Digital Infrastructure

Overcoming the digital divide in China and the European Union

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Preface

About a year ago, a team of researchers from CEPS and Zhejiang University (ZJU) participated in the 2016 Think Week, organised by the Economic Policy Forum in Beijing. The event represented a unique occasion for think tankers, scholars and practitioners from across the globe to debate the digital economy and pathways for the global sustainable agenda. Participants emphasised the need to bridge the digital divide in order to reduce socio-economic disparities across and within countries.

In this context, CEPS and ZJU decided to team up and analyse the Chinese and EU experiences in order to draw lessons and devise a set of policy recommendations, especially suited for emerging countries. The project was selected by the Emerging Market Sustainability Dialogues (EMSD) – a network of change agents and decision-makers committed to jointly developing and implementing solutions for sustainable economic development in emerging economies – to receive financial and logistical support. This research adventure without frontiers would not have been possible without its generous support.

The initial cooperation between CEPS and ZJU led to the preparation of a policy brief on the topic, which was presented at the Think20 (T20) meeting held in Berlin in the spring of 2017 and published as a G20 Insights. Then, the research team decided to transform the brief into its current, more comprehensive form, which aims to guide policy-makers in pursuing the most effective strategies to ensure social and economic inclusion by narrowing the digital divide and reaping the full benefits of a fully-connected society. While leaving to the reader the task of assessing the quality of this final report, the research efforts leading to this publication per se offer irrefutable evidence of the internet's contribution to overcoming geographical distances, bridging cultural differences and initiating a fruitful process of mutual, global learning. This report does not pretend to offer the definitive word on this issue, as the EU and Chinese experiences teach us that the digital divide is a moving target. CEPS and ZJU wish, therefore, that this publication will inspire more collective research by international teams to progressively improve, expand and update its main findings.

Felice Simonelli
Research Fellow, CEPS
Brussels, November 2017

Executive Summary

The internet is becoming the backbone of our society and universally synonymous with digital infrastructure. Even though, conceptually, digital infrastructure is more comprehensive in that it also includes cellular infrastructure and satellite networks, the internet is undeniably one of the most fundamental and vital infrastructures around the world. Coupled with other digital technology such as personal computers (PC) and smartphones, these innovations have reshaped our daily lives and how we do business globally. According to the World Economic Forum (2014), each extra 10% of internet penetration can lead to a 1.2% increase in per capita GDP growth in emerging economies.

The 'digital divide' refers to the gap in terms of usage and access to digital infrastructure and services between individuals, households, businesses and geographic areas. It remains significantly wide for emerging economies and, more specifically, for certain population segments such as low-income and rural communities. Since 1995, when the internet was commercialised globally, an ongoing debate on how to close the digital divide has attracted global attention. The digital divide prevents citizens, in particular disadvantaged socio-economic groups, from harnessing the full benefits that digital technology can deliver. This will inevitably result in widening the income gap and triggering unbalanced economic development in the long run.

While both China and Europe demonstrated the importance of efforts made to reduce socio-economic and geographical disparities by providing network access to ever more citizens, it is nonetheless critical to stress that investing in physical access alone is insufficient to enhance inclusion in the information society. Fostering digital infrastructure in the most disadvantaged areas is key to supporting inclusiveness, but public authorities should also adopt a set of corollary policies to spur social and economic cohesion through innovations that enable disadvantaged regions to catch up with more developed urban areas.

In this study, we identify four major challenges in overcoming the digital divide in emerging economies: i) insufficient levels of development in digital infrastructure and services; ii) limited affordability of network services, devices and applications; iii) insufficient levels of basic and advanced digital skills to create or add value to the entire economy; and iv) too little coordinated effort to enhance social and economic cohesion.

The study reviews the literature on the digital divide in advanced and emerging economies and explains: i) how internet connectivity promotes economic and social inclusion, efficiency and innovation; ii) why physical access to the internet alone is insufficient to realise the full benefits stemming from the digital economy and society, and what other social conditions should be considered; and iii) how to further connect the unconnected population.

Ambitious measures must be implemented at the earliest possible time: maintaining the status quo while technology rapidly pervades every sector of the economy will critically widen disparities across nation-states and between the various socio-economic segments of the population within countries. Powerful leadership is therefore needed at both global and local levels, which requires more coordination among governments and local authorities to empower local communities (e.g. through multi-level governance mechanisms). Standards of accountability and transparency should apply at all levels of government to prevent corruption and provide guarantees to businesses, civil society groups and organisations that operate under public laws on the ground.

In concluding this study, we offer our policy recommendations and suggest: i) the formulation, at the international level, of general principles to overcome disparities between emerging and advanced economies; and ii) general policy guidelines a country should follow to bridge the digital divide and foster inclusiveness among its population.

At the International level, general principles should be set for emerging economies:

- Ensuring physical access to digital infrastructure is necessary but not sufficient; other complementary actions must be taken to support digital literacy.
- The focus should shift, both in resource allocation and policy agenda-setting, from "providing infrastructure and access" to "encouraging the usage of the existing infrastructure to create value," and also from "hardware" to "human-ware".
- Digital responsibility should also be advocated; in other words, the internet and ICTs should be used in a way to improve human life, economic prosperity, equality and inclusiveness.

At the individual country level, a government should elaborate policy guidelines and take the following actions to reduce socio-economic disparities.

- Governments should promote digital innovation and entrepreneurship, which in turn would create new markets, provide new employment opportunities and eventually improve living conditions.
- Governments should foster coordinated efforts, especially at the industry level, to create affordable technologies able to overcome the digital divide.
- Governments should adapt their educational systems to the changing labour market and support digital knowledge and skill training for everyone at an affordable price.

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1. Introduction

The 'digital divide' refers to the gap in usage of and access to digital infrastructure[1] and services between individuals, households, businesses and/or geographical areas. It remains significantly wide in both emerging and advanced economies and tends to affect specific population segments, especially low-income and rural communities, due to the lack of infrastructure, limited affordability of new technology and poor digital skills.

An emerging economy is defined as an economy with low to middle per capita income. This includes a wide range of countries, varying in land mass and size of population, from China to Tunisia (Heakal, 2017). In emerging economies, especially in rural or remote areas, a recent study shows that more than four billion people remain unconnected to the internet (Facebook, 2016). In addition, there are gaps in high-speed internet access that have important effects on media access, such as streaming video.

Although the digital divide is much more common and critical in emerging economies, advanced economies also face this challenge. In advanced economies such as the European Union (EU), where connectivity – including high-speed internet – has significantly improved over the past few years, the actual levels and pace of development are still widely uneven and prove to be insufficient to address future needs (Rubio et al., 2016; Renda, 2016b).

Against this background, section 2 discusses the challenges faced by both advanced and emerging economies in tackling the digital divide as well as the potential benefits to be gained from bridging the gaps; sections 3 and 4 detail the existing digital gaps and the actions put in place to address the digital divide, respectively, in China and the EU; finally, section 5 provides concluding remarks. A set of policy recommendations derived from the analysis conducted for this paper is presented in section 6.

[1] In this study, we use the terms 'digital infrastructure' and 'digital technology' in a broad sense. Digital infrastructure is the fundamental underlying structures – material (e.g. IT equipment) or immaterial/virtual (e.g. skills, spectrum) – that connect software, content, data and devices to allow distributed data processing, storage, transmission and sharing. Digital technology refers to both hardware and software as well as information and communications technology (ICT) enabling data processing, storage, transmission and distribution.

2. Overcoming the digital divide: Challenges and benefits

This section of the paper identifies and discusses the challenges that both advanced and emerging economies are facing to overcome the digital divide as well as the potential benefits stemming from a fully connected society. This serves as a basis to analyse the Chinese and European experience in bridging the digital divide.

2.1 Challenges

Four major challenges are identified to overcome the digital divide:

- Insufficient development of digital infrastructure and services. This challenge underlines the urgent need to speed up the roll-out of network infrastructures and to support the development of a vibrant digital economy through more accessible Information and Communications Technology (ICT) devices, software and applications. Recent studies show how the internet has transformed trading capability, thus enabling market access and faster cross-border exchange of services that were once considered non-tradable. While traditional ICT services are spurred by the progressive digitalisation of the economy, a series of ICT-enabled services are significantly growing as empowered by the emergence of new intermediary platforms and innovative services. These include services enabled and delivered electronically through ICT networks (Grimm, 2016). Chinese e-commerce activity (Business to Consumers; B2C) has been booming over the last few years, to reach around $750 billion in consumer spending in 2016 (BCG, 2017). China leads the way, benefiting from the largest pool of e-shoppers worldwide – estimated at nearly 350 million digital buyers, versus nearly 275 million Europeans in 2015 (E-commerce Foundation, 2016; Hamilton, 2017). Nonetheless, as more and more individuals are gaining access to new services, large segments of the population remain excluded from the 'new' economy. Bridging the digital divide requires providing adequate infrastructure and services, particularly in disadvantaged areas of both advanced and emerging economies. The insufficient development in digital infrastructure and services is rooted in low levels of investment in past years, due to both limited financial resources as well as missing political will. Nonetheless, this trend has been recently reversed in some emerging economies. For instance, over the past decades, Chinese investments in fixed and mobile infrastructures have significantly increased from around €30 billion in 2010 (IDATE, 2015) to reach approximately €58 billion in 2015 (DBS Group Research, 2017). This was clearly stated in China's 12th Five-Year Plan, as the way forward to develop strategic emerging sectors, but also to "reorient growth and implement short and long-term efforts toward balance and sustainability" (Prasad, 2011).
- Limited affordability in network services, devices and applications. This second challenge is due to the high costs of acquiring the necessary devices and accessing services. A recent study (Facebook, 2016) shows that nearly two billion people do not have a mobile phone, which is the easiest way to get connected to the internet in emerging economies. Therefore, public actions are needed to bridge the digital divide, which also requires making ICT devices

and internet access more affordable for the most remote and disadvantaged population segments.

- Lack of digital skills to create or add value. This challenge means that internet users, especially in emerging economies, cannot create added value even when they have access to the internet, ICT devices and applications. Cullen (2001) points out that although conditions to ensure physical access to the internet are essential, they are not sufficient alone to achieve the 'full benefits' of digital technology. The essential lesson of this challenge is that, without proper education and skill training, the potential of digital technology cannot be fully tapped. Therefore, digital knowledge and skills are key to enable citizens and companies to use the internet and foster a deeper integration of digital technologies into business and public services. Stronger attention should be drawn to the necessary conditions to develop the necessary knowledge and shared competence to achieve a more inclusive digital economy.
- Few coordinated efforts to foster social and economic integration. This challenge relies on the assumption that digital technology is neutral. Its potential cannot be tapped without coordinated efforts from different stakeholders: governments, industry, civil society organisations and academics. In essence, the internet is a powerful tool that can be leveraged to deliver positive or negative outcomes; it all depends on the way it is harnessed. Interestingly, negative impacts are most likely to happen in emerging economies. In the absence of coordinated efforts, the opportunity to leverage new technologies to benefit society as a whole is missed. Conversely, negative impacts may accrue:
    - When the internet delivers scale economies for firms but the business environment inhibits competition, the outcome could be an excessive concentration of market power and the rise of monopolies, preventing future innovation.
    - When the internet automates many tasks but workers do not possess the skills that the new technology requires, the outcome will be greater inequality and unemployment, rather than greater efficiency and job opportunities.
    - When the internet helps overcome information barriers that impede service delivery but governments remain unaccountable, the outcome will be greater surveillance and control, rather than greater empowerment and inclusion.

Closing the digital divide may play a critical role in the development of the advanced and emerging economies, as it can improve the social and economic cohesion, favour social mobility, support innovation and boost economic growth. Against this background, as will be further discussed below, G20 policymakers and other leaders should coordinate their efforts and adopt innovative solutions to tackle all these challenges and achieve a sustainable and inclusive growth throughout the globe, in the digital era.

2.2 Benefits

The ultimate goal of overcoming the digital divide is to inclusively allow all members of society to have equal opportunity to harness and benefit from advances in digital technology. The potential benefits stemming from a fully connected society can be summarised as follows:

- The ICT and internet connectivity promotes efficiency. First, the decline in the price of digital technologies led businesses and governments to replace traditional factors of production such as labour and non-ICT capital with ICT capital and to automate some of their activities. Second, digital technologies strengthen the factors that are not substituted and make them even more productive. By optimising the production process and increasing the productivity of existing factors, the internet largely increases economic efficiency across firms, workers and governments.
- The ICT and internet connectivity promotes social and economic inclusiveness. By cutting down the costs for information sharing, transmission and acquiring and increasing transparency, the development of ICT and the internet largely reduces the inefficiency caused by the lack of information or information asymmetry, and makes new transactions possible. Nowadays, mobile technologies and all forms of e-commerce, such as Business to Business (B2B), B2C and Consumers to Consumers (C2C), the sharing economy, online reputation mechanisms and digital identification systems all help to overcome information barriers. While ICT and the internet make the market more efficient, one of the biggest benefits seems to be their market-creation effects: expanding trade, creating jobs and increasing access to public services—and thus promoting social and economic inclusion. The concept of 'market creation' can very well be explained by the following paragraph:

  > When most industries emerge, their products and services are so costly and inaccessible that only the wealthy can buy and use them. Market-creating innovations transform such offerings into products and services that are cheap enough and accessible enough to reach an entirely new population of customers. The Model T Ford, the personal computer, the smartphone, and online equity trading are examples of market-creating innovations. Because many more people can buy such products, the innovators need to hire more people to make, distribute, and service them (Mezue, Christensen & van Bever, 2015).

- Developing ICTs and IP (internet protocol) connectivity promote the 'new economy'. The rapid uptake of ICTs, including the internet, also leads to a growing 'new economy', in which entrepreneurs and innovators are encouraged to constantly improve existing functioning systems and where transactions are executed in a more efficient fashion. By automating certain tasks and features, and by lowering transaction costs, it enables almost frictionless communication and collaboration. As a result, the internet can support new delivery models, expand trade, encourage collective action and accelerate innovation.

Table 1 summarises the potential benefits that can be achieved by bridging the digital divide in both advanced and emerging economies.

Table 1. The benefits of digital technologies for business, people and governments

	Efficiency	Social and Economic Inclusion	New Economy
Business	Capital utilisation	Trade/market creation	Competition
People	Labour productivity	Job opportunities	Consumer welfare
Governments	Public service	Citizen participation	Foster innovations

Source: World Bank (2016).

3. Digital infrastructure in China

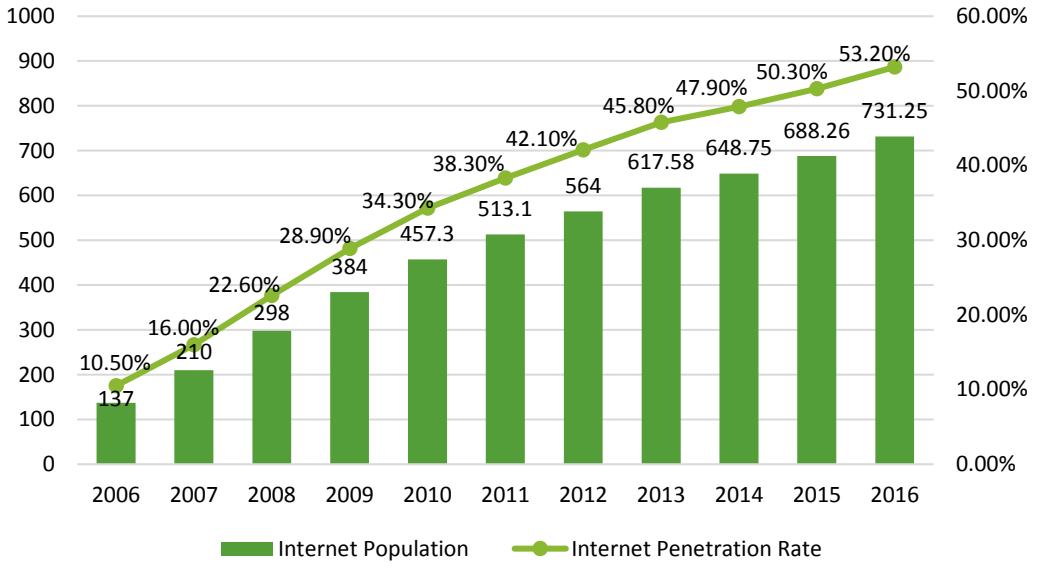
This section covers the Chinese practice in expanding digital infrastructures and tackling the digital divide. First, the characteristics of the digital development in China are discussed; then the state and evolution of the digital divide in China are reviewed; then China's national policies to enhance and integrate inclusion into the Information Society are explained; finally, the latest efforts of the Chinese government in poverty elimination are described and illustrated. Taobao villages are described as an illustration in successfully expanding digital infrastructure and enhancing its citizen's digital skills to add value to the whole Chinese economy. By bringing e-commerce practices to villagers and farmers, the Chinese government aims not only to teach digital skills and knowledge to its citizens but also to show them how to develop new products and services to help local communities to grow.

3.1 The characteristics of the digital development in China

3.1.1 The continuous progress in internet connectivity and usage

As of December 2016, the total internet users in China stood at 731 million. In the same year, the internet penetration rate reached 53.2%, which was 3.1% above the global average rate and 7.6% higher than that of Asia as a whole (Figure 1). From 2015 to 2016, there were almost 43 million new internet users, implying a 6.2% annual growth. This also means, however, that 46.8% of the remaining Chinese population (640 million individuals) has no internet access.

Figure 1. Internet access by the Chinese population (millions) and penetration rates



Data source: CNNIC (2016).

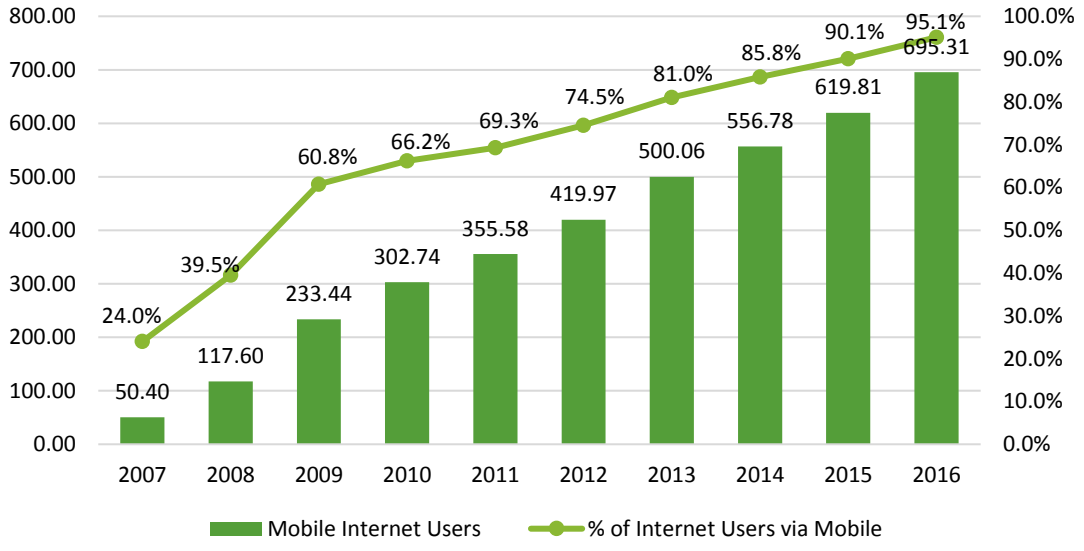
More importantly, the internet penetration is uneven across regions in China. According to the China Internet Network Information Centre (CNNIC) Survey (2016), Beijing has the highest internet penetration rate in China, reaching 74.1%. The top five regions also include Shanghai, Guangdong, Fujian and Zhejiang.

3.1.2 Rising mobile penetration rates and growing mobile services

As of December 2016, the number of mobile internet users reached 695 million, indicating an increase of 75.5 million users from 2015. Among all internet users, the share of those who surf the internet via mobile phones raised from 90.1% to 95.1%, i.e. an annual growth rate of 5%. Transactions conducted via mobile phones contributed to more than 55% of the market total, and are expected to rise continuously. The volume of mobile payment in China grew rapidly by 31.2%, reaching a total of RMB 469 million in 2016, while the percentage of internet users relying on mobile payment increased from 57.7% to 67.5%. The development of mobile internet technology has triggered a boom in sharing economy platforms, such as online taxi-calling services and bicycle sharing.

Mobile internet penetration rates, however, are highly uneven across China. While Beijing ranks first with 129.9%,[2] followed by Shanghai, the top five regions also include Zhejiang Province, Guangdong Province and the Ningxia Hui Autonomous Region. According to the statistics released by the Ministry of Industry and Information Technology of the People's Republic of China, 95.5 mobile phones were owned by every 100 people in China, and 55.5 computers were owned by every 100 families in 2015. Generally, the market for terminal devices[3] in the eastern coastal provinces and cities such as Beijing, Shanghai and Guangdong is almost saturated, while the terminal penetration rate in the middle and western regions is rising rapidly.

Figure 2. Mobile internet adoption in China (million)



Data source: CNNIC (2016).

[2] The mobile internet penetration rate is computed as the ratio of total number of mobile internet users to the total population of the city. But since one user could own more than one SIM card, the mobile penetration rate could surpass 100%.

[3] Terminal devices include PCs, mobile phone, tablets, etc.

3.1.3 Significant improvement in download speed and broadband pricing

In recent years, improvements in internet speed and cost reduction have been achieved thanks to increasing investment in high-speed broadband networks, the joint construction and sharing of telecommunications infrastructures, the increasing capacity of backbone networks and interconnection capacity between networks. According to Broadband Development Alliance (2015), in the fourth quarter of 2015, the fixed broadband network download speed in China reached 8.34Mbit/s. This was the first time the broadband download speed in China exceeded 8Mbit/s, nearly twice the download speed in the same period in 2014, which was 4.25Mbit/s. As for the broadband speed in provinces and cities, Shanghai, Beijing and Tianjin have download speeds exceeding 10Mbit/s. Meanwhile, the cost of internet use has been decreasing as a result of the government's efforts to offer discounts on data streaming and off-peak pricing.

3.1.4 Explosive growth in internet companies and market value

The number of internet companies in China has been growing dramatically. The internet has become the 'launch pad' for the economic development of China, and internet companies are making a major contribution to the country's economic growth. According to the statistics released by State Administration for Industry and Commerce of China, newly registered enterprises engaged in information transmission, software and IT services have more than tripled, from 74,141 in 2013 to 240,413 in 2015. The total number of newly registered enterprises in Guangdong Province, Shandong Province, Zhejiang Province, Jiangsu Province, Sichuan Province, Henan Province and Shanghai exceeded 10,000. According to the statistics released by the China Securities Regulatory Commission in 2015, the market value of internet companies in China increased from RMB 1.5 trillion at the end of 2014 to RMB 3.2 trillion at the end of 2015. Meanwhile, the market value of internet companies in Beijing reached RMB 1.1 trillion, accounting for one-third of the total market value of internet companies in China. In addition, in 2015, China's four leading internet companies – Alibaba, Tencent, Baidu and JD – ranked among the top-10 companies worldwide in terms of market value, and 12 internet companies in China were listed in the world's top-30 in terms of market value.

3.1.5 Innovative research and development in the ICTs

China has made significant progress in ICT innovation. According to data released in 2015 by the World Intellectual Property Organization(WIPO),[4] China has become the first middle-income economy listed in the top-25 in terms of global innovation index and has risen to no. 17 in terms of innovation quality. Thanks to the joint efforts by the government, enterprises and scientific research institutes, China continued to increase its expenditure in the ICT innovation field to ensure long-term progress in innovation.

Moreover, at the country level, almost 30,000 patent applications were submitted in 2015 in China, showing a rise of 17% with an overall upward trend, ranking no. 3 in the world in terms of total applications. In the same year, about 57,000 applications were submitted in the US;

[4] See http://www.wipo.int/portal/en/index.html

although still ranked first, the US showed an annual decline of 6.7%. Japan came in in second place, with the number of patent applications increasing by 4.4% to reach about 44,000. At the enterprise level, Huawei Technology, a large Chinese communications equipment manufacturer, applied for almost 4,000 patents, about 500 more compared to 2014. Interestingly, Huawei ranked first among the global enterprises for the second year in a row. With regard to the composition of applications, patents in the ICT field accounted for about 40% of all patents submitted, according to the Patent Cooperation Treaty. Among these, China's applications accounted for 62.5% of the total in the field, taking a leading position among large economies worldwide.[5]

3.1.6 Employment in the digital economy era

The rapid development of China's digital economy has boosted economic growth and efficiency, and contributed to regional development. According to the estimation of Tencent Research Institute (2017b), a 1% growth in the digital economy in China will lead to an increase of the national GDP by approximately RMB 140.6 billion. Being an important driver for GDP growth, the digital economy has also become the new engine driving employment. It promotes the development of ICT-enabling services and industries, which broadly boosts employment. The result is a decreasing overall unemployment rate, especially in regions where the digital economy is well developed. As estimated by the Tencent Research Institute (2017b), each 1% increase in the size of provincial internet-based activity in the digital economy might lead to a drop in the urban unemployment rate by approximately 0.02%. More specifically, this corresponded to an increase in the urban employment population of approximately 17,300 in 2016. China recorded an urban unemployment rate in 2016 slightly above 4%. Recent developments in the digital economy led the urban unemployment rate to drop by about 0.10%, which led to an increase of almost 3 million new jobs. This accounts for more than 21% in the total newly employed workers.

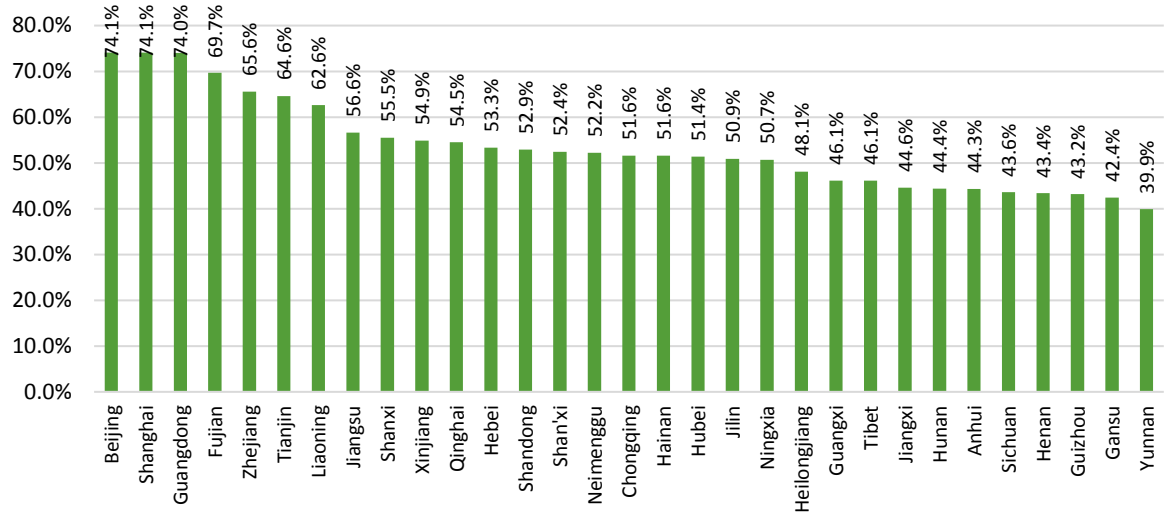
3.2 The state and evolution of the digital divide in China

3.2.1 Overview of the Chinese regional digital divide

Due to the wide differences in economic development levels and internet infrastructure deployment, the digital divide across China is particularly salient (Figure 3). In the more developed regions such as Beijing and Shanghai, the internet penetration rate exceeds 70%, while in some underdeveloped provinces in the western part of China, the penetration rate tends to be much lower. For example, the rate in Yunnan Province is below 40%. There is a positive relationship between a region's digital infrastructure development intensity and its GDP per capita. In provinces with higher GDP per capita, the digital infrastructure development intensity is also higher than in provinces with lower GDP per capita (Figure 4).

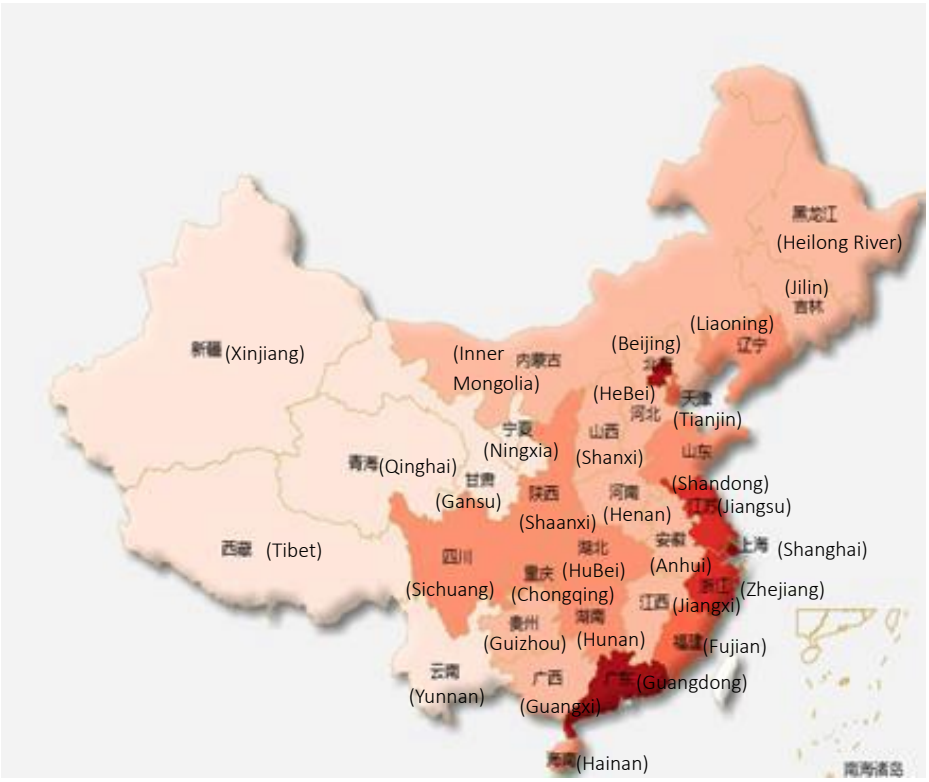
[5] See http://www.wipo.int/portal/en/index.htmlng large economies worldwide.

Figure 3. Internet penetration rates in China, by province, 2016



Data source: CNNIC (2016).

Figure 4. Informatisation development levels of Chinese provinces, 2016

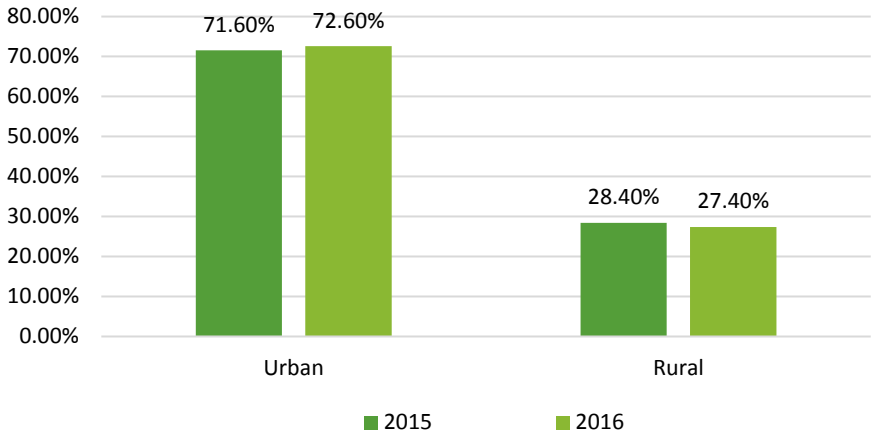


Source: State Informatisation Development Assessment Report (CNNIC, 2016).

3.2.2 The widening digital disparities between urban and rural areas

As of December 2016, the rural population using the Internet was around 201 million, revealing an increase of 5.26 million and a growth rate of 2.7% compared with the previous year, and accounting for 27.4% of the total population of internet users. The population of urban internet users was 531 million, indicating an increase of 37.72 million compared with the population at the end of 2015 and a growth rate of 7.7%, accounting for 72.6% of the total internet users (Figure 5).

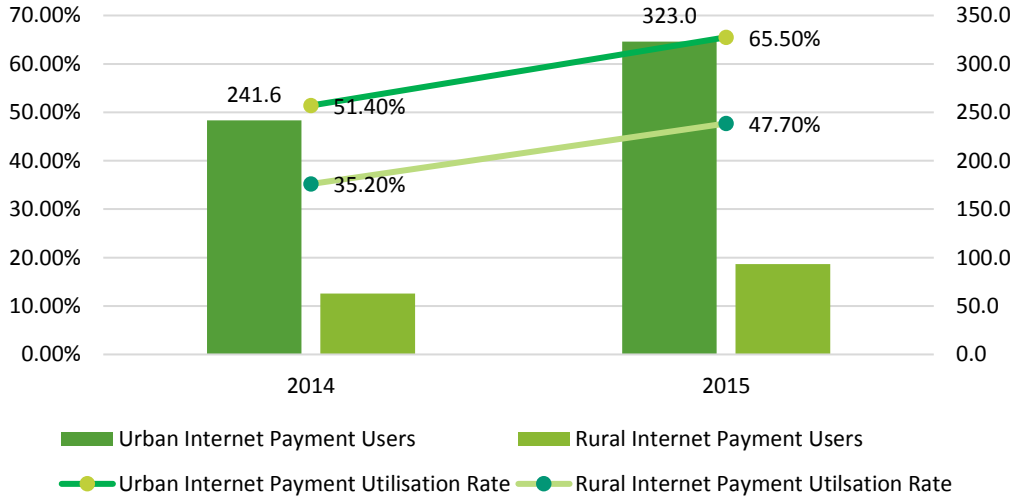
Figure 5 Percentage of internet users from rural and urban areas



Data source: CNNIC (2016).

The number of rural internet users in China continues to grow steadily, but the gap between the urban and rural internet penetration rates remains critical. As of December 2016, the internet penetration rate in urban areas was 69.1%, while in rural areas this rate was 33.1%. The gap between urban areas and rural areas has expanded from 34.2% in 2015 to 36% in 2016. Interestingly, the gap between rural and urban areas in the use of basic applications, such as instant messaging and network entertainment, was rather small, but the gap in the use of more advanced services, such as online shopping, payment and travel reservations, exceeded 20%. Figure 6 shows the gap between the rural and the urban population in the use of the Internet to make payments in 2014 and 2015.

Figure 6 Disparities between rural and the urban populations in China in their use of the internet to make payments, 2014 and 2015

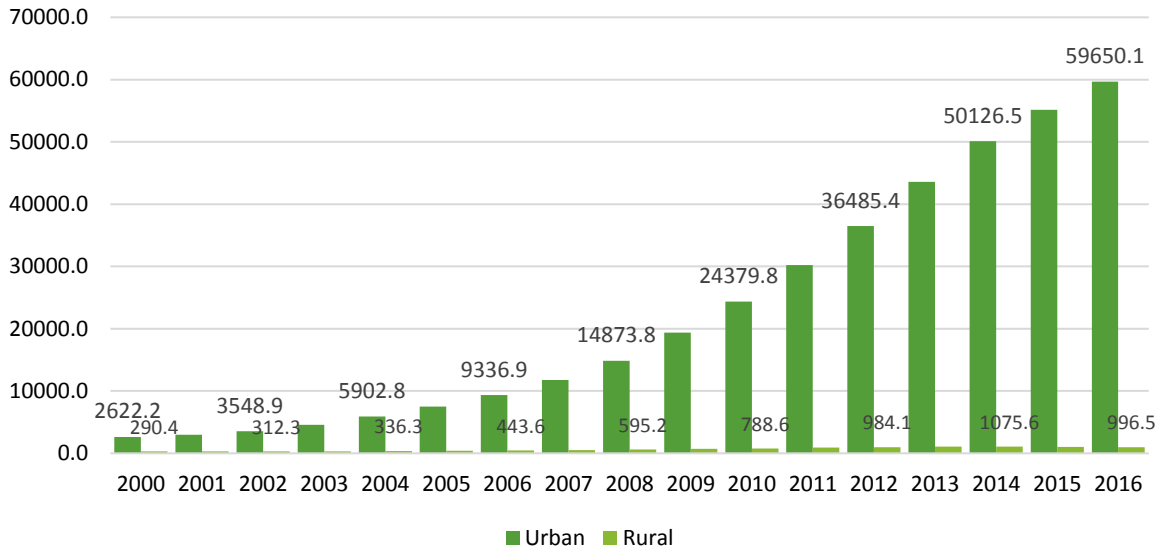


Notes: The urban population in China is shown in dark green and the rural population is shown in light green. The left-hand column shows utilisation rate (%) and the right-hand column shows the absolute number of users in millions.

Data source: 2015 Rural Internet Development Report (CNNIC, 2015).

Against this background, it is worth stressing that the total amounts invested in fixed infrastructure in urban areas are also far higher than those in rural areas. This discrepancy contributes to the widening gap in infrastructure development across the country and further enlarges the digital divide between poorer rural areas and more dynamic urban hubs (Figure 7).

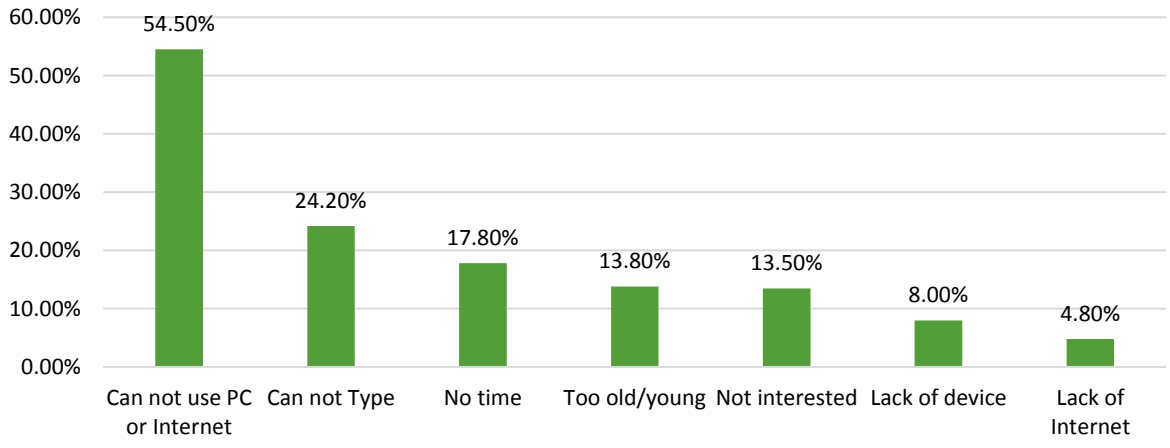
Figure 7. Total fixed asset investment in urban and rural areas (billions RMB)



Data source: National Bureau of Statistics of China.

A large portion of the rural population includes non-internet users. As of December 2016, 642 million Chinese citizens had never used the internet, of whom 39.9% were urban dwellers and 60.1% were rural dwellers. This again demonstrates a salient disparity between urban and rural areas. Influenced by factors such as low income and education level, the weak demand for the internet in rural areas is a key challenge for public authorities. According to CNNIC Survey (2016), the large number of non-internet users and the lack of digital skills constitute the major obstacles to the development of the Chinese digital economy and society. Figure 8 shows the factors affecting the rural non-internet users, ordered by the percentage of users surveyed.

Figure 8. Factors affecting the use of internet in rural areas

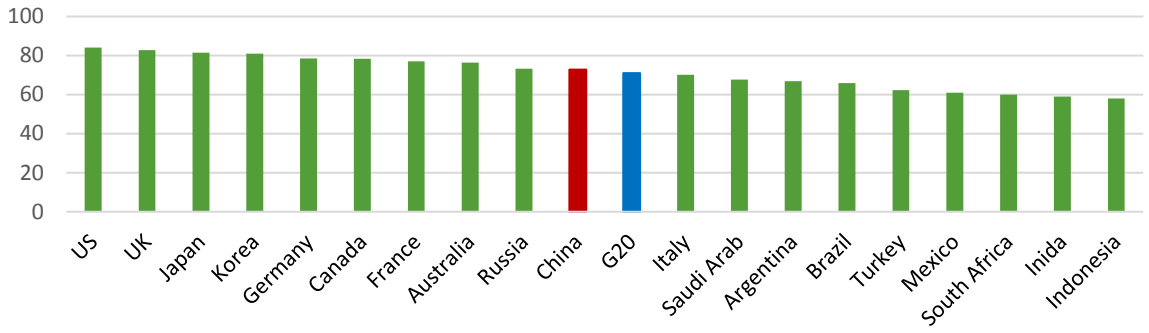


Data source: China Internet Network Information Centre (CNNIC) Survey, 2016.

Box 1. China National Informatisation Progress

In 2016, the China Internet Network Information Centre (CNNIC) released the so-called National Informatisation Index of China. This index assesses the overall development in the information society across the country and compares it with other countries, based on indicators such as the network infrastructure readiness, industrial and technical innovation, the levels of return on investment and other aspects relating to network security and sustainability. The result showed that four countries of the Group 20 (G20) were among the world's top ranking, while China (No. 25) outperformed the average level of G20 in 'informatisation' development.

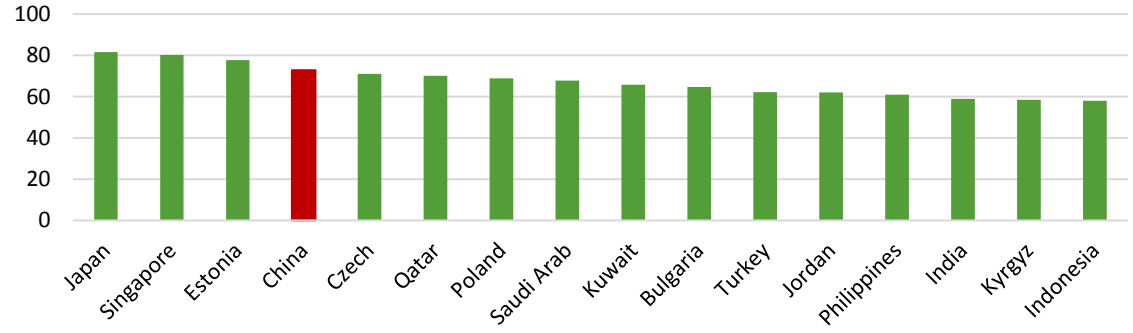
Figure 9. Informatisation index of G20 countries



Data source: State Informatisation Development Assessment Report (2016).

The imbalance in the development of an open and inclusive information society among countries along the 'One Belt and One Road'" route is also apparent. For instance, Korea, Israel and Singapore ranked in the top-10 with high informatisation development levels. Nonetheless, a large number of Belt and Road countries are characterised by a very limited IT development level.

Figure 10. Informatisation index of 'One Belt and One Road' countries



Data source: State Informatisation Development Assessment Report (2016).

3.3 National policies to integrate inclusion into the information society

The Chinese Government has put forward a set of measures and policies to promote the development of a vibrant and inclusive digital economy and society in China. These include actions to support the roll-out of digital infrastructure, especially in remote and disadvantaged rural areas, to spur innovation and support the flourishing array of digital services, as well as to encourage individuals to learn and harness digital competencies through education and skill training schemes.

3.3.1 Governmental projects to develop digital infrastructure

The 'Golden Agriculture' Project

In December 1994, the 'Golden Agriculture' project was introduced and approved by the Chinese government. Its general purpose was to accelerate and promote digitalisation in agricultural and rural areas and establish an "Agriculture Integrated Management and Service Information System". It originally had four main objectives: i) to control and manage network and information exchange service, including information exchange and sharing with other agriculture-related systems; ii) to establish and maintain a database for national agricultural levels and its application system; iii) to formulate unified standards and specifications for information collection and publication with coordinated efforts and to provide guidance and management for regional and industrial centres; and iv) to organise a modern agricultural information service alongside the development and usage of various computer application systems, such as an expert system, a geographical information system and a satellite remote sensing information system. Key players of the Golden Agriculture project included the most important national agricultural counties, some of the key large- and medium-sized agricultural product markets, and the main scientific topics in research and education units, also involving agricultural associations and societies of China.

The extension of radio and TV broadcasting coverage

In 2004, the Ministry of Information Industry issued a "Notice on Implementing a Pilot Work for Extending Radio and TV Broadcasting Coverage to Every Village Project in Some Provinces" and put forward the "General Service for Rural Communication-Implementing Plan for Extending Radio and TV Broadcasting Coverage to Every Village Project" to start bridging the gap between urban and rural areas. This was part of a national systematic project involving the construction of highways, electric power, domestic water systems and drinking water supply, telephone networks, cable TV networks and internet, etc. From 2003 to 2004, the Chinese government had invested a total of RMB 87 billion to provide landlines for 204,000 villages and towns as to convey broadband network for 111,000 villages and towns. The coverage exceeded 90% of the villages and towns in the country. And by the end of 2005, more than 95% of the administrative villages in the country had landlines available.

The 'Three in One' Project

In 2005, the Ministry of Agriculture piloted the so-called 'Three in One' project in 56 rural areas, aiming to ensure access to three information services, i.e. telephone, the internet and TV, by promoting the widespread of telephones, computers and televisions. The "Three in One" project mainly focused on the following aspects: i) collecting and publishing information via the internet and providing information resource for telephone audio system and TV program production; ii) providing audio consultation service between farmers and experts via telephone audio system; and iii) producing and broadcasting TV programmes focusing on topics of common interest to enhance information service penetration rates. By 2009, the Ministry of

Agriculture had built up 7 province-level, 78 city-level and 324 county-level agriculture information service platforms, covering 1/3 of the farmers in China, bringing more than 3 billion RMB in profits.

The Information Service project

In 2006, the Ministry of Commerce launched the "New Village Commercial Information Service System" to explore new markets for consumer goods in rural areas, strengthening logistic systems and market establishment, as well as to widen the coverage of commercial business services to rural areas. The Information Service project is an important measure adopted by the Ministry of Commerce for serving remote farmers and agricultural areas. In a nutshell, the system provides information on agricultural products, purchases and sales, so farmers can grasp the market conditions and prices in a timely manner, in order for them to price the products rationally and therefore reach higher incomes.

The 12th Five-Year Plan for Informatisation Development of Agriculture and Rural Area in China

In 2011, the Ministry of Agriculture initiated the 12th Five-Year Plan for Informatisation Development of Agriculture and Rural Areas in China. The Plan proposed that by 2015 the overall informatisation level in farming and rural areas should have been increased from 20% to 35%. The Plan had five major missions: i) to consolidate the infrastructure for rural and agricultural informatisation; ii) to accelerate the pace of equipping modern agriculture with IT, such as in planting and breeding industries; iii) to jump-start agricultural industrialisation, including to improve the informatisation of agricultural enterprises, demonstrating informatisation for farming specialised cooperatives, accelerating the progress in informatisation, for instance in wholesale markets for agricultural products and reinforcing efforts in developing e-commerce in agriculture; iv) to upgrade the administration for agricultural governmental affairs, and more specifically to promote the informatisation of agricultural resource management; and finally v) to break new ground in agricultural information services, including creating an agricultural-integrated information service platform that improves the overall information service systems.

The 12th Five-Year Plan for Broadband Network Infrastructures

In May 2012, the Ministry of Industry and Information Technology initiated another 12th Five-Year Plan for Broadband Network Infrastructures. The Plan stated that, by the end of the five-year period, a preliminary version of integrated, ubiquitous, secure and sustainable broadband network infrastructures should have been established. More specifically, this Plan proposed that "*optical fibres should be accessible in buildings and households located in urban areas, and broadband should be accessible in farming areas and remote villages*". Indeed, the purpose of this Plan was to catch up with developed countries in broadband development, as well as to considerably reduce the gaps between remote areas and the Chinese Eastern cities that are much more advanced. During the 12th Five-Year plan period, the broadband network infrastructures had been largely improved, and by 2015, the national internet penetration rate reached 48.8%.

The 13th Five-Year Plan for Informatisation of Agriculture and Rural Areas

In September 2016, the Ministry of Agriculture formally initiated the 13th Five-Year Plan for Informatisation of Agriculture and Rural Areas in China, and proposed the general objective of modernising agriculture and rural areas over a five-year period: by 2020, considerable progress should be achieved in the development of "internet Plus", [6] modern agriculture and informatisation levels in farming and rural areas. Hence, IT should be intensively integrated into agricultural production, operation, management and services, and the informatisation should become the leading force to innovatively drive the development of agriculture modernisation.

'Broadband China' strategy

In August 2013, the State Council of China released the strategic plan for 'Broadband China' to clarify the goals and paths forward for deploying broadband over the coming eight years. This landmark governmental plan shows that for the first time a national broadband strategy was being enacted, meaning that broadband was considered a strategic public infrastructure at the national level.

The strategy involves two major milestones:

By 2015, public authorities should support the deployment of a fully-fledged infrastructure for next-generation networks, able to boost economic and social development nation-wide. This includes providing access to optical fibre to all buildings and households in urban areas as well as to deliver broadband access to towns and villages in rural areas. The targets for fixed broadband penetration is to reach 50% of Chinese households, with the roll-out of the third-generation mobile communication and its Long-Term Evolution technology (3G/LTE) reaching 32.5% of coverage. Besides, the penetration rate in all administrative villages (wired or wireless access) should reach 95%. Broadband access would be generally provided in public organisations such as schools, libraries and hospitals. Broadband access capability in urban and rural families should range between 4 Mbps and 20 Mbps depending on the location, and reach up to 100 Mbps in some developed cities. The plan favours the rapid roll-out of mobile internet while stressing the urgent need to enhance network and information security levels.

By 2020, most of the disparities in the deployment of broadband network infrastructure between China and other advanced economies must be overcome, and citizens should fully benefit from the economic growth, convenient services and opportunities brought by the broadband connectivity. Fixed broadband network would fully cover urban and rural areas encompassing up to 70% of Chinese households, while the penetration rate for 3G/LTE must be in the region of 85%. The broadband penetration rate in administrative villages must exceed

[6] internet Plus, similar to Information Superhighway and Industry 4.0, is proposed by China's Prime Minister Li Keqiang in his Government Work Report on March 5, 2015, so as to keep pace with the Information Trend. Internet plus refers to the application of the internet and other information technology in conventional industries. It is an incomplete equation where various internets (mobile internet, cloud computing, big data or internet of Things) can be added to other fields, fostering new industries and business development in China.

98%. Regarding capacity and speed, broadband for urban and rural households should respectively reach 50 Mbps and 12 Mbps, or even up to one Gbps in some residential city areas. One of the targets also envisages that technological innovation and industrial competitiveness must meet leading international standards, while a robust network and information security system will be fully established.

Instructions on active promotion of "Internet plus" action by the State Council

In July 2015, the State Council initiated the "Instructions on Active Promotion of 'Internet plus' Action". According to such Instructions, by 2018, the integrative development between the internet and all economic and social sectors in China will be further strengthened. The internet will become a major driver for economic growth based on new business models, e.g. data-driven innovations, thus spurring entrepreneurship and innovation. These technologies should also improve public services and public administration as a whole; therefore, delivering efficiency gains to the entire economy. By 2025, the internet-based, intelligent service-oriented and collaborative industrial ecosystem of the 'Internet plus' will be generally completed. The 'Internet plus' business model will preliminarily shape new economic patterns and development to become the major driving force of the economy.

Outline of National Informatisation Development Strategy

In July 2016, the General Office of the Central Committee of the Communist Party of China and General Office of the State Council issued the "Outline of National Informatisation Development Strategy". This strategy envisages that, in 2020, the penetration rate for fixed broadband must reach an intermediate level of development, while the third-generation mobile communication (3G) and the fourth-generation mobile communication (4G) must cover the urban and rural areas. Also, technical R&D and standards of the fifth-generation mobile communication (5G) must be developed to identify critical breakthroughs. Total consumption in information and e-commerce transactions is expected to reach RMB 6 trillion and RMB 38 trillion respectively.

The gateway bandwidth of the internet between China and other countries will reach 20 Tbps to support the 'Belt and Road' countries' network interconnection. China will build the China-ASEAN Information Port, and initially establish the online Silk Road to significantly enhance its international competitiveness in ICT products and services. The strategy also sets an ambitious objective regarding the development of future technologies. By 2025, a new generation of ICTs must be developed in time while the penetration rate for fixed broadband should meet the level of the most advanced countries in digitalisation. Likewise, mobile communication networks must seamlessly cover the whole territory. Total information consumption and the e-commerce turnover is expected to achieve RMB 12 trillion and RMB 67 trillion, respectively.

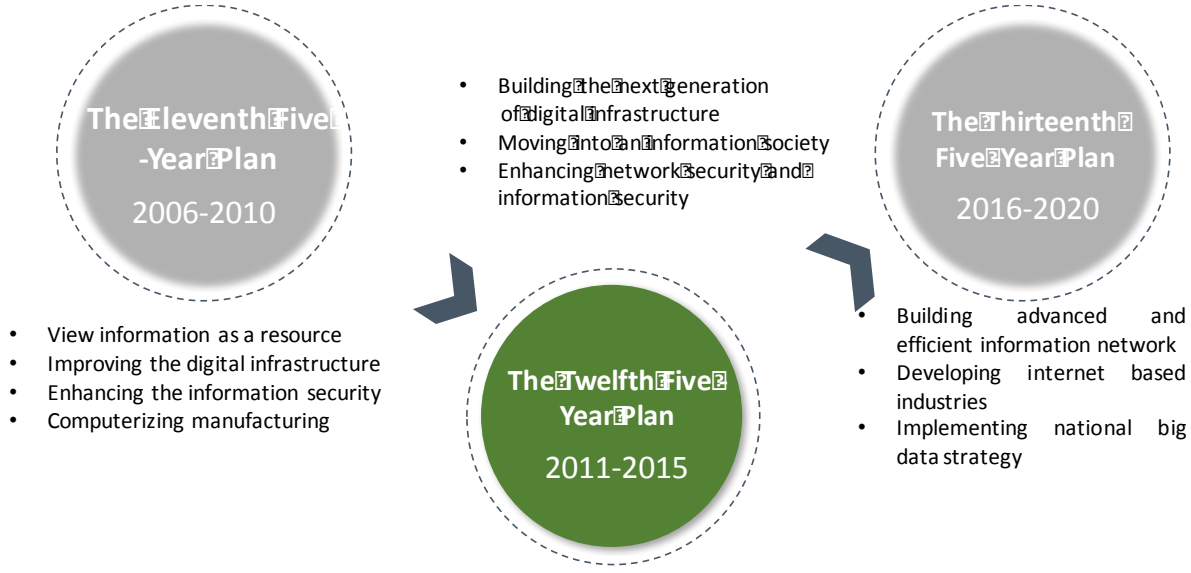
The '13th Five-Year' Plan for National Informatisation

In December 2016, the State Council issued the so-called National Informatisation Plan for the 13th Five-Year Plan. The Plan proposed six major priorities, including ushering innovation, promoting a balanced and coordinated development of digital technologies, ensuring a

sustainable and low carbon economy, promoting openness and cooperation, as well as collaboration and best-practising, and mitigating security risks. The Plan also confirmed 12 prioritised actions, including the forward-looking deployment of a next-generation information network technology, the construction and application of Navigation Satellite System, the construction of cutting-edge applications, the sharing and opening of data resources, the so-called Internet + government affairs service, the "informatisation for beautiful China", the internet poverty alleviation, the construction of smart cities, the construction of the 'online Silk Road', and a prospering internet culture, as well as the facilitation of online education schemes, and finally, the development of e-Health services in China. The plan also announced policy measures and regulations to revamp legal regimes and mechanisms in specific sectors, thus supporting innovation, encouraging investment and financing channels, facilitating access to finance and providing fiscal support for entrepreneurs, and making efforts in building dynamic working teams and propitious ecosystems.

Figure 11 below illustrates the typical path forward for the strategic plans, how they should develop and articulate over time. It is worth stressing that the role of government in overcoming the digital divide is progressively more limited.

Figure 11. Successive strategic plans to support digital infrastructure



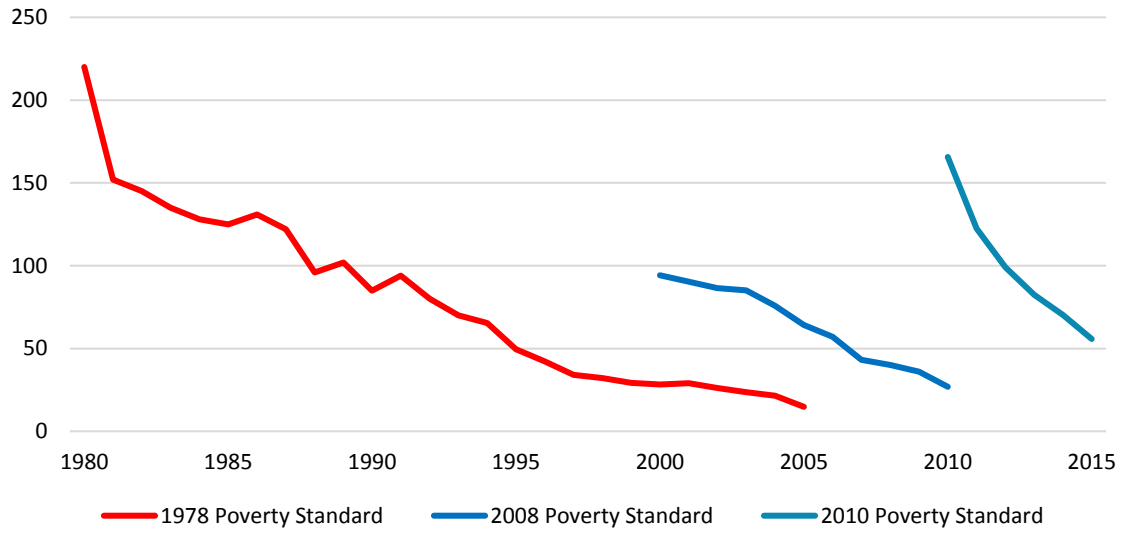
Source: Authors' own elaboration.

3.4 Ultimate governmental goal: Poverty alleviation

Over the past 30 years, the large economic reform has brought about the rapid growth of China's economy. According to the National Bureau of Statistics of China, China's annual GDP growth averaged at 9.58% from 1979 to 2016. Back to 1978, China was one of the poorest countries in the world. At that time, China's total GDP was only USD 149.5 billion with a GDP per capita of USD 156.4. In 2010, however, China exceeded Japan and became the second-largest economic entity in the world. China's total GDP was USD 11.2 trillion in 2016, with a GDP per capita of USD 8,123. China has stepped into the upper-middle-income group, as defined by the World Bank. In turn, the rapid growth of China's economy has allowed the government to

spend money to fight and reduce poverty. The reduction of poverty in China has progressed remarkably over the last few decades, as measured by the China's official poverty line, or as based on the standards from the World Bank. Figure 12 demonstrates how China's government has been subsidising the poor villages and areas to help eliminate poverty.

Figure 12. Poverty-stricken population under different poverty standards in China (million)



Data source: National Bureau of Statistics of China.

China's official poverty line has been adjusted many times. In 1986, the National Bureau of Statistics and the State Council Leading Group Office of Poverty Alleviation and Development cooperated to draw the first official poverty line based on the survey data of rural households collected in 1984. The absolute poverty line, determined at that time, was a net income per capita of RMB 206 per year. Later, the National Bureau of Statistics readjusted the line based on the census data from rural households, organised every 3 to 5 years. They finally updated the data by incorporating the consumer price index from rural residents. In 2008, China's official poverty line was an annual net income of RMB 1,067 per capita per year and RMB 1,196 per year in 2009. In 2014, the poverty line had increased to RMB 2,800 per year. Based on this threshold, China's impoverished population amounted to 55,750,000 in 2015.

Against this background, there is a growing acknowledgement that ICTs can play an important role in empowering local communities and spurring economic and social development, especially in far-flung rural regions, but also in poorer urban areas. ICTs have a positive effect on efficiency, competitiveness and market access for national firms (Kelles-Viitanen, 2003). It also seems to lower the barriers to innovation and contribute to knowledge diffusion, thus raising the overall innovative capacity in society (Donnelly and Weber, 2017). As illustrated below (Box 2), the Taobao villages is a prime example of how e-commerce has been creating economic opportunities and boosting entrepreneurship in remote rural villages.

Beyond e-commerce, there is a growing recognition that ICT can play a major role in enhancing economic and social inclusion and could also contribute to reducing poverty more directly. The

United Nation Development Programme is working with its partners to harness the benefits of ICTs to achieve the Sustainable Development Goals (SDGs), including the fight against extreme poverty. It acknowledges that ICTs are key factors to: "(i) making needs visible and actionable, (ii) expanding voice and empowerment, (iii) underpinning inclusive, sustainable growth, and (iv) accelerating and sustaining progress" (ITU, 2017). Importantly, the process of informatisation and the increasing pervasion of ICTs into public services are seen as a way to strengthen governments and improve public action towards targeted groups. Improving physical and social infrastructures, for instance by leveraging technology or data-driven solutions (often referred to as "big data" such as data analytics and visualization tools), would eventually benefit marginalized communities.

A concrete example of how ICTs can be leveraged to improve living conditions and reduce poverty is the supply of basic training and education to individuals excluded from national education systems. The ITU report (2017) mentions a case in Guatemala where mobile phones were used to "train more than 300 aspiring nurses via distance education, helping to reduce a critical lack of skills." Another example is electronic health (e-health) and mobile health (m-health) solutions that can be delivered by distance: "Telemedicine is increasingly making medical advice and treatment options available to people irrespective of their geographical location […] health platforms powered by mobile phones, for example, are used by frontline health workers to diagnose and treat pneumonia and preeclampsia, with the latter being the second-leading cause of maternal deaths" (Ibid).

Box 2. Digital Infrastructure alone is not enough- Taobao villages in rural areas

In October 2016, the Fourth Taobao Village Summit Forum was held in Shuyang, Jiangsu, on the theme: "New villages and new economy". Ali Research (2016) released "Report on China's Taobao Villages". According to the report, the number of Taobao villages reached 1,311 across China and 135 Taobao towns, generating some 840,000 job opportunities.[7] Taobao villages have demonstrated their increasing economic and social value, 'incubated' hundreds of thousands of grass-root entrepreneurs and created large-scale employment opportunities.

[7] Ali Research (2016) defines the 'Taobao village' as a village gathering a large number of online merchants selling products through the online trading platform 'Taobao'. They rely on the e-business ecosystem and form a cluster of e-commerce on a large scale. According to the report, to qualify for the title of 'Taobao village' the annual turnover in e-commerce must reach RMB 10 million and the number of active online shops in the village must be above 100, while active online shops must account for 10% or more of local households.

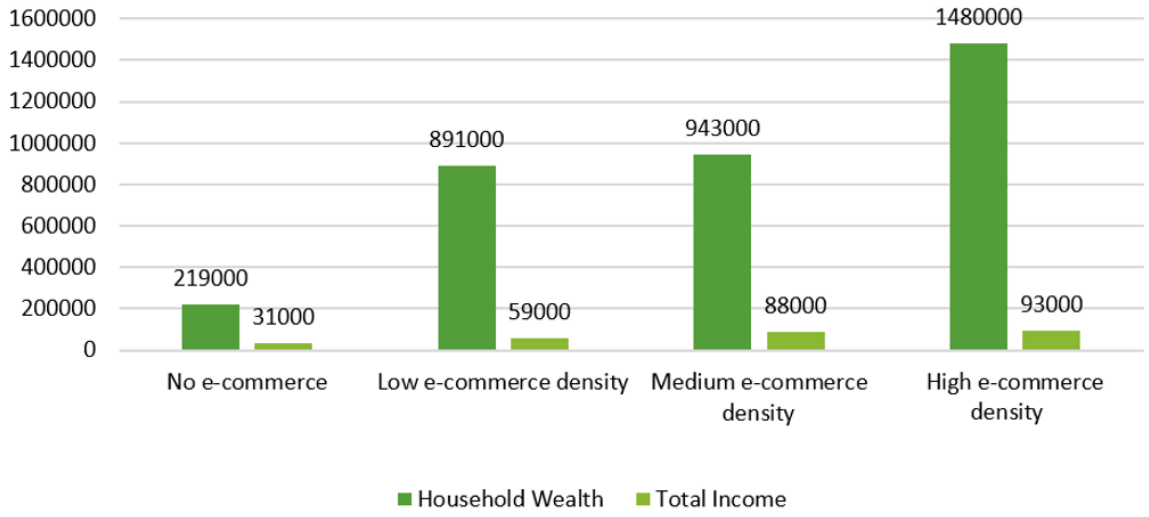
Figure 13. Distribution of Taobao villages in China, 2016

Source: Report on China's Taobao Villages, Ali Research (2016).

In recent years, along with the steady increase in the internet penetration rate in rural areas, the development of e-commerce in rural areas, as illustrated by the Taobao ecosystem, has generated enormous welfare gains, therefore contributing to the development of the rural economy and narrowing the digital divide between urban and rural areas.

- Promotion of county economic development. The general pattern in rural e-commerce will change the economic structure and distribution of resources in traditional and less developed regions of the country. It will be possible for them to engage in large-scale and highly coordinated e-commerce marketplaces at a relatively lower cost. Direct sales channels to national and even global markets will be made available, with the opportunity to develop commercial, manufacturing and emerging services industries. With the development of Taobao villages, complementary services industries flourished such as packaging, logistics, operational agency, training and other outsourcing services. This contributed to boosting employment and to the creation of a new sustainable system through the integration of the internet and local competitive industries, by exploiting the benefits of ICTs.
- Raising the income level of rural residents. Taobao villages can indeed exhibit significant wealth effects. Throughout their emergence and development, the main driving force has been the possibility for local grass-roots farmers to create wealth. Such an incentive has pushed residents to exploit local agricultural products and resources, as well as to take advantage of their geographical specificities to develop a collective e-commerce network. Many rural residents in Taobao villages became wealthier by starting their own e-commerce businesses. Ali Research and SWUFE (South-Western University of Finance and Economics; 2016) posit that e-commerce business has contributed an average annual income of RMB 20,500 and an average increase of wealth of RMB 213,000 to rural households.

Figure 14. Influence of E-commerce on Incomes and wealth of rural families (RMB)



Data source: Ali Research and SWUFE (2016).

- **Promotion of entrepreneurship and employment in rural areas.** E-commerce offers many advantages such as lower employment requirements and operational cost. It has incorporated the features of both labour-intensive and technology-intensive industries. Therefore, its positive impact on boosting entrepreneurial activities and therefore employment is significant. The e-business opportunities brought about by Taobao villages have encouraged rural residents to engage in online sales. More importantly, it also created a large amount of indirect employment opportunities in service industries such as logistics, shipping and packaging.
- **Promotion of industrial structure optimisation.** E-commerce contributes to the upgrade and reconstruction of manufacturing industry in remote areas. It also promotes the development of a modern service industry. For instance, the continual upgrading of such infrastructure facilities as logistics, packaging and distribution is crucial for e-commerce business, which could facilitate the dynamic integration of the internet and traditional local industries, and therefore places a significant importance on optimising and upgrading the industrial structures in country areas.

Acceleration of urbanisation in county areas. In the new era of the 'internet plus', one of the key factors of urbanisation lies in the transformation from the cities-centric approach of urbanisation to the more dispersed, small cities and towns-centric approach. The prevalence of e-commerce in rural areas has attracted farmers who had temporary jobs in large cities to return to the countryside to start their own business. It also created job opportunities for local farmers and has effectively driven the development of a local economy, thereby contributing to the prosperity of many traditional, remote and small towns.

4. Digital infrastructure in the EU

This section presents the European experience in deploying digital infrastructures and tackling the digital divide. More specifically, it first provides an analysis of key performance indicators, which allow various dimensions of the EU digital economy and society, including recent ICT development to be captured; and then, it offers a brief overview of the current EU policies and instruments aiming to support a faster deployment of digital infrastructure with a view to overcoming the digital divide.

4.1 The EU digital divide

The EU digital divide has recently been the topic of extensive discussions among policy analysts and scholars. The literature on this subject has investigated the relationship between ICTs and social exclusion (Brants & Frissen, 2003), describing the geographical gaps (e.g. between Northern vs. Southern Europe, Western vs. Eastern Europe) and explaining the attributes of the various groups subject to digital exclusion within member states (van Dijk, 2008). More recently, research has focused on explaining how the digital divide has turned to inequality of skills and usage (van Dijk, 2012). Another growing strand in the policy literature focuses more systematically on identifying the regulatory barriers and inconsistencies that hamper both supply and demand dimensions of ICTs (Negreiro, 2015; Rubio et al., 2016). It explores, for instance, the factors that hold back a faster, deeper and more even penetration across different geographical areas and segments of the population by analysing consumer behaviour in digital and non-digital ecosystems (WIK-Consult, 2016). It also examines the development of (or impediments to) new services in fast-changing markets and the overarching policies shaping the local and global environments for innovation (Renda, 2016a).

In Europe, the deployment of network infrastructures for fixed and mobile broadband has always been characterised by profound disparities across member states and within national territories. At any rate, it appears that efforts to foster digital inclusion have remarkably intensified over the past few years on both sides of broadband connectivity and internet usage. While certain countries have been catching up, leapfrogging some of the largest economies (e.g. Estonia over France in most indicators), clear North-South divisions remain pronounced, as well as between rural and urban areas. The evidence presents a mixed picture: on the one hand, Europe shows a vivid dynamism in performing countries; on the other hand, the digital divide persists across the EU and under-investment is likely to hamper the deployment of future-proof infrastructures. Interestingly, two of the largest EU (and global) economies, France and Italy, perform very poorly along many dimensions of the digital economy and this can be particularly harmful to the EU economy as a whole.

The picture is also nuanced when it comes to the development of new digital services and the transformation of established European players. Although Europe has recently shown some unexpected success in nurturing dynamic tech hubs, EU businesses still lack scalability to reach

global markets (Atomico, 2016). Moreover, the new policy approach adopted by the European Commission, launched as the Digital Single Market strategy, has delivered mixed results so far. Many analysts have deplored the fact that the attempt to harmonise and unify EU markets is failing to materialise, reinforcing fragmentation (Lee-Makiyama & Legrain, 2016; Simonelli, 2016). Likewise, several other factors stand in the road as regulatory hurdles inhibiting the development of ICT infrastructures. Interestingly, in this context, small and medium enterprises (SMEs) have greater difficulties in fully reaping the benefits and engaging in the digital transformation, compared to bigger players, which have significantly increased their digital investments.

4.2 Measuring the level and pace of digitalisation in the EU

The performance indicators measuring the level and pace of digitalisation in the EU have been progressively developed and refined to better capture the characteristics of supply and demand in the digital economy. Over time, additional statistics have been compiled to provide general performance assessments, responding to the growing need to benchmark the pace of ICT development and its pervading impacts in a more accurate way. Moving from describing the conditions for internet access and usage, analysts have progressively shifted their focus to equally important factors, such as human resources (e.g. ICT literacy, skills and employment), and the looming digital transformation operating in business and public services. A wide range of variables is now used to gauge the expansion of digitalisation, but also its limits and barriers, whether they are socio-economic, legal or cognitive.

The EU Digital Agenda Scoreboard[8] measures progress of the European digital economy and gathers more than 100 indicators, divided into thematic groups, which summarise some key dimensions of the European information society, e.g. telecom sector, broadband, mobile, internet usage, internet services, e-government, e-commerce, e-business, ICT skills, research and development (R&D). It includes the Digital Economy and Society Index (DESI) and Europe's Digital Progress Report, which provide an overview of the progress made by member states in digitalisation and assess their digital competitiveness.[9] More specifically, DESI gathers together some 30 composite indicators on Europe's digital performance, tracking progress over time, and enabling data analysis and visualisation across EU member states. It comprises the in-depth analysis of five key areas: i) connectivity, ii) human capital', iii) use of the internet, iv) integration of digital technologies, and v) digital public services. An additional dimension looks at vi) the development of the ICT sector and R&D performance. These fine-grained metrics are now publicly available and help to dissect the socio-demographics explaining the different levels of

[8] The Digital Agenda Scoreboard includes more than 100 indicators, divided into thematic groups, which illustrate some key dimensions of the European information society. For further details see: https://ec.europa.eu/digital-single-market/en/digital-scoreboard.

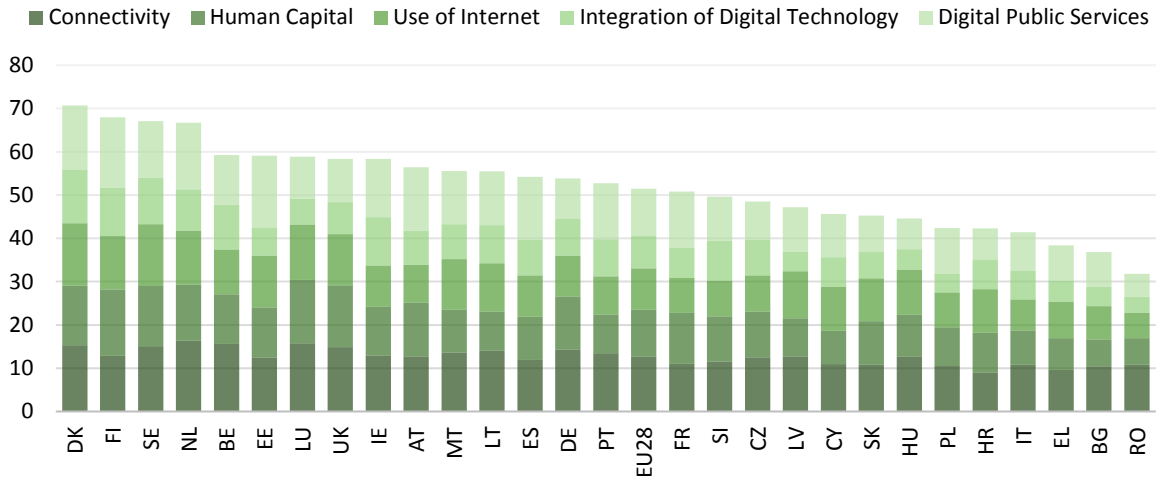
[9] Europe's Digital Progress Report provides an overview of the progress made by member states in indicators assessing the level of digitisation, and explains the policy responses by member states to address specific challenges. For further details see: https://ec.europa.eu/digital-single-market/en/european-digital-progress-report.

access and usage by individuals, businesses and public services. They also help better describe and monitor the progressive integration of ICTs into every sector of the economy.

4.3 How is the EU performing in the deployment of digital infrastructures?

As broadband becomes a key economic driver, the digitalisation in advanced countries is accelerating at an ever-faster pace. Based on the latest figures in the 2017 DESI, the EU has improved its overall performance by 3%, compared to the previous year. However, this relatively positive performance should not overshadow the uneven distribution across member states and within territories (Figure 15).

Figure 15. The European Digital Economy and Society Index (DESI), 2017



Data source: 2017 DESI, European Commission.

Considering all key dimensions of the European information society, Northern countries like Denmark, Finland, Sweden and the Netherlands, are ranking high, closely followed by Belgium, Estonia, Luxembourg, the UK and Ireland. Interestingly, according to a recent assessment by the European Commission, the three top-ranking EU countries have leapfrogged even global leaders such as South Korea, Japan and the United-States.[10] By contrast, the least-performing countries are Southern and Central Eastern EU member states, such as Poland, Malta, Italy, Greece, Bulgaria and Romania. Also, France performs below the EU average, while Spain slightly improved its ranking compared to previous years. Some countries like Slovakia and Slovenia have been catching up very fast, especially in more innovative dimensions such as mobile broadband coverage (DESI, 2017).

4.3.1 Connectivity for European households and businesses

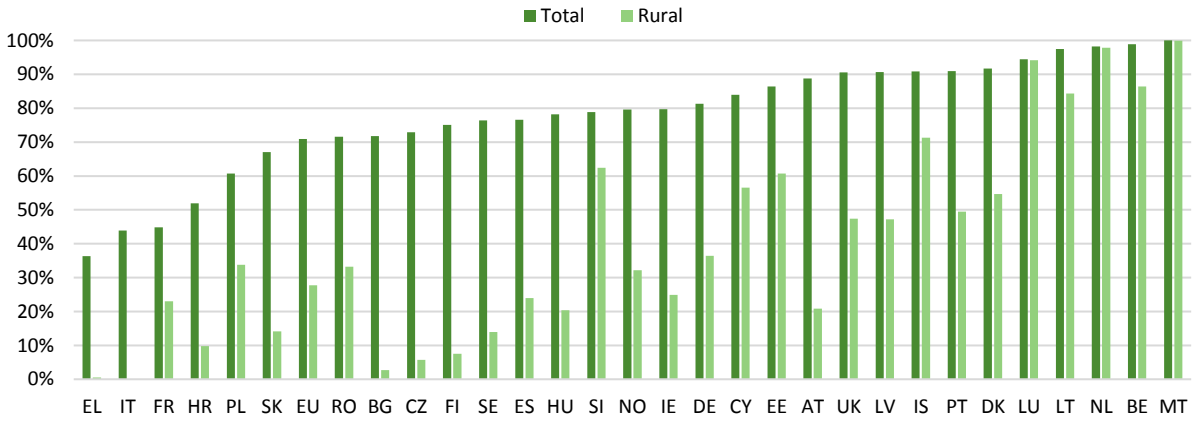
Indicators such as fixed and mobile broadband coverage, penetration, speed and pricing usually capture the supply and demand side for connectivity, describing the characteristics pertaining to broadband access and take-up. Primarily focused on enhancing connectivity coverage,

[10] For further details, see: http://europa.eu/rapid/press-release_IP-17-347_en.htm.

quality and speed, the Digital Agenda for Europe (DAE) was adopted in 2010.[11] Some of its key objectives were to provide: i) basic broadband (at least 144 Kbps) to all Europeans by 2013; ii) access to fast broadband (above 30 Mbps) to all Europeans by 2020; and iii) access to ultra-fast broadband (above 100 Mbps) for at least 50% of households by 2020.

Basic broadband is now available to everyone in the EU, with 97% of households covered, including 90% in the rural areas, with the remaining relying on satellite broadband access. Despite this important milestone being achieved, the digital divide appears to be a moving target. In fact, the divide for high-speed connections is widening across Europe, especially along salient North-South and urban-rural divisions. Although the European Commission's Digital Progress Report (2016c) indicates that the coverage of Next-Generation Access (NGA) networks had reached 71% of EU households (Figure 16), only 30% of these opted for high-speed connections of at least 30 Mbps. This proportion represents in fact only 25% of all European households.[12] Despite the growth in fast and ultrafast subscriptions, only 9% of all subscriptions are at least 100 Mbps, and the distribution across Europe is largely highly uneven (European Commission, 2016c). Countries like Belgium, Romania, Malta, Latvia, Portugal, Lithuania, Ireland, the Netherlands and Sweden have already more than 50% of their subscriptions of at least 30 Mbps, while this dimension accounts for less than 10% in Italy, Greece, Cyprus and Croatia. In ultrafast (at least 100 Mbps) subscriptions, Sweden, Latvia and Romania are the most advanced, accounting for more than 40% of total subscribers, according to the 2017 DESI. In this context, the divide between urban and rural areas appears to be significant in most EU member states.

Figure 16. NGA networks (FTTP, VDSL and Docsis 3.0 cable) coverage, 2015



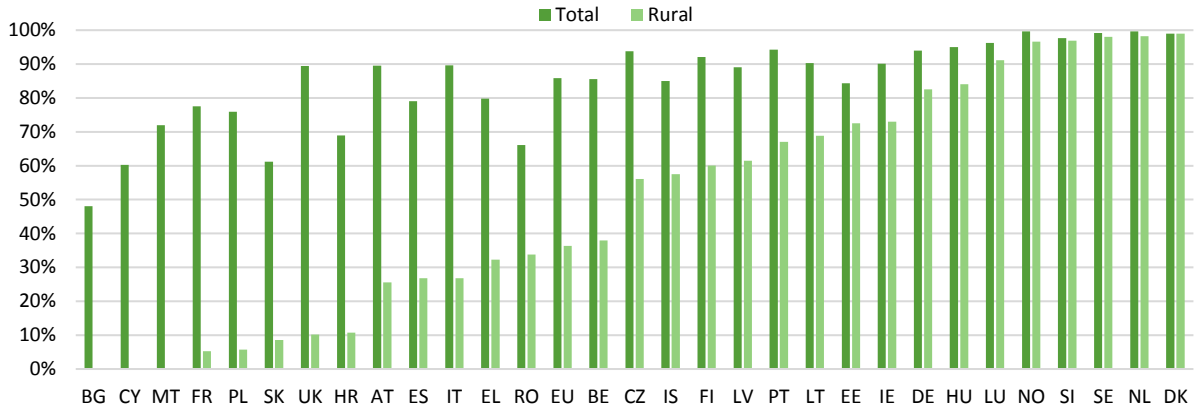
Data sources: IHS and VVA.

[11] The Digital Agenda for Europe, presented by the European Commission in 2010, is one of the seven pillars of the Europe 2020 Strategy, which sets objectives to develop a Digital Single Market to generate smart, sustainable and inclusive growth in Europe. The Digital Agenda proposes to better exploit the potential of ICTs to foster innovation, economic growth and progress. For further details, see: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:si0016.

[12] This figure is nonetheless increasing rapidly: the number of high-speed subscriptions has increased up by 36% over the last 12 months and by 74% over the last two years.

Following global market trends, mobile data subscriptions in Europe have also dramatically soared in a very short period of time, going from 58 subscribers per 100 inhabitants in 2013 to 84 in 2016. Mobile broadband, therefore, represents a very fast-growing segment of the broadband market, with now more than 60% of all active mobile SIM cards using mobile broadband. The Nordic countries such as Finland, Denmark and Sweden, but also Estonia Luxembourg and Poland, registered the highest rates with more than 100 subscriptions per 100 inhabitants. Conversely, Hungary, Greece, Portugal and Slovenia registered take-up rates at below 50%. Again, these figures reflect important disparities across EU countries. In the mobile broadband market, 4G availability had reached 86% of the EU population in 2015, up from 27% in 2012.[13] But mobile broadband penetration rates differ substantially from one country to another, and 4G LTE broadband coverage remains below that of 3G (HSPA) which is now covering the EU population almost entirely (DESI, 2017). LTE is most widely developed in Denmark, the Netherlands, Sweden and Slovenia. So far, LTE deployment has been expanding mostly in urban areas, with only 36% of rural homes being covered (Figure 17).

Figure 17. 4G (LTE) coverage, 2015



Data sources: IHS and VVA.

At EU level, enterprise connectivity has reached a very high score, with 93% of companies having a fixed broadband subscription in 2015. Almost every large enterprise had already adopted a broadband subscription in 2010, while has been a significant increase among SMEs in the last five years. The take-up rate for SMEs grew from 92% in 2010 to 97% in 2015.

4.3.2 Internet usage and development of digital services, including public services

When it comes to internet usage, the DAE included several targets to: i) foster regular internet use among the EU population up to 75% by 2015, especially for disadvantaged people up to 60% in 2015; while ii) reducing the portion of population that never used internet at all to 15% by 2015. So far, most of the DAE targets have been reached, with 79% of the EU population using the internet at least once a week and around 65% daily. However, there is still 18% of the EU population who have never used the internet. In addition, there is a clear divide as in the

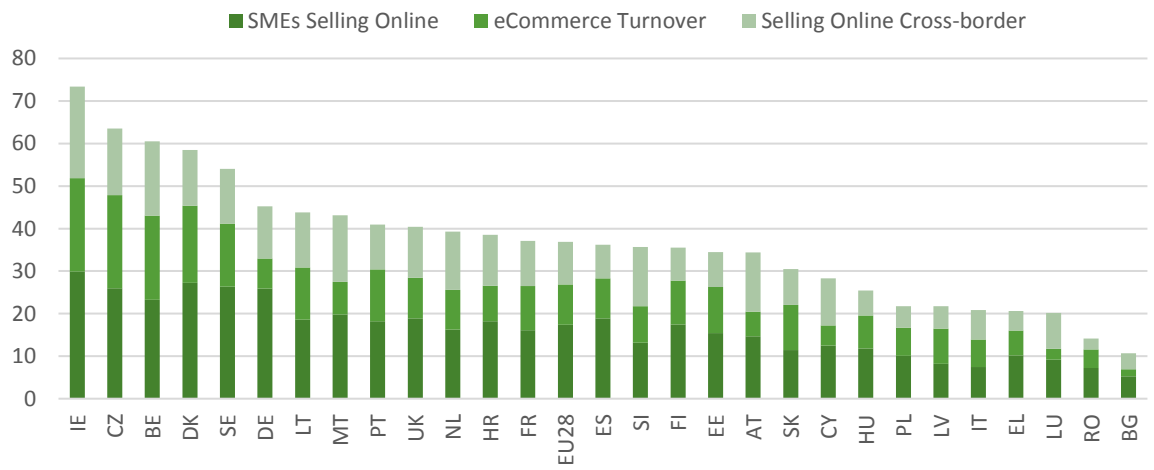
[13] This is measured as the average of each mobile telecom operator's coverage within each country.

North-Western member states, where, on average, a larger share of the population uses the internet than in the Southern and Central-Eastern member states. France, Poland and Italy have the lowest scores in these indicators. Interestingly, the main reasons reported for not subscribing to fixed broadband were a lack of interest (45%), lack of skills (41%) and cost factors for equipment (27%) and access (24%). Digital literacy is an important factor that has slightly improved compared the previous year. Age and education are key drivers characterising the digital divide, with 52% non-users having a low education and 50% aged between 55 and 74 in 2015 (DESI, 2016).

At any rate, it is apparent that a growing number of Europeans are surfing the web. Over the last five years, the number of Europeans ordering goods and services online has significantly increased, especially among younger and higher-educated segments. The various indicators on internet usage are nonetheless evolving slowly, except for the use of social networks that has increased by five percentage points over the last year (63%). Internet users in the EU are active in accessing content online, reading news and downloading music, videos and games. A large number of internet users rely on online banking services (57%) and shop online (65%).

Despite the growing number of shoppers online, the number of enterprises offering e-commerce solutions to their domestic consumers is unevenly distributed across Europe (Figure 18). This aspect of the business digitalisation is less developed in Southern and Central European countries, except for the Czech Republic, which shows a vivid dynamism in e-commerce indicators. Disparities vary significantly also depending on the size of business: large and small companies are unequally equipped to operate in the digital ecosystem. The DESI data on e-commerce shows that the share of SMEs selling online in 2016 was 17.2%, while the overall turnover in e-commerce represented 9.4% of their total turnover. Finally, the share of SMEs selling online cross-border was only 7.5% (DESI, 2017).

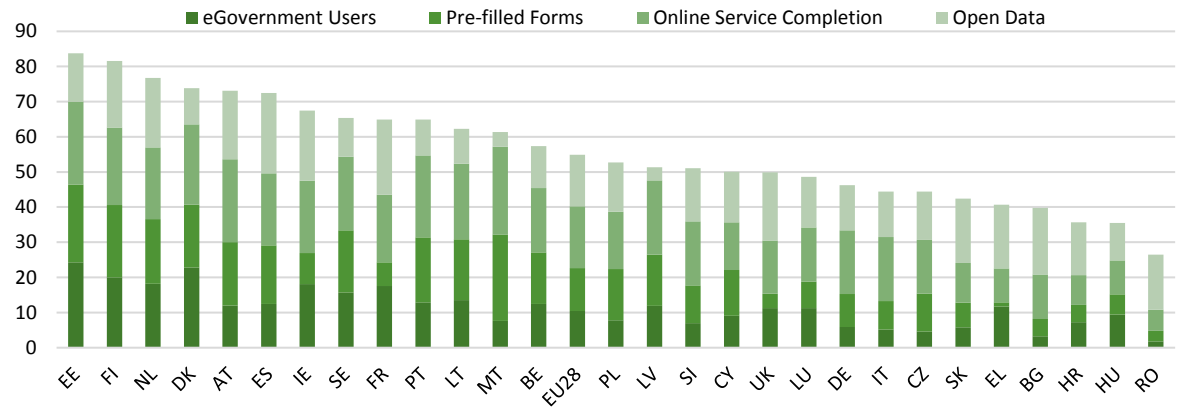
Figure 18. Level of development in e-commerce business practice and adoption in Europe, DESI component by aggregate scores, 2016



Data source: European Commission, Digital Agenda Scoreboard.

Finally, it is generally admitted that the digitalisation of public services can bring benefits to the entire society, notably in enabling public administration, individuals and businesses to streamline administrative proceedings and reduce red tape. Going a step further, it can also bring a real added value to the economy, through transparency and pro-active public data sharing policies that motivate business to develop innovative services, in particular in sectors like in healthcare, transport, energy distribution (Renda, 2016). Figures from the 2017 DESI index (based on data from 2016) show that Estonia is leading the way in the e-government indicators, closely followed by Finland, the Netherlands and Denmark, which are the European champions in the digitalisation of public services; by contrast, Bulgaria, Romania, Hungary and Croatia were lagging far behind.

Figure 19. Level of development in e-government practice and adoption in Europe, DESI component by aggregate scores, 2016



Data source: European Commission, Digital Agenda Scoreboard.

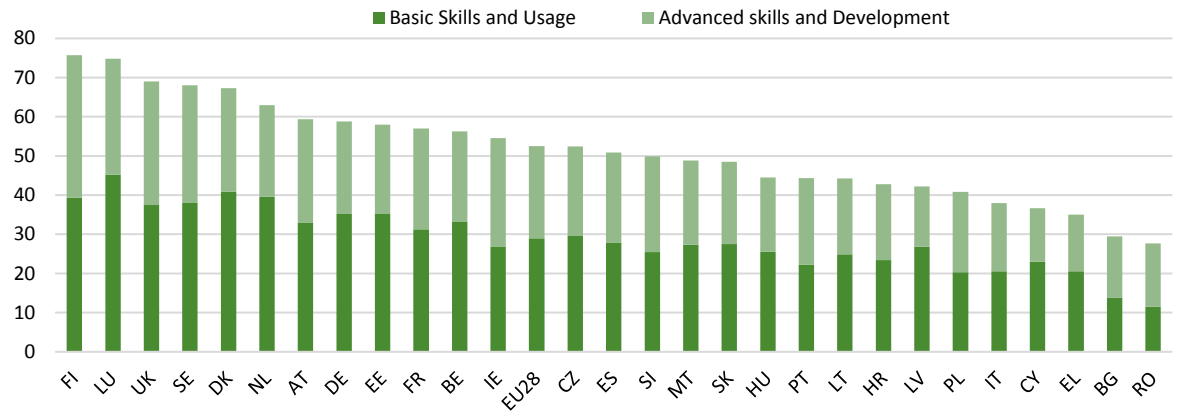
On the supply side, the number of public services available online rose from 75% in 2014 to 82% in 2016. As for the demand side, 34% of internet users returned filled forms online to their public administration, up from 27% three years ago. A number of barriers still prevent a larger share of the population from using online public services, such as a lack of trust, transparency or user-friendly interfaces. According to the European Commission's Digital Report Progress (European Commission, 2016c), personal characteristics are less relevant in the explanation for not using online public services. In 2014, lack of skills or knowledge decreased from 23% to 19%, while concerns about protection and security of personal data went down from 28% to 24%.

4.3.3 Human capital and digital competence in Europe

Digital literacy is pivotal for boosting ICT development and fostering inclusion in the information society. Tomorrow's hyper-connected society will call for ever more Information Technology (IT) engineers and specialists on the labour market to meet future demand in manufacturing and services industries. The increasing integration of cutting-edge software, artificial intelligence (AI) and robotics into industrial value chains will significantly change the nature of work and have a major impact on labour markets and industrial relations (De Groen et al., 2017). It has long been emphasised that Europe risks facing a skills shortage, and this already seems to be

an issue in some member states (Figure 20), especially in those sub-sectors where demand for high-skilled ICT specialists is growing very fast. According to the Commission's figures, employment for ICT specialists is growing at around 3.5% in 2015 as opposed to 3.2% in 2012. Recent forecasts estimated that some 825,000 vacancies could remain unfilled in the ICT sector by 2020 (DG Employment, 2016).

Figure 20. Level of development in Human Capital in Europe, DESI Component by aggregate scores, 2016



Source: European Commission, Digital Agenda Scoreboard.

A recent study shows how much ICT skills are, and will become, ever more important in every sector of the economy (Ecorys & DTI, 2016). For instance, most jobs require basic digital skills, including being able to communicate via email or social media, to create and edit digital documents and to search for information, or to protect personal information online. Over the last five years, investments in ICT have increased to improve business volume and efficiency. Interestingly, these investments were more frequent in sectors with traditionally low levels of digital intensity, such as agriculture, manufacturing or construction. Interestingly, 38% of EU workplaces have reported that the lack of digital skills has an impact on their performance, pointing to a loss of productivity (46%) or customers (43%). More worrisome, 88% of the EU workplaces did not take any action to tackle the lack of digital skills of their employees.

4.4 EU policy and instruments to bridge the digital gaps

Now that a new major industrial paradigm is operating all over the globe, a new wave of disruptive technologies is reaching market maturity levels and rapidly changing both manufacturing and services industries. Moreover, in the wake of the smartphone revolution, users have adopted new consumption patterns revealing an ever-growing demand for video streaming services (WIK-Consult, 2016), which seriously intensified the traffic load on communications networks. Future demand requires a gargantuan broadband capacity, considering the amount of data flows required for innovations such as the IPTV, connected cars, self-driving vehicles, smart manufacturing, the Internet of Things (IoT) and robotics.

In this context, the DAE was flagged as a key pillar of the Europe 2020 Strategy launched in 2010. Meant to generate "jobs and smart, sustainable and inclusive growth" (European Commission, 2010b), its main objective was to boost the deployment of high-speed internet networks to support the growing digital economy and ICT sector in Europe. However, it became clear that more should be done to shape a common path forward across EU member states, such as undertaking a more profound regulatory overhaul leading to a more integrated Single Market for digital good and services that would benefit individuals, businesses and public services alike.

Four main challenges were identified as complementary public policy actions to support an inclusive and productive digital ecosystem in Europe:

- Breaking down the regulatory barriers to complete a fully integrated and pan-European Digital Single Market;
- Spurring overdue investments in the telecoms sector to modernise network infrastructures and meet future demand needs;
- Addressing the digital skill and talent shortage Europe faces, and provide basic digital literacy and more advanced ICT skills to the population; and
- Adopting a fully-fledged cybersecurity strategy to secure underpinning networks, and in particular for essential facilities.

In this context, in May 2015, the European Commission unveiled a concrete and detailed plan to create a Digital Single Market, thereby reiterating its commitment to unify national markets and reduce regulatory barriers for digital entrepreneurs and innovators to enter digital, and digitally-enabled markets. The Digital Single Market strategy presented a set of legal reforms revolving around three main dimensions: i) ensuring better access for consumers and business to online goods; ii) designing a friendly regulatory landscape for digital networks and services; and iii) enabling Europe's economy, industry and employment to take full advantage from digitalisation (European Commission, 2015).

Although connectivity, including high-speed internet, have significantly improved over the past few years, the actual levels and pace of development are widely uneven throughout Europe and remain insufficient to address future needs. The European Commission estimates that internet traffic is growing by 20% annually, and by more than 40% on mobile networks (European Commission, 2016b). As part of its Digital Single Market strategy, the Commission has recently proposed a new 'connectivity package' setting strategic (non-binding) objectives for the deployment of so-called Very High Connectivity (VHC) capacity networks and also emphasising the need to foster digital inclusion in rural areas. This package, inter alia, envisages a universal coverage of 100 Mbps connections by 2025 in all urban areas and all major terrestrial transport paths having uninterrupted 5G coverage.

4.4.1 Investment needs and gaps in network infrastructures

Despite the handful of top-ranking European countries running ahead in most indicators measuring the level and pace of digitalisation, it is nonetheless apparent that the EU, as a whole and on average, lags behind the US, South Korea and Japan, mostly due to the wide national and regional disparities (Yoo, 2014; Rubio et al., 2016). In this context, the successive attempts to reform the EU rules applying to the electronic communications sector were meant to support the DAE objectives (Table 2): the roll-out of next-generation access networks was conceived as a pre-condition driving an inclusive digital transition and enhancing citizens' participation in the information society.

Table 2. Main targets from the Digital Agenda for Europe

Broadband	**2014**	**Target**
Basic Broadband coverage for all	100%	100% (2013)
Digital Single Market		
Population buying online	47%	50% (2015)
Cross-border e-commerce	12%	20% (2015)
SMEs selling online	14%	33% (2015)
Digital inclusion		
Regular Internet Use	72%	75% (2015)
Regular Internet Use by disavantaged people	57%	60% (2015)
Population never having used the Internet	20%	15% (2015)
Public Services		
Citizens interacting online with public authorities	42%	50% (2015)
Citizens returning filled-in forms to public authorities	21%	25% (2015)

Source: European Commission (2014).

The European approach to telecommunications regulation was characterised in the 1990s by the efforts of policymakers to break down national monopolies and gradually open the telecommunications sector up to competition. At that time, liberalisation aimed at creating a service-based competition to lower prices for fixed telecommunications and, as a consequence, at maximising consumer choice and welfare, as well as spurring investment and boosting innovation and economic growth (Renda, 2016b). Regulators had in mind that alternative operators would be able to progressively invest in and develop their own network infrastructures.[14] Therefore, a series of obligations were imposed on national incumbents, including the mandatory network-sharing obligations, forcing incumbents to decouple their networks and provide access to new entrants at regulated prices and following further clear

[14] This idea pertains to the so-called "ladder of investment" principle, set out by Martin Cave (2006), as a regulatory principle based on the objective of encouraging investment by both incumbents and new entrants and ultimately promoting network competition. It is based on the idea that investments by new entrants should be gradual as their customer base increases.

and stringent rules.[15] Such obligations include, inter alia, provisions on general authorisation to operate in every single member state, the mandatory provision of universal services, strict rules on consumer protection and access to key resources (e.g. consumers' data).

These provisions have been relatively successful in attracting new competitors and driving prices down for fixed-line telecommunications. These developments spurred a new wave of investment that gradually modernised and expanded copper networks, thus unleashing potential for both incumbents and new entrants, while improving conditions for consumers (Renda, 2016). It has long been demonstrated, however, that the EU, over the past 20 years, has experienced a slowdown in the development of new technologies and most fully-fledged infrastructures. Researchers (IDATE, 2015) have pointed the finger at a risk-adverse regulatory framework that has failed to foster a virtuous competition environment among economic operators and discouraged them from investing in future-proof network infrastructures.

In fact, rules governing access have been successful in liberalising the telecoms markets and spurring competition in Europe. It has achieved important outcomes in terms of connectivity, both regarding coverage and affordability. But some authors have argued that in the current context, heavy-handed network-sharing obligations are inhibiting the market for electronic communications compared to other regions. They notably claim that the EU regulatory regime hampers investment in next-generation networks (Renda, 2016b, Rubio et al., 2016). Even more problematic is the extent of fragmentation throughout Europe, with carriers having to deal with highly fragmented markets, applying different rules (e.g. Spectrum allocation) and a lack of integrated vision that prevents network operators from developing high-quality and pan-European networks (Rubio et al., 2016). As Renda (2016b) explained, this lack of supranational vision stems from the fact that the EU regulatory framework had emerged from the very beginning as a compromise between national and EU interests.

While data traffic and the demand for high-quality internet access are growing altogether, the European telecoms operators saw the average revenues per customer falling (ETNO, 2016). With the increased pressure on margins, uncertain return on investment and dwindling revenues, a new regulatory impulse may help reinvent the industry model. In pursuing a level playing field, both network operators and digital services providers are calling for a new deal to make the conditions fit for the 'gigabit society'. This would include measures to support the deployment of upgraded infrastructures and investing massively in fibre technologies, as well as measures to equip EU citizens with ICT competencies to better match the needs of employers in the labour market or to start an innovative business themselves.

Europe is lagging behind other advanced economies in terms of internet traffic and high-speed broadband penetration, but also in both public and private investment per capita (Yoo, 2014; ETNO, 2016). In fact, the EU would need massive investment to build broadband networks able

[15] For a comprehensive analysis of the ex-ante regulation and the EU multi-level governance structure characterising the European electronic communication framework, see Renda (2016b).

to match rival mobile networks such as in the US and South Korea, and more importantly to support emerging markets like the Internet of Things, e-health, e-government, smart manufacturing and other technology-driven innovations. Capital expenditure levels in both fixed and mobile domestic markets have been decreasing from EUR 47 to 40 billion over the 2005-09 period, and started to slightly go up again from then onwards (IDATE, 2015; Renda, 2016b). In fact, the EU has invested much less than other countries e.g. the US or Australia over the same period, while the gap in investments is widening compared also with China.[16]

4.5 Roles of government and policies to spur digital infrastructures and inclusiveness

Public intervention that supports the deployment of future-proof digital infrastructures is essential, especially to encourage economic operators to bridge the geographical gaps by deploying their networks in low-density areas, where costs are high and return on investments low. Both the EU institutions and the European Investment Bank (EIB) have fiercely advocated for providing strong support to fill the gap in public investment by means of direct subsidisation and co-financing involving various actors at EU, national and local levels (Rubio et al., 2016). Public funds are usually used to finance broadband deployment projects with grants supporting economic and social development through various institutional levels.

- The European Structural and Investment Funds (ESIF) aims at funding projects addressing challenges in five areas: research and innovation, digital technologies, supporting the low-carbon economy, sustainable management of natural resources and small businesses. ICT development is supported mostly by the European Regional Development Fund (ERDF), the European Agricultural Fund for Rural Development (EAFRD), the European Social Fund (ESF) and the Cohesion Fund (CF).
- The Connecting Europe Facility (CEF) together with the European Investment Bank (EIB), specifically dedicated to the goals of the DAE, including the European Fund for Strategic Investment (EFSI), aims to overcome current market failures and gaps by mobilising private capital in key areas such as infrastructure, research and innovation, education, renewable energy and energy efficiency as well as risk finance for SMEs.[17]

ERDF and the EAFRD allocate a compounded amount of about EUR 21 billion over the multi-annual programming period 2014-2020 to ICT development.[18] These investments are allocated

[16] However, some authors have importantly stressed that higher investments do not automatically lead to faster broadband connectivity and that access regulation and service-based competition in the EU have had a positive impact on broadband speeds. They also called for caution when comparing Internet performances across regions and drawing conclusion on the efficacy of national regulatory frameworks, mostly due to the highly diverse European realm and distinct experiences across geographical areas (Rajabiun and Middleton, 2017).

[17] A budget of EUR 1.04 billion was earmarked for the development of trans-European digital services for 2014-2020. In addition, the Innovation and Networks Executive Agency (INEA), is responsible for implementing an estimated amount of EUR 300 million from the CEF Telecom budget, in the form of grants during the same period. For more information please consult: https://ec.europa.eu/inea/en

[18] The ERDF is the European structural fund made available by the European Commission to strengthen economic and social cohesion in the EU by correcting imbalances between its advanced regions and those lagging behind in socio-

across a wide range of actions meant to enhance access, use and quality of ICTs, particularly in regions lagging behind. In addition to broadband roll-out, these investments support digital literacy, education and training in the field of ICTs (Table 3). ERDF accounts for 91.6% of the funding, while EAFRD provides the remaining 8.4%, making ERDF the first contributor (EUR 19 billion) to the deployment of digital infrastructures. Among these, EAFRD and ERDF contribute respectively EUR 1 billion and EUR 6 billion to broadband deployment projects.

Table 3. Estimated ICT relevant results per ICT theme within the ESIF

ICT Themes	Amounts (EUR billion)
Research & Development	~ 5.5
eGovernment	~ 3.46
PSI / eCulture / eTourism	~ 0.95
Support to SMEs	~ 1.8
R&I processed in SME (including voucher schemes)	~ 5.8
eInclusion / eAccessibility / eLearning / eEducation	~ 1.22
eHealth and Healthy ageing	~ 1
eSkills (lifelong learning)	~ 0.6- 1

Source: European Commission.

In addition, the European Commission has initiated a 'European Broadband Award' aimed at boosting projects in deploying high-speed broadband networks deployment and promoting best practices in this area.[19] The projects awarded must apply in one of the following categories so as to improve sustainable territorial development and competitiveness: i) innovative models of financing, business and investment; ii) cost reduction and co-investment in a future-proof infrastructure; iii) territorial cohesion in rural and remote areas; iv) socio-economic impact and affordability; and v) openness and competition.

More recently, greater attention has been drawn to the human side of digitalisation in designing public policies to enhance inclusion in the information society and digital economy. There is broad acceptance that basic digital literacy and the development of more advanced ICT skills are essential drivers for innovation, productivity growth and employment. In June 2016, the European Commission published a new research report and adopted a strategy for a "Skills Agenda for Europe" (European Commission, 2016a). Among the several actions meant to tackle the skills deficit in Europe, the Commission has launched a Digital Skills and Jobs Coalition to develop a large talent pool and ensure that "individuals and the labour force in Europe are equipped with adequate digital skills."[20] Under the Commission's impulse, member states are invited to set up comprehensive national digital skills strategies and to adopt targets that will be monitored through the European Digital Progress Report.

economic indicators; and EAFRD was designed to contribute to improving the quality of life and the management of economic activity in rural areas.

[19] See https://ec.europa.eu/digital-single-market/en/european-broadband-award

[20] See at: https://ec.europa.eu/digital-single-market/en/digital-skills-jobs-coalition

In building up this broad multi-stakeholders partnership to strengthen human capital and address the mismatch between education systems and labour market needs, the Commission has engaged in dialogue with specific economic sectors to collect evidence on the gaps and their potential impact on jobs, innovation, and competitiveness at a sectoral level. The so-called 'Blueprint for Sectoral Cooperation on Skills' aims at mobilising economic operators, encouraging private investment and promoting a more integrated use of both EU and national funding programmes to: i) translate sectoral strategies for the next 5-10 years into identification of skills needs and development of concrete solutions, such as joint development of higher Vocational Education and Training opportunities and business-education-research partnerships; and ii) support agreements on the recognition of sectoral qualifications and certifications (European Commission 2016)a.[21]

While the demand for ICT professionals has grown by 4% annually over the past ten years, it was estimated that 90% of jobs will require basic digital skills by 2020, leaving the number of unfilled vacancies for ICT professionals expected to reach 756,000 (European Commission, 2016a). Therefore, more public action should push for national governments to adopt measures for re-skilling and up-skilling to be implemented within companies, as well as to adapt the national educational systems and to harmonise competence and qualification schemes to avoid excluding segments of the population who cannot easily access highly specialised qualification training.

[21] The Blueprint for Sectoral Cooperation on Skills was launched as in January 2017 as a new framework for strategic cooperation to address short and medium-term skills needs in economic sectors. Following a multi-stakeholders approach involving businesses, trade unions, public authorities, research, education and training institutions, six pilot sectors were first retained: Automotive; Defence; Maritime Technology; Space (geo-information); Textile, Clothing, Leather & Footwear (TCLF); and Tourism. Additional sectors will be included in the future.

5. Conclusions

The digital divide commonly considers two main aspects: the first looks at the conditions to access ICTs from the supply side of digital infrastructures and services; the second focuses on the levels of internet use, the motivations and abilities in using ICTs and internet services. The concept keeps on evolving, along with technological developments supported by industrial trends (e.g. Internet of Things, AI), emerging consumption patterns and the uptake of new devices and applications (e.g. smartphones, tablets, smart TVs) spurring demand for an increasing data traffic load on communication networks.

It is interesting to note some differences between China and EU in the practice of expanding digital infrastructures. China started with basic technology, basic data rate and then gradually took higher speed connections to villages. More importantly, this process, which also aims to eliminate poverty, requires major government initiatives and policy support. By contrast, EU countries face a different digital infrastructure issue, which is to bring very high-speed infrastructure to more distributed areas. The EU has a very advanced statistical system for tracking progress in bridging the digital divide, which helps EU policymakers to develop more precise policies to address the differences across EU countries.

Against this background, it is apparent that the digital divide is a moving target and there may not be any quick or easy solutions to bridge the gaps. Although providing physical access to the internet remains essential to connect the unconnected, it is not sufficient to develop local economies and reap all the benefits stemming from digital technology. Therefore, in concluding this paper advances the following proposals to help close the digital divide in emerging economies:

- Connect the unconnected. A useful framework to analyse supply-side ICT policies is to consider the value chain that stretches from the point where the internet enters a country (the first mile), passes through that country (the middle mile) to reach the end-user (the last mile), and certain hidden elements in between (the invisible mile).
    - The first mile can be improved by liberalising the market for satellite dishes and eliminating monopoly status over the international gateway and cable landing stations.
    - Strengthening the middle mile involves liberalising the market for building and operating backbone networks, encouraging open access to the incumbent's network, requiring all major infrastructure programmes (such as roads, railways, pipelines and energy distribution) to include provision for an optical fibre link, setting up internet exchange points and creating local caches for frequently used content.
    - Government policies can encourage the provision of last-mile connectivity by permitting competing facilities, especially for intermodal competition (spurring a so-called 'facility-based competition' between cable, wireless and digital subscriber lines), and mandating

the incumbent to make local access lines available to competitors at wholesale prices (local loop unbundling).

- The most critical portion of the invisible mile involves spectrum management, which requires increasing the amount of spectrum available, ensuring competitive access, encouraging sharing of essential facilities, such as radio masts, and liberalising the market for spectrum resale.
- Finally, focusing on access to the network, affordability should be ensured via government intervention (e.g. subsidies or support to private investments) aiming to reduce prices of digital devices (e.g. computers, tablets, smartphones) and render internet connections affordable to everyone (e.g. by pricing the services based on income levels in different regions).

- Supportive industrial innovation plan. In the PC era, visionaries advocated the concept of a USD 100 laptop. In the mobile and social computing era, a sustainable industrial innovation plan to offer USD 20 smartphones is needed.[22] Smartphones are key to bridge the digital divide, as they provide internet access to populations living in remote areas. Poushter (2016) reports that "young adults, minorities, those with no college experience, and those with lower household income levels" are more likely to access the internet primarily through their phones.[23] Digital investments need to be accompanied by: i) adaptive regulations, so that firms can leverage the internet to compete and innovate; ii) improved social digital skills, so that people can take full advantage of digital opportunities; and iii) accountable institutions, so that governments respond to citizens' needs and demands. Digital technologies can, in turn, augment and strengthen these complements, thereby accelerating the pace of economic and social development.
- Dynamic education. Technology is dynamic, so should education be. The interplay between digital investments and reforms in complementary areas resides at the core of policy debates on technology impacts. Goldin & Katz (2009), drawing on earlier work by Jan Tinbergen, framed these dynamics in the labour market as a "race between education and technology." As technology progresses, some skills become obsolete. Workers must acquire new skills that help them become more productive with the help of technology. Policy and regulations should make sure that education is equally received, especially for the underprivileged, such as people living in remote areas and having insufficient access to educational resources.

[22] This plan should ensure economic, social and environmental sustainability by relying on e.g. mature technology and components which become cheaper year after year (see for instance Leo Mirani (2014), $30 smartphones are here—and they're getting better every day, Quartz), compulsory licensing schemes and open source software to reduce costs linked to intellectual property rights and sponsorships from large technology companies to sell at cost or below cost.

[23] China's practice, for instance the so-called 'Connected Villages', constitutes a good example of overcoming the digital divide in rural area via mobile devices. China's population living in rural villages represents 80% of the total population, spread over about 69,000 villages. Mobile broadband and mobile-commerce seems to be key in this regard. According to some estimates (BCG, 2017), online transactions made with mobile phones in China will account for 74% of total e-commerce in the country by 2020.

- General knowledge and digital knowledge are equally important. While AI and automation are changing manufacturing and services industries, workers need to adapt to these new environments. They need to develop competencies to match the changing labour market needs, especially regarding decision-making and judgment, alongside specialised skills to steer and complement robotics and digital technology. Too often, the potential benefits arising from the internet are not reaped. Instead, the internet can sometimes make persistent problems worse. The key insight is that for complex occupations, business activities or public services, the internet usually can make only a portion of the tasks cheaper, more efficient or more convenient through automation. Another portion still requires capabilities that humans possess in abundance but computers do not. Many traditional tasks of an accountant or bank teller are now automated, such as making calculations or processing withdrawals. Others require complex reasoning or socio-emotional skills, such as designing tax strategies or advising clients. Likewise, many public services involving the provision of information or routine authorisations can be automated. But others, such as teaching or policing, need a high degree of human discretion, tacit knowledge and judgment.
- More coordinated efforts. First-generation ICT policies involving market competition, private participation and light-touch regulation have led to near-universal access and affordability of mobile telephone, but they have so far been less successful in spreading internet services. Much of the explanation lies in continued policy failures such as regulatory capture, troubled privatisations, inefficient spectrum management, excessive taxation in specific sectors and monopoly control of international gateways. At the same time, the absence of global consensus in dealing with the next-generation issues – such as privacy, cybersecurity, censorship and internet governance – is resulting in more circumspect and diverse approaches to regulating the internet. The challenges facing internet stakeholders today are as much about how networks are used (demand) as how they are built (supply). Global interconnectedness introduces new vulnerabilities in areas where coordination mechanisms are weak, still evolving or based on non-government models. Threats to cybersecurity and censorship are undermining confidence and trust in the internet and increasing costs to businesses and governments, resulting in economic losses. Coordinated efforts at both the global and national government levels are needed in developing policies, standards and regulations to ensure a high degree of competition, sufficient training in digital skills and improvement in basic and higher education accessibility, and institutional accountability.

6. Policy recommendations

Based on the analysis above, the following policy recommendations can be formulated: i) at the G20 level, general principles should be set for emerging economies, supporting their economic development to close the digital divide globally and thus reducing gaps between poor and rich countries; ii) at the national level, governments should elaborate general policy guidelines and take actions to reduce socio-economic inequalities across national populations. These guidelines should also clearly indicate specific measures and strategies to design innovation-friendly policies that every country should follow to sustain its economic growth.

6.1 G20 level

The following guiding principles should be defined by the G20 for emerging economies. As mentioned, the purpose is to close the digital divide globally and reduce gaps between rich and poor countries.

- Holistic approach. Physical access to the internet or digital infrastructure is necessary but not sufficient to reap the full benefits potentially stemming from digital technologies. Other complementary actions must be taken, such as skills training, affordability, innovation policy, multi-level governance and institutional accountability.
- Usage of the internet infrastructure. The focus should be shifted, both in resource allocation and policy agenda-setting, from *"providing infrastructure and access" to "encouraging usage of the existing infrastructure to add or create value*". This added value includes economic, education and life improvements.
- Human capital. In the same vein, the focus should be shifted, both in resource allocation and policy agenda setting from "*hardware*" to "*human-ware*", i.e. from "*digital technology development*" to investing in human capital, for instance by "*enhancing digital skills training*" in the short term, and "*increasing the share of the highly-educated population in a country*" in the longer term.
- Digital responsibility. Digital responsibility should be advocated, which means that internet technology or ICT in general should be used in a way to improve human life, equality and inclusive prosperity and not just as a commercial means for profit-making.

6.2 Country level

When it comes to country-level guiding principles, the purpose is to overcome disparities across the various socio-economic segments of the population and between national territories.

- Market creation. Developing policies and providing economic incentives to promote innovation that will create new markets, which in turn will help i) close the digital divide, ii) increase new employment opportunities and iii) eventually improve living conditions.

- Industrial plan. Innovation and collaboration should be vigorously promoted to create technologies that support efforts to overcome the digital divide. For example, a $20 smartphone will be a game-changer in mobile internet access.
- Education. Developing policies to adapt the education system to changing labour markets and encourage digital skills training for everyone at an affordable price.
- Affordability. Deregulating the telecommunications industry and developing a friendly environment for digital services to flourish and foster multiple applications and encourage the use of the internet and ICT to create and add values to the society.

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Since 1995, when the internet was commercialised globally, an ongoing debate on how to close the digital divide has attracted much attention. The digital divide prevents citizens, in particular disadvantaged socio-economic groups, from harnessing the full benefits that digital technology can deliver. This situation will inevitably result in widening the income gap and triggering unbalanced economic development in the long run.

While both China and Europe have undertaken major efforts to reduce socio-economic and geographical disparities by providing network access to ever more citizens, investing in physical access alone is not sufficient to enhance inclusion in the information society. Fostering digital infrastructure in the most disadvantaged areas is key to supporting inclusiveness, but public authorities should also adopt corollary policies to spur social and economic cohesion through innovations that enable disadvantaged regions to catch up with more developed urban areas. The focus must shift, both in resource allocation and policy agenda-setting, from "providing infrastructure and access" to "encouraging the usage of the existing infrastructure to create value", and also from "hardware" to "human-ware".

Overcoming the digital divide in emerging economies faces four major challenges: i) insufficient levels of development in digital infrastructure and services; ii) limited affordability of network services, devices and applications; iii) insufficient levels of basic and advanced digital skills to create or add value to the entire economy; and iv) too little coordinated effort to enhance social and economic equality.

Ambitious measures must be implemented as soon as possible: maintaining the *status quo* while technology rapidly pervades every sector of the economy will critically widen disparities across nation-states and between the various socio-economic segments of the population within countries. Powerful leadership is therefore needed at both global and local levels, which requires more coordination among governments and local authorities to empower local communities. In this context, governments should promote digital innovation and entrepreneurship, foster coordinated efforts and adapt their educational systems to the changing labour market.

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