
**ADBI Working Paper Series**

# THE DIGITAL REVOLUTION IN ASIA AND ITS MACROECONOMIC EFFECTS

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**Abstract**

Asia is at the forefront of the digital revolution, which promises a radical transformation of the global economy, and indeed of society itself, while at the same time threatening substantial disruptions and dislocation. For instance, workers worry that robots will make them obsolete, while financial supervisors are concerned about the risks to financial stability posed by the latest fintech innovations. At the same time, digitalization may well be a key driver of productivity growth and improved welfare. This paper focuses on whether the digital revolution in Asia is driving growth or disrupting it. Given the diversity of digital innovations and the sparsity of data, the paper uses a multipronged approach to analyze the digital economy in Asia.

**Keywords:** fintech, digital innovations

**JEL Classification:** G21, MI3, O33

# Contents

# 1. INTRODUCTION AND MAIN FINDINGS

The digital revolution is underway. While digitalization and automation are not new, they have accelerated in recent years, and a new wave of innovation—triggered by advances in artificial intelligence, robotics, computing power, and cryptography, as well as the explosion of big data—is reshaping the global economy. More so than during past periods of innovation, including the spread of personal computers in the 1980s and the rise of the internet in the 1990s, today's technological advances are multiple and overlapping, creating synergies and accelerating outcomes. The digital revolution is affecting all sectors, with a far-reaching social and economic impact. The new technologies are general purpose, with the potential to transform the global economy, boost productivity, and fundamentally alter the way we live and work, much as the steam engine and electricity did. But in the process, these technologies may also cause substantial disruptions and dislocations. This paper focuses on whether the digital revolution in Asia is driving growth or disrupting it.

## 1.1 Key Findings

First, Asia has been at the forefront of the digital revolution, though with heterogeneity across the region:

- There are Asian players leading nearly every aspect of digitalization, while at the same time some economies are lagging behind. In fact, the region's economies have the highest dispersion in terms of the adoption of digital technologies—not surprising given that Asia covers the entire income spectrum. Nonetheless, at any given income level, Asian economies are at the frontier relative to their global peers; moreover, digitalization is accelerating even for relatively poor Asian economies.
- Automation via industrial robots is one area in which Asia is clearly at the forefront, although it is limited to a few Asian economies. With Asia being the "factory to the world," it is perhaps to be expected that a full two-thirds of the world's industrial robots are employed in the region. The use of robots has accelerated since 2010. The People's Republic of China (PRC) is now the single biggest user, accounting for some 30% of the market; further, in 2016, the PRC, Japan, and the Republic of Korea each employed more robots than the US. But this is not just because production volumes are high in Asia. Robot density (the number of industrial robots per 1,000 workers) is high and rising fast in several Asian economies, attesting to their rapid and extensive adoption. Indeed, the Republic of Korea and Singapore are the global leaders in robot density, followed by Germany and Japan. Finally, Asia is a leader not only in the use of robots, but also in their production—Japan and the Republic of Korea are the world's top two producers, with market shares of 52% and 12%, respectively.
- E-commerce and fintech are other areas in which Asia leads. For instance, the PRC accounted for less than 1% of global retail e-commerce about a decade ago, but that has grown to more than 40%, and the penetration of e-commerce (as a percentage of total retail sales) now stands at 15%, compared to 10% in the US. E-commerce penetration is lower in the rest of Asia, but it is growing fast, particularly in India, Indonesia, and Viet Nam. In terms of fintech, Asian economies have made significant progress, in many cases leapfrogging into new types of technology. For example, in 2016, mobile payments made by individuals

for consumption purchases totaled $790 billion in the PRC, 11 times the size of such payments in the US. Asia has also been a leader in cryptoassets, including initial coin offerings. Finally, some small states in the region have even been approached by private investors to adopt cryptoassets as the legal tender, raising serious legal and regulatory concerns.

A second key finding is that Asia has already benefited immensely from digitalization. This paper finds that the diffusion of technological innovation has been the key driver of growth in per capita gross domestic product (GDP) in Asia over the past two decades, with digital innovation alone accounting for nearly 30%. The digital component of GDP, proxied most narrowly by the share of the information and communication technology (ICT) sector, is relatively large in many Asian economies—Asia is home to seven of the world's top 10 economies in terms of the ICT share of GDP. The sector has also been growing substantially faster than overall GDP—twice as fast in India and Thailand, and nearly four times as fast in Japan. Digitalization has also boosted the productivity of non-ICT sectors. Innovation in Asia is tilted toward the digital sector, further highlighting its potential to boost future growth.

Third, e-commerce has the potential to support growth and rebalance economies. For consumers, e-commerce may translate into better access to a wider range of products and services at lower prices, ultimately boosting consumption. For firms, e-commerce could also provide new business opportunities and access to larger markets and may thus support investment. The econometric analysis shows that participation in online commerce is associated with a more than 30% increase in total factor productivity at the firm level in Asia. Innovation, human capital, and, to some extent, access to finance seem to be behind online firms' stronger performance. Finally, the paper finds that firms engaged in e-commerce also export 50% more, relying on their skilled labor force and capacity to innovate. Interestingly, e-commerce seems to be especially beneficial for small firms in Asia.

Fourth, digitalization presents opportunities for improving public finance in Asia. Government adoption of digitalization can, by improving reporting of transactions, increase value-added tax (VAT), tariffs, and other revenue. The analysis indicates that if Asian economies were to move halfway to the global frontier, import-VAT revenue could rise by 0.6% of GDP. Digitalization can also improve the efficiency of public spending, including via the targeting of social assistance, by reducing inclusion and exclusion errors. More generally, digitalization can improve public financial management systems.

Fifth, the paper finds the impact of robots on employment depends on country-specific conditions. Using an approach pioneered by Acemoglu and Restrepo (2017a), the paper analyzes the impact of robot usage on employment across a large sample of economies in Asia, Europe, and the Americas. Contrary to some observers, the paper finds no evidence that robots destroy jobs on net—that is, the productivity-enhancing (and thus job-creating) effects of industrial robots have offset the displacement effect (that is, the destruction of old jobs). Restricting attention to Asia, however, there is a slight negative impact on overall manufacturing employment, and particularly so in certain heavily automated sectors like electronics and automobiles. Furthermore, like others, this paper finds that workers with medium-level education are more vulnerable to displacement than those with either low or high education levels. Interestingly, in Japan, with its aging population and declining labor force, increased robot density in manufacturing is associated not only with greater productivity, but also with local gains in employment and wages. Japan's experience suggests that other Asian economies facing similar demographic trends in the future, such as the PRC, the Republic of Korea, and Thailand, may also benefit from automation.

Finally, the paper finds that economies with a greater propensity for technological leapfrogging have also tended to see declining traditional financial infrastructure, particularly bank branches. Unlike US tech companies, Asian tech giants, especially in the PRC, have become key providers of financial services, putting competitive pressures on traditional financial institutions.

Neither the opportunities nor the challenges related to digitalization have yet become fully apparent. Some economists have questioned the ability of technological progress to keep propelling the economy forward, arguing that the low-hanging fruit have mostly been picked, and further advances will become increasingly difficult. Others argue that the new technologies are not widely diffused, complementary innovations and production processes that will boost productivity have not been fully developed, occupations may need to be redesigned, and the capital investments required to implement new technologies have not yet been made. It is worthwhile recalling that it took more than 2 decades for electricity to substantially increase productivity.

## 1.2 Striking the Right Balance

While the digital revolution is inevitable, the outcome—utopian or dystopian—will depend on policies. To realize the potential of the digital revolution, comprehensive policies and fresh thinking are needed. For policymakers, the first hurdle is to accept that the digital revolution is inevitable. Policy responses will need to strike the right balance between enabling digital innovation and addressing digitalization-linked risks. Policy priorities differ across Asia (and the world), as economies' initial conditions are different. Policies to harness digital dividends include revamping education to meet the demand for more flexible skill sets and lifelong learning, as well as new training, especially for the most adversely affected workers; reducing skill mismatches between workers and jobs; investing in physical and regulatory infrastructure that spurs competition and innovation; and addressing labor market and social challenges, including income redistribution and safety nets. But considering the inherent global reach of these technologies, regional and international cooperation will be key to developing effective policy responses.

Policies to soften the labor market impact of new technologies can improve welfare. The more willing society is to support the necessary transition and those who are left behind, the faster the pace of innovation that society can accommodate, while still ensuring that the outcomes improve welfare, with all members better off. With the right policies, the digital revolution could be a new engine of growth and prosperity for Asia and the world.

This paper first surveys the Asian digital landscape. It then revisits the debate on the sources of growth in Asia, focusing on the role of digital innovation. The paper then turns to analyzing four specific topics: automation and the future of work; e-commerce as a new engine of growth; digitalization of financial services; and digitalization to strengthen public finance. The final section concludes with a discussion on policy challenges.

# 2. ASIA'S DIGITAL LANDSCAPE

Asia has made significant strides in the digitalization of consumption, production, and innovation. While the PRC has been the global trendsetter in many aspects of digitalization, many economies in Asia have advanced significantly. Nonetheless a digital divide still exists, with only a select few economies adopting digitalization at the highest level of sophistication. The impact of digitalization has also been far-reaching, with fintech already starting to impact traditional banking, e-commerce supplanting smaller businesses, and governments adopting digitalization to improve public finance.

## 2.1 Defining and Measuring the Digital Economy

The digital economy can be defined in a narrow or broad sense. The narrow definition refers to the ICT sector only or the "digital sector," including telecommunications, the internet, services, hardware and software, etc. The broad definition includes both the ICT sector and parts of traditional sectors that have been integrated with digital technology, often called the "digital economy." The lack of a generally agreed-upon definition of the "digital economy" or "digital sector" is a hurdle to measuring both concepts. In the future, as digitalization penetrates an increasing number of activities and sectors, the boundaries between the digital and physical worlds will be blurred, and the entire world economy may be considered to be digital.

Reflecting different definitions, there are a range of measures of the digital economy; unsurprisingly, these provide very different size estimates.[1] In addition, there are also many blended indices that include the enabling conditions for driving digitalization (such as ICT infrastructure and mobile penetration) and indicators for certain digital industries (such as e-commerce transactions). For the purposes of this paper, the analysis mainly uses the narrow definition because of data availability. However, the paper also uses other measures to capture developments in specific areas such as robotics and e-commerce. A blended index has also been created for the purpose of the paper.

## 2.2 Supply

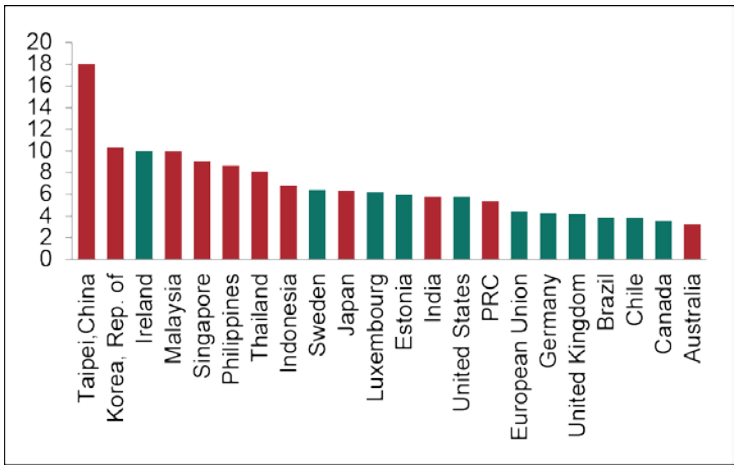
Asia's digital sector is growing, as detailed in Figure 1. Not surprisingly, advanced economies such as Taipei,China; the Republic of Korea; and Japan have a large ICT sector. During 2005–15, the ICT/GDP ratio in Taipei,China almost doubled from 9.3% to about 18% of GDP, while the Republic of Korea's increased from 7.5% to about 10% of GDP. Major economies that are members of the Association of Southeast Asian Nations, such as Malaysia, Singapore, Thailand, and the Philippines, are also among the global leaders in the ICT sector.

Asia is the world's largest supplier of ICT goods[2] and services, accounting for about half of global exports. Within Asia, the PRC's contribution is about 60% (including Hong Kong, China) and has contributed to more than half of ICT export growth over the past decade, followed by the Republic of Korea. Most of the contribution comes from goods exports, but services are starting to gain momentum (Figure 2).

[1] See Zhang and Chen (2019).

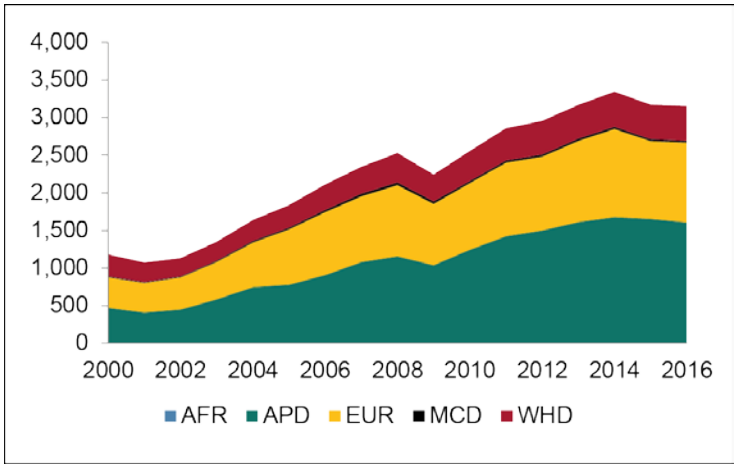
[2] ICT goods exports include computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods.

**Figure 1: ICT Sector as a Share of GDP, 2015**
(% of GDP)




GDP = gross domestic product, ICT = information and communications technology, PRC = People's Republic of China.
Note: Canada and Ireland data are from 2014.
Sources: European Commission; CEIC Data Co.; and IMF staff calculations.

**Figure 2: Exports of ICT Goods and Services**
($ billion)



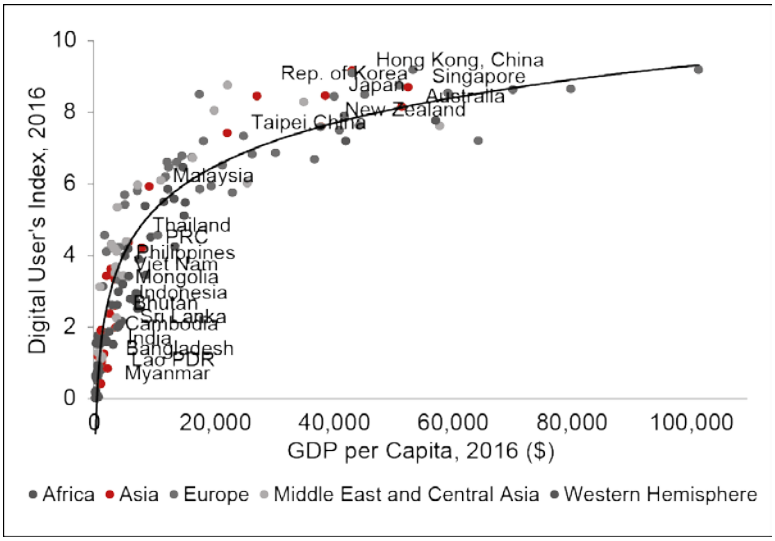

AFR = Africa Department, APD = Asia and Pacific Department, EUR = European Department, ICT = information and communications technology, MCD = Middle East and Central Asia Department, WHD = Western Hemisphere Department.
Sources: World Bank, World Development Indicators; United Nations Conference on Trade and Development; and International Monetary Fund staff calculations.

## 2.3 Use of Digital Technologies

Asia has the highest dispersion of economies in terms of the adoption of digital technologies. Economies such as the Republic of Korea and Japan are global trendsetters not only in the adoption of technology, but also in its production. On the other side of the spectrum, there are economies such as Myanmar and the Lao People's Democratic Republic, which rank low in digital adoption. Between these extremes lie Bangladesh and Cambodia, which are rapidly adopting certain aspects of

digitalization. Nonetheless, at any given income level, Asian economies generally have adopted digitalization more than their global peers (Figure 3).[3]

**Figure 3: GDP per Capita and Digital Usage**
(index, 0–10)




Note: GDP = Gross Domestic Product, IMF = International Monetary Fund, Lao PDR = People's Democratic Republic, PRC = People's Republic of China.

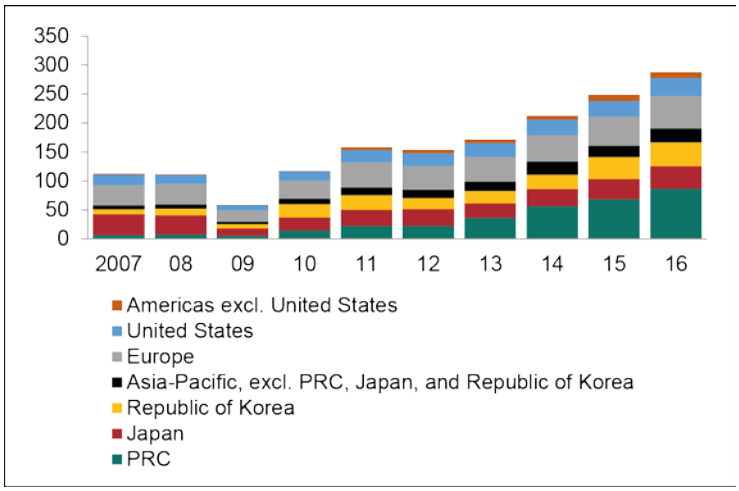
Sources: IMF, World Economic Outlook; International Telecommunication Union; and IMF staff calculations.

Fewer digitalized economies in Asia appear to be catching up. Digital convergence is likely given the accelerating speed of adoption by those at the lower end of the spectrum.

The use of higher-end digitalization products, such as robotic equipment, is limited to a few select Asian economies. Over 60% of the world's industrial robots are used in Asia, but the PRC remains the dominant global player, with twice as many as the second-largest consumer, the Republic of Korea (Figure 4). On average, 7.4 robots operated per 1,000 employees in manufacturing worldwide in 2016, but the comparable figures were 63 in the Republic of Korea, 49 in Singapore, and 30 in Japan, far exceeding the global average (Figure 5).

[3] Figure 3 is based on the Digital User's Index, which is a composite index created by International Monetary Fund staff that consists of the average of six indicators: mobile phone subscriptions in terms of subscriptions per 100 population; percentage of individuals using the internet; percentage of households with a personal computer; percentage of households with internet access; fixed broadband internet access in terms of subscriptions per 100 population; and mobile-broadband subscriptions in terms of subscriptions per 100 population.

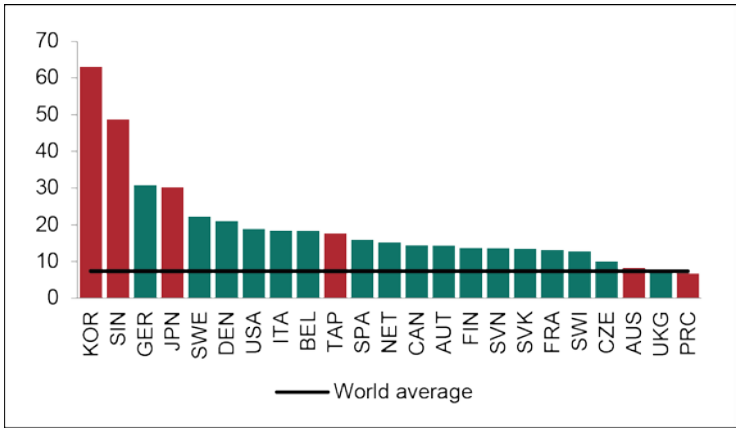
**Figure 4: Worldwide Destination of Industrial Robots by Region**
(thousands of units)




PRC = People's Republic of China.

Sources: International Federation of Robotics (2017); and International Monetary Fund staff calculations.

**Figure 5: Robot Density in Manufacturing, 2016**
(number of industrial robot stock per 1,000 employees)

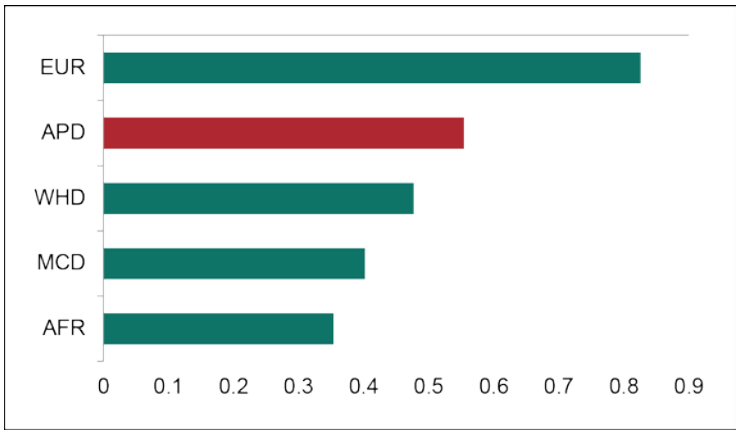



KOR = Republic of Korea; SIN = Singapore; GER = Germany; JPN = Japan; SWE = Sweden; DEN = Denmark; USA = United States of America; ITA = Italy; BEL = Belgium; TAP = Taipei,China; SPA = Spain; NET = Netherlands; CAN = Canada; AUT = Austria; FIN = Finland; SVN = Slovenia; SVK = Slovakia; FRA = France; SWE = Switzerland; CZE = Czech Republic; AUS = Australia; UKG = United Kingdom; PRC = People's Republic of China.

Source: International Federation of Robotics (2017).

Asia is second only to Europe in digital payments, with implications for traditional banking. However, practices vary across the region (Figure 6). For example, in Thailand, the launch of a government-backed electronic money transfer service forced banks to waive fees for retail e-transactions in April 2018, and mobile banking is replacing internet banking. E-money is also gaining ground in Indonesia and Malaysia, while in other economies, banks are reducing the number of physical branches and shifting toward digital banking. Although the fintech revolution may not eliminate the need for traditional brokers and bankers, it has the potential to significantly reduce the costs and time involved in cross-border banking transactions, increasing banks' efficiency.

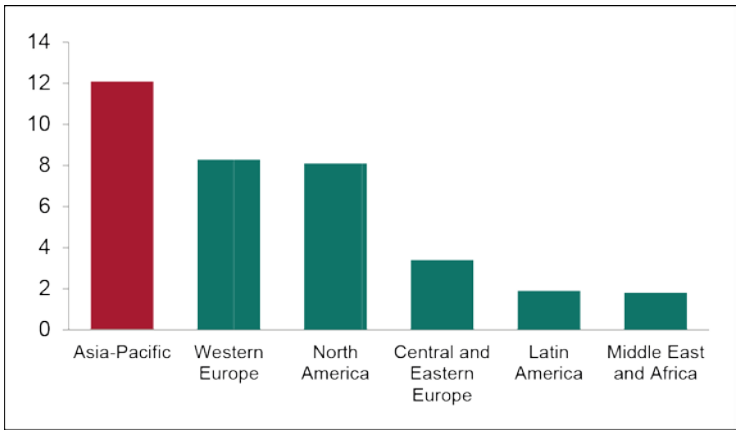
**Figure 6: Share of Population That Made or Received Digital Payments in 2016 (% of population aged above 15 years old)**




Note: AFR = Africa Department; APD = Asia and Pacific Department; EUR = European Department; MCD = Middle East and Central Asia Department; WHD = Western Hemisphere Department.

Source: World Bank, Global Findex database 2017.

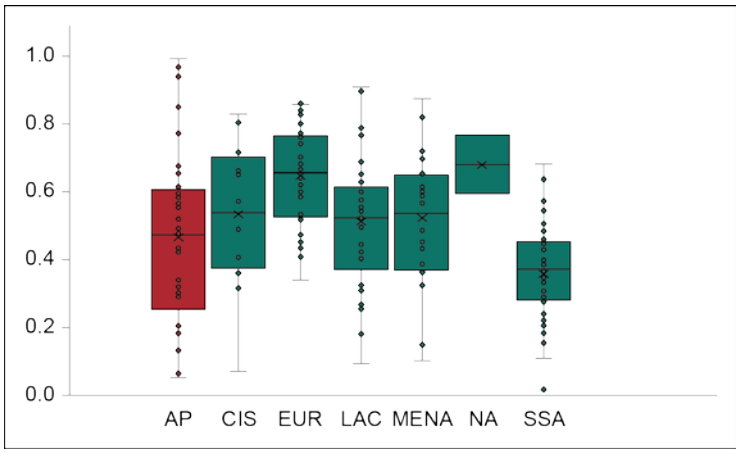
**Figure 7: E-Commerce Sales, 2016**
(% of total retail sales)




Sources: ystats.com; and International Monetary Fund staff calculations.

E-commerce is already large in Asia but has room to grow, given still low e-shopper penetration. Globally, Asia dominates other regions in terms of the share of retail sales that occurs via e-commerce (Figure 7). Internet connectivity and mass adoption of mobile technologies have made it easier for e-commerce companies to target consumers. For example, increasingly, online shoppers in the PRC are buying via their mobile devices. However, this trend is not limited to the PRC, as the Republic of Korea, Japan, and India are also among the top 10 economies in the world in terms of e-commerce sales (as a percentage of retail sales). Economies that are not among the global trendsetters are also seeing rapid growth—Indonesia, for example, witnessed a four-fold increase in its e-commerce sales (as a percentage of retail sales) in a span of 4 years between 2014 and 2017. Some Asian economies are at the forefront of digital business and digital government, while others have room to do more. Overall, Asian economies run the gamut in terms of government adoption of digital technologies, but trail economies in North America and Europe (Figure 8). Nonetheless, the top three global leaders in terms of digital adoption are from Asia: the Republic of Korea, Singapore, and Japan. Malaysia, India, and the PRC also perform better than the European average.

**Figure 8: Digital Government across Regions**
(Digital Adoption Index for governments, latest available year)




AP = Asia and the Pacific; CIS = Commonwealth of Independent States; EUR = Europe; LAC = Latin America and the Caribbean; MENA = Middle East and North Africa; NA = North America; SSA = Sub-Saharan Africa.

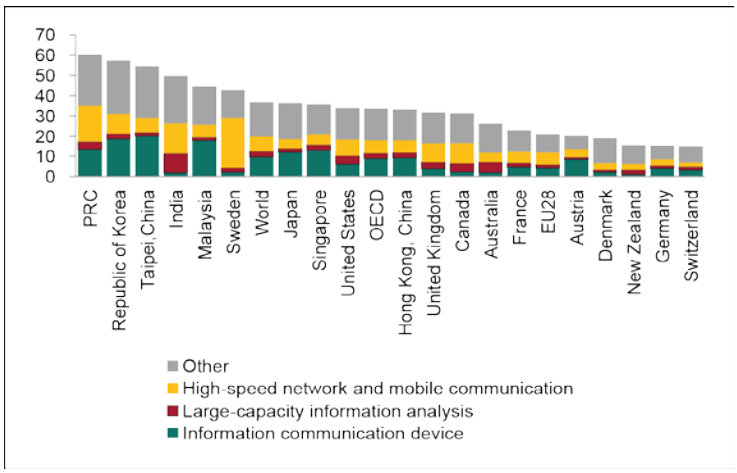
Note: The boxes depict the first, second, and third quartile of the normal distribution.

Source: Fiscal Affairs Department, International Monetary Fund.

## 2.4 Innovation

Innovation in Asia is tilted toward ICT. The top five economies in terms of the ICT share of patents are all Asian: the PRC; the Republic of Korea; India; Malaysia; and Taipei,China. Japan and Singapore also outperform the US and the Organisation for Economic Co-operation and Development (OECD) average (Figure 9). This is a promising indication that the ICT patents may ultimately develop into digitalization products that may propel growth, but this transition has yet to take place.

**Figure 9: Specialization in ICT-Related Patents, 2012–2015**
(patents in ICT as % of total IP5 patent families)




Note: ICT = Information and Communications Technology, IMF = International Monetary Fund, OECD = Organisation for Economic Co-operation and Development, PRC = People's Republic of China.

Sources: OECD, and Innovation Micro-data Lab: Intellectual Property; and IMF staff calculations.

# 3. ASIA'S GROWTH: FROM PERSPIRATION TO DIGITAL INSPIRATION

A classic question in the literature is whether Asia's remarkable growth has been driven more by factor accumulation or by technological progress—in other words, by "perspiration" or "inspiration". This section offers a new twist on this question by focusing on the role of digital technologies in particular. The analysis finds that the diffusion of technological innovation has been the driver of growth in Asia since the 1990s, with innovation in the digital sector accounting for around 28% of growth in per capita GDP. Rapid accumulation of human capital has also contributed, but interestingly, and in contrast to the past, capital deepening has not, suggesting that Asia has transitioned to rely more on technological progress to drive economic growth.

Asia has maintained remarkably high growth rates, accounting for nearly two-thirds of global growth. Much of the debate on Asia's strong growth performance has centered on whether this growth reflects increases in total factor productivity (TFP) or factor accumulation (Young 1992). Early research using data for 1965–90 found that most, and in some cases all, growth had come from factor accumulation, especially capital. Krugman (1994) popularized the zero TFP growth thesis and provocatively argued that Asian growth was mainly a matter of perspiration rather than inspiration—of working harder, not smarter. This section takes a fresh look at this debate, focusing on the role of digitalization.

To tackle this issue, the respective contributions of the various sources of growth are calculated using the accounting framework presented in Jones (2002), which allows estimation of the contribution of the digital sector using a (semi-) endogenous growth accounting framework. In this framework, growth in labor productivity (that is, increases in output per worker) is divided into capital intensity (or capital deepening), rising labor quality (or human capital per worker), and growing TFP, or the stock of ideas/knowledge. This last term is proxied by the frontier economies' contribution to research, measured by R&D intensity (the share of workers doing research) in both ICT and non-ICT sectors, and population growth.

One of the main pillars of this framework is that growth in TFP depends on new ideas. Production of new ideas is related to the number of researchers, their efficiency, and the stock of existing ideas. Unlike physical and human capital, which are rivals in use, ideas can be shared by all (that is, they are non-rival). While capital deepening and rising education attainment (measured by years of schooling as a proxy for human capital) have bounded effects on output per person, higher R&D intensity in employment can raise TFP and thus support GDP growth on a more sustained basis. For economies with still-low R&D intensity, such as the PRC, the number of researchers can increase for a while, even as population growth slows.

## 3.1 Asia's Rising R&D Intensity

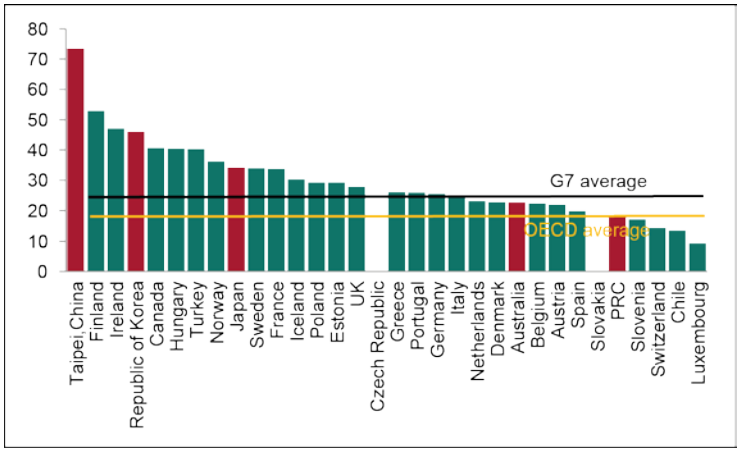
While technological developments have historically been concentrated in a few large industrialized economies, mainly the US and Europe, Asia is increasingly contributing to the global stock of ideas, as the region's R&D intensity has increased significantly. Jones (2002) and Fernald and Jones (2014) focused on the US and use G5 economies (France, Germany, Japan, the UK, and the US) in constructing a measure of the global stock of R&D ideas. This section adds the evolving role of emerging market economies, particularly in Asia. Thus, the PRC; the Republic of Korea; and Taipei,China have been added as contributors to global knowledge. Since size matters

in the Jones (2002) and Fernald and Jones (2014) framework, and since the creation of new ideas is ultimately a function of population, it stands to reason that Asia, with its large and fast-growing population, should also increasingly contribute to global knowledge.

R&D efforts, whether measured in terms of expenditure or number of researchers, have risen globally in recent decades. Asian economies have seen especially rapid growth in R&D, particularly in the PRC; the Republic of Korea; and Taipei,China. The R&D-expenditure-to-GDP ratio and the share of researchers in total employment (R&D intensity) are both higher in Japan; the Republic of Korea; and Taipei,China than in, for example, the US. Asia, however, still has scope for growth—R&D intensity in the PRC, for instance, has more than doubled since 2000, but is still at relatively low levels.

Asia's R&D intensity in the digital sector and associated patents have increased even faster, but important heterogeneity exists. The share of researchers working on the digital sector ranges from 18% in the PRC to 23% in Australia; 34% in Japan; 46% in the Republic of Korea; and 73% in Taipei,China, as against an OECD average of 30% (Figure 10).

**Figure 10: Share of ICT Researchers**
(% of total number of researchers)




ICT = information and communications technology, ISIC = International Standard Industrial Classification, PRC = People's Republic of China, UK = United Kingdom.

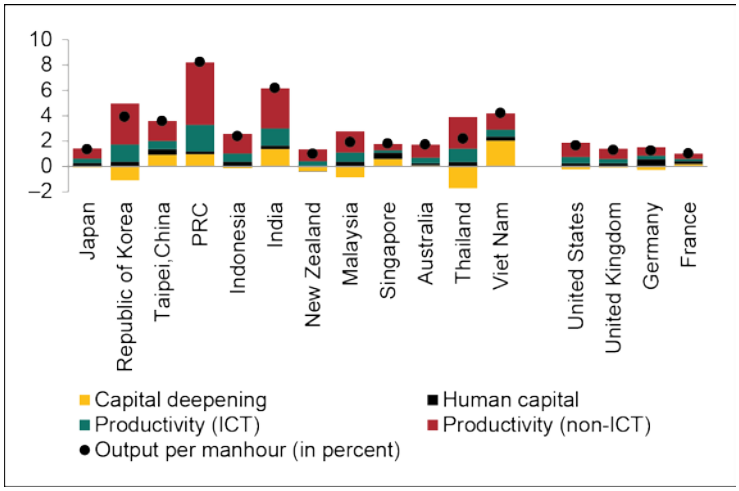
Sources: Organisation for Economic Co-operation and Development, Research and Development Statistics: Business Enterprise R-D Expenditure by Industry – ISIC Rev. 4; and International Monetary Fund staff calculations.

## 3.2 Results

While earlier literature found that factor accumulation was the key driver of Asia's growth in the 1960s, 1970s, and 1980s, this section finds that TFP growth (or technological progress) explains most of the economic growth over 1995–2016, though the results vary across countries. In advanced economies, which are closer to the global frontier and have older populations with greater human capital, factor accumulation played a more limited role than in emerging and developing economies.

Increases in human capital contributed 11.9% to per capita income growth on average, with the contribution ranging from –0.5% in New Zealand to 27% in Singapore. For some economies in the region, especially those that were affected by the Asian financial crisis, the process of capital deepening made a negative contribution to per capita income growth, ranging from 78.6% in Thailand to 7.2% in Indonesia (Figure 11).

**Figure 11: Sources of Economic Growth, 1995–2016**
(percentage points)




ICT = information and communication technology, PRC = People's Republic of China.

Sources: Organisation of Economic Co-operation and Development; Fernald and Jones (2014); and International Monetary Fund staff estimates.

More interestingly, the analysis for this section finds that innovation in the digital sector contributed to around 28% of per capita growth over 1995–2016, with contributions ranging between 12% (Singapore) and 49% (Thailand). Since the analysis uses the narrow definition (based on the OECD framework), the share of researchers working on the digital sector could be underestimated. Thus, the contribution of the digital sector to per capita growth could be higher if a broader definition of digitalization were used. In addition, these estimates do not capture the overall contributions from the digital sector to growth, since those from digital capital stock could not be estimated due to data availability issues across economies.

Looking forward, the digital sector will likely be an even more important driver of growth in Asia. Indeed, assuming current trends continue, innovation in the digital sector could account for 36% of Asia's economic growth within 15 years.

This section has estimated the contribution of the digital sector to Asia's per capita growth over the past 25 years. Technological progress is found to have been the main driver of Asia's per capita growth, and digital technological progress is especially important, accounting for between 12% and 49% of per capita growth.

The next four sections dig more deeply into specific aspects of the digital revolution, starting with automation and the future of work.

# 4. AUTOMATION AND THE FUTURE OF WORK IN ASIA

This section analyzes the impact of robot usage on employment across a large sample of economies in Asia, Europe, and the Americas. The analysis finds no evidence that robots destroy jobs on net. Restricting attention to Asia, however, there is a slight negative impact on overall manufacturing employment, particularly in certain heavily automated sectors. Furthermore, the analysis finds that workers with medium-level education are more vulnerable to displacement than those with either low or high education levels. Interestingly, in Japan, with its aging population and declining labor force, increased robot density in manufacturing is associated not only with greater productivity, but also with local gains in employment and wages.

Automation, like other technological changes, brings both opportunities and challenges. By reducing costs and improving productivity, it may boost economic growth at a time of lackluster productivity growth and demographic headwinds. But the fear is that it may disrupt labor markets in transition as it takes over tasks and makes traditional jobs obsolete. One of the most discussed examples of automation technologies is the use of industrial robots. In 2016, there were about 1.8 million industrial robots—machines that are automatically controlled and reprogrammable to perform physical, production-related tasks—operating in the world, and their use has been growing at double-digit rates in recent years (International Federation of Robotics 2017). More importantly, they are becoming more flexible, safer, and cheaper.

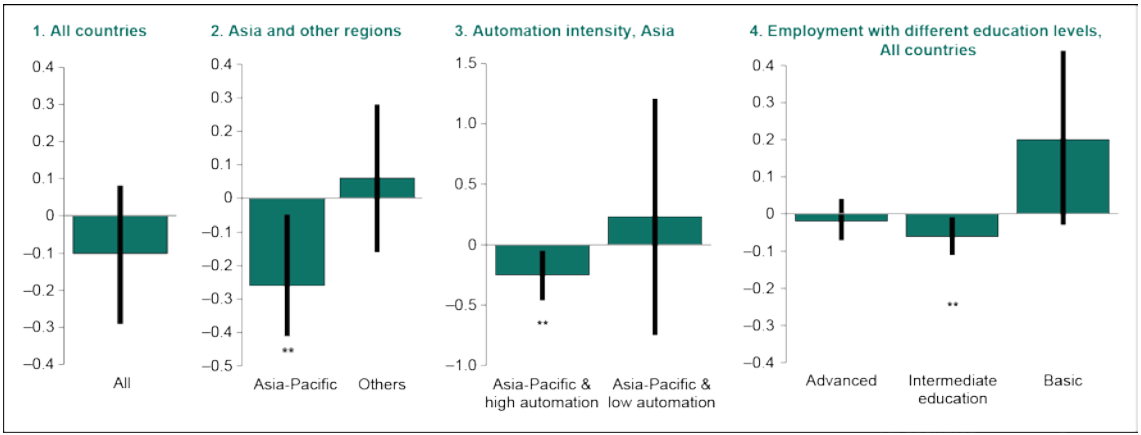
Many economies in Asia have been at the forefront of automation using industrial robots. More than half of the estimated operational stock of industrial robots is in Asia (1 million units out of a total of 1.8 million units in 2016). These robots are used almost exclusively in manufacturing, with automotive manufacturing being by far the most automated subsector. In several Asian economies, the rise of industrial robots in recent years has also been driven by their use in the manufacturing of computers and electronics.

Automation can have two opposing effects on employment. On the one hand, robots may displace jobs, as they replace human labor and reduce labor demand directly. But on the other hand, they may also increase labor demand by boosting productivity and facilitating expanded production (Acemoglu and Restrepo 2017a). Furthermore, the employment impact of industrial robots may also indirectly reach across industries, as a productivity boost in one sector may have positive spillovers across supply chains, thus raising total production and income in the overall economy (Autor and Salomons 2018).

The analysis for this section finds a negative impact of robots on manufacturing employment in Asia, but not in the world overall (Figure 12). Following the framework of Acemoglu and Restrepo (2017a), the analysis finds that robot penetration is not significantly associated with net employment losses in a sample of 14 manufacturing subsectors in 40 economies in Asia, Europe, and the Western hemisphere for the period 2010–14. This suggests, contrary to some observers' worst fears, that the job-creating productivity effect of automation might have offset the displacement effect even at the industry level. When restricting attention to Asia, however, the analysis finds that the increased use of robots is associated with lower employment growth. One more robot per 1,000 employees is associated with a 0.26 percentage point decrease in employment growth in manufacturing sectors. The negative employment effect estimated for Asian economies is driven by highly automated sectors and economies, such as manufacturing of automotive components, plastic and rubber products, and electronics, where robot density was relatively high already in 2010 and has been increasing rapidly since then. This suggests that as automation intensifies, the job displacement effect may start to outweigh the productivity effect at least in the short run

at the sectoral levels; a critical mass of robots may be needed before the impact becomes apparent. Also, it is important to note that employment data do not capture jobs created outside the sectors (for example, companies providing robotics repair and maintenance services).

**Figure 12: Estimated Effect on Employment Growth, 2010–2014**
(percentage points, associated with one more robot per 1,000 workers)




Note: Figure is based on regressions of the changes in employment on the changes in robots per 1,000 employees during the period 2010–2014. The left three charts are based on 14 manufacturing subsectors in 40 countries, and the right chart is based on countries for which education breakdown of employment data is available. Intermediate education refers to workers with upper secondary and post-secondary non-tertiary education. Bars show the estimated total effects calculated based on the estimate coefficients for each specified group in the horizontal axis. Error bars refer to the 95% confidence interval: ** p<0.05.

Sources: International Federation of Robotics; World Input-Output Database; International Labour Organization; and International Monetary Fund staff calculations.

The impact of automation, however, depends on country-specific conditions. For example, in Japan, whose demographics dictate a declining labor force, increased robot density in manufacturing is associated not only with greater productivity, but also with local gains in employment and wages. Specifically, panel regressions using estimated prefecture-level robot density show that Japanese prefectures with higher exposure to robots had higher productivity and employment growth. The analysis for this section finds that those prefectures more exposed to robots have sizable positive effects on local labor market outcomes as well as productivity—an increase of robot density by 1% corresponds to a 15% increase in TFP growth for all samples, and of 6% in a manufacturing subsample.[4] In addition, employment growth is also positively correlated—a 1% increase in robot density leads to a 0.2% increase in employment growth. Japan's experience suggests that other Asian economies facing similar demographic trends in the future, such as the PRC, the Republic of Korea, and Thailand, may also benefit from automation.

Automation has an uneven impact on employees with different skill levels (Figure 12, panel 4). Automation will render many jobs obsolete, and many will be created and changed. Jobs that are most susceptible to automation tend to involve routine and manual tasks, most prevalent in manufacturing. Those jobs have traditionally been performed by workers with mid-level skills or in the middle of the pay scale (Autor, Levy, and Murnane 2003). Several studies have documented that the use of industrial robots has a negative impact on middle- or low-skilled workers, with little effect on high-skilled jobs (Graetz and Michaels 2015). The analysis here also supports an uneven

[4] For more details, see IMF (2018).

impact: penetration of industrial robots is negatively related to employment growth for workers with secondary education, while there is no significant relation for those with higher education. For workers with upper-secondary education (for example, high school), a standard deviation increase in robot penetration at the economy level (equivalent to about 0.12 more robots per 1,000 employees in an economy over the period of 2010–14) is associated with a decrease in employment of about 0.24 standard deviations (or about a 0.01 percentage point decrease in employment in the sample) on average across the sample economies.

The challenge is how to manage the transition. Automation will help increase productivity (Graetz and Michaels 2015), and, as noted above, it may be necessary in the face of population aging. Acemoglu and Restrepo (2017b) found that economies with more pronounced demographic changes tend to invest more in automation technologies, and that helps mitigate the potential negative effect of aging on productivity and output. The challenges with automation, however, involve supporting those who are more vulnerable to changes and in need of a transition to new jobs. The analysis suggests that automation-induced labor market changes may already be happening in some highly automated sectors in Asia. As automation intensifies, there will be a bigger transition necessary, and more workers may need new jobs, especially those who are less skilled. It is thus imperative to provide training and retraining opportunities to help workers adapt and acquire skills that will be in demand. Policies that help create more flexible labor markets, such as active labor market policies, can help absorb employment displacement related to automation.

Neither the opportunities nor the challenges have become fully apparent, as robots have not yet been widely used. As with past technologies, productivity effects await complementary innovations. For example, to boost productivity, firms need to redesign production processes and occupations. As these changes are slow, the impact of automation on productivity may even follow a "J-Curve," that is, productivity may even decline before it ultimately increases (Brynjolfsson, Rock and Syverson 2017).

# 5. E-COMMERCE AS A NEW ENGINE FOR GROWTH

E-commerce can support growth. The econometric analysis shows that participation in online commerce is associated with a more than 30% increase in TFP at the firm level in Asia. Innovation, human capital, and, to some extent, access to finance account for online firms' better performance. Finally, the analysis for this paper finds that firms engaged in e-commerce also export 50% more, relying on their skilled labor force and capacity to innovate. Interestingly, e-commerce seems to be especially beneficial for small firms in Asia.

E-commerce can boost private consumption and investment. For consumers, e-commerce may translate into better access to a wide range of products and services at lower prices, ultimately boosting consumption. Two studies by McKinsey in the PRC and Indonesia highlight that e-commerce generates new consumption. In the PRC, one study shows that out of $100 in internet spending, close to 40% represents incremental (new) consumption, while the remaining 60% is diverted from traditional offline retail channels (Dobbs et al. 2013). In Indonesia, about 30% of online commerce spending is new consumption, capturing previously untapped needs (Das et al. 2018). For firms, e-commerce could also provide new business opportunities and access to larger markets, supporting investment.

E-commerce has great potential to improve labor and capital productivity, including for small and medium-sized enterprises. Fast-growing cross-border e-commerce is also

gaining traction, bringing greater potential to increase participation in regional and global value chains and support international trade. The empirical literature on the impact of e-commerce on firm activity is limited, but existing evidence suggests an overall positive effect on firm performance.

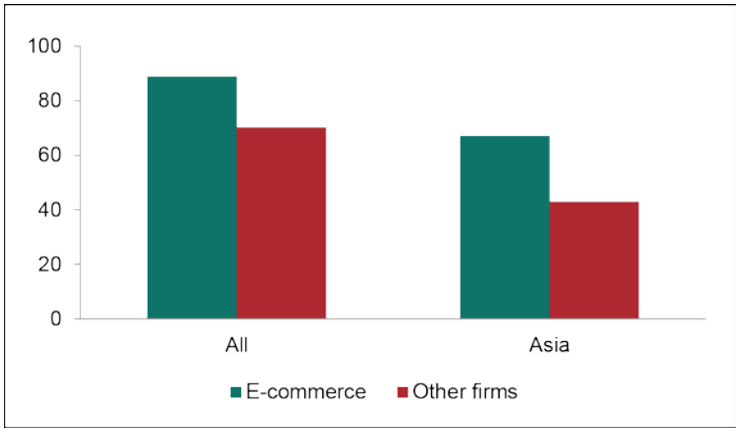
## 5.1 Evidence from Firm-Level Data Highlights the Benefits of E-commerce for Productivity

This section provides a novel analysis of performance differences between firms engaged in e-commerce and other firms. It relies on World Bank Enterprise Surveys (WBES) and uses a comprehensive sample of developing economies, including several Asian economies during 2006–12. The WBES data include information on firms' inputs and outputs as well as various characteristics of firms such as age, size, foreign ownership, and export status.

Firms with online activities differ on many fronts from other firms. Evidence from the WBES suggests that firms engaged in e-commerce activities tend to have a more educated labor force and better access to finance, and they innovate more than other firms. For instance, a larger portion of online firms, relative to other firms, introduced new products or processes, used technology licensed from a foreign company, spent on R&D, or acquired internationally recognized quality certifications. Possibly reflecting the above factors, e-commerce firms tend to enjoy higher sales, value added, stock of capital, and exports than non-e-commerce firms.

Firms with online activities have higher labor productivity. A first look at labor productivity, defined as the ratio of value added to the number of employees, highlights that firms with online activities (sales or purchases) have higher labor productivity (Figure 13). In Asia, firms engaged in online activities seem to have sizably higher labor productivity—on average 50% higher than other firms.

**Figure 13: Labor Productivity**
(average, $'000)




Note: Labor productivity is the ratio of value added to the number of employees.
Sources: World Bank, Enterprise Survey; and International Monetary Fund staff calculations.

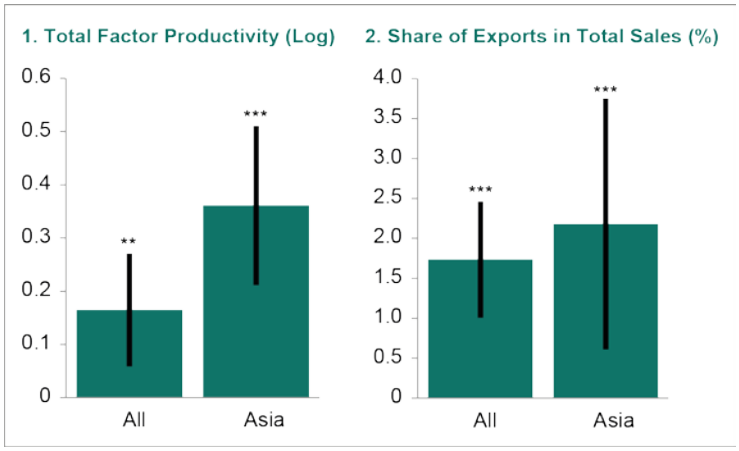
Firms with online activities, including small firms, also have higher TFP. To capture a more complete picture of the performance differential between firms with online activities and other firms, this section analyzes those differences in TFP. Comparing the distribution of TFP between the two groups confirms that firms with online activities have higher productivity, particularly in Asia. Interestingly, e-commerce seems to be especially beneficial for small firms in Asia.

Controlling for firms' characteristics confirms the results presented in the analysis here (Figure 14, panel 1). The suggestive evidence that firms (including small and medium-sized ones) involved in e-commerce are more productive holds after controlling for several firm characteristics (age, size, foreign ownership, and export status) that are also known to affect performance. Consistent with the earlier evidence presented here, the potential impact of e-commerce on firm productivity seems to be greater in Asia than in other developing regions.

Innovation, human capital, and to some extent access to finance seem to support online firms' greater performance. The higher productivity of firms with online activities seems to occur through their more highly skilled labor force, faster pace of innovation, and, to some extent, better access to finance, which allows these firms to deliver products and services with internationally recognized quality certification.

E-commerce firms also export more, relying on their skilled labor force and capacity to innovate (Figure 14, panel 2).[5] Firms with e-commerce activities generate a larger share of sales revenues from exports, particularly in Asia, highlighting the potential of e-commerce to promote cross-border trade. A better-skilled labor force and a higher quality of products seem to support higher exports by firms with online activities. The role of skill premia in supporting export activities seems particularly important in Asia.

**Figure 14: Estimated Impacts of E-Commerce Participation on Productivity and Exports**




Notes: These figures illustrate coefficients and confidence intervals from two firm-level estimations: (a) the impact of e-commerce participation on total factor productivity controlling for firms' age, size, foreign ownership, and export status; and (b) the impact of e-commerce participation on the share of exports in total sales controlling for firms' size, age, and foreign ownership. The error bars refer to the 95% confidence intervals around the estimated coefficients. For Asia, the estimated coefficients imply that participation in e-commerce is associated with more than a 30% increase in total factor productivity and an increase in the share of exports to total sales by about two units, corresponding to a 50% rise. ** p<0.05; *** p<0.01.

Sources: World Bank Enterprise Surveys; and International Monetary Fund staff calculations.

[5] For more details, see Kinda (2019).

E-commerce, therefore, has the potential to support growth and economic rebalancing by boosting consumption and supporting new industries, especially smaller firms in Asia.

## 5.2 Platforms Can Magnify the Benefits of E-Commerce but also Raise Competition Issues

Platforms can create positive externalities, including through network effects. Platforms have great potential to amplify the economic benefits of e-commerce. In addition to increased competition within the market and pressure to lower prices, including through reduced search costs, a broader geographical reach of suppliers, and savings in supply chain management, platforms bring about additional advantages through network effects. As illustrated in the section above, firms with online activities also have better access to finance. For instance, Ant Financial Services Group, an affiliate company of the PRC Alibaba group, collects information from Taobao, an e-commerce platform that is a subsidiary of Alibaba, to extend the credit frontier to firms not served by traditional banks. By enabling small and medium-sized enterprises to access advanced ICT infrastructure, data centers, applications, and processes usually available to the most productive firms, platforms can further help firms boost their productivity. A higher number of providers or customers using a platform tends to enhance its efficiency, including through using big data to better customize products and services, attracting more providers and customers (same-side network effect).

Platforms can also raise competition issues. While e-commerce can provide various benefits, economies of scale and exclusive access to information platforms pose anti-competitive concerns, particularly when e-commerce platforms become large. Network effects also make it challenging for retailers and vendors to switch platforms, reinforcing their market power and exacerbating the risk of anti-competitive practices.

Overall, the development of a platform economy has brought significant benefit to consumers, but it also poses many challenges as new issues emerge. Designing the proper policy response remains an open question, especially in the areas of taxation, competition, and data privacy. As a dynamic area of economic development, further research and regulatory experiments would be needed to establish a formal framework for the platform economy.

# 6. DIGITALIZATION OF FINANCE IN ASIA

Fintech can support growth and poverty reduction by strengthening financial development, inclusion, and efficiency. Fintech also poses risks to the financial sector, however. While the use of fintech in Asia is heterogeneous, the analysis for this section finds evidence of convergence. It also finds that fintech is positively associated with financial inclusion yet demonstrates that it also has a potentially disruptive impact on traditional financial services.

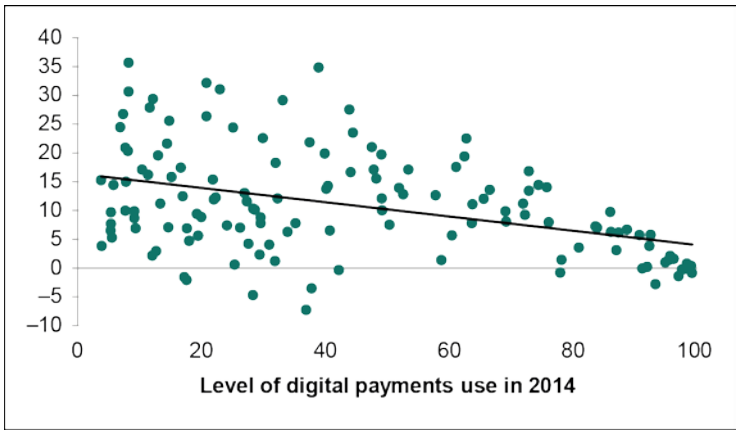
In Asia, digitalization of finance has been growing faster than the global average. Three of the five economies identified as having the highest rate of fintech adoption globally are in the region (the PRC, India, and Australia). Fintech activities are widespread and have grown rapidly in frontier economies such as Mongolia and Bangladesh, as well as in emerging markets such as Malaysia and Thailand. The growth of fintech activities in Asia has been fueled by a dramatic rise in funding. Since 2010, investments have picked up, led by the PRC, but also in Southeast Asia by Singapore, Malaysia, and Thailand.

Cumulative fintech equity funding reached about $28 billion in 2017, with two-thirds of that growth captured by the PRC.

However, the development of fintech has not been uniform. Economies have adopted a wide range of technologies based on consumer needs, level of development, regulatory stance, and existing financial and technological infrastructure. For example, while mobile payments have grown rapidly in the PRC, Australia has instead experienced growth in contactless card payments, building on existing infrastructure and experience with the use of cards for secure payment. Similarly, several economies have not developed mobile money products that operate by monetizing pay-as-you-go phone credit, as "postpaid" monthly phone contracts have become standard (replacing prepaid phone credit).

The empirical work shows evidence of convergence (Figure 15). Using data on digital payments between 2014 and 2017, the analysis finds economies catching up to the frontier of universal access to digital payments. Economies with low levels of digital payment in 2014 have significantly higher growth rates over 2014–17. This initial evidence of convergence is surprising given the wide underlying heterogeneity in the technologies and business models used.

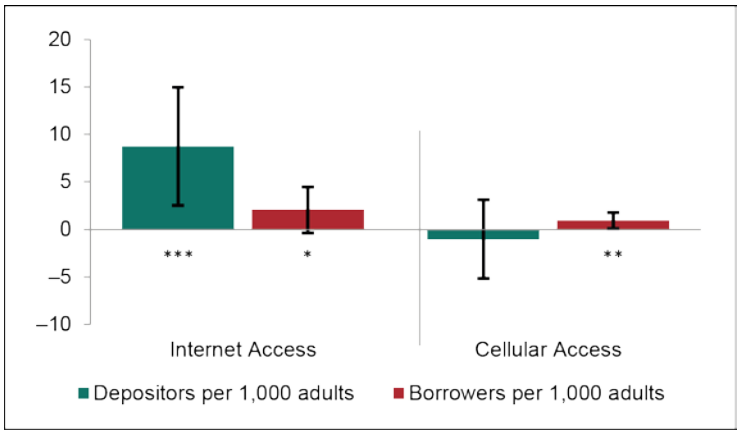
**Figure 15: Change in Share of Population Using Digital Payments, 2014–2017**
(percentage points)




Sources: World Bank, Global Findex database 2017; International Monetary Fund, World Economic Outlook; and International Monetary Fund staff calculations.

The econometric evidence indicates that digital financial services can boost financial inclusion (Figure 16). These results are particularly relevant for Asia, where nearly 30% of the population still lacks access to even a basic savings account. Furthermore, given the existing evidence that greater inclusion in the financial system has positive effects on growth, poverty, and inequality, there is potential for greater adoption of mobile technology for financial inclusion to translate into positive macroeconomic outcomes. In addition to direct benefits, fintech has complementary benefits given its role in facilitating other digital activities such as e-commerce.

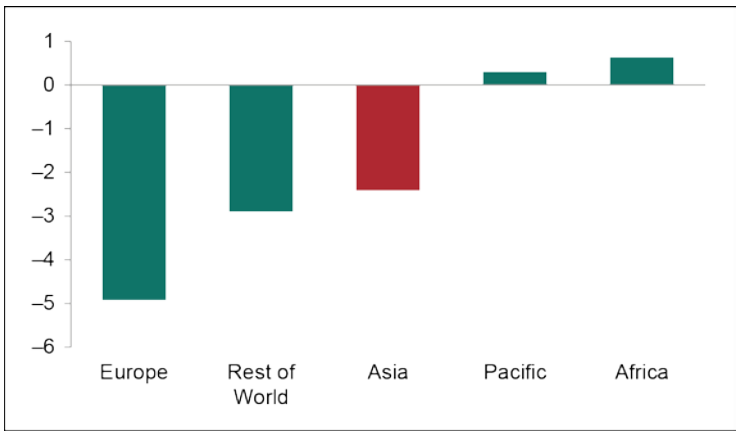
**Figure 16: Technological Development and Financial Inclusion**
(marginal impact of increase, after controls, including country fixed effects)




Source: International Monetary Fund staff calculations.

The econometric results also highlight the potentially disruptive nature of fintech innovations (Figure 17). Specifically, they suggest that economies with a greater propensity for technological leapfrogging in moving to cellular technologies have also tended to see falling levels of traditional financial infrastructure, particularly bank branches. Specifically, there is a negative association between the adoption of new technology without widespread adoption of prior technology and traditional financial infrastructure. This is particularly pronounced in Europe and the Western hemisphere. However, in Africa, as well as the Pacific, the picture is more mixed, and technology may complement traditional means of financial service delivery, even after controlling for relatively lower levels of income and cellular access. The empirical results are supported by developments at the country level, where many economies in the region have seen an increase in digital banks and a corresponding decline in their physical presence.

**Figure 17: Leapfrogging and Financial Infrastructure**
(marginal impact of increase in leapfrogging variable on bank branches per 100,00 adults by geographic region)




Sources: International Monetary Fund, Financial Access Survey, World Bank, World Development Indicators; and International Monetary Fund staff calculations.

However, fintech also faces challenges in promoting economic development or financial inclusion. Much of the use of fintech has replicated patterns seen in the use

of conventional financial products. For example, in Bangladesh, while 20% of the population report having a mobile money account, this masks a large disparity between men (30%) and women (10%). There are gaps across Asia regarding use of fintech based on both gender and position on the income distribution. This suggests that, without attention from policymakers, there is a risk of a digital divide rather than a digital dividend from financial services, at least in the near term.

Fintech may also pose risks to the financial sector if its applications undermine competition, monetary policy transmission, financial stability and integrity, and consumer and investor protection. The unique blend of large hybrid technology/ financial companies that dominate service provision could have spillover effects on the financial system. The development of financial services outside the boundaries of the supervisory and regulatory framework may lead to new risks. Technologies, while accelerating the speed and volume of financial transactions, could also amplify the impact of spillovers. And to the extent that services are increasingly offered by specialized firms along the payments chain, as opposed to large, vertically integrated intermediaries, there may be fewer controls for the processing of data and the management of risks.

# 7. DIGITALIZATION TO STRENGTHEN PUBLIC FINANCE

Digitalization is transforming markets quickly and presents important opportunities and challenges for public finance, both in terms of revenue and expenditure. In taxation, more transactions could be subject to fairer taxes. On the other hand, digital platforms can erode tax bases by shifting transactions to sectors of lower taxation or compliance, and even abroad. In expenditure, digitalization can improve the effectiveness of public spending in Asia, particularly in the targeting of social safety nets, as long as robust design and legal and technological institutions address privacy and cybersecurity concerns.

## 7.1 Taxation: Opportunities and Risks

Digitalization presents opportunities for improving tax collection in Asia. Digitalization can lead to better reporting of transactions in international trade, increasing VAT and tariff revenue. It can also lead to better reporting of financial account transactions and to improved cross-country collaboration, both of which could increase income and wealth tax revenues through better reporting of offshore wealth and its related income.

### 7.1.1 Methodology

Using the estimates of the analysis developed in Chapter 2 of the April 2018 *Fiscal Monitor*, this section quantifies possible improvements in tax compliance and the likely increase in revenues associated with them. The model estimates the average gains of reducing the gap with the frontier in digitalization by 50%, measured by the UN Online Service Index. This variable assesses the scope and quality of public sector online services, including for tax submission and registration of businesses. Using bilateral trade data, the model estimates the impact of an improvement in digitalization in reducing the misreporting of prices of imports. Misreporting of prices is measured as the difference between the declared value of imports at destination and exports at origin.

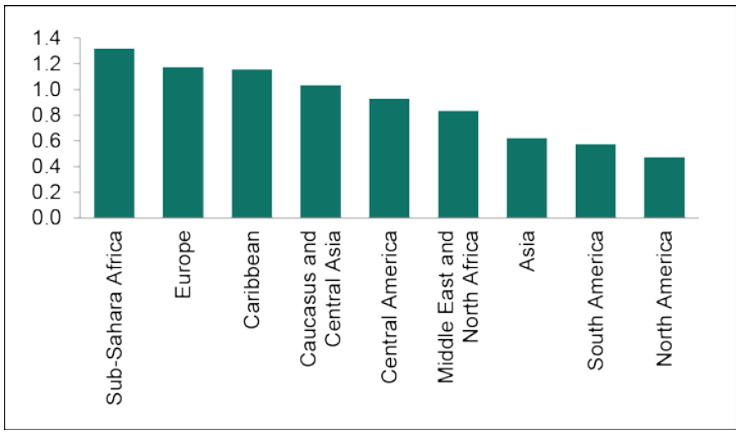
First, the difference in price (misreporting) is regressed on a gravity model that takes into consideration country and time fixed effects, as well as other economic and institutional

variables. The regression includes the variable that measures the level of digitalization (UN Online Service Index). After estimating that regression, the effect of higher digitalization on revenue related to international trade can be estimated. With that, and the appropriate tax rates, the increase in revenue is computed. The section uses the expected higher reported prices of imports to estimate the additional VAT revenue. Using tariff rates (instead of VAT rates), the model then estimates the increase in tariff revenue. Finally, the analysis uses another model that estimates the increase in wealth and income taxes related to undeclared offshore wealth. Using tax rates on wealth, income, and inheritance, it estimates country-specific revenue increases based on financial returns and the country's proportion of offshore deposits, as well as on offshore wealth.

### 7.1.2 Results

Estimates of increased import-VAT revenue suggest benefits from technology adoption. According to the model, for Asian economies, the estimated increase in the VAT is 0.6% of GDP. It is much lower than in other regions, with several regions expected to benefit by more than 1% of GDP. It is higher, however, than for economies in the Western hemisphere. For ASEAN countries, the gains are estimated at 1.2% of GDP, while for Pacific island countries they are estimated at 2.5% of GDP (Figures 18 and 19). Median gains are lower for advanced and emerging economies, at 0.1% and 0.7%, respectively, and are lower in Asia than worldwide. However, for low-income countries the estimate is slightly higher at 1.8% of GDP.

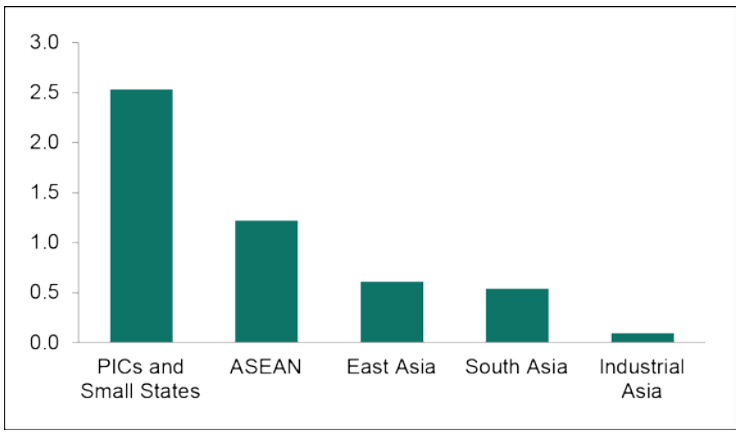
**Figure 18: Potential Import-VAT Revenue Gains from Closing Half the Distance to the Digitalization Frontier, 2016**
(% of GDP)




GDP = gross domestic product, VAT = value-added tax.

Sources: International Monetary Fund, April 2017 Fiscal Monitor; and International Monetary Fund staff calculations.

**Figure 19: Potential Import-VAT Revenue Gains in Asia from Closing Half the Distance to the Digitalization Frontier, 2016**
(% of GDP)




ASEAN = Association of Southeast Asian Nations, GDP = gross domestic product, PIC = Pacific island countries, VAT = value-added tax.

Sources: International Monetary Fund, April 2017 Fiscal Monitor; and International Monetary Fund staff calculations.

The results also suggest that digitalization can boost tariff revenues in Asia by 0.2% of GDP on average; as with the VAT, most other regions are estimated to see higher increases, although Asia surpasses Europe and North America. Again, Pacific island countries are estimated to benefit more in the region, with an estimated 0.7% of GDP increase, followed by ASEAN countries, with 0.5% of GDP. The median gain for emerging markets is estimated at 0.2% of GDP, and at 1.1% of GDP for low-income countries. These values are about 0.1% of GDP lower than estimated for other regions.

Finally, increases in wealth and income tax revenue related to offshore wealth are estimated at 0.2% of GDP for Asia, also low when compared with other regions. Offshore wealth of Asian economies is estimated at 7.3% of GDP, lower than most other regions, except for North America. Among Asian economies, South Asia has the highest estimates of tax increases, at 0.3% of GDP. Advanced economies in Asia have a slightly higher median of estimated gains, even when the proportion of wealth is lower than emerging markets and low-income countries.

One caveat is in order for appropriate interpretation of the results. As previous sections of this paper have shown, digitalization is a function of GDP per capita, and for each income bracket Asian countries are at the frontier. Therefore, the estimated revenue increase for Asia being less than other regions may simply show that the distance to the frontier is smaller (indeed, zero for some), especially for Asian advanced economies.

One should caution against being too optimistic about revenue increases, as digital platforms raise the risk of base erosion from informality and internationalization. In recent years, the development of digital platforms has been quick and large, bringing a transformation in the way of conducting business in many markets. The transformation presents opportunities and risks for taxation. Base erosion shifts transactions and profits from established formal commerce to informal types or abroad. Transactions in the formal sector of the economy can be shifted to other sectors with lower or fewer taxes or to the informal sector and paying no taxes at all. For example, regional peer-to-peer (P2P) platforms like GO-JEK, Grab, and Tujia allow transactions in highly taxed sectors, like taxi service or hotels, to be transacted with a lower effective level of taxation. P2P platforms also allow an increase in international transactions for agents

that would otherwise make only domestic transactions. E-commerce can shift transactions abroad, too, by replacing domestic retail.

Proper legislation can, however, enable digital platforms to share valuable data, formalize informal transactions, and withhold taxes. There are already many cases of P2P platforms withholding funds for tax purposes and reporting payments to authorities in several economies. For example, in India, digital platforms are required to charge and remit service taxes due on the income of sellers. In Australia, drive-sharing platforms are required to have their drivers registered as a business and charge a goods and services tax. There are a variety of tax treatments in the P2P sector, and governments are making many changes as the sector is changing rapidly.

## 7.2 Improving Social Safety Nets with Digitalization

Digitalization can help governments improve public financial management through various channels. For example, integrated beneficiary databases for social safety nets can facilitate inclusion of the previously unreached population, and digital identification for citizens can reduce benefit leakage. In addition, digital technologies allow governments to track and reduce absenteeism of teachers, doctors, and nurses, while removing "ghost" workers from government payrolls. E-procurement can also trim budgets by promoting competition among contractors. While there would be more channels than listed here, this subsection focuses on the first one—improving social safety nets through digitalization—considering its critical role for inclusive growth in Asia.

There is scope to develop social safety nets in developing Asia. While income inequality has risen in the region since 1990, Asia's public spending on social safety nets has remained at 1.2% of GDP, a level lower than in developing Europe, Latin America, and Caribbean, and sub-Saharan Africa. The main objective of social safety net reforms is to reduce inclusion errors (leakage of benefits, that is, when individuals receive benefits to which they are not entitled) and exclusion errors (when eligible individuals do not receive benefits to which they are entitled). Digitalization can support this objective.

Developing digital social registries is a solution to reduce exclusion errors. Social registries are information systems that support outreach, intake, registration, and determination of potential eligibility for one or more social programs (Leite et al. 2017). As a single gateway for various programs, they lower transaction costs for citizens and governments, thereby helping governments reach out to targeted groups. The Philippines' registry (*Listahanan*), for example, serves as a gateway for as many as 52 social programs, ranging from cash transfers to emergency assistance, with 75% of the population registered. Social registries appear to have helped expand the coverage of conditional cash transfer programs in Indonesia and the Philippines. While social registries store information to determine potential eligibility such as income and other socioeconomic data, they rely largely on self-reported information from citizens. Thus, reducing inclusion errors would require data verification with other information systems such as civil and land registries. This function has yet to be developed for social registries in Indonesia and the Philippines.

Digital identification (ID) can help governments reduce inclusion errors. Digital ID systems store personal data in digital form and credentials that rely on digital, rather than physical, mechanisms to authenticate the identity of their holder (World Bank 2016). Digital ID can serve as a necessary "key" to connect social registries with regulatory databases, thereby facilitating eligibility verification (Leite et al. 2017). Digital ID also facilitates transition from in-kind to cash-based benefits by linking beneficiaries with their bank accounts for benefit payments, thereby reducing leakages. Developing Asia

appears to be in a good position to advance on this front, as many economies already have operationalized digital ID systems.

India's experience with the *Aadhaar* identification system is a case in point. *Aadhaar* is the world's largest biometric identification system, providing a unique 12-digit ID number for 1.2 billion residents in India. It is linked to various social programs, providing authentication for eligible beneficiaries. Before 2015, the subsidy on liquefied petroleum gas in India was subject to substantial leakage, partly because of the government's inability to authenticate beneficiaries. The government attempted to reduce leakages in two ways. First, starting in 2013, beneficiaries' *Aadhaar* numbers were linked to the liquefied petroleum gas program to prevent claims from ghost beneficiaries or multiple claims. Second, the government made electronic transfers of the subsidy directly to the *Aadhaar*-linked bank account of beneficiaries, bypassing dealers. These reforms have reportedly reduced leakage and saved costs, although estimates vary.

# 8. THE ROLE OF POLICIES

While the digital revolution is inevitable, the outcome—utopian or dystopian—will depend on policies. To realize the potential of the digital revolution, comprehensive policies and fresh thinking are needed. For policymakers, the first hurdle is to accept that the digital revolution is inevitable. Policy responses will need to strike the right balance between enabling digital innovation and addressing digitalization-linked risks.

## 8.1 Policies to Facilitate Technological Advances

Policies should focus on further enhancing productivity; encouraging more R&D in digital and other sectors; promoting the diffusion of global knowledge by incentivizing new and dynamic firms; upgrading physical and soft infrastructure; and improving access to and the quality of education. Policies to increase R&D intensity and speed up the diffusion of innovation in Asia also include protection of intellectual property (patent policy), competition in research grants, and optimal government subsidies. Investment in R&D and human capital are essential not only to build innovation capacity, but also to maximize the absorption of existing innovations.

## 8.2 Fostering E-Commerce

There is room to improve enabling factors to further boost e-commerce in Asia. Existing digital divides and gaps in key infrastructures and e-commerce legislation are still preventing many Asian economies from fully reaping the potential benefits. Despite its rapid growth, e-commerce, including cross-border e-commerce, could expand faster if various barriers were removed, further supporting international trade, creating more opportunities for businesses, and increasing consumers' welfare:

- *Economic factors and conditions.* A successful e-commerce transaction requires several critical elements, including internet access to allow the user to place an order, secure servers to safeguard payments and personal information, a payment method such as a credit card, e-wallet, or mobile payment, and reliable delivery services for physical goods. While advanced economies, including in Asia, have high readiness for e-commerce, emerging and developing economies in the region still have sizable gaps.
- *Legal and institutional environment.* The absence of laws to regulate the e-environment inhibits participation in e-commerce both for consumers and

suppliers. For instance, e-transaction laws are essential to make electronic forms of exchange legally equivalent to paper-based transactions, a critical condition for most e-commerce transactions. A lack of consumer protection laws and legislation on privacy, data protection, and cybercrime may prevent potential customers from shopping online. While all advanced Asian economies and most emerging and developing economies in the region benefit from legislation covering electronic transactions, consumer protection, data protection, and cybercrime, this legislation is practically nonexistent in Pacific island countries. Enacting appropriate legislative and regulatory mechanisms can lower legal barriers to e-commerce use, raise consumer confidence, and expand domestic and particularly cross-border transactions.

## 8.3 Policies to Manage the Transition and Reduce Inequality

Policies to harness digital dividends include revamping education to meet the demand for more flexible skill sets and lifelong learning, as well as new training, especially for the most adversely affected workers; reducing skill mismatches between workers and jobs; and addressing labor market and social challenges, including income redistribution and safety nets.

As automation intensifies, more workers will need to find new jobs, especially those who are less skilled. Rethinking education, particularly at secondary or lower levels, may have a far-reaching effect on managing the transition to the new age of automation. For instance, a stronger emphasis should be placed on promoting foundation skills, digital literacy, high-order thinking competencies, and social and emotional skills (OECD 2016). It is also imperative to provide training and retraining opportunities to help workers adapt and acquire skills that will be in demand. This should be preceded by the effort to more precisely identify emerging skills and examine how they can be translated into training programs.

As Korinek and Stiglitz (2018) showed, policies to soften the labor market impact of new technologies can make a difference in terms of improving welfare. The more willing society is to support the necessary transition and provide support to those who are left behind, the faster the pace of innovation that society can accommodate while still ensuring that the outcomes are welfare improvements, with all members of the society better off.

## 8.4 Digitalization of Finance

Given the widespread adoption of fintech, and the proliferation of different modes of delivery, there is a significant need for international collaboration to learn from and develop best practices. Fintech has implications for the role of market imperfections and cost structures in financial markets that will in turn have implications for financial stability and competition.

Better data are needed for monitoring emerging developments, and greater agility may be needed from regulators and supervisors given the rapid rise of various fintech products. This is particularly true in settings where regulation is unclear or outside traditional lines of reporting.

Meanwhile, promoting lower barriers to entry while maintaining a level playing field becomes a growing issue with the rising dominance of large firms. Regulations should allow for more competition and further reduce the costs of financial intermediation, while helping solve some problems of the current banking environment, such as the too-big-to-fail issue. In addition, regulation could encourage low leverage among new market participants from the beginning, which would allow for the sustainable growth of the industry and improve discipline, while addressing risks arising from anti-money laundering/combatting the financing of terrorism and cybersecurity threats. Harnessing digital dividends requires a strong cybersecurity framework.

## 8.5 Policies to Strengthen Public Finance

Policy actions can transform risks into opportunities. Digitalization also allows for an increased monitoring of business transactions that would otherwise be informal. This possibility of data collection is particularly evident in P2P platforms when they replace decentralized informal activities. Moreover, the development of P2P platforms can even present an opportunity for governments to pass legislation requiring the withholding of funds related to transactions. The withholding can be established for income, goods and services, or value-added taxes applicable to sellers. This withholding already seems straightforward for indirect taxes.

Better data sharing is possible with the increased adoption of digital technologies. The OECD and the G20 have established an automatic exchange of information of nonresident financial accounts. Other useful measures include the establishment of international registers of asset ownership and shareholders, which allows for taxation of capital income on a residence rather than a source basis. A combination of information on assets and capital incomes would allow for the introduction of dual income tax systems under which capital income and wealth would be linked under a single schedule, creating a synthetic capital income tax.

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