforcing the social safety net.[2] It will expand data, network, and artificial intelligence (DNA) infrastructure; it will develop on-line education; it will further promote "untact" (not face-to-face) activities; and it will digitalize social overhead capital, such as transport, water, and logistics networks. The Digital New Deal will enable further diffusion of digitalization across the Korean economy and society. However, to make the most of this potential, policies will need to enhance skills, adapt regulations, and create networks for technology diffusion and innovation.

Against this background, this article assesses the unused potential of digitalization, examines the main obstacles to widening diffusion, and outlines policies to overcome them.

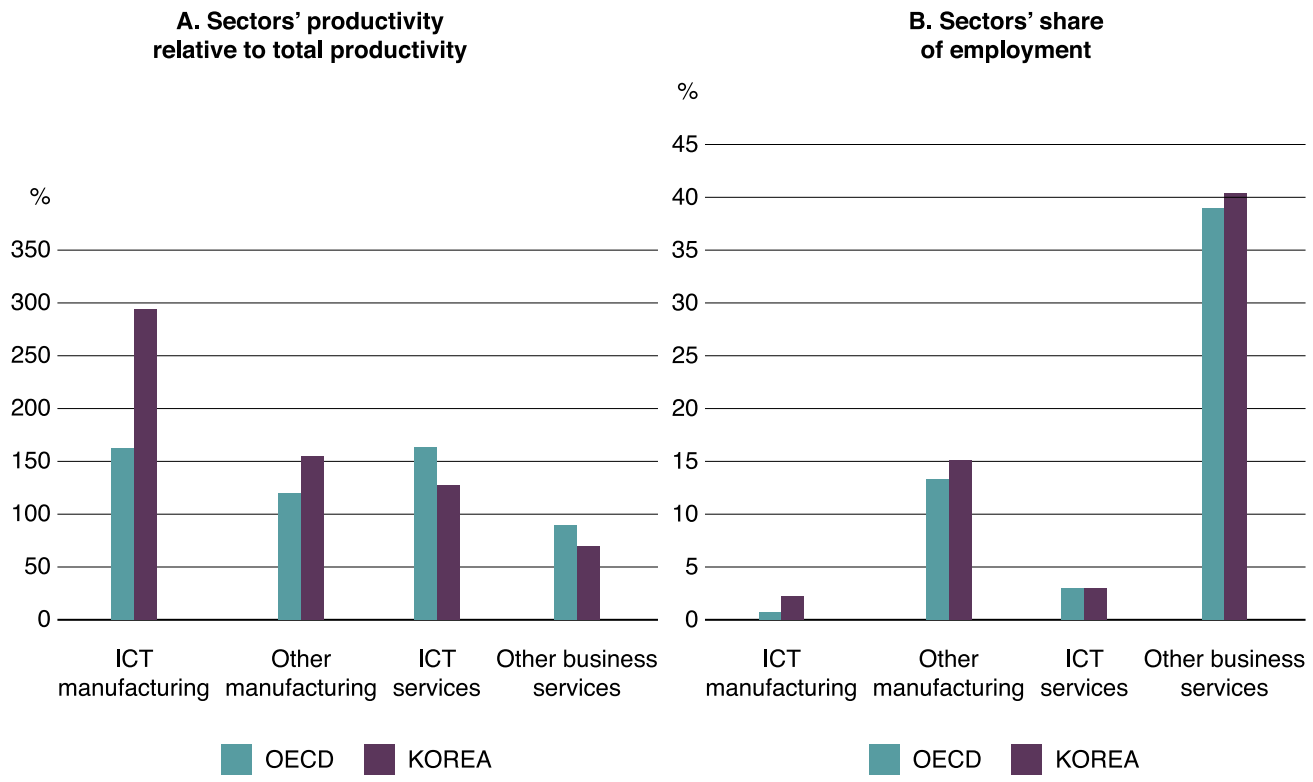
Figure 1 High-speed broadband is widespread in Korea



Note: 2010 for Canada, Turkey, and United Kingdom instead of 2009.

Source: OECD Broadband database, https://stats.oecd.org/Index.aspx?DataSetCode=BROADBAND_DB (accessed on 4 October 2019).

Figure 2 Low-productivity sectors account for a high share of total employment



Note: Data refer to 2015. "ICT manufacturing" includes manufacture of computer, electronic and optical products. "ICT services" includes publishing, telecommunication, and IT services. "Other business services" includes wholesale and retail trade (G in NACE Rev. 2), transportation and storage (H), accommodation and food services (I), financial and insurance activities (K), professional, scientific, and technical activities (M) and administrative and support service activities (N). It excludes real estate activities (L).

Source: Authors' calculations based on OECD STAN database, https://www.oecd.org/sti/ind/stanstructuralanalysisdatabase.htm.

Digital technologies are not used to their full potential

Smart factories to boost manufacturing SMEs

Smart factories use information and intelligence technology – cloud computing, big data, artificial intelligence (AI) and Internet of Things (IoT) – to move the production process from traditional automation to a fully connected, flexible and optimized system, and to design customized products at mass-production prices. In enterprises that have adopted smart technology and actively used and shared data generated by technology, productivity and product variety have improved, while defect rates have fallen.[3] Smart factories can also contribute to job creation by encouraging the reshoring of Korean enterprises operating elsewhere, and are central to the government's plan for the Fourth Industrial Revolution. According to a May 2019 survey by the Ministry of SMEs and Startups on 5,003 companies that introduced smart factories from 2014 to 2017, their productivity and quality increased 30.0 percent and 43.5 percent respectively, while their costs fell 15.9 percent (Table 1). At end-2020, Korea had 19,799 small and medium-sized smart factories. The goal is to reach over 30,000 small and medium-sized smart factories and to increase the number of smart industrial zones from two to ten by 2022. To promote the development of small and medium-sized smart factories, the government has introduced support for pilot projects, inspired by experiences in countries such as Germany. Factories operating successfully can be designated as pilots and get financial support for half of their expenses on purchasing smart devices and developing partnership programs. In early 2020, 51 SMEs in car parts, paper, electronic parts, aircraft, and machinery industries became pilot smart factories. Other strategies to expand and upgrade smart factories include financial support from the government and large business

partners, the construction of a cloud-based smart factory for SMEs lacking data storage and management skills, and development of training and diplomas in smart factory-based technology. To strengthen a culture of cooperation between SMEs and large firms, the Korean government established in 2019 the Inclusive Companies Project, with the participation of 14 major companies, including POSCO, Naver, Samsung Electronics, Hyundai-Kia Motors, Kookmin Bank. This project helped some mask and COVID-19 test kit manufacturing companies create smart factories, which allowed them to increase daily mask production and weekly test kit production by 51 percent and 73 percent, respectively.

The development of smart factories goes through five levels (Table 2). In 2018, most smart factories in Korea were at the basic or intermediate I level (80 percent and 19 percent respectively), only 1% were at the intermediate II level, and none of the SMEs had reached the advanced level. The main reasons behind this slow take-off include shortages of workers with the relevant skills, an inefficient retraining system, and underdeveloped innovation networks promoting collaboration between innovative companies, especially between SMEs and large enterprises.

Table 1 Process improvement in firms that have introduced a smart factory

Classification *(share to total 5 003 companies)*	**Productivity (%)**	**Quality (%)**	**Cost reduction (%)**	**Reduction in delivery time (%)**
Firms with less than 9 employees (8.9%)	39.0	44.4	17.6	16.1
Firms with 10 to 49 employees (52.4%)	31.3	43.9	15.3	15.4
Firms with 50 to 99 employees (19.7%)	26.9	42.7	15.8	15.5
Firms with over 100 employees (16.9%)	26.0	43.7	15.5	15.6
Average	**30.0**	**43.5**	**15.9**	**15.5**

Source: Ministry of SMEs and Startups, "Analysis on performance of smart factory," Press release in Korean, May 24, 2009, https://www.mss.go.kr/site/smba/ex/bbs/View.do?cbIdx=86&bcIdx=1011893&parentSeq=1011893.

Table 2 The five levels of smart manufacturing

Development Stage	**Level**	**Goal**	**Main ICT tools**
Basic	Level 1 – Identify	Construct the information system to identify materials	Barcodes and RFID
	Level 2 – Monitor	Gather and monitor data in real time from the workforce, machines, equipment and materials	Sensors
Intermediate I	Level 3 – Analyze	Control, measure and analyze data collected in level 2	Sensors and analysis tools
Intermediate II	Level 4 – Optimize	Gather, analyze and simulate data to optimize the production process (workforce, machines, equipment, materials, operating conditions)	Sensor controller optimizers
Advanced	Level 5 – Customize	Customize the production process by optimizing the workforce, machines, equipment, operation and environment conditions	Artificial Intelligence, Augmented/Virtual Reality, Cyber-Physical System

Note: RFID stands for radio frequency identification.

Source: Ministry of SMEs and Startups, https://www.smart-factory.kr/smartFactoryIntro.

Creating value through servicification of manufacturing

With the development of ICT technologies, services are increasingly embedded in manufactured products, a phenomenon known as "servicification" of manufacturing. Firms engaged in manufacturing increasingly rely on services, either as inputs, as production activities within the firm, or as output sold bundled with goods. For instance, manufacturers of cell phones can bundle their product with telecommunication services to allow users to install apps, which will generate additional service transactions, such as audio-visual services with video streaming and music, publishing services with e-books, or computer services with video games. Smart manufacturing, as well as IoT and 3D printing, contribute to the increasing servicification of manufacturing. ICT services, such as computer programming, software publishing, telecommunication, data processing and advanced data analytics, are the main producers and users of data, which are central to smart manufacturing. For instance, data processing services such as cloud computing generate data for smart factories, while advanced data analytics services optimize the production process based on this real-time information.

Korea lags behind the most advanced OECD countries in the servicifaction of manufacturing in terms of service inputs, production and exports. First, the share of service inputs in Korean manufacturing exports is one of the lowest among OECD countries (25 percent), with half of these inputs outsourced to foreign firms. Second, the share of in-house services produced by Korean manufacturing firms to export their goods is one of the lowest among OECD countries (less than 10 percent of gross exports), along with Eastern European countries, while the United States and Germany have over 20 percent of in-house services in their exports. Third, Korea has one of the lowest shares of firms selling both manufactured goods and services (4 percent) in the OECD after Mexico, Chile, and Iceland. The share of firms exporting both manufactured goods and services is even lower (0.5 percent).[4]

Raising productivity in services through digitalization

Service-sector productivity is only 42 percent of that of manufacturing. While ICT service productivity is relatively high at 74 percent of manufacturing, it is offset by low productivity in retail and wholesale trade, transportation, and accommodation (31 percent). Traditional services have intrinsic characteristics that reduce the scope for productivity gains. Compared to goods, they tend to be less standardized and require more face-to-face interactions in their delivery. This holds back productivity in services through three channels. First, the additional transaction costs reduce competitive pressures, efficient reallocation mechanisms, and hence incentives to improve productivity. Second, the gains from economies of scale and automation are smaller. Third, services are less tradable within and across countries, which limits productivity gains through knowledge spill-overs, better specialization, and heightened competition.[5]

Digital technologies offer new ways of producing and consuming services. For instance, artificial intelligence and advanced robotics can automate cognitive tasks typically carried out in service activities. Digital platforms can enhance competition among service providers and increase productivity in services by reducing information asymmetries between consumers and service providers, thanks to ratings and reviews, or by substituting existing services, like Kakao T for taxis or Baemin and Market Kurly for delivery services. Digital platforms also provide a wide range of services for consumers, such as market services that can replace home production, including housework, with gig economy platform Daelijubu, or innovative FinTech services, such as peer-to-peer money transfer services proposed by Viva Republica's mobile app "Toss." However, the rapid emergence of digital platforms is facilitated by network externalities and the intensive use of data as input to their matching algorithms, which favor the emergence of dominant platforms and hinder competition. In Korea, Kakao T has emerged as a dominant platform in transportation, with 28 million users registered, representing 96 percent of the economically active population as of the third quarter of 2020.[6]

Digital technologies improve the tradability of services and provide alternative ways of trading. For instance, blockchain provides new financial services that are fully digitally tradable and require no direct physical interactions. However, Korean exports of digitally deliverable services are well below the OECD average. SMEs can also benefit from digital technologies to gain access to international markets and take advantage of enhanced linkages to boost their productivity. E-commerce can help SMEs expand their business within and across countries, by significantly reducing upfront fixed costs, such as logistics or customer services. In low-productivity sectors such as accommodation and trade, where SMEs are numerous, the share of Korean firms using websites for online ordering or reservation has significantly increased and has room to rise further.

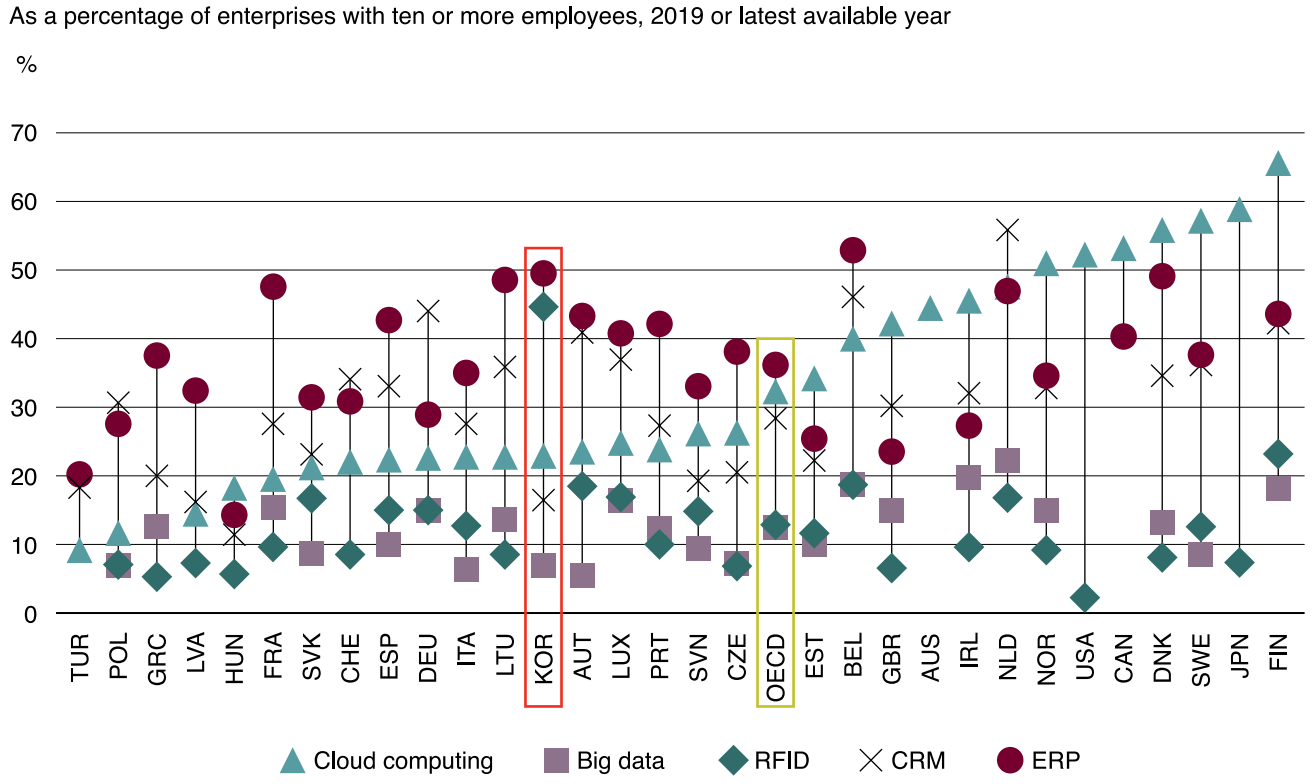
The diffusion of digital technologies among firms and workers is slow

The development of smart factories, servicification of manufacturing and digital platforms requires sophisticated digital technologies, such as cloud computing, big data, IoT and artificial intelligence. While Korea actively contributes to the development of emerging digital technologies and benefits from nationwide 5G coverage, it still lags behind most advanced OECD countries in the adoption of these technologies, especially in SMEs.

Korea has margins for improvement in the adoption of sophisticated digital technologies

Over the past two decades or so, Korea remained at the cutting edge of ICT technologies, thanks to outstanding achievements in mobile devices, chips, and appliances. In recent years, Korean firms have strived to reinforce their global competitiveness in new sophisticated digital technologies, such as artificial intelligence, cloud computing, big data, 3D printing, and IoT. However, in 2019 Korea was estimated to lag behind the US frontrunner by two years in 3D printing, artificial intelligence, big data, and cloud computing, and by one-year in IoT.[7] Only 23 percent of Korean companies used cloud computing, compared to over 50 percent in the Nordic countries. Less sophisticated technologies, such as radio frequency identification (RFID), which enables contactless transmission of information via radio waves, and enterprise resource planning (ERP), which uses digital tools to better integrate information and processes across the enterprise's various business functions, are more widespread. However, intensive ICT use in customer-relationship-management (CRM) to collect, integrate, process and analyze customer information, remains relatively rare (Figure 3).

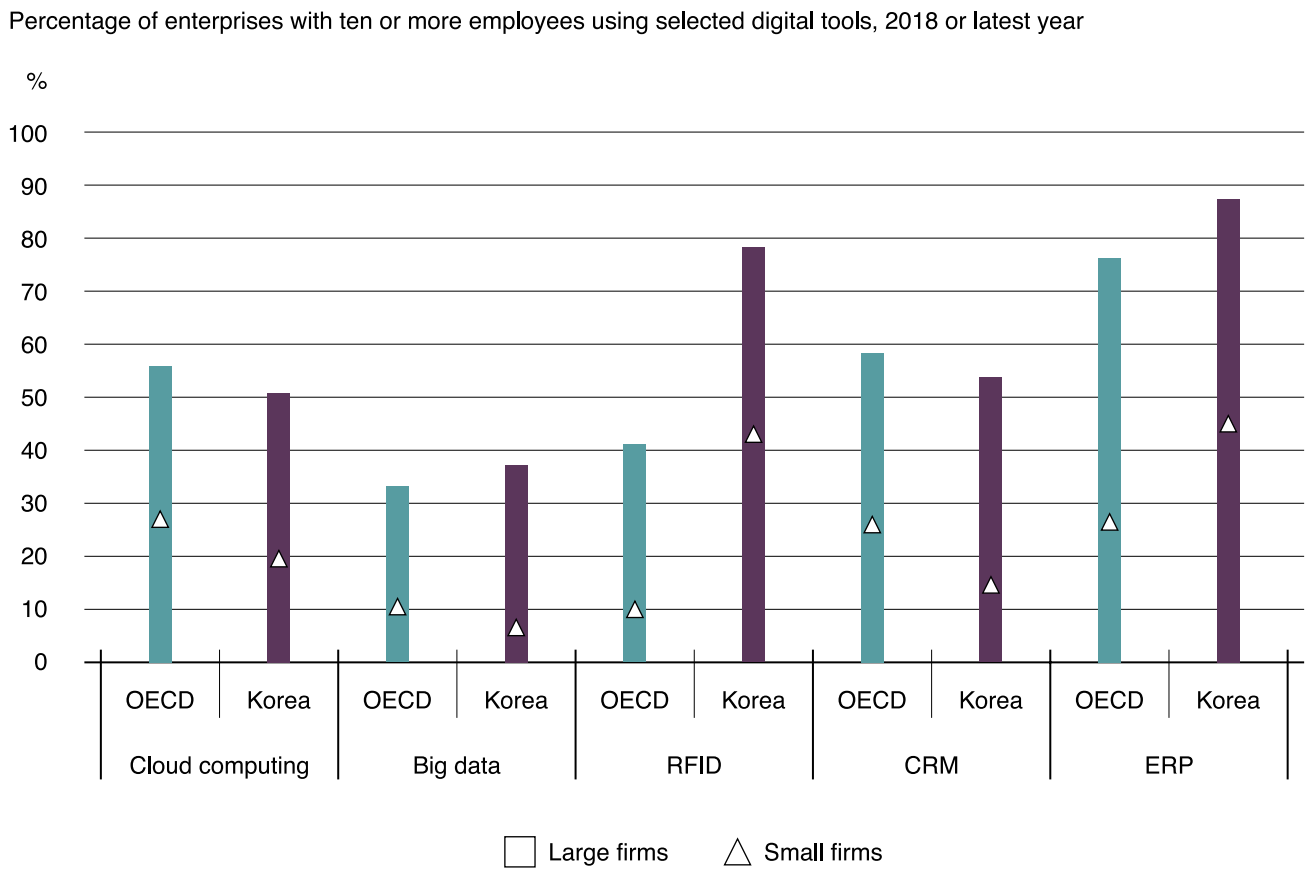
Figure 3 Korea is below the OECD average in sophisticated digital technologies adoption



Note: RFID stands for radio frequency identification; CRM for customer relationship management; ERP for enterprise resource planning. The statistical unit for Korea is the establishment and not the enterprise and covers both the public and the private sector.

Source: OECD ICT Access and Usage by Businesses database, https://stats.oecd.org/Index.aspx?DataSetCode=ICT_BUS (accessed on 1 June 2020).

Figure 4 Digital gaps between large and small firms remain high



Note: RFID stands for radio frequency identification; CRM for customer relationship management; ERP for enterprise resource planning. The statistical unit for Korea is the establishment and not the enterprise and covers both the public and the private sector.

Source: OECD ICT Access and Usage by Businesses database, https://stats.oecd.org/Index.aspx?DataSetCode=ICT_BUS (accessed on 21 May 2020).

The Korean government and private firms are taking measures to catch up, especially in the adoption of cloud computing and artificial intelligence. Major business groups like Samsung and LG are implementing ambitious plans to expand their cloud-based systems. For SMEs and young firms, cloud-computing services can greatly facilitate the digital transition by reducing the cost of experimenting with new technologies and increasing flexibility, as data processing and storage are managed in a remote data center.

The digital divide between SMEs and large enterprises is wide

Digital technologies are increasingly powerful and affordable for SMEs, but the gap with large firms in the adoption of sophisticated digital technologies remains wide (Figure 4), reflecting several obstacles. First, Korean SMEs are concentrated in services such as trade, transportation, accommodation, and food services, which are less knowledge-intensive, and hence less prone to innovation than manufacturing: 57 percent of service firms are not innovating, i.e., investing in R&D (against 48 percent in manufacturing) and they are less likely than manufacturing firms to engage in innovation to pursue cost reductions.[8]

Second, SMEs tend to lack information and funds. They are often unaware of the potential that new digital tools could offer to increase their productivity or lower their production costs. They also consider the costs of adopting more sophisticated digital tools to upgrade their business model as too high. According to the Survey on the Informatization Level in Small and Medium Business conducted by the Korean Agency of Information on

Technology, these were the main difficulties SMEs faced while participating in the smart manufacturing program. In 2017, 57 percent of the 356 companies surveyed mentioned the lack of information on smart factories and 51 percent the issue of raising initial investment. The lack of information causes a lack of trust, which is the main obstacle to the adoption of cloud computing by SMEs.

Third, SMEs face a lack of skilled workers and low access to training. Compared to other OECD countries, Korean SMEs find it harder to hire high-skilled university graduates than larger firms because they offer less attractive jobs in terms of wages, stability, working hours and career advancement opportunities. In Korean micro-firms, 34 percent of workers have low problem-solving skills in technology-rich environments (against 28 percent for the OECD average), while this share is much lower in large firms (19 percent). Firm-based training can complement and update academic qualifications and enhance generic digital skills, as well as complementary skills such as managerial skills, which are essential to technology adoption. However, training participation in Korean SMEs is one of the lowest among OECD countries, especially in micro-firms. For SME workers, the main barrier to training is the lack of time because of work (52 percent of workers, against 32 percent for the OECD average). For firms, the lack of manpower in the firm is the most frequently cited reasons for not implementing or supporting training (30 percent of SMEs), along with fear of poaching.[9]

The lack of access to training in SMEs, compared to larger firms, along with the low quality of training, are important issues. In 2015, 52 percent of SMEs provided only legally mandatory training (mostly industrial safety and health training) or no training at all to their workers. Compared to other OECD countries, Korean SME workers seem to be less satisfied with their training, with less than a third of them finding it useful. The government is already addressing issues related to the lack of training participation in SMEs. Nevertheless, there is still a lack of information about the benefits of training, available training options and their quality, as well as available financial support.

The digital divide between generations exacerbates social inequality

Korea has the largest gap in digital skills between youth and older people. The share of 16- to 24-year-olds with limited or no digital skills is the lowest across OECD countries (37 percent). But most adults aged between 55 and 65 lack digital skills. Digital and basic technology divides between generations are primarily due to a sharp increase in investment in tertiary education during the 1990s, as well as insufficient investment in lifelong learning.

In an aging and increasingly digitalized society, people should be able to keep up with the pace of technological advances and be equipped with the adequate skills to participate in diversified and sophisticated online activities. Otherwise, the digital divide will exacerbate economic and well-being inequalities, as part of the population will be left behind.

Policies supporting digital adoption and productivity need strengthening

Widespread diffusion requires adequate policies, notably to enhance skills, adapt regulations and create networks for technology diffusion and innovation.

Enhancing ICT skills is crucial

The lack of adequate skills and knowledge is the main barrier to the diffusion of digital technologies among firms and workers. Preparing individuals to thrive in a digital society begins in families and at school and continues at work with on-the-job learning and training. More than half of Korean teachers do not feel sufficiently prepared for the use of ICT for teaching and should receive mandatory refresher training to update their skills on a regular basis. Furthermore, to attract highly qualified teachers, their working conditions should be enhanced.

Well-trained ICT professionals (such as programmers and data analysts) are key to the diffusion and the efficient use of digital technologies, as well as competitiveness in the digital economy. The share of Korean tertiary graduates is second to Germany among OECD countries in science, engineering, ICT, and creative and content fields. These qualifications are useful in a digitalized working environment. However, there is a growing need for specialists and high-level researchers in fourth industrial revolution core technologies like AI and big data. The Korean government is promoting plans to train more experts in these fields. In 2019, the government initiated a strategy promoting the adoption of AI, which includes making AI courses compulsory in primary and secondary schools, opening AI departments in colleges, and providing AI training to the military and public officials. Such courses and training should be extended to other fourth industrial revolution core technologies such as big data, and training should be provided to private sector workers as well.

Career guidance services are fragmented, with numerous competing online platforms (HRD-net, Neulbaeum, Work-Net, Q-Net, regional lifelong learning portals, K-MOOC, Smart Tech Education Platform), which could be merged to facilitate finding information. Targeting adult learning programs on SME managers would help ensure they are aware of the potential of digital technologies, and hence supportive of training. Korea could learn from countries such as the United Kingdom, Mexico, New Zealand, and Australia, where special management programs are provided to SMEs' CEOs and owners. Korean SMEs have access to numerous training subsidies, funded by the Employment Insurance for those that meet a number of criteria. Making these criteria less restrictive would allow more SMEs to receive these government-supported subsidies. Furthermore, financial incentives should be aligned to SMEs' training needs and hence be more generous for innovative training content or methods that better fit SMEs' need. Finally, developing an online guide like in Ireland (Supporting SMEs Online Tool) would help SMEs be aware of all the subsidies.

R&D support needs to better target innovative and productive SMEs

The digital divide between Korean SMEs and large enterprises is high and Korean SMEs do not take sufficient advantage of advanced technologies to enhance their productivity. Access to finance is critical for SMEs to adopt innovation and scale up. The Korean government has supported SMEs through the Korea Small Business Innovation Research (KOSBIR) program and R&D grants since 1998. KOSBIR is based on the US Small Business Innovation Research (SBIR) program that supports SMEs in three phases: feasibility, R&D, and commercialization. Compared to SBIR, KOSBIR dedicates most of the funding to the R&D phase, at the expense of the feasibility and commercialization phases. Reallocating financial support for turning successful technology R&D into commercial applications could help SMEs convert their R&D inputs into economic benefits. The lack of funds and market analysis and research consulting on project feasibility are considered to be the main barriers to commercialization, especially for small firms.[10]

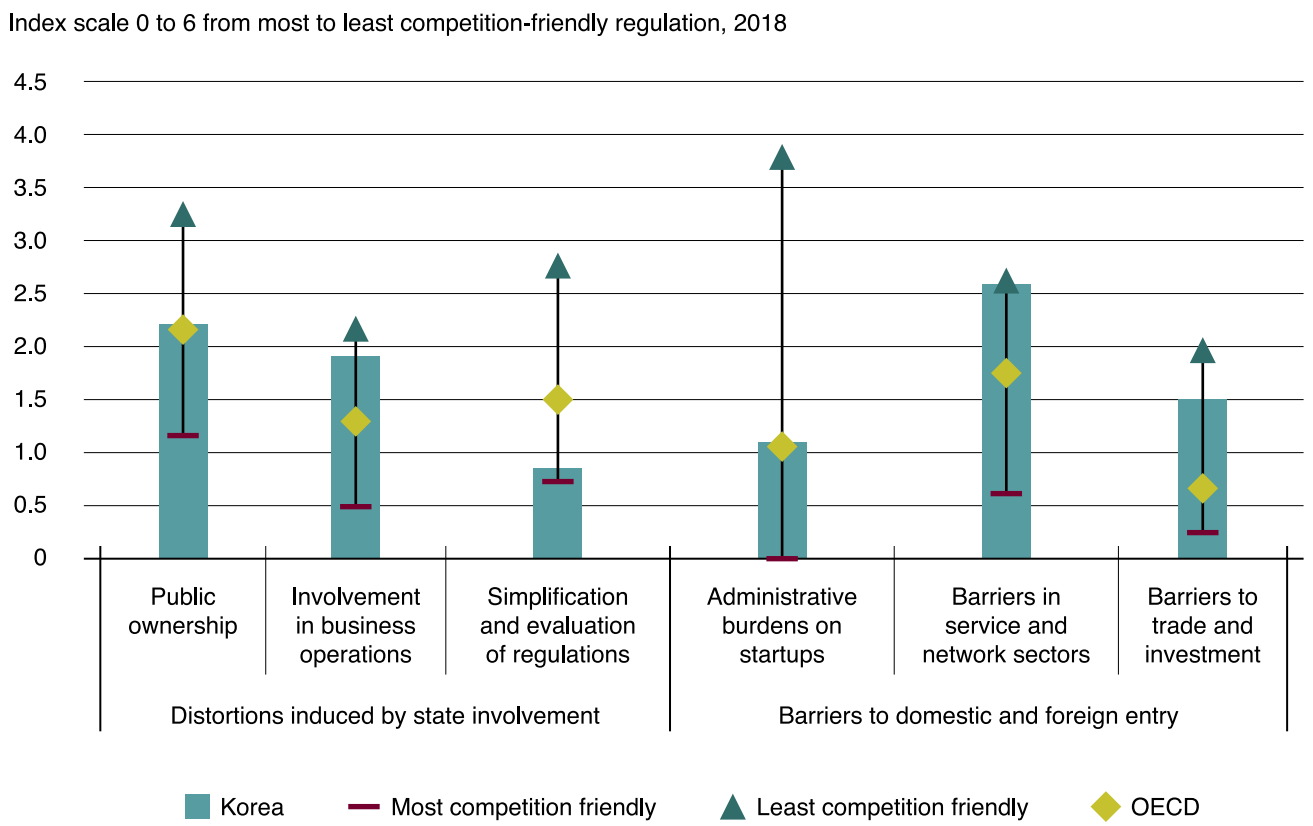
However, when it comes to supporting commercialization, financial markets and innovative financial services like FinTech should also be considered for funding and expertise on project feasibility. Directing R&D support towards innovative SMEs and boosting their productivity requires an efficient selection process of recipients. For instance, recipients of government R&D grants selected on the number of their registered patents expanded their investments in R&D, intellectual property rights, tangible assets, human capital, and marketing over the period of 2010-15, but on average did not show significant improvement in their value added, operating profits and sales, unlike non-recipient SMEs.[11] In August 2020, three data bills (Personal Information Protection Act, Information and Communications Network Act, and Protection of Credit Information Act) came into effect. FinTech companies are expected to be among the first applicants to have access to anonymized personal data such as electricity bills, and use them to establish new credit ratings using algorithms. SMEs can then have higher credit ratings than those provided by commercial banks and have access to funding for their R&D and commercialization projects.

R&D support mainly benefits firms already investing in R&D. Providing SMEs in manufacturing and services with innovation vouchers would encourage them to engage in innovative projects and assess the feasibility of their research projects, for instance by purchasing studies on potential for new technology introduction from universities and research institutions. Introduced for the first time in the Netherlands in 1997, innovation vouchers are now used by many European countries, as well as in a number of US states and Canadian provinces. Evidence of advantages in using innovation vouchers includes increased R&D projects, reduced time-to-market, and further collaboration with academia.

Regulatory barriers to the adoption and diffusion of digital innovations are too high

Regulatory frameworks are often unable to adjust to rapid technological innovations, such as FinTech services or gig economy platforms. Stringent regulations limit possibilities to experiment, and create uncertainty for innovators, hampering investment in digital innovations and the emergence of new business models. Furthermore, stringent regulations hinder competition and reallocation, restraining productivity growth. Product market regulations in Korea are among the most stringent in the OECD, especially state involvement in business operations, barriers in service and network sectors, and barriers to trade and investment (Figure 5). Reducing barriers to trade and investment would promote foreign investment in R&D and SME innovation through better connection to global innovation networks.[12]

Figure 5 Korea has high regulatory barriers to competition



Source: OECD Product Market Regulation database, https://www.oecd.org/economy/reform/OECD-PMR-Economy-Wide-Indicator-values-2018.xlsx.

Services such as ride hailing and healthcare are subject to strict regulations, hindering the development of new business models or the commercialization of new digital products. Companies like Uber and Kakao Carpool struggle to service the Korean market, because of the "Passenger Transport Service Act" that limits commercial use of private cars during rush hours (7-9 in the morning and 6-8 in the evening). Huinno had to delay the launch of its wearable electrocardiogram monitoring system until 2019, despite finalizing its development in 2015 (before the Apple 4 watch) because of the stringent regulations on medical services.

Regulatory sandboxes can enhance regulatory flexibility as they allow firms to experiment with innovative products and business models without being subject to all existing legal requirements. The government has introduced regulatory sandboxes since January 2019. Regulatory sandboxes have approved projects in a wide range of areas, such as FinTech, health, manufacturing, electronics, telecommunication, energy, and mobility. In terms of digital technology, regulatory sandboxes have been approved for app-based platform technology, IoT, big data, blockchain, artificial intelligence and virtual reality. Huinno was among the first firms to benefit from the regulatory sandboxes program. By December 2020, 404 projects were approved by the regulatory sandbox system.

The government also announced the designation of regulation-free special zones. Like regulatory sandboxes, they allow firms to experiment with innovative technologies in designated areas without restrictions from regulations (digital healthcare in Gangwon, blockchain technology in Busan, autonomous driving in Sejong, and so forth). After four years at most, if a regulatory sandbox is considered effective and safe, it can lead to the definitive nationwide suppression of the regulation that was temporarily waived, or its amendment. It can also lead to the creation of licences with a narrower scope, for example for FinTech companies, which could be allowed to provide some banking services, without needing a full banking license.

Conclusions

Korea is a leader in ICT technologies, which have become one of its main economic engines. However, the potential to develop smart factories, create value through servicification of manufacturing, and raise productivity in services remains underused. This is unfortunate, as it would help reduce the productivity gaps that slow economic growth and generate large inequalities among firms and between workers. While the Digital New Deal enables further digital progress, the spread of digital tools to SMEs needs to widen to generate better shared prosperity. To this end, policies need to support digital adoption through investments in ICT skills, to better target R&D support towards innovative and productive SMEs, and to reduce red tape that hampers the adoption and diffusion of digital innovations.

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