OECD DEVELOPMENT CENTRE

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Harnessing the digital economy for developing countries

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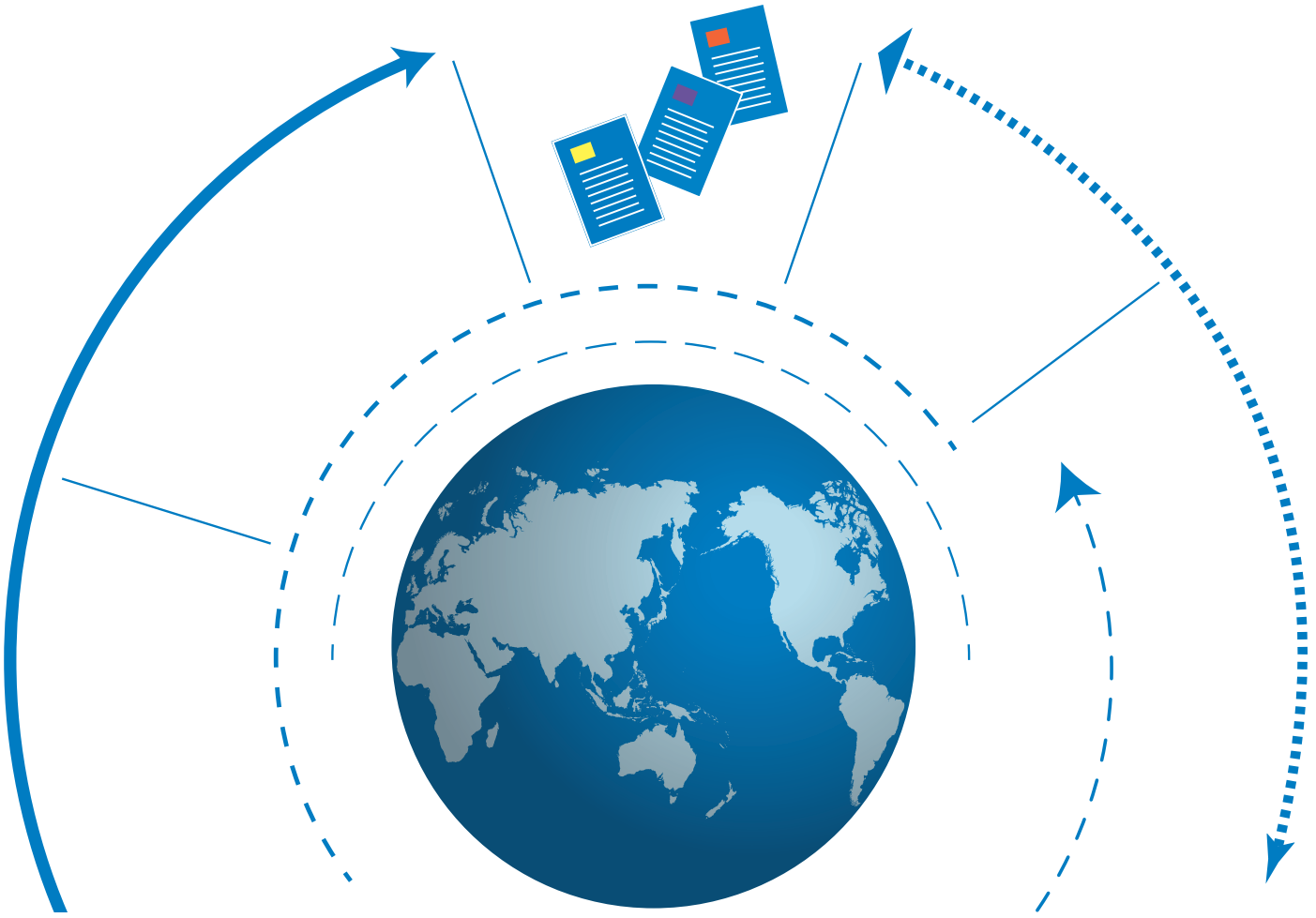

OECD DEVELOPMENT CENTRE

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PREFACE

The OECD has long been a pioneer in addressing the opportunities and challenges of the digital economy in industrialised countries. The Development Centre has expanded this scope to analyse the digital economy and the impact of digitalisation in developing countries. Building on earlier work conducted by the Centre and the International Telecommunication Union (ITU) on the potential of telecommunications for development (OECD and ITU, 1983), and more recent work on the prospects and policy issues of e-commerce for development (Goldstein and O'Connor, 2000) (Goldstein and O'Connor, 2002), this paper explores the major challenges and opportunities digitalisation poses for developing countries, and how such countries can prepare to best exploit the benefits of the digital economy.

Digital technologies are spreading throughout the world at a faster pace than previous waves of technological innovation, and are re-shaping consumer behaviour, social interaction, business models and governments. Digitalisation has important implications for developing countries' growth prospects and productivity by exploiting economies of scale and network effects, raising the productivity of labour and capital and facilitating access to global value chains. The digital economy also contributes to greater inclusion by lowering transaction costs and addressing information asymmetries associated with certain activities like access to finance.

Despite the apparent benefits of the digital economy, potential drawbacks also exist. A serious risk is unfolding of a growing digital divide between developed and emerging economies as well as within emerging countries between cities and rural areas and between educated and non-educated. Whilst digital technologies are spreading around the world faster than ever, their widespread penetration within countries after their initial adoption is slowing down. Digitalisation and automation in both advanced and emerging economies also could contribute to the re-shoring of production and thus amplify the trend of premature deindustrialisation across the developing world. Finally, developing countries are likely to find themselves digitalising in a world where global regulatory standards are set largely by the advanced countries.

This paper situates these challenges and opportunities in the context of case studies of countries that have successfully navigated the process of digitalisation – something that is a dynamic and iterative process. In this way, the paper contributes to the Development Centre's ongoing work on digitalisation and innovation for development, and the OECD's broader programme of work on the digital economy.

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RÉSUMÉ

Ce rapport défend l'importance de l'économie numérique pour les pays en développement, et ce que ces pays doivent considérer lorsqu'ils développent une stratégie numérique à l'échelle nationale. Le monde connaît une révolution numérique ayant des implications significatives sur les économies mondiales et nos modes de vie. Cette révolution repose sur le rythme en constante accélération de l'innovation et de la diffusion technologique. Les technologies numériques et leurs applications transforment des domaines entiers de l'activité humaine, et se répandent à travers le monde plus rapidement encore que les précédentes vagues d'innovations technologiques. La révolution numérique est donc trop importante pour qu'un pays puisse la négliger. L'économie numérique peut être exploitée afin d'atteindre une croissance inclusive et durable : les technologies numériques facilitent la vie des citoyens et des consommateurs, augmentent la productivité des salariés et des entreprises, et permettent aux gouvernements d'offrir des services clés à ceux qui en ont le plus besoin. Cependant, une telle dynamique ne s'enclenche pas de manière aléatoire : les gouvernements doivent s'engager à mettre en place une planification stratégique qui maximise l'impact du numérique sur le développement, et assure que ses bénéfices soient équitablement distribués. En s'appuyant sur l'expérience des puissances économiques dans le champ numérique, ce rapport analyse quatre facteurs déterminants, que les pays en développement peuvent utiliser comme bases pour leurs économies numériques : l'infrastructure, les compétences, la finance et la régulation. Ce rapport conclue en donnant des principes directeurs pour l'élaboration d'une stratégie numérique nationale fondée sur les facteurs clés de l'économie numérique.

Classification JEL: O31, O32, O35, O38
Mots-clés: technologie, politique, inclusivité, croissance

ABSTRACT

This report makes a call for why the digital economy matters for developing countries and what they need to consider when developing a national digital strategy. The world is undergoing a digital revolution with significant implications for global economies and livelihoods. This revolution is predicated on the ever-increasing pace of technological innovation and diffusion. Digital technologies and their attendant applications are reshaping whole domains of human activity, and are spreading across the world faster than previous waves of technological innovation. The digital revolution is thus too important for any country to overlook. As outlined in Section II, the digital economy can be harnessed for inclusive and sustainable growth: digital technologies make life easier for citizens and consumers, raise the productivity of workers and firms, and help governments extend key services to those who need them most. However, this does not just happen randomly: governments must engage in strategic planning to maximise the development impact of digitalisation and ensure that its benefits are evenly distributed. Using the experience of leading economies in the digital space, Section III looks at some of the broad and generic enabling factors that developing countries can develop and use as foundations for their digital economies. The concluding section, Section IV, examines three key lessons developing countries can learn from other countries' digital experiences. It provides some guiding principles around thinking about how to craft a national digital strategy that builds on top of the enablers of the digital economy.

JEL Classification: O31, O32, O35, O38

Keywords: technology, policy, inclusiveness, growth

I. INTRODUCTION: WHY THE DIGITAL ECONOMY MATTERS FOR DEVELOPING COUNTRIES

The world is undergoing a digital revolution with significant implications for global economies and livelihoods. As with previous waves of technological innovation, such as the development of the combustion engine and electrification, digital technologies are remaking economies and societies. Digitalisation is disseminating and democratising knowledge, education and entertainment to the world's populace at an unprecedented rate. The rise of digital imaging and advances in artificial intelligence are aiding doctors diagnose and cure disease. The emergence of an interconnected Internet of Things (IoT)[1] has the potential to make workplaces and transportation systems safer, cities more liveable, and domestic lives simpler. Broadband networks and their associated applications are being used to transform the way people communicate, socialise, shop, travel and work, and are creating entirely new business models and markets. Meanwhile, digitalisation has turned many consumers into "prosumers", through the production of content on digital platforms and participation in peer-to-peer (P2P) networks and the sharing economy.

The digital economy fosters growth and productivity and supports inclusive development. This growth is demonstrated by the adoption of digital technologies by a large number of consumers, firms and governments albeit at varying rates across sectors and countries. Adoption and usage of digital technologies raises the productivity of capital and labour and enables the participation in global value chains (Miller and Atkinson, 2014). The digital economy contributes to great inclusion by lowering transaction costs, addressing information asymmetries and exploiting economies of scale and network effects (World Bank, 2016a). Through these mechanisms, the digital economy has increased the accessibility to previously marginalised groups of a whole range of markets and services – education (edX, Coursera), peer-to-peer lending (Lending Club, Grid Finance), the sharing economy (AirBnb, Uber), crowdfunding (Indiegogo, Kickstarter), and online job matching platforms (Taskrabbit, Souktel).

The digital revolution is too important for any country to overlook. Exploiting the benefits of the global digital eco-system is important for both advanced and developing countries. Many advanced economies already have sophisticated digital economies and have extensively exploited the benefits of digitalisation for their economic prosperity and to improve and facilitate lives of their populations. Developing the digital economy can support inclusive growth

[1] The IoT consists of an intelligent network of sensors and devices connected to computers. These networks and sensors monitor the physical and natural environment, relay on real-time data, receive instructions and undertake autonomous action based on information they receive.

independent of the development stage of a country. For example, in less developed economies, the adoption and use of mobile technologies can provide access to basic financial services for anyone, or help rural farmers selling their products at appropriate prices. Given the right infrastructure, countries at any stage of development can use digital technologies to accelerate the delivery of broad-based, high quality healthcare, education and government services. The more countries develop and setup the grounds of their digital economies, the more they can move into areas where they become a supplier of digitally-enabled products and services in the contested global digital eco-system.

The rise of the digital economy is not without its challenges, however. Digitalisation creates new jobs, destroys old ones, and alters the composition of existing jobs. It contributes to skill-biased technological change, a major cause of rising inequality in labour income (OECD, 2011). Such disruption in the labour market has raised concerns that digitalisation might both bring about jobless growth and worsen existing disparities in the income distribution (Cowen, 2015). Features inherent to the success of the digital economy – its universality, decentralisation, network effects, and speed of technological diffusion – also throw up novel problems for policy makers. The "placeless" digital economy, characterised by the cross-border production and consumption of digital goods and services, challenges public policies on taxation and trade that are traditionally geographically based. The rise of the "gig" economy and digital platforms such as Uber and Mechanical Turk challenge labour and social policies, such as health insurance, training, and working conditions, that are designed to be implemented by firms and organisations in many countries. Digital platforms have also instigated debates around market concentration, equal access and adequate competition, things that are far from being new to the overall communication industry. Transnational data flows that cut across national jurisdictions raise issues around data ownership and privacy. Governments' and businesses' increasing reliance on digital systems also leaves them more vulnerable to attack: the threat of cyberterrorism is real. Finally, policy makers will also need to encourage IT standardisation and device interoperability to exploit the full benefit of various digital technologies, such as the IoT.

Digitalisation poses particular challenges for developing countries. Maximising the benefits of the digital economy depend on a basic level of ICT infrastructure that many emerging economies still lack. Furthermore, digitalisation is far more advanced in OECD countries: many developing countries will be "takers" of technological and regulatory developments in the rest of the world. This is not a cause for pessimism, however. Emerging economies have the most to gain but also the most to lose from digitalisation because they are often further from the technological frontier than OECD countries. As such, developing countries need to engage in strategic planning to maximise the development impact of digitalisation. Countries that fail to do so run the risk of falling behind in their international competitiveness and may find it increasingly difficult to improve the wellbeing of their populations.

This report stresses why digitalisation matters for developing countries and what they need to consider when developing and implementing strategies for the digital economy. The next section introduces the concept of the digital economy and illustrates trends, opportunities and challenges. Section III outlines four major enabling factors (infrastructure, skills, finance and

regulatory environment) behind the digital economy and uses country experiences to chart the evolution of these factors in different contexts.[2] In the area of regulation, major unique challenges to the digital economy – such as privacy, consumer protection, security and market concentration – are discussed. Section IV wraps up and provides guidance as to what developing countries of different types need to consider when planning the development of their digital economy and exploring how to foster the emergence of a niche in this important sector dominated by a few companies.

[2] The digital experiences of the United States, Germany, Sweden, Singapore, the Philippines, Korea, Estonia, China and India are illustrated in various boxes and annexes in this report. Examples of experiences in other countries are also provided.

II. EXPLORATION: DEFINITION, TRENDS, OPPORTUNITIES AND CHALLENGES OF THE DIGITAL ECONOMY

This section introduces the concept of the digital economy and illustrates how it benefits societies and economies. It maps the growing digital economy and underlying eco-system and provides illustrative data why the digital economy matters for economic growth and inclusiveness in advanced and developing countries. The section shows that the digital economy benefits people, businesses and governments and puts an emphasis on how the IoT is transforming economies around the globe. However, the digital economy is not without its drawbacks and could amplify skills-biased inequalities, for example, as explained at the end of the section.

What is the digital economy?

Defining exactly what constitutes the digital economy is problematic as digital technologies increasingly permeate multiple aspects of society and the economy. Building on previous conceptions of "information economies" (Bell, 1973) and "network economies" (Castells, 1996), the concept of the digital economy is rooted in digital technologies, information networks and the activities people carry out over such networks. The digital economy is the amalgamation of several general purpose technologies (GPTs) and the range of economic and social activities carried out by people over the Internet and related technologies.[3] It encompasses the physical infrastructure that digital technologies are based on (broadband lines, routers), the devices that are used for access (computers, smartphones), the applications they power (Google, Salesforce) and the functionality they provide (IoT, data analytics, cloud computing). The digital economy has permeated multiple aspects of modern life, including retail, transportation, education and agriculture, and benefits consumers, businesses and governments.

Because there is no universally accepted definition of what the digital economy is, measuring it is difficult. As demonstrated throughout this report, the line between digital and non-digital realms is increasingly blurred. As such, finding appropriate measures to empirically operationalise the concept of the digital economy – which is already ill-defined – is not an easy task. Even finding data for proxy measures such as ICT indicators can be troublesome. However, it is not the goal of this report to develop a composite index of the digital economy; rather it is to provide some stylised facts around the growth, benefits and challenges of the digital economy, and help developing countries prepare for digitalisation through the use of illustrative case studies and data.

[3] This definition has been adapted by the authors from a previous OECD definition of the Internet economy (2013). It is important to note that the Internet is a necessary but not sufficient feature of the digital economy.

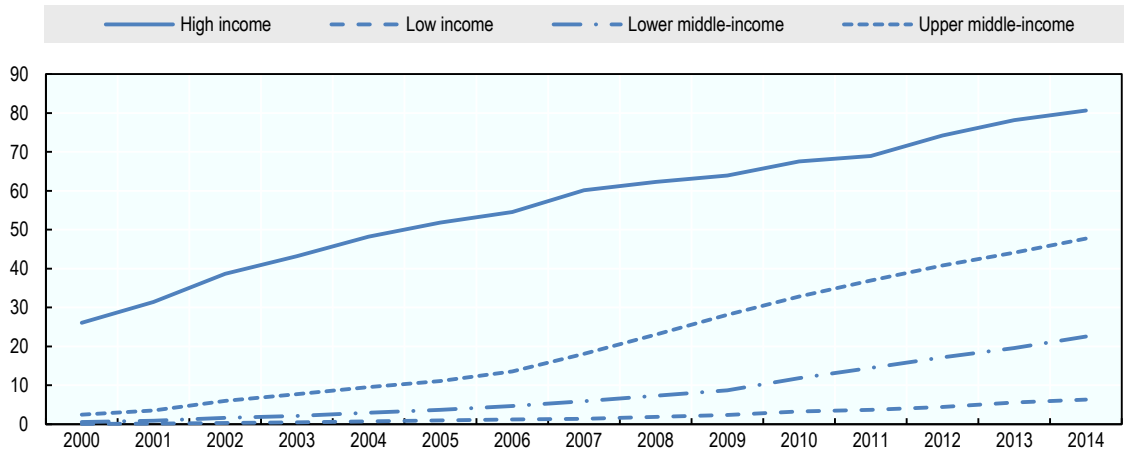
The growing digital economy and its eco-system

The digital economy is growing and supports economic growth and productivity. As stated above, defining and quantifying the digital economy is problematic due to conceptual and data issues. Nevertheless, a number of high profile studies demonstrate the economic importance of the digital economy:

- Cross-border data flows raised world GDP by 3% annually between 2003 and 2014. This equates to USD 2.2 trillion in 2014 (McKinsey Global Institute, 2016).
- The Internet economy in G20 countries will be worth more than USD 4 trillion in 2016, up from less than USD 2.5 trillion in 2010 (Boston Consulting Group, 2012).

The Internet has been widely adopted but access is still unevenly distributed. The Internet – short for Internetwork - began as an important tool for connecting computer networks but has developed into a universal technology underpinning all sectors of the economy in most OECD countries. Internet usage has almost tripled in the space of a decade, from approximately 1 billion users in 2005 to over 3 billion today. Of those 3 billion users, two-thirds are located in developing countries. But access remains unevenly distributed: around 40% of households in upper middle-income countries have Internet access, compared with more than 80% in high-income OECD countries. In low-income countries, less than 10% of individuals have access (Figure 1). Limitations in Internet access in developing countries are due to a combination of geographical, infrastructural and financial constraints, as well as a lack of competition amongst service providers in some markets. The most successful countries have used competition in mobile markets to great effect but there are often bottlenecks with fixed access and backhaul networks. Google, amongst other organisations, is developing a novel balloon-based approach in an attempt to assist in addressing this problem (Box 1).

Figure 1. **Access to the Internet is growing at a fast pace in developing countries**
Internet users (per 100 people)



Source: Authors' calculations based on World Bank (2016b), *World Development Indicators*, http://data.worldbank.org/indicator.

Box 1. **How Google plans to provide global Internet coverage**

Approximately two thirds of the world's population does not have access to the Internet. These 4.3 billion people generally live in rural, geographically dispersed areas where telecommunications companies have not found it profitable to build cell towers, fibre optic cables or other supporting Internet infrastructure. Satellite-delivered Internet is frequently the only option, although satellite dish installation and data costs can be prohibitively expensive for poorer communities (Solon, 2015).

Google hopes to solve this problem with Project Loon by using giant helium balloons to deliver Long-Term Evolution (LTE) connectivity to areas where regular Internet connectivity is unavailable. The Loon balloons fly in the stratosphere at altitudes between 18 and 25 kilometres above the earth's surface, typically only used by weather balloons and spy planes. This enables them to avoid clouds, storms or commercial flights but does leave the balloons exposed to powerful winds, sometimes exceeding 300 kilometres per hour. Moreover, the Loon balloons can currently only provide connectivity to an area of approximately 40 kilometres in diameter. Piloting the balloons to provide uninterrupted coverage presents an interesting engineering challenge. Google engineers designed a software programme to exploit changing wind speeds and direction at different altitudes. A smaller balloon inside the main balloon inflates and deflates to rise and fall and thus change the main balloon's direction. The technology is ready to be tested at a global scale and by the end of 2015 it was planned to have a "quasi-continuous" service along a thin band around the Southern Hemisphere, involving 100 Loon balloons circling the globe (Simonite, 2015).

Facebook (Internet.org and drone-delivered Internet) and Space X (satellite-delivered Internet) are also attempting to expand global Internet coverage. Whilst the potential societal benefits are manifest, these companies' motivations are primarily commercial. Google and Facebook's advertising-based businesses depend on finding new Internet users for personal data and targeted ads. Expanding the global pool of Internet users supports this ambition. Google believes Project Loon will provide significant cost advantages over drone and satellite based alternatives but is hedging regardless: it invested USD 900 million in SpaceX in January of 2015 (Simonite, 2015).

The mobile revolution coincided with the decline in fixed-line telephone usage and, as it has always been, mobile phone access is more widely distributed than Internet access. More than 5.5 billion mobile phone subscriptions now exist in developing countries and 1.5 billion in developed countries: almost one subscription for every person on the planet Rapid mobile phone adoption coincided with the decline of fixed telephones. Fixed-line telephone subscriptions decreased across the developing and developed world, falling from a total of more than 1.2 billion in 2005 to approximately 1 billion in 2015 (ITU, 2015). That being said, fixed line penetration was always very low in developing countries compared to developed countries and all stakeholders need to be cognisant that all wireless technologies, such as cellular networks or Wi-Fi, are extensions of fixed networks. The technologies are in many respects complimentary as mobile operators rely on fixed networks to offload traffic and to provide backhaul.

The spread of the Internet and mobile broadband is indicative of a broader trend in diffusing new technologies to developing countries at a faster rate than ever before. The time span between the invention of a new technology and its widespread adoption[4] has decreased rapidly (Comin and Hobjin, 2009). This differential has been speeding up since the 19th century when the gap was 120 years for trains and 100 years for telephones, to the 20th century when the gap was 25 years for personal computers and today when the gap has been 16 years for mobile phones. Today's technology companies, who build their applications on top of the Internet and

[4] Defined as when 80% of countries that use a given technology first report it.

mobile technologies, thus have access to a rapidly growing global market that enables them to scale at unprecedented rates due to network effects (see Box 2, for an illustration of the case of Facebook and WhatsApp).

Box 2. **Exploiting network effects in the global economy: The case of Facebook and WhatsApp**

The emergence of Facebook and WhatsApp illustrate that new innovative ideas, platforms and applications in the digital economy can reach global scale with near zero marginal costs due to network effects. Whilst the nature of such new platforms puts a challenge in terms of market concentration, the case of Facebook and WhatsApp illustrate that new digital ideas could emerge anywhere in the world and thus innovators in developing countries have an opportunity to find a niche in the digital eco-system. Internet companies require relatively little capital to start and whose customer acquisition cost decreases with each additional customer because the underlying engineering is scalable.

Facebook was founded in 2004, when social networking was still nascent. By 2015, Facebook has 1.49 billion monthly active users, meaning almost 20% of the world's population is a Facebook user. Each Facebook user spends an average of 20 minutes on the site per day. Of its monthly active users, almost half access the site only from a mobile device (Facebook Investor Relations, 2015). Facebook typifies the multifunctional nature of modern social media: it acts not only as a social platform but also mobile messaging service, a data mine for advertisers and an organising tool for activists.

Facebook purchased the mobile messaging service WhatsApp for USD 17 billion in 2014, at a valuation equivalent to Jamaica's GDP. WhatsApp was founded in 2009 and today has 900 million users, just under one seventh of the world's population, making it the most popular messaging service globally. It uses the Internet to allow users to send instant text and multimedia message to one another. Over 30 billion messages are sent over its platform daily (Koum, 2015).

The rise of Facebook and WhatsApp are illustrative of several characteristics of the digital revolution: it has transformed central domains of human activity (how we socialise and communicate), the speed and scale at which digital services can grow, and how they can disrupt existing markets and create entirely new ones - the disruption of the telecoms' SMS messaging services and the emergence of advertising services based on social media data in this case.

Facebook and WhatsApp are representative of what are called "scale-free networks," i.e. networks where the connectivity levels of nodes follow a power law distribution rather than a bell curve. Small numbers of nodes in scale free networks have massive numbers of links, whilst many nodes have few or no links at all. This pattern follows a phenomenon called preferential attachment, whereby new nodes do not connect randomly to other nodes in a network when they join but are more likely to connect to nodes that are already well connected. This is true both of power users within a network such as Facebook but also of the network itself: people are more likely to join Facebook because it is already the most popular social network. Facebook as a network is further strengthened and made more valuable the more users that join it (Werbach, 2011).

Network effects also represent potentially negative aspects of the digital economy: the tendency of Internet companies toward monopoly, and their housing of vast swathes of personal user data (see more discussion around these challenges in the next section).

The digital eco-system is characterised by the rise of multi-sided markets and platforms. Unlike traditional one-sided markets, wherein two sets of economic agents interact directly with each other, multi-sided markets are characterised by the "presence of two distinct sides whose ultimate benefit stems from interacting through a common platform (Tirole and Rochet, 2003, 991)." At a basic level, platforms solve co-ordination or transaction cost problem: finding jobs, information or consumers to advertise to. Platforms exhibit two types of indirect network externalities: usage externalities and membership externalities. A usage externality arises when two economic agents must co-ordinate to create value. In the case of ride-sharing, drivers and passengers can only enter into a value-creating exchange if they match together. Uber is a digital

platform that co-ordinates this exchange by reducing the transaction costs involved in matching drivers and passengers through a mobile application. Platforms like Uber also increase the value of the usage externality by increasing the quality of the matches: it makes it easier for drivers to find passengers and vice versa, and reduces the time spent in matching the two (Evans and Schmalensee, 2012). Membership externalities arise when the value received by one type of user increases with the number of another type of user. This externality often creates a positive feedback loop. For example, iOS application developers value Apple's App Store more highly the more users it attracts, whilst users value the App Store more highly if it has more applications. The largest Internet companies in the world tend to be platforms. Their emergence benefited from first-mover advantage, large domestic markets and the emergence or existence of clusters (Box 3).

Box 3. **The nature of digital platforms brings challenges for new entrants and thus for competition policy**

Internet companies require relatively little capital to start and whose customer acquisition cost decreases with each additional customer because the underlying engineering is scalable. For example, WhatsApp acquired 900 million users within six years with about 50 software engineers (also see Box 2 above).

The speed and low cost at which Internet platforms can scale has important implications for the market structure of certain Internet industries. Of those ten largest Internet companies, seven are located in the United States and three are in the People's Republic of China (hereafter "China"). This is largely due to a combination of the benefits first-mover advantage confers on digital incumbents (Google, eBay, etc), large domestic markets and the emergence of clusters. It is also reliant on having an open and competitive market for Internet access.

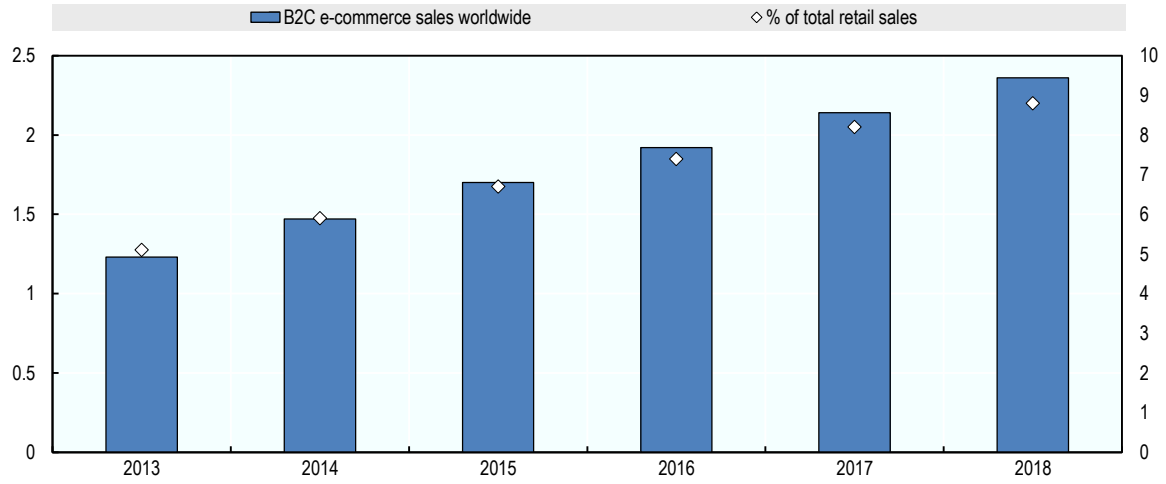
Most of the technologies underpinning the digital economy originated in the United States; as such, clusters like the Silicon Valley attracted large inflows of capital and skilled labour that founded several landmark technology companies. This created an agglomeration economy and a positive feedback loop as successive waves of founders, skilled labour and venture capital congregated there.

In the case of China, the government erected a digital firewall to limit citizens' access to digital content. This had the unintended consequence of protecting indigenous Internet companies from external competition. Local firms, such as Alibaba and Baidu, were thus in a position to exploit the large domestic market and become the predominant platforms in e-commerce and search respectively.

While digital upstarts from any developing countries can scale to a global level (see for example, Box 2 and Section IV), the nature of platform economics means that market entrants need to identify a niche market in general and can rarely take up part of an existing market. This should provide policy makers with food for thought when considering how to best harness the digital economy for inclusive growth.

E-commerce is growing rapidly with important implications for developing countries. E-commerce reduces transaction costs and better enables firms in emerging economies to access world markets (Goldstein and O'Connor, 2000). Global business-to-consumer (B2C) e-commerce revenues have been increasing at an average rate of about 20% from 2010 to 2014, rising from USD 804 billion to USD 1.47 trillion during that period (Figure 2). E-commerce accounted for 6% of the total retail market worldwide in 2014. This share is projected to increase to around 9% by 2018 (Emarketer, 2014). China and the United States are the leading e-commerce markets globally, comprising 55% of global e-commerce sales in 2014. The Chinese e-commerce market will grow rapidly over the next two years, exceeding USD 1 trillion in e-commerce sales by 2018, and eclipsing the United States' projected total of USD 500 billion in that year.

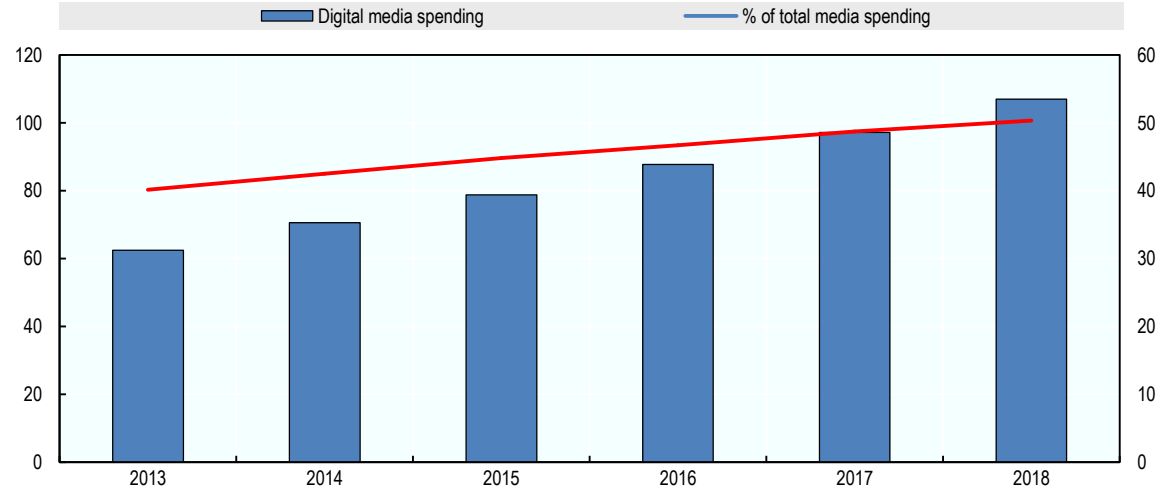
Figure 2. **E-commerce is growing at a significant pace**
Global e-commerce sales (in USD trillion)



Note: Data for 2015 onwards are projections.
Source: Authors' calculations based on Emarketer (2014), "Retail sales worldwide will top USD 22 trillion this year", Emarketer, 23 December, www.emarketer.com/Article/Retail-Sales-Worldwide-Will-Top-22-Trillion-This-Year/1011765 (accessed 10 November 2015).

Global consumer spending on digital media has been growing in absolute terms and as a proportion of overall spending on media (Figure 3). Digital spending rose by more than 10% in 2014, accounting for almost 50% of total spending on media (McKinsey & Company, 2015). Digital spending will continue to be the primary market driver of media spending and is projected to generate 55% of total media consumer spending by 2019. Moreover, developing countries are a significant factor behind this growth. Collectively, Latin America and Asia Pacific will account for around 43% of global spending in 2019, up from 40% in 2014 (McKinsey & Company, 2015).

Figure 3. **Growing importance of digital media spending**
Consumer spending on digital media as a proportion of spending on total media (USD billions)



Note: Data for 2016 on are projections.
Source: Authors' calculation based McKinsey & Company (2015), *Global Media Report 2015*, www.mckinsey.com/client_service/media_and_entertainment.

Emerging digital opportunities for consumers, citizens, businesses and governments

The digital economy is simplifying lives for citizens and consumers

The digital economy is bringing about greater convenience for consumers and citizens in a whole range of areas. Consumers can now order their groceries and have them delivered with Instacart, buy and sell second-hand goods via eBay, book holidays with Expedia, review travel destinations with TripAdvisor, hail a taxi with Hailo or call a driver with Uber, rent a room with AirBnb and find a job using LinkedIn. Facebook's 1 billion daily active users spend an average of 20 minutes daily on the social networking platform (see Box 2). Spotify and Netflix have contributed to the de-materialisation[5] of the entertainment industry, whereby people no longer own content but pay a subscription fee to stream it. Consumers expect music, films and other digital media to be on demand across all of their linked devices. Nest – recently acquired by Alphabet, Google's parent company – devises smart thermostats and home appliances so households can adjust their central heating and other functions from a mobile device. Nearly every domain of human activity has been transformed by digital technologies. Two important areas – education and finance – are discussed below:

- **Education with MOOCs:** The development of massive open online courses (MOOCs) has broadened the array of learning opportunities available to students and made education accessible to previously marginalised groups. MOOCs are freely accessible and open-licensed educational courses led by certified instructors and delivered by certified institutions. They are generally self-directed, can be started at any time and can be taken by anyone online. MOOCs are moreover able to scale up educational opportunities far more efficiently than traditional educational institutions: once the sunk cost of producing the initial class, lecture series or laboratory experiment is accounted for, the marginal cost of reproducing them is almost zero. This has profound implications for the future of education delivery specifically and the economy more generally (Box 4). Over 30 million users are now enrolled in MOOCs across 500 colleges and universities, and 200 organisations and institutions (Oakley, 2015). In 2013, around 8% of Internet users in the European Union followed an online course compared with 5% in 2007 (OECD, 2015a). Although the data is incomplete, a significant portion of MOOCs users are located in developing countries. Anant Agarwal, the CEO of edX, one of largest providers of university-level MOOCs, stated that 40% of its current 3.5 million students come from developing countries (Valerio, 2015).

[5] De-materialisation is the process of how specific industries and the economy as a whole reduce the total amount of physical inputs required to grow output.

Box 4. **Digital goods and services can be reproduced at zero marginal cost**

Digitalisation has rapidly transformed information-intensive sectors – music, advertising, publishing, newspapers, education – because the economics of digital products do not follow a classical marginal cost curve, whereby marginal costs decrease with scale until the limits of scale are reached and marginal costs begin to increase again. Once the sunk cost of producing a song, article, book, etc, is accounted for, the marginal cost of reproducing each additional digital unit of that good decreases indefinitely with scale. The idea that the marginal cost of reproducing digital services tends to zero has profound implications for developed and developing countries.

First, it destroys business models and creates new ones. Digitalisation has wreaked havoc on the media industry's traditional business models as print newspaper and CD revenues have plummeted. New models have arisen in their stead. Newspapers, such as the Financial Times and the New York Times, follow a premium/tiered pricing model, whereby a certain number of articles are freely accessible before the consumer needs to buy a subscription to access more.

Second, and more importantly, it is de-materialising the economy. Consumers no longer expect to own content that is digitally available: rather they prefer to pay a subscription fee to access it on demand (Spotify for music, Netflix for films, etc.) or expect it to be free (Wikipedia for information). This spills over into the physical world as well: consumers are increasingly likely to rent a car (ZipCar), share a ride (BlaBlaCar) or hire a driver (Uber) as own a car. The UK economy has grown by about 60% since 1990 but the physical mass required generating that output has fallen by nearly 20% (Coyle, 2015). The rise of 3D printing and additive manufacturing will accelerate this trend as parts of the production process are re-localised, manufacturing wastage is reduced, and global supply chains are shortened. Developing countries seeking to move up the global value chain will need to think critically about where to focus their resources in light of the creative destruction of digitalisation.

- **Education with digital schools in a box:** Digital technologies are also transforming educational possibilities in the developing world. Vodafone and the UNHCR (Vodafone, 2015) estimated that by the end of 2013 there were over 50 million refugees and displaced people worldwide, half of whom are under the age of 18. Refugees are displaced from their homes for 17 years on average and many have no access to education. The Vodafone Instant Classroom aims to ameliorate this situation by providing a digital "school in a box" that can provide education to refugees, displaced people, and communities with poor infrastructure. The Instant Classroom contains a laptop, 25 tables pre-installed with educational software, a projector, a speaker and hotspot modem with 3G connectivity. The tablets connect to the laptop locally so that teachers can deliver content offline. Instant Classroom has been deployed to over 15 000 children and young adults across Kenya, Tanzania and the Democratic Republic of Congo in 2015 (Vodafone, 2015).

- **Mobile finance:** For about 2.5 billion people in the developing world[6], access to banking and financial services is a luxury beyond their means. For these people, savings means storing excess cash in pillow cases or tin boxes under the bed, making a payment transaction means travelling for large distances with huge wads of cash and access to credit is non-existent. Mobile banking, however, is set to change this and is predicted to enable some 2 billion people to have access to banking services by 2030 (Bill and

[6] Based on figures cited in the Gates Annual Letter 2015.

Melinda Gates, 2015). Mobile solutions reduce the marginal costs of financial transactions to almost zero, allowing service providers to profitably offer mobile banking services to the poor. Mobile banking is already showing great potential in many developing countries. Since its launch in 2007, M-PESA, a mobile phone-based banking service, has garnered more than 15 million customers (almost half of Kenya's total population) and handled over USD 1.7 billion in transactions, representing about 10% of Kenyan GDP. In Bangladesh, bKash, a mobile money provider is processing about 2 million transactions a day, with a total value of almost USD 1 billion every month. In India, many banks have seen mobile banking logins surpass internet banking logins. The service is so popular that it has prompted one of the banks, Kotak Mahindra Bank, to launch an app that could process transaction without data connections. In countries where significant portions of the population are unbanked, mobile technology contributes to growth by reducing information asymmetries and providing access to credit and better price signals.

- **Digital healthcare:** Providing healthcare in slums has always been a challenge, not least because of cost issues. For the healthcare service to remain sustainable, the revenues have to be able to cover the costs. Yet, for the healthcare services to be affordable, prices have to be kept low. This seemingly irreconcilable dichotomy has barred many slum residents from accessing healthcare services in developing countries. As with mobile banking, digital technologies could potentially be used keep the costs low and so enabling businesses to profitably provide affordable healthcare services. This approach has already been pioneered by Access Afya in Nairobi with modest success. Using iPads and analytics software to manage operations, patient's data and inventory, Access Afya is able to reap a cost advantage from managing these tasks centrally, thereby keeping costs low and providing services from KES 100 (or USD 0.96). Although the non-government organisation (NGO) is still reliant on donations to cover costs, 70% of their operational costs are now covered by patients' fees. Should the Access Afya model prove successful, it will provide a feasible solution for governments in developing countries to provide affordable healthcare without straining the government budget. Digital technologies are shaping new business models

Digital technologies are shaping new business models

The digital economy is changing the way existing firms conduct business and providing novel market opportunities for new entrants. Digital technologies have brought about greater convenience for consumers but also more flexibility for businesses, for example through cloud computing and data analytics:

- Cloud computing provides significant advantages for businesses, although there is significant room for expansion in this area. Cloud computing is a "service model for computing services based on a set of computing resources that can be accessed in a flexible, elastic, on-demand way with low management efforts" (OECD, 2014a). In the past, companies would run software programmes and applications on physical

computers and servers on premise. Cloud service providers such as Salesforce (customer relationship management), Workday (human resources) and Dropbox (file storage and collaboration) now allow businesses to access such applications online. Cloud computing offers firms several benefits such as: flexibility, by easily scaling services up and down to match business demand; disaster recovery, by backing up data across multiple servers to prevent redundancy; mobility, by enabling employees to from anywhere provided they have Internet access; financing, moving from a capital expenditure to an operating expenditure model frees up resources and makes expenditure more predictable; and focus, outsourcing key IT requirements to dedicated cloud service providers enables firms to focus on their core competencies and increase efficiency. However, there is significant room for expansion in this area: only 22% of businesses in the OECD used cloud computing services in 2014 (OECD, 2014). Several issues around data security and privacy, and data localisation, need to be resolved before more businesses feel comfortable moving to the cloud.

- Firms are exploiting data analytics to uncover trends about consumer behaviour and make more informed business decisions. The continual decline in the cost of computer processing power, and the advent of advanced analytics techniques, such as text analytics, machine learning, data mining and prediction, has given rise to data analytics. The use of data and analytics to improve or foster new products, processes, organisational methods and markets – "data-driven innovation" (DDI) – is a new source of growth (OECD, 2015b). Firms are exploiting the use of big data in diverse and innovative ways. The case study of ZestFinance demonstrates how data analytics and big data are being used to extend loans to previously underserved customers (Box 5). Ayasdi is a company originally funded by the United States Department of Defence Agency DARPA that uses visualisation platforms to unearth new trends from big data. Its work has helped customers such as Merck and Citigroup solve a variety of problems, including: categorising the genetic traits of cancer survivors, tracking the source of an E. coli outbreak, analysing the impact of a childhood polio vaccination programme in Syria, and mapping Al-Qaeda behaviour around Baghdad (Fast Company, 2015).

Firms, consumers and governments in developing countries can all benefit from new business models based on the sharing economy. Sharing goods and services through bartering and exchange are some of the earliest forms of human interaction. Traditionally, as well as in many developing countries today, this sharing was largely confined within networks comprising the family and community. Rapid advances in digital technology now allow access to a much broader network, thereby increasing the scope for mutually beneficial transactions. The resulting "sharing economy" has transformed the way people travel, shop, borrow and access resources. For example users can share rides (BlaBlaCar, relay rides), apartments or spare rooms (Couchsurfing, AirBnb), clothing (ThreadUp, Free-cycle Network), meals (Shareyourmeal.com) and retail goods (Yerdle). Although the potential of the sharing economy in developing

countries are manifold, the challenges and negative spill-overs posed by it are also complex and varied.

Box 5. **The power of big data analytics: The case of ZestFinance**

Credit access is crucial to low-income households as a means to tide over periods of irregular cash flows. Credit access, however, is dependent on an individual's credit worthiness. In the United States, the FICO credit scores that are used to assess an individual's credit worthiness for loans are derived from a limited number of variables, which are often not updated for years. This runs the risk of locking out creditworthy individuals from lending institutions.

ZestFinance, a LA-based startup founded in 2009, seeks to solve this problem using data analytics. Data analytics is the use of advanced analytics techniques, such as text analytics, machine learning, data mining and predictive analytics, against large and diverse data sets to categorise data, predict scenarios and inform decision making (IBM, 2013). Douglas Merrill – ZestFinance's CEO and former Google CIO – developed a series of algorithms to mine databases comprising of thousands of credit-related variables, such as how many times somebody has changed address in the past ten years and an applicant's stated income versus the income of their peers. Various models then transform these indicators into meta-variables that are, in turn, aggregated and voted upon as to whether or not to extend a loan to an applicant.

This new method of computing credit scores has proven to be superior to the existing ones in a few ways. By using a wider array of indicators, ZestFinance is better able to predict whether an applicant will repay or default. Monitoring repayment schedules enables the firm to expand their datasets and iterate their algorithms. Through big data analytics ZestFinance has also contributed to what we understand about consumer finance: for example, a borrower who calls to inform that he or she is likely to miss a payment is more likely to repay in full in the future.

The company has extended 1 000 000 loans with an estimated the default rate of about 15%, about half the average rate of payday lenders. As a testament to their business viability, the start-up has secured USD 62 million in venture financing and another USD 50 million in debt financing from hedge fund Victory Park Capital Advisors to grow their business. Besides growing their business through extending more loan and debt underwriting services, the company is considering licensing their technology to banks to help improve the credit assessment process. Improving credit assessment through data analytics is one way of boosting financial access for vulnerable groups. This in turn enhances inclusiveness by providing households with the financial means to manage their cash flows.

The sharing economy[7] can benefit developing countries in many ways. Ownership rates of assets tend to be low, so the sharing economy allows users access to goods for which they might not otherwise have the opportunity to use, for example a car. It provides amateurs with opportunities to enter fields that previously required a large capital expenditure such as hotel proprietor or restaurateur. Flexible working conditions allow workers in the informal sector to obtain experience and a path to formalisation. It encourages the efficient use of idle resources which places less strain on the environment and helps developing countries move onto a sustainable development path. In some cases, it can even provide social benefits as users from different communities can meet, interact and bond over say a shared meal.

[7] There are a broad range of activities that fall under the umbrella of the "sharing economy" making it difficult to settle on a universal definition. Some of these activities also go by different names including "collaborative economy", "peer-to-peer economy" or the "gig economy". Generally, it involves individuals granting each other temporary access to underutilised assets.

The disruptive nature of the sharing economy also brings with it challenges for regulation, competition and taxation that must be addressed. Some regulatory reform is required so that rules designed for traditional business models do not unnecessarily hinder the sharing economy while also addressing concerns for consumer safety. Licenses required for hotels and restaurants would need to be made more appropriate for users renting a spare room or sharing a meal. Maintaining consumer safety requires platforms to develop policies to deal with emergencies such as theft or assault; sufficient insurance to cover accidents; and to clearly define the liability of the platform in such cases.

Sharing platforms are an example of a two-sided market where, on account of network effects, the platform becomes more valuable as the number of users rise. The desire to build scale could lead to anti-competitive behaviour such as exclusion restrictions or predatory pricing. Similar practices have arisen in other two-sided networks such as credit-cards and operating systems. Competition regulators should remain vigilant to ensure that market power is not abused. Tax laws have failed to keep pace with many of the new business models associated with the sharing economy. As it can be cumbersome for amateurs renting out a room to collect, file and remit taxes to the state, many jurisdictions have now partnered with platforms to collect these taxes directly. AirBnb now collects and remits taxes in several jurisdictions including Amsterdam, Portland, Rhode Island and Washington.

Governments in developing countries should work with sharing platforms and other stakeholders to design appropriate regulation to formalise the sharing economy, ensure public concerns are addressed and taxes collected. The sharing economy can thus contribute to much needed economic development, environmental sustainability and social cohesion (Soans et al., forthcoming).

Governments are exploiting the digital economy to simplify service provisions and enhance the delivery of social welfare programmes

Digital technologies can help governments in the delivery of services. Critical issues to government service delivery, which can benefit from the use of digital technology, include the collection of taxes, data, provision of healthcare, essential services and policy formulation. Estonia has exploited digital technologies to become a global leader in e-government (Box 6).

One key challenge of government welfare and poverty alleviation programmes is the identification of groups who qualify for social assistance. In developing countries, personal data records are often incomplete or absent completely. Without clean and up-to-date population records, social programmes are prone to delivering assistance to the unqualified people, excluding eligible persons and ending up over-budget. For example, an estimated 40% of global food aid is wasted because of these reasons (World Bank, 2013). Reducing such leakages is crucial to ensuring food aid reaches those who need it most urgently.

Box 6. **How Estonia became a global leader in e-government**

When Estonia regained its independence from the Soviet Union in 1991, it had few natural resources, no administrative system to speak of, and less than half its population had a telephone line. The story of how this Baltic country with 1.3 million inhabitants transformed itself from such humble beginnings into a global technology leader is a remarkable one.

In the early 1990s, Mart Laar's young government (the average age of ministers was 35) introduced a significant programme of taxation reform, free trade, sound monetary policy and privatisation to spur growth. Instead of building on top of legacy technologies left behind by the Soviets, successive Estonian governments decided to leapfrog to the edge of the technological frontier. For example, even though the phone system in Tallinn then dated back to 1938, and Finland offered to build an analogue telephone-exchange for free – Toomas Hendrik, the Estonian President declined the offer, opting to invest in the latest digital network equipment instead. Similarly with mapping property rights, Estonia went from having no land registry to a digital one, bypassing the stage of paper records. This kind of progressive thinking fed into the broader government policy of Tiigrihüpe ("Tiger Leap") to invest heavily in computer and network infrastructure, especially in education. Estonia now ranks fourth amongst OECD countries in wireless mobile broadband subscriptions per capita and its Internet speed is frequently cited as the fastest in the world in terms of download speed (OECD, 2015a).

The Digital Signatures Act of 2000 laid the foundation of the digital state in Estonia. The Act introduced a standardised national Public Key Infrastructure (PKI) that links citizens' identities to digital cryptographic keys. This enables people to sign any contract electronically and grants digital contracts and documents the same legal validity as paper ones. One byproduct of this law was to digitalise all aspects of government through market demand. As citizens prefer the convenience of digital documents, government bodies have had to invest in the necessary digital infrastructure to facilitate such documentation. Microchips in traditional ID cards carry digital certificates for legal signatures and for authenticating for various services. Every citizen over 15 is required to have an ID card – there are 1.2 million active cards, close to the size of the entire population. The number of e-services available to Estonian citizens and businesses are now 600 and 2,410 respectively (Anthes, 2015). 95% of Estonians pay their taxes online whilst 24% of voters in the 2011 parliamentary elections voted online after Estonia became the first country in the world to allow online voting nationwide in 2005 (Tamkivi, 2014). To further accelerate innovation, public and private bodes can access the same data exchange system, called X-Road. This has fuelled progressive public-private initiatives, such as ProgeTiiger ("Programming Tiger"), which introduced universal computer coding for five year olds in 2012. It is difficult to quantify the overall economic impact of Estonian e-government but savings from the Digital Signatures Act alone are estimated at USD 500 million per year, or about 2% of Estonian GDP (Anthes, 2015). The technology friendly environment has also given rise to a thriving local startup scene, with TransferWise – a foreign exchange platform – and Skype having already garnered international acclaim.

Increased reliance on digital technologies also increases the risk of cyberattacks, as the "Cyberwar" of 2007, whereby various government ministries were targeted by malware, demonstrates. Estonia has since invested heavily in cybersecurity measures and became the home to the NATO Cooperative Cyber Defence Centre of Excellence in 2008. Moreover, because the essential apparatus of the Estonian state has been digitised and is backed up in the cloud, it is possible for the government to restart core functions from exile if the country came under physical attack.

Although Estonia faced an unusual set of historical circumstances when rebuilding its state, it provides an instructive example of what progressive political intent can achieve in harnessing the digital economy for developing countries.

Digital technologies can help governments to provide a reliable way of collecting and storing population data. To this end, the Indian government has committed to providing each of its 1.3 billion citizens with a unique digital identification signature, and has spent USD 2.2 billion on the project in 2010 (Box 7). Successive Indian governments can not only use this data to optimise social programmes but also gain a deeper understanding of the underlying causes of poverty.

Box 7. **Digital identification may help improve social welfare delivery in India**

Identifying beneficiaries poses problems for social welfare deliver in India. Inadequate data records mean that government agencies frequently distribute social welfare benefits to the same people multiple times, or to people who do not qualify for welfare. It is estimated that 58% of the subsidised grains and 38% of the subsidised kerosene disbursed under the Public Distribution System (DPS) programme do not reach their intended beneficiaries (Government of India, 2005). Such duplication and waste afflict several social welfare programmes including scholarships, healthcare and subsidised household goods.

Identification issues also result in some eligible households being denied social assistance. Currently, citizens are registered with each local village, town or city and receive their rights and entitlement according to their place of residence. Ration cards, for example, are issued at the town or city level. The lack of a portable identification means that people who have relocated from one city to another may be denied social assistance. As a result, this rigid system also imposes a cost on labour mobility.

To overcome these challenges, the Indian government has launched the Aadhaar Project to issue every Indian citizen with a unique digital identification signature based on their biometric information such as thumbprints and iris scans. The project made use of digital technology and computing devices to digitise the scans, match the biometric and personal data against an existing database, and issue a unique identity number. Unique identification make it simpler for authorities to verify that subsidised goods are delivered to the right recipients while the use of biometric markers limit the scope of fraudulent activities.

With an initial estimated cost of is between USD 2.2 billion and USD 2.4 billion (about 0.1% of the country's GDP in 2010), the project is expected to yield many benefits, chief of which would be the reduction in "leakage" of social assistance. Factoring in only the tangible costs of "leakage" reduction, the project is expected to yield an internal rate of return of 53% to the Indian government (National Institute of Public Finance and Policy, 2012). However, the project is expected to yield other intangible benefits too. By decoupling identification from location, the project could also provide a boost to labour mobility by reducing the costs of relocating from one city to another for work. Boosting social inclusiveness is also expected to have profound, if unquantifiable impact, on the economy. It could help to alleviate poverty and boost domestic consumption of the low income groups.

The capacity to link the physical world to digital networks – the Internet of Things – can transform societies and economies

The IoT is expected to deliver significant economic value over the next decade as the number of connected devices grows exponentially. The IoT consists of intelligent networks of sensors and devices connected to computers. These networks and sensors monitor the physical and natural environment, relay on real-time data, receive instructions and undertake autonomous action based on information they receive. More than 9 billion connected devices now exist around the world, including smartphones and computers (Cisco, 2013). This is expected to rise dramatically over the next decade, with estimates ranging from 25 billion to 50 billion devices by 2025 (McKinsey Global Institute, 2015). The economic potential of the IoT is enormous: the overall value of this impact, including consumer surplus, is estimated to be equivalent to about 11% of the global economy in 2025.[8]

In transportation, adaptive traffic systems use real-time data to adjust the timing of traffic lights and thus improve traffic flow. Such systems can also prioritise traffic types based on need,

[8] See Section III on interoperability rules, particularly relevant for the emergence of the Internet of Things.

thus ensuring the smooth flow of buses during peak hours, or ambulances and fire engines during emergencies. Abu Dhabi implemented SCOOT, an adaptive traffic system that covers 125 main intersections in the city in 2015 (Abu Dhabi, 2014). Smart parking meters adjust parking prices based on traffic volume and demand and send real-time information to motorists through connected applications. The cities of San Francisco and Berkeley have already piloted such systems. It is estimated that adaptive traffic systems and smart parking meters could reduce traffic congestion and the time spent looking for parking spaces by between 10% and 15%, which could be worth more than USD 500 billion globally by 2025 (McKinsey Global Institute, 2015). Autonomous vehicles can also reduce fatalities, ease traffic congestion, and free up time for drivers. Popularised by Google's self-driving car that has driven more than 100 000 miles on Californian public highways, autonomous vehicles are already in use in industrial environments such as mines and construction sites. Whilst there are still significant regulatory obstacles to overcome, between 1% and 2% of all light vehicles (15-30 million) could be fully autonomous and on the roads by 2025, with another 12 to 15% being semi-autonomous (McKinsey Global Insitute, 2015). The reduced fatalities, lower fuel consumption, and optimal use of road and parking space could be worth USD 235 billion to the global economy.

IoT also has great potential for developing countries. Whilst the IoT is likely to create more economic value in the developed world than in the developing world over the next decade because of the higher value of each deployment, the potential uses and applications are very important in developing countries, for example:

- The use of IoT-enabled drones helps the delivery of key humanitarian resources. In many developing countries, road infrastructure is poor, disconnected or inaccessible during the rainy season. This makes disaster relief and the delivery of healthcare extremely difficult. Médecins Sans Frontières partnered with Matternet, an unmanned aerial vehicle (UAV) company based in Silicon Valley in 2015 to pick up and deliver tuberculosis diagnoses in Papua New Guinea (Smedley, 2015). They served 10 000 patients living in remote rural areas. The use of drones and other digital technologies to optimise "the last mile" of delivery service could have a transformative effect on development policy in emerging countries.

- Developing countries start reaping the benefits of IoT-enabled precision agriculture. Precision agriculture uses data analytics and the IoT to improve agronomic decision-making, increase yields and reduce energy consumption. Global Positioning System (GPS) technology enables farmers to practice variable rate fertilisation, whereby farmers apply fertilisers at different rates throughout a field based on the soil's acidity level and phosphorus and potassium content (Lowenberg-DeBoer, 2015). Until recently, precision agriculture was seen as irrelevant to small-scale farmers in developing countries: their small plots were thought not to have the variability of industrialised farms, and they could not afford the technology. Recent research has indicated that significant variation in nitrogen supply does exist in plots of even two hectares (Khosla, 2012). Moreover, the cost of the technology is cheapening, and microloans provide alternative means to finance it. Tata Chemicals carried out a trial

with farmers on two acre plots in the province of Uttar Pradesh in India to determine if precision levelling improved wheat yields. Traditionally farmers used oxen to level the fields, which yielded approximately 800 kilograms per harvest. The Tata experiment used a small precision leveller tractor with GPS; yields rose to 2.25 tonnes, a 281% increase (Mondal, 2009). Increasing the productivity of small-scale farms through precision agriculture has enormous implications for developing countries, as several such as India and Indonesia face demographic booms over the coming decades.

With digital opportunities come challenges

The digital economy provides enormous value for developed and developing countries but confronts policy makers with some difficult challenges. Technology can spur development through a number of channels: by lowering the costs of production and exploiting returns to scale; by increasing the efficiency of existing markets, enlarging the size of markets and creating new markets; by creating economic opportunities in other sectors; and by yielding quality improvements that go beyond total factor productivity. However, the pace of technological change is accelerating, and technological change often outpaces regulation. One key challenge for policy makers then is how to craft policies to exploit the digital economy rather than merely reacting to its effects. Failing to proactively harness the digital revolution will have deleterious consequences across a range of domains, including countries' growth prospects, regional competitiveness, incorporation into high-value global production chains and attractiveness as a destination for high-skilled labour. Policy makers must realise that inaction is a policy choice in itself, and that proactively harnessing the digital revolution requires strategic planning. Moreover, because of the ratcheting up of the pace of technological change, this is not something that countries can afford to neglect, even to the near-future. Accessibility of the digital economy and the digital divide between various groups within countries (urban-rural, older people-younger people, etc), is a significant challenge and is discussed below. The biggest challenge for several developing countries will be to build a basic level of ICT infrastructure, on top of which the rest of the digital economy sits. This is not just a question of the right amount of public and private funding, but also the technical and institutional expertise with which to invest it.

Diffusion of digital technologies within developing countries presents a significant challenge for both cross-national income convergence and accessibility. Whilst developing countries have become more adept at adopting new technologies in terms of reducing the initial adoption lag, they are falling behind in terms of widespread technological diffusion within-country. Divergence in long-run penetration rates once technologies are adopted can account for 82% of the increase in the income gap between Western and non-Western countries since 1820 (Comin and Ferrer, 2013). Slowing technological penetration within developing countries is problematic because it exacerbates the digital divide: between urban and rural communities, educated and less educated people, and younger and older people. Rectifying this situation means everything from investing in ICT infrastructure in remote areas to upskilling workers or providing IT illiterate people with the skills needed to flourish in the digital economy.

Digitalisation and automation changes the composition of jobs across all skill segments. The rapidly evolving digital economy highlights concerns about the process of creative destruction and its resulting re-distributional effects on jobs and the income distribution. Robotics and automation have long been considered a threat to repetitive manual work, such as warehouse stocking and agricultural planting. Recent developments in digital technologies, however, are increasingly threatening the cognitive elements of jobs traditionally thought of as white-collar. The combination of powerful data analytics, machine learning, and the IoT is raising computer performance to rival that of humans in both routine tasks and tasks that humans were thought to hold a permanent cognitive advantage in, such as pattern recognition (Elliott, 2014). Computers are now as likely to write basic newspaper copy as well as make widgets. In a similar vein, e-discovery software is increasingly replacing the work of paralegals. Whole swathes of work in other fields traditionally conceived of as white-collar, such as tax and accounting, are also at risk of automation. It is estimated that the occupations of 47% of the US labour force are at risk of computerisation within the next two decades (Frey and Osborne, 2013).

The digital economy could thus exacerbate income inequality. Much of this can be explained by skill-biased technological change (SBTC), which increases the demand for educated workers (OECD, 2011). The college premium – the returns to a university education – has been rising across OECD countries since the 1970s, and accounted for between 60 and 70% of the rise in the dispersion of US wages between 1980 and 2005 (Autor, 2014). Concurrently, digital technologies have automated a wide range of manufacturing and clerical jobs, leading to a hollowing out of the middle skill distribution. This structural shift in the labour market has reallocated workers to low-skill jobs less susceptible to automation and increased the demand for high-skill jobs, thus heightening income inequality (Frey and Osborne, 2013). Moreover, by exploiting network effects benefits in the digital economy to scale rapidly, digital technology companies also exacerbate the winner-take-all phenomenon of superstar labour markets (Rosen, 1981). Superstar markets are labour markets where a small proportion of workers in a given field – athletics, acting, music performers, etc. – receive a disproportional share of the overall income distribution. WhatsApp acquired 900 million users – about 50% of the global instant messaging market – in less than six years, all with fifty engineers, who received huge pay-outs when the company was acquired by Facebook in 2014. Increasing computer-surveillance and analysis of worker performance could accentuate value differences between employees and intensify the winner take all effect (Cowen, 2015). New digital technologies continuously expand organisations' capacity to substitute capital for labour. Such substitution boosts productivity but does not help wages; instead, it enhances the return to capital and heightens disparities in wealth as well as income. Policy makers could thus be faced with a scenario whereby overall labour productivity is rising but with an increasingly polarised income and wealth distribution and less employment.

Digitalisation poses potentially severe implications for developing countries. First, digitalisation and automation in advanced economies may reduce the need for migrant labour to supplement ageing labour forces there. This could deprive emerging economies of a significant means of financing in the form of remittances, and up-skilling, in the form of return migrants with enhanced skills developed in their host countries.

Second, even though the initial effects of digitalisation on employment will be felt more acutely in developed countries, the long-term effects will potentially be much larger in the developing world as a greater share of the labour force is susceptible to automation there. Nike used 106 000 fewer contract workers in 2013 than in 2012 because it is "shifting toward automation," even in lower margin geographies, such as China, Viet Nam and Indonesia (McAfee, 2014). Foxconn, the manufacturer that supplies Apple and several other electronics companies, is planning to introduce robotics and more heavily automate its production process in an effort to reduce its 1.3 million strong labour force over the coming years (Gold and Lee, 2015). Moreover, the rise of 3D printing and additive manufacturing has the potential to re-localise parts of the production process and shorten global supply chains; with significant implications for jobs in low-value added manufacturing activities in developing countries. These trends are contributing to "premature deindustrialisation" and mean developing countries need to think carefully about where they want to position themselves in global value chains (Rodrik, 2015). This implies a particular challenge for developing regions with fast growing working-age populations, such as South Asia and sub-Saharan Africa, which may be less able to employ the millions of job entrants in basic manufacturing industries.

Third, developing countries will most likely have to navigate these challenges in a world in which the globally relevant regulations and standards of the digital economy are set largely by developed countries. Fora do exist where developing countries can contribute to the global digital policy regime. The UN Internet Governance Forum (IGF) provides a multi-stakeholder platform that facilitates discussion of public policies pertaining to the Internet, in which many developing countries participate. The Governmental Advisory Committee (GAC) of the Internet Corporation for Assigned Names and Numbers (ICANN) provides advice to ICANN on public policy aspects of ICANN's responsibilities regarding the Internet Domain Name System (DNS) and currently has 171 members, many of which are developing countries. And the Internet Engineering Task Force (IETF) is also open to any participant. However, policy-making in the global digital regime is still dominated by the private sector and governments of advanced countries. As "takers" of the global regulatory regime, developing countries may be at a disadvantage when building their own digital economy – some of these issues are discussed further in the enabling factors section below.

Section II has explored the major contours of the digital economy for developing countries. Digitalisation provides significant opportunities to help solve specific development challenges across a range of domains, such as government service delivery, enhancing agricultural productivity and providing access to financial services. With these opportunities come risks, however: digitalisation can compound pre-existing inequalities and potentially undermine the industrial-led models of development that have been successful in the past. As such, emerging countries need to think carefully about how to best exploit the benefits of digitalisation and set their economies up for success. The next section examines four enabling factors that are crucial for developing the digital economy.

III. ENABLING FACTORS: WHAT COUNTRIES CAN DO TO DEVELOP THEIR DIGITAL ECONOMY

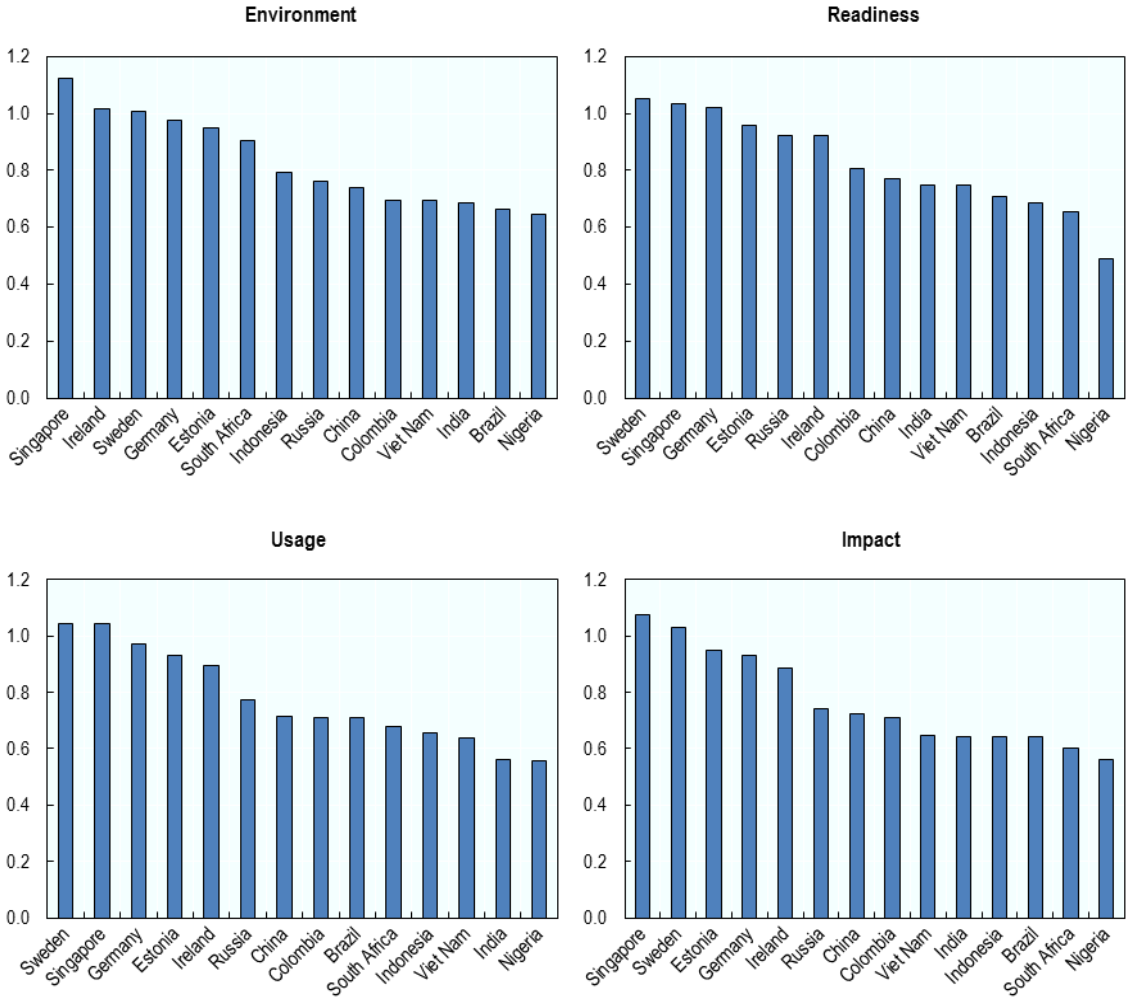
Several factors are crucial to the development of the digital economy within developing countries. These factors range from broad factors such as a business-friendly environment (including the protection of intellectual property) and socio-political stability to factors specific to the digital economy such as data and cyber security regulations, ICT infrastructure, funding for research related to the digital economy and skilled labour. Open and competitive telecommunication markets also need to be at the forefront of any digital strategy. In addition, these factors interact with each other and the broader business environment to strengthen or weaken the impact of each factor. The availability of and the extent to which these factors are developed in an economy determines the digital capabilities of a country that in turn, determines the benefits a country can extract from digital technology. For example, smart grids, which use digital technology to automatically adjust electrical delivery based on changes in energy usage, require engineering, statistical and computing expertise to implement and operate. Or, smart transportation systems, which rely on commuters' mobile devices to detect traffic hold-ups, will require a relatively high rate of smart phone penetration.

Well-developed digital capabilities are often associated with higher digital usage and impact. The World Economic Forum's Networked Readiness Index measures the performance of the various enablers of the digital economy. Beyond measuring enabling or input factors of the digital economy such as the regulatory and business environment (Environment sub-index) as well as the development and affordability of digital infrastructure and the availability of skilled labour (Readiness sub-index), WEF's index also provides indicators on the outcomes. These include the intensity of digital usage of individuals, businesses and governments (Usage sub-index) as well as the impacts of the digital economy on countries' economies and societies (Impact sub-index) more broadly. Expectedly, more advanced countries with higher score on the enabling factors generally also perform better on the outcome indicators (Figure 4).

This section will examine four enabling factors of the digital economy – infrastructure, skills, finance and regulation – and the interaction effects between them. The section will provide suggestions on how governments of developing countries can develop these enablers and harness the benefits of the digital economy by drawing on lessons from more digitally-advanced countries such as Estonia, Germany, Singapore, Sweden and the United States. Additionally, case studies from emerging countries which are rapidly building up their digital capabilities, like China and India, will also be used to provide ideas on how policies can be tailored to the needs of less developed countries.

Figure 4. **Better digital capabilities are associated with higher usage and impact in the digital economy**

Networked Readiness Index 2015 (1= United States)



Notes: The four sub-indexes are from the World Economic Forum's Networked Readiness sub-index. Methodological details can be consulted online: http://reports.weforum.org/global-information-technology-report-2015/network-readiness-index/. Each of the four sub-indexes is based on pillars, whose index scores are themselves based on various indicators. The sub-index *Environment* is based on the following pillars: (1) Political and regulatory environment, (2) business and innovation environment. The sub-index Readiness is based on: (3) Infrastructure and digital content, (4) Affordability, (5) Skills. The sub-index Usage is based on: (6) Individual usage, (7) Business usage, (8) Government usage. The sub-index Impact is based on: (9) Economic impacts, (10) Social impacts.

Source: Authors' calculations based on WEF and INSEAD (2015), *The Global Technology report 2015 ICTs for Inclusive Growth*, http://reports.weforum.org/global-information-technology-report-2015/.

Infrastructure: Developing the backbone of the digital economy

Without the appropriate infrastructure, it is impossible to implement the digital technology which underpins the digital economy. The communication infrastructure is the foundation which enables the transmission of digital information. Improving the communication infrastructure is critical for many developing countries, which are still lagging behind in terms of the performance and coverage of communication networks. Improving the communication

infrastructure is also a necessary first step to harness the benefits of advanced enablers such as cloud computing. At the same time, it is essential to recognise the importance of establishing a competitive telecommunication market and the need for an independent regulator to ensure predicable and evidence-based decision-making. This section will look at both the physical infrastructure needed to enable the transmission of digital data and the data infrastructure and resources needed to harness the benefits of more advanced digital technology.

New potential for developing countries to close the infrastructure gap

Communication infrastructure enables the transmission of digital information. Communication infrastructure consists of several components including transmission cables, along which data travels, and transponders, routers and servers route data traffic, and cell phone towers to enable wireless communication. Typically, data is carried by copper wires or optic fibre cables that connect the various networks together. Increasingly, 4G wireless technology is also enabling high-speed wireless transmission of data (via radio wave) until it reaches a cellular tower after which the performance is influenced by whether there is sufficient backhaul capability. In addition, spectrum limitations always ensure that operators endeavour to offload traffic onto fixed networks as soon as possible. Transponders, routers and servers form part of the active infrastructure to route or switch data flow through the various networks and enable the various users to be connected into a single network of a multitude of networks.

Communication infrastructure determines the network robustness and Internet speed, which in turn, determines the ways in which digital technology can be applied. Activities like web browsing and music streaming require only a basic download speed of 1 to 4 megabits per second (mbps). Activities like gaming and video streaming would require higher download speeds. Higher end digital services such as telemedicine and video-based education would require even higher download speeds of 10 to15 mbps, while business activities such as video conferencing with multiple users, real-time data collection and remote supercomputing (supercomputing on cloud technology) will require a download speed of at least 50 mbps (see Annex 1).[9]

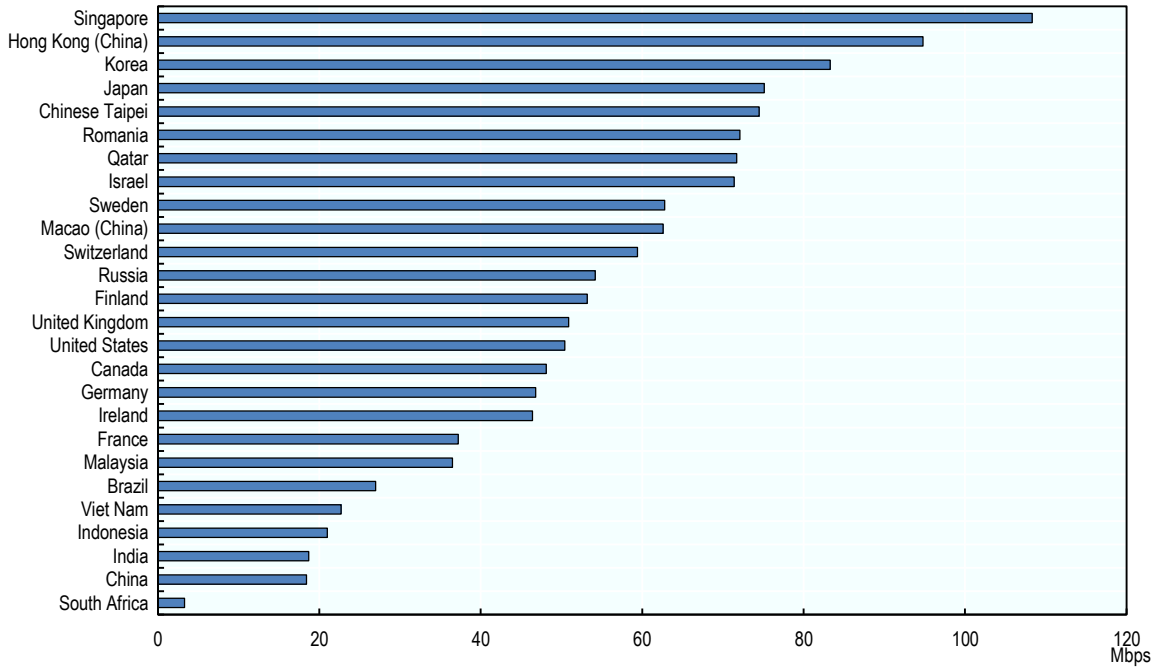
Although developing countries still lag developed countries in Internet speeds, developing countries have the potential to close this gap at a fast pace due to newly available and increasingly less expensive communication infrastructure. Many developing countries like India, Indonesia and Costa Rica still lag substantially behind more advanced countries (Figure 5). Developing countries can potentially close this gap quickly by leapfrogging the stages of development in digital infrastructure development. For example, instead of moving through the different phases of network development as the developed countries did from analogue to copper and then to fibre

[9] More specifically, the Internet speed is dependent on two factors: the bandwidth and the latency of the connection. The bandwidth refers to the maximum amount of data that can be transferred at any one point in time and is dependent on the number of 'transmission lines' between a computer and the Internet service provider (also known as the "last mile connection"). The latency of the connection refers to the speed data packets travel through the "transmission lines." Fibre optics cables have a lower latency and can produce faster Internet speed. Increasingly, 4G wireless technology is also enabling high-speed wireless transmission of data that reduces the need for expensive cable installation within a country.

optics, developing countries can choose to directly install fibre optics. Moreover, 4G wireless communication continues to improve, it may well be possible that developing countries can use 4G wireless networks for the provision of high-speed Internet in place of fixed line services, providing greater convenience and connectivity to business and consumers.

Figure 5. **Many developing countries are still lagging far behind advanced countries in terms of Internet speed**

Average Peak Connection Speed in Second Quarter 2015 (Mbps)



Notes: The average peak connection speed is computed from the highest connection speed from each unique IP address determined in a specific country or region, or state in the United States. While the average peak connection speed is reflective of the Internet connection capacity, it does not reflect the connection speed during "normal" usage conditions, which are also influenced by the types of activities that the average user in the country or region engage in.

Source: Akamai Technologies, Inc. (2015), *Akamai's State of the Internet Q2 2015 Report*, https://www.akamai.com/us/en/our-thinking/state-of-the-Internet-report/.

The large capital out-lay required for communication infrastructure investment sometimes poses a significant barrier to entry. That being said, it is noteworthy that experience in OECD countries shows that competition drives investment and that the opening of markets in developing countries has coincided with tremendous investment by the private sector across multiple competitors in many countries. Thus, governments play a crucial role in stimulating competition within the sector to ensure that the telecommunication sector remains competitive. A competitive telecommunications sector is crucial not just for ensuring competitive prices for consumers, but also to stimulate investments that would improve the communication infrastructure. Liberalisation of the sector or the introduction of foreign competitors could increase the competition in the sector. India is an example of a country that successfully stimulated its telecommunication sector through the introduction of foreign competition and liberalisation of the sector. However, as India's example has shown (Box 8), liberalisation requires more than a relaxation of rules, it also requires establishing agencies to provide

regulatory oversight and to arbitrate on disputes within the sector. The latter is especially critical to provide confidence to foreign investors of impartiality in the event of legal disputes.

Box 8. **How India achieved its mobile revolution, benefiting livelihoods across the board**

India's successful mobile revolution stemmed from the Indian government's success in transforming and liberalising the telecommunications sector. India's successful example illustrates how a less developed country can leapfrog technological development through the right policies.

Prior to the liberalisation of the telecommunications sector in 1994, telephones were considered a luxury with tele-density at 0.8 per hundred persons, well below the world average of 10 per hundred persons, but the liberalisation of the telecommunications sector transformed the country into one of the fastest growing markets for mobile communications with millions of new mobile subscribers every month. The mobile revolution provided Indians from all walks of life, such as construction workers, cab drivers, grocers and farmers, access to the mobile communication. Calls which used to cost as much as INR 0.75 per minute now costs INR 0.025 per minute (Krishnamurthy, 2008). Besides democratising access to communication technology, the mobile revolution is also boosting productivity. Fishermen in South Kerala use their mobile phones to check the prices of their catch, farmers use mobile technology to obtain weather information while crop producers (i.e. vegetables, fruits and flowers) use their mobile phones to directly access market information, thereby removing the need to pay for price information through intermediaries. Two factors underscored the country's phenomenal success in boosting teledensity: first, the ability to enact policies which encouraged private sector investment and competition in the telecommunications sector, and second, emphasis on consumer protection.

In the early 1990s, recognising that tele-infrastructure in India significantly lagged behind those in many countries, including developing countries, the Indian government undertook efforts to reform the telecommunications sector. Prior to the reforms, the telephone network covered only 140 000 villages out of 576 490, or 24.3% of the villages. Waiting lists for fixed-lines was about 2.54 million. At that point in time, telecommunication services were provided by a single state-owned operator as a result of the archaic Indian Telegraph Act. In 1994, the government initiated the National Telecom Policy (NTP 1994) with the explicit target of extending telephone coverage to all villages by 1997. Recognising that the cost for such a project would be prohibitive, estimated to be INR 230 billion), the government involved the private sector in this initiative. Although the NTP 1994 did not achieve its target by 1997, it did succeed in replacing the monopoly with a duopoly structure instead. Subsequently, the government introduced the Telecom Regulatory Authority of India Act 1997 (TRAI 1997) to create an independent statutory regulatory authority for the telecom sector. This body would play an important role in ensuring the affordability of telephone and mobile services and promoting competition within the sector through the wide remit[10] it enjoys through the TRAI 1997.

The government continued reforming the sector by liberalising the cellular mobile service, fixed line service and cable service through the passage of the New Telecom Policy 1999 (NTP 1999). The government also addressed specific issues undermining the telecom sector such as interconnection disputes between service providers by clearly asserting that interconnection between mobile service providers and basic service segment is permissible in the NTP 1999. The act defined the universal service obligations, the role of the regulator and spectrum management. Most importantly, the NTP 1999 further enhanced competition in the industry by removing all barriers to entry for the sector, and encouraging the inflows of foreign direct investment (FDI) into the sector[11]. The efforts to promote FDI, in particular, provided access to foreign funds for telecommunications infrastructural investment and also the latest telecommunications technology.

[10] These include ensuring technical compatibility and interconnection between operators and service providers, regulating revenue-sharing agreements, ensuring quality-of-service standards, protecting consumer interests and approving tariffs for telecom services.

[11] Under the NTP 1999, foreign investors could invest up to 49% in a joint venture, and up to 74% subject to specific conditions. Full foreign ownership in the manufacture of telecom equipment was permitted under the NTP 1999. As a result, FDI inflows increased by more than tenfold from INR 3.4 billion in 2000 to INR 46.0 billion in 2007 (Prasad, 2008).

Box 8. **How India achieved its mobile revolution, benefiting livelihoods across the board** (*cont.*)

Finally, to safeguard investors' interests in the sector, the government also established a specialised dispute resolution tribunal, the Telecom Disputes Settlement and Appellate Tribune (TDSAT) in 2000. The tribunal's responsibilities were to adjudicate disputes between a licensor and licensee, service providers, or service providers and consumers. It is headed by a judge of the Supreme Court of India or chief Justice of a High court with relevant experience in the fields of technology, telecommunications, industry, commerce or administration. By establishing the tribunal, the government signalled a firm commitment to the protection of investors' rights through due legal processes and gave confidence to investors to invest in the country.

In summary, highly successful mobile phone penetration was driven by the government's firm commitment to introducing competition in the telecommunications sector. The government's approach of gradually liberalising the sector, commitment to protecting consumer and investor interests through clearly articulated laws and effective arbitration channels were key factors to successfully liberalising the sector.

Source: Prasad, 2008.

Both developed and developing countries can improve the exploitation of data resources

Data resources are increasing exponentially and are a critical input for the digital economy. Digital technology such as data analytics, cloud computing and the IoT make use of data in different ways to generate new insights, optimise production or evaluate policies. The amount of data resources in the world is projected to increase exponentially with the increased use of digital technology in all aspects of life. Organisations are increasingly collecting operational data such as point-of-sales data, transaction data, logistics data, among others, to improve their production and planning process. The use of the Internet by consumers is generating a large volume of user-created data such as Facebook posts or Twitter tweets, and web search data (Table 1). It is estimated that 2.5 exabytes (EB, a billion gigabytes) of data are generated every day, an amount equivalent to 167 000 times the information contained in the Library of Congress of the United States (OECD, 2015b).

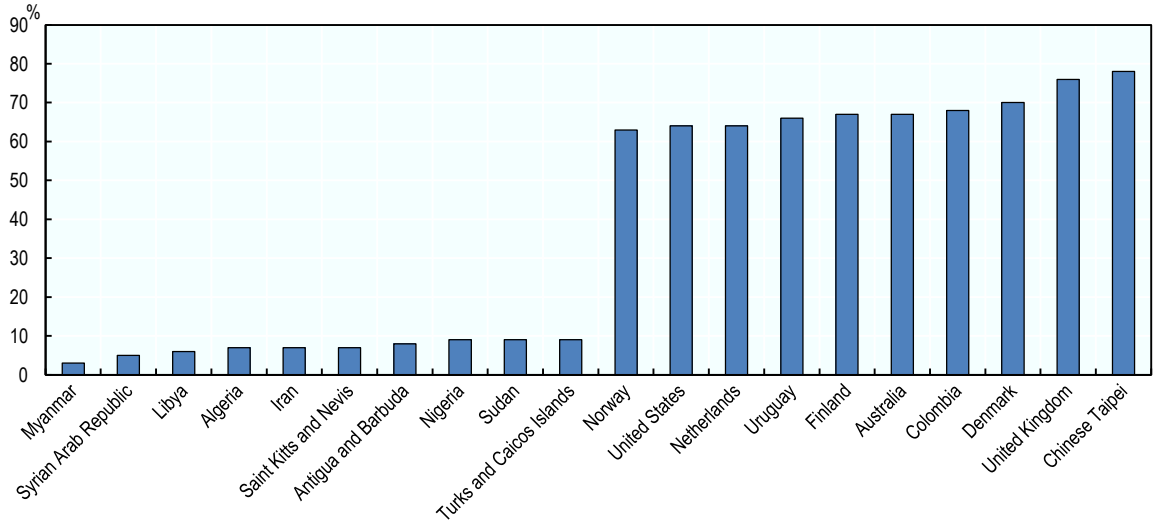
Table 1. **Overview of types of digital data sources**

Data source	Definition and examples:
User created	▪ Refers to digital content created by consumers and share via online platforms ▪ The creator of the content may or may not retain the rights over the shared materials ▪ Examples include user created videos, photographs, music, text and status updates on social media
Administrative	▪ Refers to data collected by the government for administrative purposes ▪ Data maybe collected in non-digital format or digitised, or collected via digital platforms ▪ The data is typically owned by the government ▪ Examples include e-tax filings, e-medical records, economic data
Activity generated	▪ Refers to data generated as a result of using digital platforms ▪ Data is typically owned by companies which collect the data ▪ Examples include Google web searches, web-activity logs, tracking data, censor data
Transactional data	▪ Refers to data arising from commercial transactions over digital platforms ▪ Data is typically owned by merchant and/or payment solution companies

Source: Authors' illustration.

Governments play a particularly important role in encouraging the use of data resources. Because of some of the properties of data resources, the benefits of data resources may not be fully realised if left purely to market force. First, unlike most other goods, the benefits of data resources do not diminish with usage – a property known as non-rivalry. Thus, as with other non-rival goods, the benefits of data resources can be theoretically maximised by maximising the access to the data (OECD, 2015b). Second, data resources serve a general purposes and its benefits are not restricted to the purpose for which the data was collected (OECD, 2015b). For example, demographic data can be used by urban planners for infrastructure planning, by healthcare providers for service planning, by businesses and market research firms to size or segment markets. The benefits of a dataset are further amplified when merged with other datasets. Combining different datasets together creates new dimensionality in the data which could enable the use of more sophisticated analysis methods and yield new insights.

Figure 6. **Developing countries still have a lot of room to improve government data openness**
Open Data Index 2015, top and bottom 10 countries



Note: The Global Open Data Index benchmarks open data by looking at 13 key datasets in 122 countries. The datasets were chosen based on the G8 key datasets definitions and in consultation with the Open Government Community. The 13 datasets used in this assessment are national election results, company register, national map (at a map scale of least 1:250 000 or better), government spending by sector, national government budget, legislations, economic and demographic information from the national statistical office, national postcode/ZIP database, water quality, pollutant emissions, weather forecasting, land ownership and public transport timetables for national public transport services.
Source: Authors' calculations based on Open Knowledge Foundation (2015), "Global Open Data Index", http://index.okfn.org/place/.

There is still much room for improvement in the area of data sharing for both developed and developing countries. The Open Knowledge Foundation has found that Chinese Taipei performs best in terms of sharing data openly (Figure 6).[12] Among developing countries, Colombia performs well with an Open Data score of around 68, in the range of Australia and Denmark. In general, developing countries have a lot more room for improvement. The bottom ten countries ranked according to the index were all developing countries with an index score of less than 20.

[12] These measures include transport timetables, government budget, government spending, election results, company register, national map, national statistics, legislation, postcodes or zip codes and pollutant emission scores.

However, for many developing countries, collecting data itself could be a challenge due to a combination of lack of expertise, inadequate resources or poor standards and accountability. For example, 62% of all non-officially registered births are estimated to have occurred in less developed countries (UNICEF, 2013). Governments of developing nations may refer to the Paris 21[13] road map to develop the capabilities and institutions to maintain proper data and statistics.

Broadly, there are two ways to improve the access to data, first, through provision of non-sensitive data collected by public agencies, and second, by facilitating the access to non-public sources of data through subsidies or data-sharing platforms and/or frameworks. As the owner of administrative datasets and national statistics, governments can play a huge role in facilitating data openness.[14] For example, transport timetables, legislation, economic indicators, and non-sensitive geospatial data could be shared openly to help consumers and businesses optimise travel routes or business plans, among other measures. Increasingly, "open data" platforms also provide an avenue to access public and non-public sources of data. Although the term "open data" platform has yet to be properly defined[15], these platforms generally provide universal access to data available on the platform. An example of such a platform is the data.gov portal set up by the government of the United States. (Box 9). The platform can be structured in a way to allow users to freely upload and download data, there by encouraging the sharing of data.

Box 9. **The US Government encourages data openness with various initiatives**

Since 2013, the US has launched a series of Open Data Initiatives aimed at making government data more readily available and useful to ensure a more efficient and transparent government. Besides launching initiatives to make available data from the health, energy, climate, education, finance, public safety and global development sectors, the government has also put in place an executive order to make open and machine-readable data the default format for all government data. This would improve data accessibility by enabling web scraping and data trawler algorithms to "scrape" data off government websites.

To promote the use of government data and foster collaboration of the Open Data Policy, the government of the United States also launched Project Open Data, an online public repository where members of public could access government datasets. By publishing the project on an open source platform called GitHub, developers are able to work collaboratively on the sources code of the repository to develop complementary tools and resources for the datasets. For example, developers have created a tool that can instantly convert spreadsheets and databases into application programme interfaces (APIs) that can be used by other application developers. Such datasets and tools can then be integrated into applications and software, which make use of public data for benchmarking or informational purposes. Even individual consumers can access the repository to use the data in his or her own way.

[13] The Partnership in Statistics for Development in the 21st Century (PARIS21) is a consortium established in 1999 for the purpose of promoting the use of statistics and evidence-based decision-making in international development. The consortium brings together analysts, policy makers, statisticians and development practitioners to facilitate statistical capability development and advocate the use of data in policy making.

[14] For many developing countries, collecting data itself could be a challenge due to a combination of lack of expertise, inadequate resources or poor standards and accountability. About 35% of all births are not officially registered, 62% of which is estimated to have occurred in less developed countries (UNICEF, 2013). Governments of developing nations may refer to the Paris 21 road map to develop the capabilities and institutions to maintain proper data and statistics.

[15] The term "open data" is commonly applied to government initiatives, such as data.gov (United States), data.gov.uk (United Kingdom) and data.gov.fr (France), to provide greater access to public data. However, in the scientific community, "open data" could also refer to access to scientific data for research purposes (OECD, 2015b).

Broadly, there are a few key principles in establishing "open data" platforms. These principles help to maximise the access to data while ensuring the reusability and portability of the data. Ensuring the reusability of data may be as important as improving access to the data, as only data stored in common formats can be easily read and accessed across a variety of IT systems (OECD, 2015b). Storing data in common formats also help ensure data portability, allowing data to "flow" across organisations, facilitating the integration of data across multiple sources, and enabling consumers an easier way to manage multiple data.

1. **Accessibility** – making data accessible involves ensuring that there are minimal restrictions on the access, usage and redistribution of the data. Crucially, non-discriminatory access is necessary to ensure that no one user group is disadvantaged in the use of the data (OECD, 2007). Ensuring non-discriminatory access involves ensuring that the terms of use are independent of the users' "identity or intended use."

2. **Reusability** – In general, data in machine readable formats are reusable data. This involves ensuring that the data has a minimal defined structure such as a matrix structure. Common data formats which are considered machine readable include the RDF (Resource Description Framework), XML (eXtensible Markup Language) and JSON (JavaScript Object Notation). Standard file formats such as CSV (comma-separated values) and Excel files are also considered reusable (OECD, 2015b).

3. **Portability** – Data portability refers to the ability for individuals to transfer their data across multiple platforms. The benefits of portable data are two fold, first it saves the consumers the hassle of having multiple sets of similar data by allowing them to port data across platforms, and second, it facilitates the integration of multiple datasets through the use of a common identifier in all the datasets. Ensuring data portability, however, requires a framework governing the use and protection of personal data. It needs to be able to protect the consumer's right on whether to have their data ported from one controller to another (OECD, 2013a).

Skills: Nurturing talent for the digital economy

Skilled labour is a critical input for the digital economy. Engineering expertise is required to build, maintain and service the network equipment used to transmit digital data, computing and data storage systems, and other machinery or equipment which may be embedded with a digital network to facilitate the Internet of Things. Computer science specialists are needed to create the computing algorithms and user interface needed for users to operate the digitally connected networks. Data science expertise is also required to create predictive or analytical models to analyse big data. Thus, a deep and diverse field of expertise is required to produce the service or equipment which underpins the digital economy.

However, the digital economy also requires that all participants, including consumers utilising digital services, possess a minimum level of digital and computer literacy on its users.[16] Because the digital devices typically run on computing platforms or involve embedded digital networks, even consumers need to have some basic knowledge of how to operate a computing device or digital appliance to participate in the digital economy. For example, it is not possible to engage in e-commerce without the use of a smart phone or a computer.

Thus, in understanding the types and level of skills required to grow a country's digital economy, it is important to distinguish between the end-users and specialists as the skill level required of each type of users is very different. Digital users may be further distinguished between professional users who use digital services in the course of their work and general users who use digital services for leisure (Table 2). The skill level required for professional users is much higher. Different types of users will require different skill sets (Table 3). For example, a financial analyst using a data analytics tool to perform his financial forecasting needs to have a minimum level of programming skills to operate the tool. However, he does not have to possess the programming knowledge required for him to create the tool or the user interface for the tool. On the other hand, specialists who create new services out of new or existing technologies are expected to have the necessary programming or even engineering skills, in addition to digital and computer skills. For example, a combination of digital, computing, programming and engineering skills may be essential to develop smart home applications that can be integrated with home electronic appliances. Data analytics may also require advanced statistical knowledge, in addition to programming skills.

Table 2. **Different types of users or labour for the digital economy**

Role	Description
Specialists	• Their main job is to develop, provide and maintain the digital equipment, networks or services for customers • They need to possess the knowledge to operate and maintain info-communications technology systems
Professional Users	• Advanced users are competent users of advanced or specialised software or digital tools for work-related purposes such as data analysis, problem-solving, research or manufacturing production • Their job involves the application of digital technology in relation to other fields such as industrial production, medicine, business and finance, agriculture, research and development, statistics, etc • Examples include bank analyst, telehealth worker, etc
General Users	• Basic users are users of generic tools for personal purposes such as information retrieval, entertainment, social interaction, communication, etc. • They are typically individual consumers • Examples of generic tools are Internet browsers, office suites, mobile applications

Source: Authors' illustration.

[16] Digital skills refer to the ability to use digital networks to transmit, retrieve and analyse digital data (Friedon, 2005). Computer skills refer to the ability to operate and use computing devices for informational, entertainment, communication and basic work functions such as creating a word document or presentation.

Table 3. **Skill requirements for different users in the digital economy**

Labour/User type	Skill requirements				Skill level
	Digital	Computer	Programming	Engineering	
Digital service specialists	✓	✓	✓	✓	High
Professional users	✓	✓	✓		Moderate
General users	✓	✓			Low

Source: Authors' illustration.

Fostering skills for digital specialists and professional users

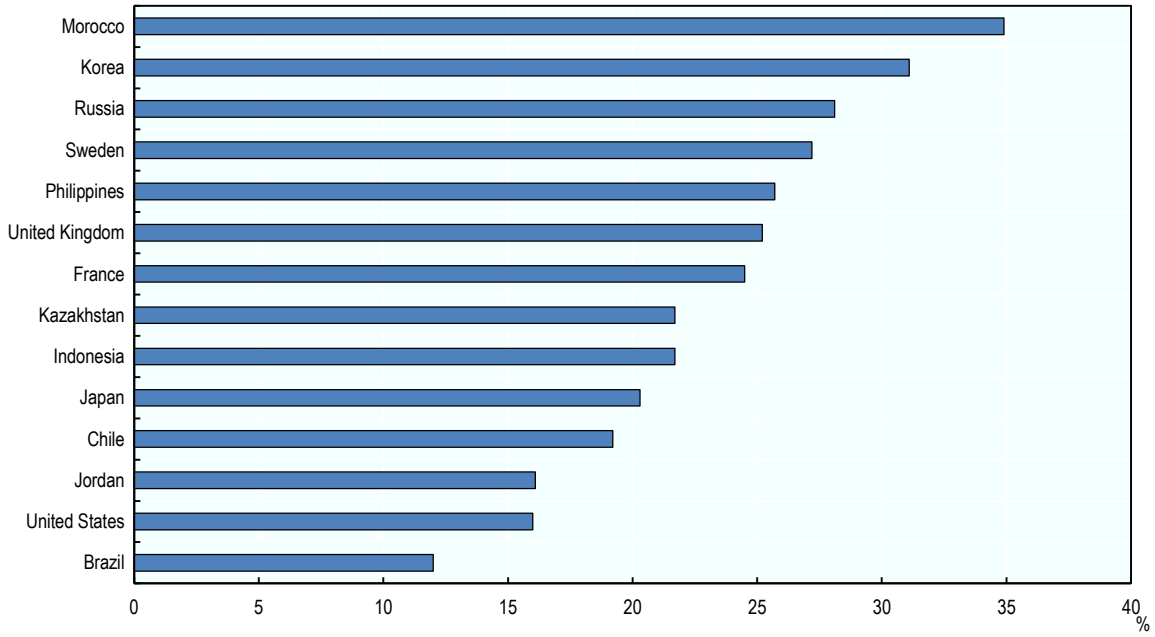
Specialists and professional users usually require deeper expertise on computer programming or engineering which are obtained through a tertiary education. For more advanced work to develop new digital services, a doctoral degree in computing may be necessary. Depending on the job requirement, training in other disciplines may also be necessary. For example, data scientists are required to possess both computing and statistical knowledge to use computer algorithm to analyse statistical trends.

Because specialists and professional users utilise a broad range of technical skills such as computer science, engineering, mathematics and statistics, investing in science and technology education and vocational training is crucial to building up a base of talent pool for the digital economy. Broadly, there are two ways of building up this pool of talent: First, to train more science and technology graduates in the local education institutions, and second, by attracting global talent with the requisite skill sets to work in the country. Although building an indigenous pipeline of talent requires investment and time, it results in a more stable talent pipeline. On the other hand, leveraging global talent allows a country quick access to some of the top talents in digital technology, however, the flow of talent may be smaller and less secure.

To build an indigenous pipeline of specialist and professional users, economies not only need to have a significant share of graduates in science and technology tertiary programmes but also invest sufficiently in these programmes. Developing countries do not necessarily lag behind more advanced countries in the proportion of graduates in science, engineering, manufacturing and construction programmes (Figure 7). Less developed countries like Morocco and the Philippines have produced as high a proportion of tertiary graduates in science, engineering, manufacturing and construction programmes as developed countries like Korea, Sweden and the United Kingdom. However, most of these countries (with the exception of Morocco) lagged the developed countries in terms of government expenditure per tertiary student (Figure 8). This suggests that despite the comparable proportion of graduates in science, engineering, manufacturing and construction, there may be differences in the quality of the education due to funding differences. This is consistent with lower ICT Readiness scores in WEF's ICT Networked Readiness Index in developing countries as compared to advanced countries, which among others, measures the level and quality digital skills in the country (see Figure 4 above).

Figure 7. **Comparable proportions of graduates in the fields of science, engineering, manufacturing and construction**

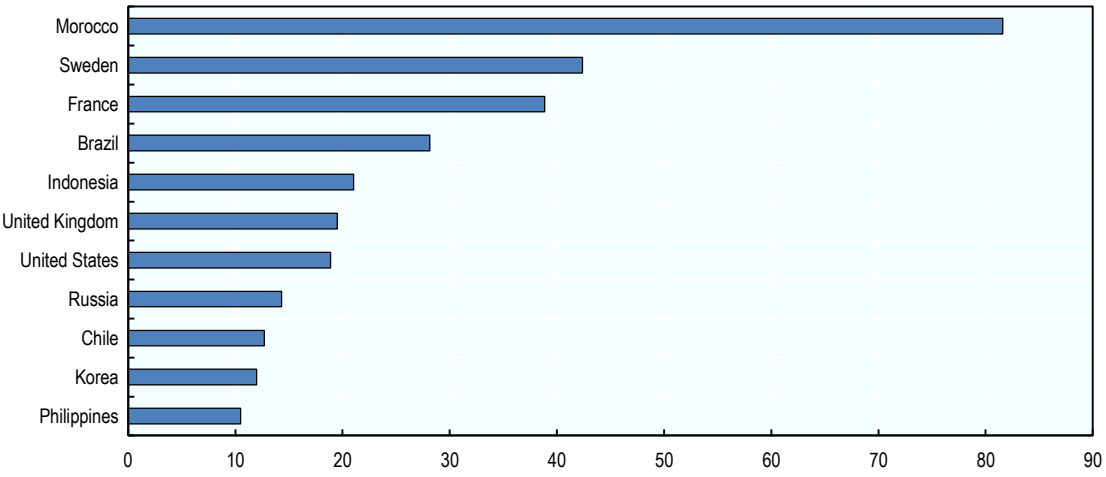
% of Graduates from Tertiary Education Graduating from Science, Engineering, Manufacturing and Construction Programmes



Notes: Data of France, Kazakhstan, Philippines, Korea and UK refers to 2013; data of Brazil, Chile, Japan, Sweden and the United States refers to 2012; data of Jordan refers to 2011; data of Morocco refer to 2010; data of Indonesia and Russia refers to 2009
Source: Authors' calculations based on UNESCO (2016), UNESCO Institute for Statistics, http://data.uis.unesco.org/.

Figure 8. **A gap in government expenditure on tertiary student exists between the developing and developed countries**

Government expenditure per student, tertiary (% GDP per capita)



Note: Based on 2009 figures, except for Russia, which is based on 2008 figures.
Source: Authors' calculations based on World Bank (2016b), *World Development Indicators*, http://data.worldbank.org/.

In building a pipeline of indigenous talent, ensuring that the curriculum is relevant to the industry needs is critical to ensuring that the graduates are equipped with skills to meet the needs of the digital economy. For this purpose, consultation with representatives from the industry is necessary to shape the curriculum. In Germany, for example, students from vocational institutes are required to undergo an apprenticeship to equip them with industry knowledge. The institutes and industry collaborate closely on the learning objectives for their students. Doctoral students can also opt to work in collaboration with an industry partner on a thesis, thus helping to shape their thesis in a manner that is relevant to industry needs.

Moreover, adequate funding for academic institutions is needed to develop the needed digital skills. To that end, governments may earmark funds for tertiary education. These funds should be distinct from R&D activities that an academic institution may undertake. The Swedish government, for example, provides SEK 100 million in scholarships each year and generous state loans are available to help students cover the costs of accommodation, food and other expenses during their studies (Swedish Institute, 2013). The German government provides free tertiary education for undergraduates of all nationality and funding for doctoral students working on their thesis.

Academic institutions also provide a pool of research and development talent and a repository of knowledge for firms in the digital economy to tap on, in addition to providing a sustainable pipeline of skilled labour. To effectively leverage the academic institutions, governments may forge close collaborations between the industry and the academic institutions. Sweden's triple helix model of co-operation between government, academia and industry exemplifies the close collaboration that is needed to drive the digital economy forward (Box 10).

Box 10. **How Sweden used the triple helix structure to develop its digital economy**

Sweden is one of the leading nations in the area of network and communications technology. The information communication technology (ICT) sector, which is crucial to the delivery of digital services, is also an important part of the Swedish economy. The sector accounts for 5.0% of the country's GDP with an annual CAGR of 5.0% between 2009 and 2013 (OECD Statistics). Sweden's technological lead in the area of network and communications technology is evident through its pioneering work on the 2nd Generation (2G) and 3rd Generation (3G) Global System for Mobile Communications (GSM) network. Sweden's ICT sector also contributed to improving the Voice-over-Internet-Protocol (VoIP) technology for consumers. Since then, Sweden has remained a driving force behind technological advances in network technologies. Most of the country's ICT activities are concentrated in a region known as Kista Science City, a municipality northwest of central Stockholm.

Kista Science City, also known as the "Silicon Valley of Europe" or the "Wireless Valley," is a dense cluster of ICT activities and is home to many ICT companies such as Ericsson, IBM, Nokia as well as the KTH Royal Institute of Technology. In 2012, there were 750 companies based in Kista, employing almost 28 000 people. Much of the region's success in ICT can be attributed to the government's heavy effort in developing the country's ICT sector. These efforts include providing the necessary infrastructure and business environment for ICT businesses and digital services. Most importantly, the Swedish government collaborated closely with key stakeholders – businesses and the academia – to jointly promote the sector.

Box 10. **How Sweden used the triple helix structure to develop its digital economy** (*cont.*)

Kista was created as an industrial complex in the 1960s for industrial and commercial purposes. The region began to develop a competitive edge in electronics and digital technology when three large ICT firms, SRA, RIFA and IBM relocated to Kista between 1976 and 1978. In the 1990s, Ericsson's work in mobile phones and network systems helped Kista develop an edge in 2G and 3G network technology, mobile Internet and wireless technology. In the 2000s, Kista leveraged its expertise in network technologies to provide integrated networked solutions for corporate clients so that by 2001, all manufacturing activities ceased in Kista. Mirroring this shift, Ericsson also transitioned from a handset and telecommunications equipment maker to a service company. Since 2008, a medical technology cluster began emerging in Kista. The medical technology cluster in Kista developed as a result of synergies between ICT and medical technology. Research and development (R&D) in medical technology leveraged the ICT capabilities which Kista was strong in.

The deep pool of specialised talent, particularly in the field of wireless communication technology, was the main draw for global companies to locate their operations in Kista. Academia and businesses contribute in different ways to building the talent pool, resulting in a talent pool that is diverse in terms of the skill levels, degree of specialisation and experience.

As an education institute, the KTH Royal Institute of Technology, a key partner within the triple-helix structure, is responsible for providing skilled workers for the region. KTH Royal Institute of technology, in particular, is known for its strengths in engineering. Established companies, like Ericsson, also helped to build up talent pool by imbuing the fresh graduates with practical experience. In fact, it was this pool of experienced engineers which became a huge draw for many global ICT companies. Interactions between the education sector and private industry helped to refine the curriculum and ensure that the skills of graduates remain relevant to the needs of the industry.

In 2001, the dotcom bust triggered a wave of corporate downsizing. Many global ICT companies that were operating in the Kista region either closed down their operations or reduced the scale of their operations there. However, in spite of the crisis, the number of new firm formation declined only slightly from 511 during the boom period to 424 in the bust period. In addition, the employment growth in the region actually accelerated from 500 in 1998, to 1 450 in 2003. Strategic decision undertaken by the Electrum Foundation to reposition the Kista region during the crisis helped the region weather the crisis.

After the crisis, the Electrum Foundation, a joint venture formed by the municipality of Stockholm, the KTH Royal Institute of Technology and Ericsson, made a conscious effort to diversify away from wireless communication technologies into adjacent areas such as microelectronics, computer electronics, nanotechnologies and digital services. These fields were chosen because they required similar scientific knowledge and skills as wireless communication technologies. To that end, Kista Science City AB, a wholly owned subsidiary of the Electrum Foundation, was established.

Since its establishment, Kista Science City AB has played a crucial role in the development of the Kista region. In the early years of its existence, the organisation was responsible for transforming the Kista region from a science park dedicated to wireless communication technology, into a hotbed of innovation and ideas. To achieve this, Kista Science City AB focused on driving entrepreneurship within the region and facilitating connection between budding entrepreneurs, experienced business leaders and technical experts from the universities. Business coaching, training programmes and business networks are provided by the organisation to promising start-ups. At the same time, the organisation was also heavily involved in the city planning to provide facilities that could help promote innovation. Several offices catering to the needs of start-ups, such as GrowHouse and Office Hotel, were established.

To diversify the region beyond its focus on wireless communication technology, Kista Science City AB shaped the region's development through a mix of funding and advisory services. Business mentoring programmes were offered for microelectronics, information technology, applied information technology, computer and systems science. A venture capital funding arm, KTH Seed Capital, was established to fund areas with scientific development. This broad-based approach, driven by the pursuit of scientific knowledge, helped to diversify the region from the narrow focus on wireless communication technology.

To further support entrepreneurs in the region, the STING incubator, a sister company of Kista Science City AB and a wholly owned subsidiary of the Electrum Foundation, was established in 2002. The incubator was tasked to provide seed funding to new start-ups and further enhanced the support available to start-ups with their own incubator programmes that also include business coaching and networking.

Source: Mariussien (2003).

Alternatively, governments can attract global talent to supplement the local workforce. This strategy may be important if the government needs to build up a pool of talent within a very short span of time. Attracting global talent is also important if the country endeavours to conduct research and developing activities as the diversity of talent could help spur innovation. Sweden and Singapore have implemented strategies to attract top global talents to supplement their workforce. Sweden, for example, offers a 25% reduction in taxable personal income for foreign experts or key personnel (also see Box 10 above).[17] Singapore has also launched the agency Contact Singapore that is dedicated to headhunting overseas citizens and foreign experts with skills and experience for which there is a shortage of in Singapore. Singapore has also attracted foreign multinational corporations with deep expertise in digital services to set up regional headquarters in Singapore. By attracting established global players to base their operations in Singapore, the country can quickly access a pool of international talent who can in turn, help to train a pool of indigenous talent.

A combination of long-term and short-term measures is perhaps the best strategy for building up the pool of required talent in the digital services sector. Long-term investments in education will help to sustain the country's comparative advantage in the sector over time. However, short-term measures to leverage global talent may be necessary for a country to scale quickly and develop the needed labour resource quickly.

Improving digital literacy amongst general users

The basic skills that general users require are the ability to operate a computing device and to use the Internet to obtain information or communicate with others. With these basic skills, any user can retrieve the necessary information or seek technical assistance to perform more complicated tasks on digital platforms.

Digital and computer skills can be taught in schools as part of an ICT-enabled learning curriculum. Many governments have equipped schools with computers and ICT tools to promote the use of ICT in learning (OECD, 2013b). It is also equally important to ensure that the teachers are adequately trained in using digital tools to promote the use of digital tools in education. Underscoring the emphasis on computer and digital skills, the Swedish government explicitly stated in their Digital Agenda 2011 that one of the goals of primary and lower secondary education is to ensure that all can use modern technology to seek new knowledge and to communicate. To achieve these education outcomes, the government had dedicated SEK 39 million between 2005 and 2010 to the development of ICT tools in education. New syllabuses involving the use of ICT have also been introduced for all subjects and courses at the upper secondary level. Such emphasis not only signals to the citizens the importance of ICT training, but also ensures that all students are equipped with the necessary ICT skills to integrate into a digital society.

[17] These include scientists, researchers, technicians, specialists, executives and managers in qualifying industries.

Beyond equipping students with the necessary digital skills, governments also need to ensure that socio-economic status, gender and age do not become impediments to using digital tools. Students from higher socio-economic backgrounds have been found to have greater access to computer and Internet at home, which could account for the higher digital reading performance of some students (OECD, 2013b). Girls have also been found to be less confident than boys in performing computer functions, in particular, programming or multi-media presentations. This confidence issue might account for the overwhelming male presentation in computer science faculties. Men account for about 80% of both computer science students in ICT-related fields and ICT specialists. Older people were also found to use ICT less than young people (also see Box 7 above on jobs and inequality in the digital economy).

Governments in developing countries should also ensure that gaps in communication infrastructure do not result in a gap in digital literacy. For many developing countries, building up the communication infrastructure and encouraging the use of digital technology in the rural areas can be a challenge because of the smaller population size and lower incomes there. However, governments should not allow these challenges to widen the gap in digital literacy. Governments can provide avenues for rural communities to make use of digital technology through state-provided facilities. China, for instance, has found ways to make digital technology relevant to farmers in rural areas through the use of e-commerce platforms for agriculture input (see Box 11).

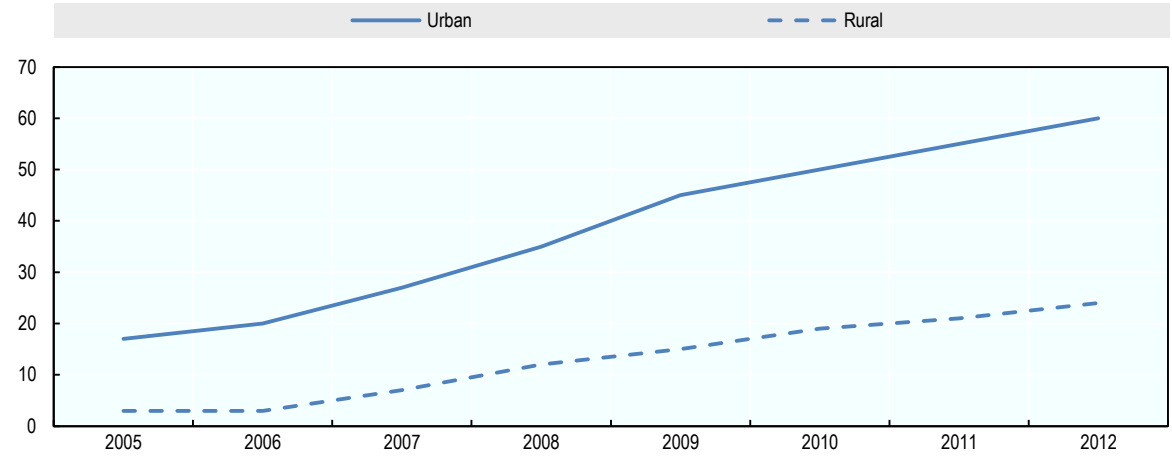
Box 11. **Encouraging the use of digital technology in the Chinese countryside**

Since the economic reforms implemented in 1978, China has enjoyed strong economic growth. Much of this growth was led by the export sector and by investments in the manufacturing sector. It was not until the 12th Five Year Plan (2011 to 2015) when the Chinese government began prioritising the development of the services sector. From then on, China is committing to a more proactive opening-up strategy in key service sub-sectors such as finance, logistics, education, healthcare and it is aiming to rank among the top exporters for transportation, tourism and construction, sub-sectors in which the country has a revealed comparative advantage. However, the growth has produced a very big rural-urban income gap as the growth regions were mainly concentrated along the coastal areas. Reflecting this income, Internet penetration in rural areas was 24% compared to 60% in urban areas in 2012, with the gap increasing between 2005 and 2012 (Figure 9).

At the national level, the State Council has launched the National Broadband Plan in 2013 to address this gap and to strengthen the country's ICT infrastructure to meet the infocommunication coverage, penetration and speed targets outlined in the plan, the central government has launched the Villages Access Project to extend telephone coverage, the Home Appliance Subsidy Programme to subsidise the cost of home appliances including computers, among other initiatives. The Villages Access project had been successful in extending telephone network to the rural areas. By 2010, all administrative villages and 94% of natural villages had access to the telephone network. The mobile coverage is even more extensive. However, the Home Appliance Subsidy Program had more modest success in raising the penetration of computers. Although computer penetration in households rose after implementation of the programme in 2009, computer penetration remained lower than that of any other major household consumer durable.

Box 11. **Encouraging the use of digital technology in the Chinese countryside** (*cont.*)

Figure 9. **Widening gap in the Internet penetration rates in China**
Internet penetration rate (internet users per 100 people)



Source: Authors' calculations based on Minges et al (2014), *Information and Communications in the Chinese Countryside A Study of Three Provinces*, World Bank Studies, http://dx.doi.org/10.1596/978-1-4648-0204-1, and World Bank (2016b), *World Development Indicators* (database), http://data.worldbank.org/indicator.

At the provincial level, some provincial authorities have done more to support rural digitalisation. Efforts include developing agricultural information websites, information service hotlines, television broadcasting including distance learning, provision of public Internet access points and training.

- **Guizhou**, a relatively underdeveloped province in the west of China, has established "multi-functional information service stations" equipped with video facilities and computers with Internet connection in 77 villages. They are also capitalising on the popularity of smartphones in China to bring greater information to the rural communities in Guizhou. For example, they are collaborating with private companies to develop applications that could provide pricing information and an e-commerce platform for farmers.
- **Jilin**, a more developed province in the east of China, has partnered with local small-and medium-enterprises to launch an e-commerce platform. By aggregating demand for seeds, fertiliser and pesticides on the platform, farmers are able to collectively negotiate for lower prices on their farm input. Free Internet access for farmers is also available at the SME's business locations. These e-commerce shops have been established in 700 administrative villages in Jilin and have generated RMB 50 million (USD 7.9 million) in trading volume through mid-2103.

China's experience has shown that digital technology, even in rudimentary forms, have a big role to play in enhancing the productivity and the livelihoods of rural farmers. This underscores the importance of ensuring equality of access to Internet and digital technology. And as the experiences of Guizhou and Jilin have shown, improving rural access need not have to start with expensive infrastructural projects to provide high-speed broadband access to rural areas. Extension of telephone network coverage, particularly mobile coverage, and provision of simple Internet facilities and platforms can go a long way in helping the rural community make use of digital technology in their agriculture businesses.

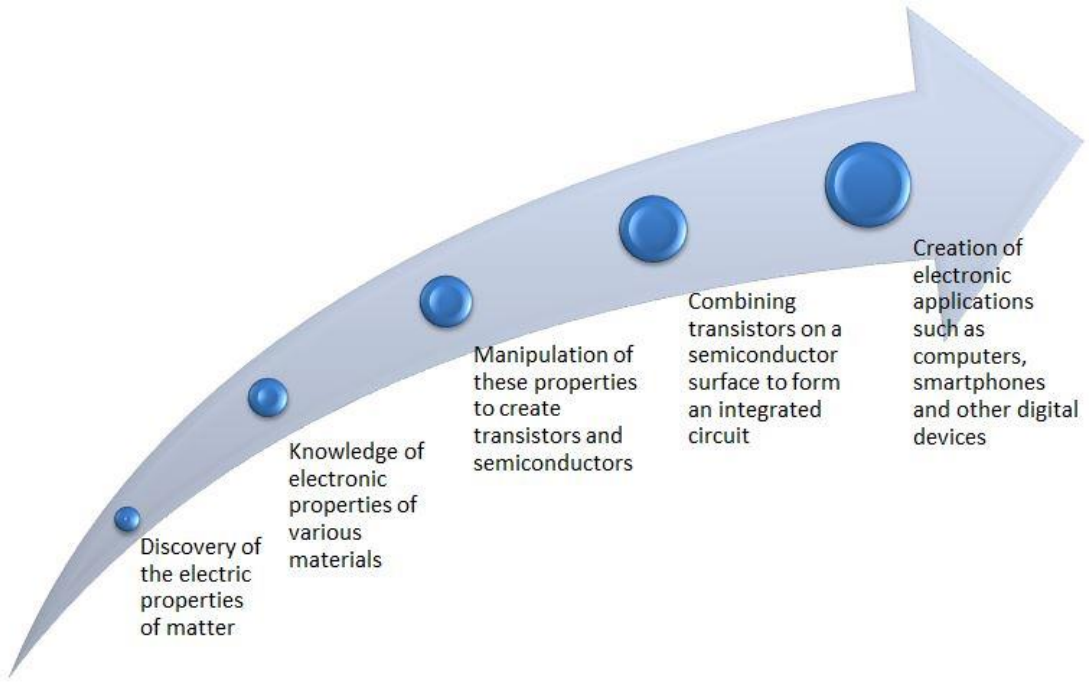
Finance: Funding new technology development and entrepreneurship

Technology and entrepreneurship are two key contributing factors to the dynamism and growth of the digital economy. Technological advances enable new methods of production or new products and services to cater to consumer needs. Entrepreneurship is one key mechanism through which new technology or new ideas to utilise existing technology is diffused through the digital economy. Thus both contribute to the innovative process in the digital economy (see Figure 8 above for a comparison on how advanced and developing countries fare in their innovative capabilities in the digital economy). Funding is critical to ensuring innovation within the digital economy.

The funding requirement for technological innovation (or research and development, R&D, activities) in the digital economy varies depending on the type of innovation. Broadly, there are two types of innovation within the digital economy: first technological innovation that results in a new technology or marked improvement in an existing technology; and second, the application of a new technology in a new way to deliver a new product or service, or enhance an existing product and service (henceforth, the former type of innovation will be named *technological innovation* and the latter, *business model innovation*). To illustrate the difference, the following examples of microchips for technological innovation and software and consumer platforms are used for business model innovation. However, this by no means suggests that innovations can only be business model innovations. Indeed, the blockchain idea underlying bitcoins are a revolutionary way of accounting for transactions which could count as a technological innovation.

- Microchips, which enabled the creation of computers, smartphones and other digital devices, for technological innovation: The microchip is essentially an integrated circuit of many (up to a billion) transistors on a semiconductor material. The transmission of electronic signals across these transistors enables electronic appliances to work as intended when an electric current is passed through it. The microchip however is built on two inventions, the transistor and semiconductor, which in turn required knowledge on the electronic properties of semiconductors (Figure 10). Such knowledge, however, would not have a foreseeable commercial application, and if left to market forces, investments in the knowledge discovery process prior to the invention of a product would most likely be underfunded. Thus, public funding might be essential for some part of the knowledge discovery process.

Figure 10. **Innovation process for the semiconductors**



Source: Authors' illustration.

- Airbnb, Spotify and alike for business model innovation: Business model innovation rarely involves the discovery of a new technology, but merely, leveraging existing technology in different ways to serve a new market segment or to create a new product or service (Table 4). For example, Airbnb's innovative ideas of tapping unoccupied homes for temporary accommodation does not require any new technology, but merely using existing tools to help link up lessors and lessees. Likewise, peer-to-peer (P2P) and streaming technology behind Spotify's music streaming service or Skype's Internet telephone service has been in existence long before the two companies did further research to adapt the technology for their respective service offerings.

Table 4. **Recent business model innovations**

Company	Country	Business model innovation
Airbnb	United States	• Using consumer-to-consumer (C2C) platforms to enable people to share homes for short periods
Uber	United States	• Using C2C platforms to enable people to offer labour services (e.g. transport service) to others
Spotify	Sweden	• Using P2P technology to provide entertainment services
Skype	Sweden	• Using P2P networks for voice transmission (i.e. Voice over Internet Protocol)

Source: Authors' illustration.

Thus, the dynamics of business model innovation and technological innovation differ in two fundamental ways: First, the business model innovation tends to have a specific commercial

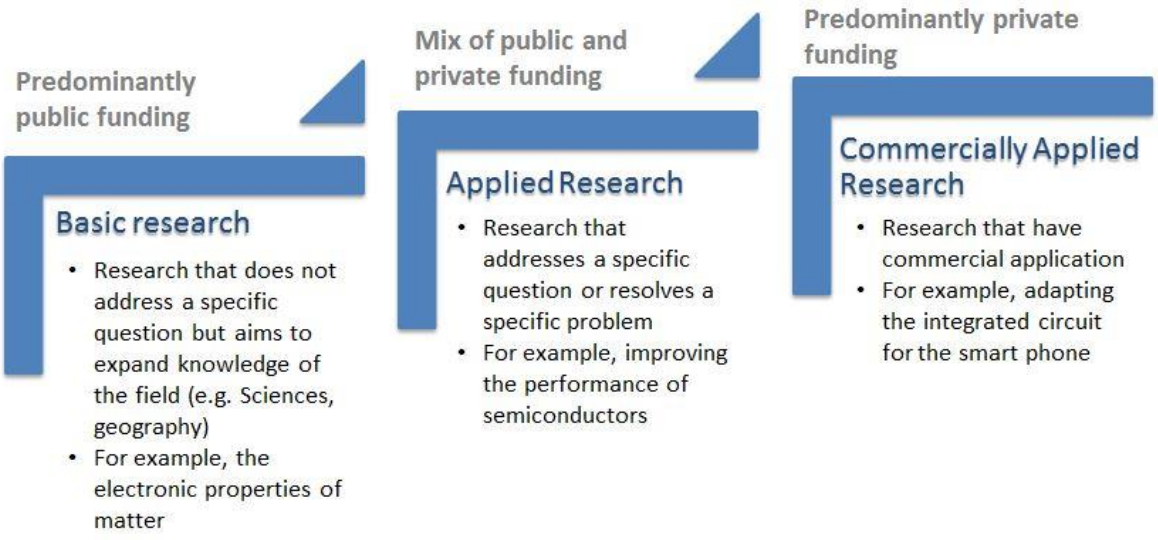
objective, while the commercial objective of technological innovation is not always apparent. This stems from the fact that business model innovation is about adapting an existing technology for commercial purposes, while technological innovation is about trying to discover a new technology that could have multiple applications. Second, the goals of technological innovation research tend to be more nebulous than those of business model innovation. *Ex ante*, it is difficult for researchers to predict the new discoveries they could make or the new technology that could be invented. The outcome from such research is typically a culmination of a long research process to integrate various pieces of scientific knowledge to uncover something new.

These differences also translate into differences in the R&D activities that underlie the two types of innovation. The R&D required for technological innovation tends to be more broad-based and academic in nature while that for business model innovation tend to have a narrower and a strong business focus. As a result of the different nature of the R&D activities undertaken, the funding requirements for the different types of innovation are also different.

Public funding for early stage technological innovation

Public funding is crucial for technological innovation, particularly early stage basic research, when the commercial returns on the research undertaken would look more uncertain. The high costs of failure at this stage could discourage private sector funding, resulting in a funding gap at this stage. Thus, public funding is crucial at this stage. As the research progresses towards commercialisation stage, the expected returns on the research would become easier to predict as the commercial applicability of the research results become clearer (Figure 11). Concomitantly, the proportion of private funding in the funding mix would increase.

Figure 11. **Changing composition of funds in technological innovation**

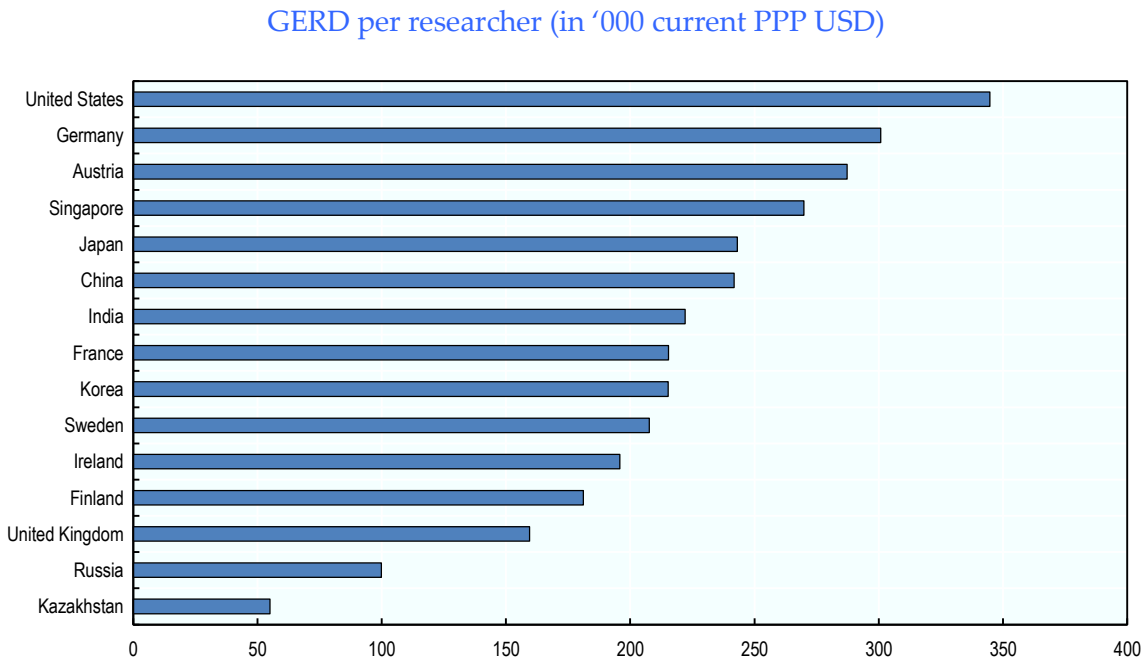


Source: Authors' illustration.

Besides filling the funding gap, there are other advantages in using public funds for funding basic and applied research for technological innovation. Given the broad findings or outcomes from this research may be applicable to a wide range of businesses, there may be benefits in having governments fund such research to share the knowledge with a broader community. Second, funding from public institutions could provide a signalling effect as to the strength of the research proposal or potential impact of the findings. The signalling effect is particularly important to lend credibility to the research and to getting the paper published in reputable journals. Finally, some studies have shown that private sources of founding could bias the outcomes of the research. Notably, industry funding of nutrition-related articles have been found to bias the results in favour of the sponsors' interest. Thus, it may be better to provide independent or government research funds for such research instead.

Governments in developing countries tend to spend less than governments from more developed countries on research. The gross expenditure on R&D per researcher provides a rough proxy of the amount of resources researchers have for technological innovation type of research. The governments of the United States and Germany are among the government spending most per researcher (Figure 12). This investment appears to have borne fruits as these two countries are known to be leaders in different types of technology. The United States is a leader in military technology and Germany is known for its precision engineering and automation technology.

Figure 12. **The United States and Germany are among those countries spending most on R&D per researcher**



Notes: Based on 2014 data, except for Kazakhstan, which are based on 2013 data.
Source: Authors' calculations based on UNESCO (2016), *UNESCO Institute for Statistics*, http://data.uis.unesco.org/.

Box 12. **How DARPA has made the United States the technological leader in the world**

The United States is widely recognised to be at the forefront of technology, and in particular, the information-communication technology that enables digital services. Many of the world-changing technological innovations, such as the integrated circuit which enabled modern computing, the network connections enabling the Internet, and Global Positioning System (GPS) used to provide locational services, were all invented in the United States.

The Defence Advanced Research Project Agency (DARPA) is the key agency tasked with disbursing funds allocated for R&D in military technology. Established in 1957 with the explicit objective of preventing 'technological surprises' by other countries, DARPA continues to play a big role in ensuring the technological superiority of the United States through funding promising research projects. Besides being granted a sizeable annual budget of around USD 3 billion for research, DARPA also has a unique operating structure and funding strategy that sets it apart from most other government research agencies.

First, programme managers in DARPA are technical experts plucked from the academia or private sector for a fixed period to push the boundaries in their field of research. These technical experts are better-placed than civil servants or bureaucrats in identifying emerging technology trends. Their fixed contracts with DARPA also put pressure on the teams to complete the research within a pre-defined period of time as well as ensure that each programme is headed by a manger with relatively current industry and technical knowledge.

Second, unlike other government-run research agencies, DARPA is not restricted by particular topics, agendas or fields when selecting their research focus. Instead, programme managers are free to fund researchers working on disparate projects revolving around a common theme, or even competing research teams. This flexibility allows the programme managers to experiment with more than one approach or technical field to resolve a particular military challenge or to finding a new breakthrough in military science. Funding competing research teams also enhances competition in research that would lead to a diversity of ideas and greater project outcomes.

Unlike other government-run research agencies, programme managers at DARPA do not dictate research agendas, approach or field of study. Instead, they operate more as a facilitator of knowledge-sharing and co-ordinator of research activities undertaken by various parties. Through invite-only workshops, programme managers are able to facilitate cross-industry knowledge sharing between competitors and research teams, and thereby advance the overall level of knowledge amongst the research teams. Such knowledge-sharing is tremendously useful in diffusing knowledge and encouraging the birth of new ideas through the confluence of new knowledge and new perspectives. This process also appears to be unique to DARPA.

Programme managers are also assisted in their tasks of assembling the best teams for the research by a team of administrative assistants, special statutory hiring authorities and alternative contracting vehicles. These factors help DARPA bypass the typical bureaucracy that tends to encumber government organisations, allowing DARPA to achieve greater speed and success in delivering research outcomes.

Thus, with a headcount of not more than 100 employees at any one point in time, DARPA has been able to invent many world-changing technologies. The Internet, for example, was spun out of a project by DARPA to create a network that could survive a nuclear attack. GPS technology was spun out of an attempt to create a technology that could locate and keep track of active servicemen.

Of course, technology and know-how created by DARPA can only be applied in civilian setting if the government, which owned the rights to technology from government-funded projects, allowed commercial entities to further develop the technology and apply it to non-military uses. To this end, the government introduced the Bayh-Dole Act in 1980 to allow universities to own and license to the private sector intellectual property based on their discoveries made with federal funding. This act had a huge impact on technology licensing and innovation. Prior to the introduction of this act, only 23 academic and research institutions had an office of technology licensing to facilitate technology transfer to industries and of the 28 000 patents held by the American government prior to 1980, less than 5% had been licensed to companies. Following the passage of this act, academic and research institutes began establishing an office of technology licensing so that by 2008, almost all of such institutes had an office to facilitate the transfer of technology. By 2010, technology licenses granted by academic and research institutions contributed to between USD 86 billion and USD 338 billion (in 2005 USD dollars) to GDP over the period from 1996 to 2010. Some of the products which had roots in university research include the web browser, hollow optical fibres, nicotine patch, and cochlear implants.

Besides the amount of funds allocated for R&D, the mechanism of disbursing the public R&D funds is another important aspect in funding technological innovation. A good mechanism should minimise misallocation and should direct funds towards promising areas. Sweden, for example, disburses majority of the public funds for research to universities and research institutions (based on 2012 figures). Companies may tap on these research funds through collaboration with the academia or research institutions. Germany similarly has provided research funds for research consortium, comprising academia and industry, to research on pre-approved topics. Both Sweden and Germany have technical experts on the panels evaluating the feasibility of the project. In both countries, the funding models require the government to identify and "make bets" on research areas such as smart manufacturing or green technology. On the other hand, the United States has a funding mechanism that provides more flexibility. Central to their funding mechanism is the Defence Advanced Research Project Agency, which funnels a sizeable about of government budget devoted to military research into various research programmes. With a strong focus on transformational rather than incremental advances, and an emphasis on resolving specific military issues, the Defence Advanced Research Project Agency sidesteps the problem of making bets by funding different technologies addressing the same challenge to find the best solution to the problem (Box 12). Although the agency's focus remains solely on military, the technology arising out of research undertaken by the agency have been further developed and commercialised for civilian use. Examples of civilian technology which have roots in projects funded by the Defence Advanced Research Project Agency include the voice recognition technology behind the iPhone application SIRI, global position system (GPS) used to enable locational based services and route guidance as well as the Internet.

Funding for business model innovation, entrepreneurship, and commercially applied research

Business model innovation, entrepreneurship and commercially applied research are often interlinked. The idea of offering a new product or service, or catering to a new or underserved market segment, often arises from start-ups rather than incumbents. Many of these new products or services may also be based on a new technology that has yet to be commercially applied. Many of the technology giants today also had their humble origin as a start-up, championing a new way of doing things. Amazon started as a one-man outfit in 1995 to pioneer a new way of retailing books. Google began as a start-up pioneering a new algorithm for web searches. Airbnb, Spotify, Skype all began as new companies pioneering new ways for people to rent short-term accommodations, enjoy music or communicate with others. The development work to apply speech recognition technology for consumers was also undertaken by a technology start-up called SIRI Inc., before the company was acquired by Apple. Thus, findings for business model innovation, entrepreneurship and commercially applied research are intricately-linked.

Unlike the case for technological innovation, private sector funding may be more suited for business model innovation and entrepreneurship. First, private sector investors may be in a better position than government officers to assess the business viability of a new technology. Second, commercialising the new product or service often requires a deep business management expertise, which private sector investors can offer. Third, having financial support from an established private investor with a proven record of picking "technology winners" could signal

the potential and commercial viability of the product, similar to how the financial support from an established research institute signals the potential importance of a basic research project.

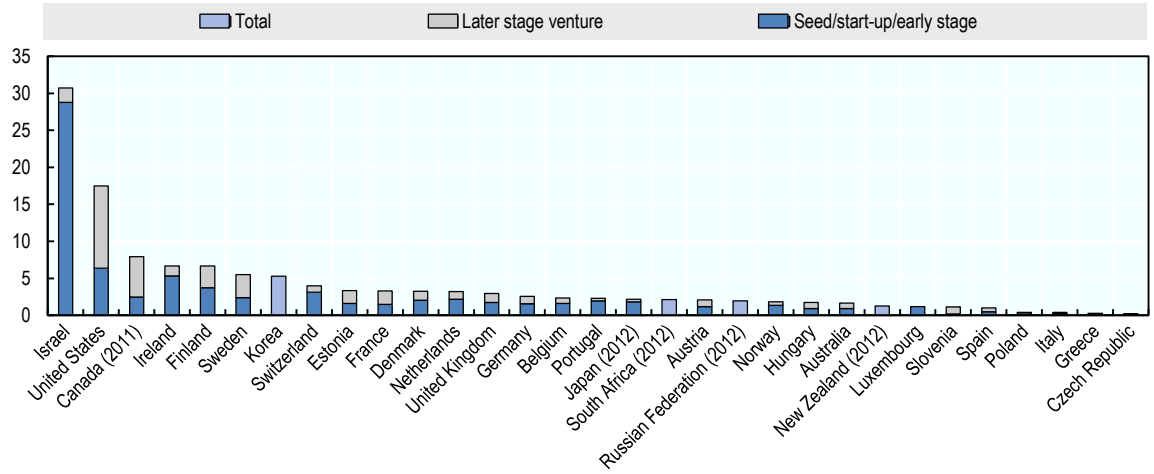
Among the various types of private funds available for R&D, seed funding, angel funds and venture capital may be the most crucial for business model innovation and entrepreneurship for technology companies. Venture capital and angel funds ensures financing to young and promising start-ups which might otherwise be unable to funds for growth because of their small size, lack of assets and reliable cashflows. This is because banks typically use a standard procedure based on past financial track record to access the credit worthiness of a new loan applicant, which biases against new start-ups. This problem may be particularly acute for technology companies which may not be charging their early customers for their service in exchange for the user base needed to achieve economies of scale quickly and to muscle out competitors (see Box 2. on network effects). Seed capital is necessary for companies at even earlier stages of development.

Furthermore, even relatively established firms with a steady income and cashflow, may find difficulties in obtaining loans from banks. This is because technology firms, unlike firms in other sectors, do not have much physical assets and instead, invest mainly in intangible assets such as intellectual property which may be difficult to value. Venture capital funding also appears to be three to four times more effective than corporate R&D investment in raising the amount of patenting activities (Kortum and Lerner, 2000). The patents arising from venture-backed firms are also found to be more frequently cited than patents by non-venture-backed firms.

Relative to GDP, Israel and the United States lead the world in terms of venture capital investments (Figure 13). Venture capital investments in these two countries amount to well over 10% of the country's GDP, unlike the case for most other countries. The great differences in the relative size of venture capital investments suggest differences in the extent of development in the venture capital industry.

Figure 13. **Within the OECD, Israel and the United States report the highest shares in terms venture capital investment relative to GDP**

Venture capital investment as % of GDP, 2013



Source: OECD (2014b), *Entrepreneurship at a Glance 2014*, http://dx.doi.org/10.1787/entrepreneur_aag-2014-en.

Besides the provision of seed funding by the government, catalysing a venture capital industry also requires building a supporting eco-system for venture capitalists (Box 13 on the case of Silicon Valley). Start-ups that enable the emergence of new digital technologies and those firms supporting start-ups with specialised finance (venture capital), legal and professional services have very different business (environment) needs. Start-ups typically require legal services specialising in technology management and marketing services focusing on brand-building. Venture capital investors require specialised finance and legal services that protect their investment in start-ups and allow them to quickly and easily sell their stakes in start-ups when the time is right. One way for developing countries to establish the eco-system for venture capitalists quickly is, for example, to attract foreign expertise by offering tax concessions to foreign companies with such specialised services (see Box 15 on a comparison of venture capital eco-system and associated regulations in Sweden and the United States).

Box 13. **Supporting eco-system for start-up and venture capital: The case of Silicon Valley**

Most of the research and development activities related to digital services are concentrated in Silicon Valley, a region in the southern part of the San Francisco Bay Area. Since the 1960s, the region has been known for introducing many world-changing inventions on which the modern digital technology is built on, for example, the transistor which forms the basic building block of microprocessors and the hard disk drive which enables storage of data. Today, Silicon Valley is known for the development of new software and technology such as cloud computing and the Internet of Things. Many major technology companies like Google, eBay, Amazon, Facebook and Apple have based their headquarters there. But what made Silicon Valley famous was perhaps the multitude of successful start-up companies including Google, Amazon, Facebook, eBay and Twitter.

In trying to understand the factors that made Silicon Valley so successful in nurturing innovation, many academics have highlighted the role played by start-ups (Eisenhardt and Schoonhoven, 1989, Florida and Kenney, 1988). Some viewed Silicon Valley as an "ecosystem" of institutions that helped nurture entrepreneurship (Bahrami and Evans, 1995) or as a network of interrelationships built to mobilise resources to tap business opportunities (Robertson and Langlois, 1995). A more sophisticated theory modelled the region as a composite of two economies, an economy built on technology companies and entrepreneurs, and a secondary economy that supported the first through specialised finance, legal and professional services (Kenny and von Burg, 1999).

These views invariably underscore the importance of specialised institutions established to support entrepreneurs in the Silicon Valley. The growth of this specialised industry stemmed from the specialised needs of both start-ups and venture capitalists. First, entrepreneurs and start-ups often have to wrestle with legal issues related to intellectual property protection, technology and venture capital financing. Second, start-ups require marketing firms to help market a brand new firm, including designing its logo and branding the company. Third, venture capitalists and "matured" companies require the services of banks skilled in initial public offers (IPOs) and analysis of technology stocks. Within Silicon Valley, there are several law firms such as Venture Law Group, Wilson, Goodrich & Rosati and Colley Godward that specialise in technology-related issues. The marketing and public consulting firm which specialises in creating images for new firms, McKenna Group is also based in Silicon Valley. The region is also home to many investment banks that specialise in IPOs such as Hambrecht and Quist, Robertson Steffens and Montgomery.

These specialised legal, marketing and banking services firms are able to thrive despite their niche market because the concentration of entrepreneurs and venture capital within Silicon Valley region is sufficient to sustain their business. The presence of such specialised industries, in turn, would help more start-ups to develop and grow successfully and attract more start-ups to the region.

In addition to promoting financing for entrepreneurship, governments also need to ensure that there is sufficient financing for telecommunications infrastructure, which form the backbone

underlying the digital economy. Given the huge cost of telecommunications infrastructure, a very high capital outlay for such projects is required. In more developed countries, such projects are financed by a myriad of instruments including debt, equity and hybrid instruments. The availability of options is also determined by the depth and maturity of the financial market. For example, securitised bond issuance and hybrid instruments such as subordinated debts are more likely to be used in countries with a deep and sophisticated financial market. For developing countries, where the relatively less developed financial market poses a challenge to securing investment funds, the governments can play a role by offering loans or loan guarantees for the project. Alternatively, the governments of these countries can seek loan assistance from international or regional development banks such as the World Bank or the Asian Infrastructure Investment Bank.

What to invest in?

The type of innovation activity a developing country should prioritise is dependent on the country's development objectives and strengths. For a country to engage in technological innovation, it needs to have a base of Ph.D. qualified researchers, laboratories, and credible education and research institutes to facilitate the research. Engaging in business model innovation, by contrast, requires mainly entrepreneurs and engineering talent. Besides talent constraints, development objectives matter to the decision on which areas to focus on. If the objective is to drive growth, then prioritising business model innovation may be of greater relevance as the profits arising from business model innovation are more tangible (see Section III on developing a strategy for harnessing the digital economy).

Regulation: Addressing emerging regulatory challenges

The digital economy provides enormous value for developed and developing countries but confronts policy makers with some difficult regulatory challenges. As demonstrated in Section II, the pace of technological change is accelerating, and technological change often outpaces regulation. This section will examine some of the commonly debated regulatory issues, which may not often have an easy solution.

Changing business models in the digital economy challenge regulation policy

Network effects and multi-sided markets have led to concerns about whether incumbent internet firms are too large and could abuse their market power in the absence of regulation. In many multi-sided markets, the structure of the pricing model matters more than the pricing level itself (see Section II for a description and discussion of platforms and multi-sided markets). This is because platform companies frequently do not charge one side of the market or charge one side below the marginal cost point (Evans and Schmalensee, 2012). Pricing below the marginal cost level does not necessarily imply predation however, as in many multi-sided markets the pricing level does not always reflect the value received by the user. For example, Google provides its search service for free to consumers in order to build its user base and thus provides a more valuable platform for its end customer, the advertiser. Concerns abound, however, that

predominant digital platforms can exercise monopoly power in other ways than price hikes or predatory pricing (Box 1 on Google). Barriers to market entry may arise because users are co-ordinated and locked into a single platform (Levin, 2011). As such, new platforms may struggle to gain market share even if their underlying technology is better.

Despite these concerns, the case for platform regulations remains unclear for several reasons. First, the traditional view that a dominant incumbent firm equates to a monopoly may need to be revised in light of multi-sided platforms. Market power dynamics in a multi-sided market is rather complicated and a dominant incumbent may not exert monopoly-like behaviour because of multi-sided market considerations. Second, there are also clear advantages, even to consumers, of having a dominant incumbent. For example, consumers on social media benefit from the network effects when the social media company has a wider reach. Finally, the traditional regulatory toolbox that governments possess may be inadequate to effectively regulate multi-sided platforms because of the dynamic interactions across the markets. Policies regulating prices in one market will necessarily affect prices in the other, thus complicating the regulatory strategy (OECD, 2016). Thus, it is recommended that governments objectively and thoroughly analyse the need for platform regulation within the country's context, before embarking on an independent study on the tools required to implement platform regulation.

Cyber security is another key issue related to the digital economy. Like data privacy, cyber security is needed to establish trust and to ensure the smooth running of the digital economy. Cyber security breaches could result in service downtime or data loss. However, given the global nature and interconnectedness of the internet, governments may have little influence over criminals based outside of their jurisdiction. Thus, some form of bilateral or multi-lateral collaboration, like the cyber security agreement between the United States and China[18], may be necessary to establish trust.

Interactions: Exploiting reinforcing effects across enabling factors

Interaction effects exist amongst the various enablers. In particular, regulation has a strong power to shape the development of other enablers. By contrast, all other enablers seem to have a limited impact on regulations. As a result, regulations are very powerful tools that governments can tap on to grow the digital economy and the general economy (Table 5). However, it is also important to note that regulations can be a double-edged sword. Some regulations can negatively impact the development of other enablers, potentially hampering the growth of the digital services sector.

[18] The deal was announced in September 2015, during a visit by the Chinese President, Mr Xi Jinping, to the United States. Under this agreement, the United States and China have agreed to (i) not conduct or knowingly support cyber-enabled theft of intellectual property, including trade secrets and other confidential business information; (ii) to provide timely responses and assistance to requests for information or co-operation concerning suspected cyber crimes or potentially malicious cyber activities, including the provision of electronic evidence, efforts to mitigate such activities and timely updates on investigations; (iii) create a senior experts group for further discussion on international cyber security issues; and (iv) establish a high-level dialogue mechanism for fighting cyber crimes.

Table 5. **Interaction amongst the different enablers**

	Infrastructure	Funding	Skilled labour
Regulations	• Affects the competition within the telecommunications sector • Affects the data security of the network infrastructure	• Affects the inflow of foreign investment • Affects the availability of funds for investment (e.g. use of pension funds) • Specific regulations may impact venture capital (e.g. regulation on intellectual property or taxes)	• Affects the inflow of global talent
Infrastructure		• Better infrastructure can enable better financial connectivity with the world and help boost investment	• Affects the availability of data resources • Bandwidth and speed affects the type of activities that can be implemented (e.g. telemedicine, videoconferencing, etc)
Funding	• Affects the level of infrastructural investments		• A larger research budget can help to attract more renowned researchers for technology innovation projects
Skilled Labour	• Affects the types of infrastructure that can be constructed and maintained	• Affects the level of foreign investment	

Source: Authors' illustration.

Effective regulation in the telecommunications sector is the key to ensuring digital inclusiveness and effective digital infrastructure. Effective regulation in the telecommunications sector helps ensure digital inclusiveness by encouraging competition in a sector that is viewed as a likely monopoly in some countries. Regulation in areas where there is significant market power should take into account the need for substantial investment in networks and that competition may not be possible in all locations (e.g. areas of low population density). However, issues around scale do not mean there should be a limit placed on competition and, in the absence of sufficient competition, regulators should ensure effective regulation.

Broadly, a government can use regulations to encourage competition within the sector in two ways and thereby promote investment. One is infrastructure competition including regulated access to essential facilities that cannot be replicated in a reasonable time frame. Another could be to offer subsidised infrastructure deployment with open access requirements or impose requirements for structurally separated networks.

Mandating the sharing of network bandwidth through legislation is another policy approach to encourage competition. One way is to adopt an open access network model that "opens up" selected segments of the telecommunications sector to competition. For example, United States introduced the Telecommunications Act 1996 to increase competition within the telecommunications sector. Part of the legislation requires incumbent telephone companies to share their network to competitors at regulated prices. However the act was widely viewed to have failed in encouraging access to facilities that were not easily replicated. Six years after the passage of the act, the incumbents continued to control almost 90% of the market (FCC,CDC), though this was in part due to the bursting of the dot-com bubble which led to the closure of many local access providers. As a result, the United States moved to emphasise the infrastructure competition between different platforms (i.e. cable broadband networks versus xDSL telecommunication providers). One reason they could do this was the widespread availability of cable television networks.

Box 14. **Regulating the telecommunications sector with the open access network (OAN) model: The case of Sweden and Singapore**

More governments are moving towards the OAN model, in which the roles of the service provider and the network infrastructure owner are separated (Forzati et al, 2013. The OAN model contrasts with the traditional model of "vertical integration," in which the network infrastructure provider is also the service provider that directly contracts with the end-users (i.e. households or corporates). To understand the distinction, it helps to think of the Internet network as consisting of several different pieces of infrastructure:

- a passive infrastructure such as the fibre optics, DSL or ADSL cables through which data travels;
- an active infrastructure consisting of transponders, routers and switchers;
- control management services that form the backbone of the Internet by routing data requests across the Internet; and
- an access point that controls data flow from a modem to the active infrastructure. Traditionally, the passive and active infrastructure and the access points were managed by a single entity.

Increasingly, competition has been introduced into the industry by allowing varying number of entities to operate in the different levels.

Separating the management of the passive infrastructure from the active infrastructure and access points introduces competition within the industry without sacrificing economies of scale. Economies of scale effects are most evident at the passive infrastructure level, followed by the active infrastructure level. By separating these two levels from the provision of access points, it is possible to introduce competition at the access point level, and even at the active infrastructure level while still reaping economies of scale at the passive infrastructure level.

Sweden is one of the countries that have implemented open access networks. The majority of the houses within Stockholm have access to fibre optic broadband, and a home network with at least two broadband outlets in every room. An interesting feature of the network access model in Stockholm is that various different models of access coexist within the city (see Box 4.1). The proliferation of models allows additional flexibility for service providers and network providers to enhance their service provision to the end users. However, most of the passive and active infrastructure providers are wholly owned by the city of Stockholm.

Singapore's OAN model to implement an ultra high-speed fibre network and wireless coverage as part of its Intelligent Nation 2015 sees a greater involvement of the private sector. In Singapore's OAN model, the design, build and operation of the passive infrastructure comprising of the dark fibre and ducts will be managed by a single company, while the active infrastructure level will comprise of switches and transmission equipment to be managed by another company. Maintaining "structural separation" (i.e. autonomous decision-making) and operational separation between the passive and active infrastructure companies and the retail service companies help ensure a strict form of open access at these two layers. Contracts to build and manage the passive and active infrastructure are awarded based on tender. The retail service layer is structured as a fully competitive layer that is open to all companies.

In some other countries with lower population densities and an absence of widespread cable networks, such as Australia and New Zealand, the approach adopted was to structurally separate markets while others pursued approaches such as functional separation (e.g. United Kingdom) to compliment the use of tools such as unbundling. Still a further model adopted by cities such as Singapore and Stockholm was to implement an open access network model which segregates the passive network from the active network and the last mile connection, including public investment (Box 14). By segmenting the sector, authorities limit their investment in areas which have the most economies of scale (i.e. passive network management) while introducing more competition in segments that potentially have the greatest influence on areas such as innovation or the level of pricing for consumers. Nonetheless, these approaches effectively create a monopoly at the wholesale level.

Regulations and other institutional factors could also play a role in shaping the growth of the venture capital industry. General rules affecting business flexibility and tax attractiveness shape business confidence, and influence venture capital investments in a country. A country which has poor safeguards for investors, regulations that reduce the return of financial investments or onerous taxes on financial returns can reduce the level of venture capital investment in a country. Rules that are biased against venture capitalism include higher taxation on equity returns or prohibiting pension funds to invest in venture capital funds. In addition, rules affecting general business flexibility such as labour rules also have strong impact on business profitability and entrepreneurship. Thus, the difference in the development of the venture capital industries in the United States and Sweden has been attributed in part to regulatory differences (Box 15).

Box 15. **A comparison of the development of the venture capital industry in Sweden and the United States**

Sweden's venture capital investment as a percentage of GDP stood at 3% in 2013, slightly more than one-third of the corresponding figure of the United States. The sharply lower level of venture capital investments in the economy stands in stark contrast to the greater effort by the Swedish government to develop the venture capital industry. These differences may be attributed in part to three key factors: the financial market, tax policy and labour rules.

Compared with Sweden, the United States had a better developed stock market the 1960s and 1970s. This was crucial to the development of the venture capital industry as venture capitalists typically "exit" a company by selling their stakes via an Initial Public Offer (IPO). An under developed stock market would limit the variety of exit options to a venture capitalist. The surge in Sweden's venture capital industry began around the end of 1980s, after a bout of financial deregulation which resulted in a surge in IPO. In addition, Sweden also lagged the United States in permitting pension funds to invest in venture capital. While United States revised the "prudent man rule" in 1978 to permit pension funds to invest in venture capital funds, similar changes were only drafted in 1996 in Sweden. As a result, the development of the venture capital industry in Sweden may have been hampered.

Second, the tax policy was also believed to have played a major role in hampering the growth of the venture capital industry in Sweden. One key issue was that entrepreneurial income was taxed much higher in Sweden than in the United States, thus reducing the profitability of start-ups. In addition, equity investment in start-ups also carried a higher tax than debt investments in Sweden. As venture capital investments are equity investments, the bias against equity instruments might have contributed to the slower rate of venture capital development in Sweden.

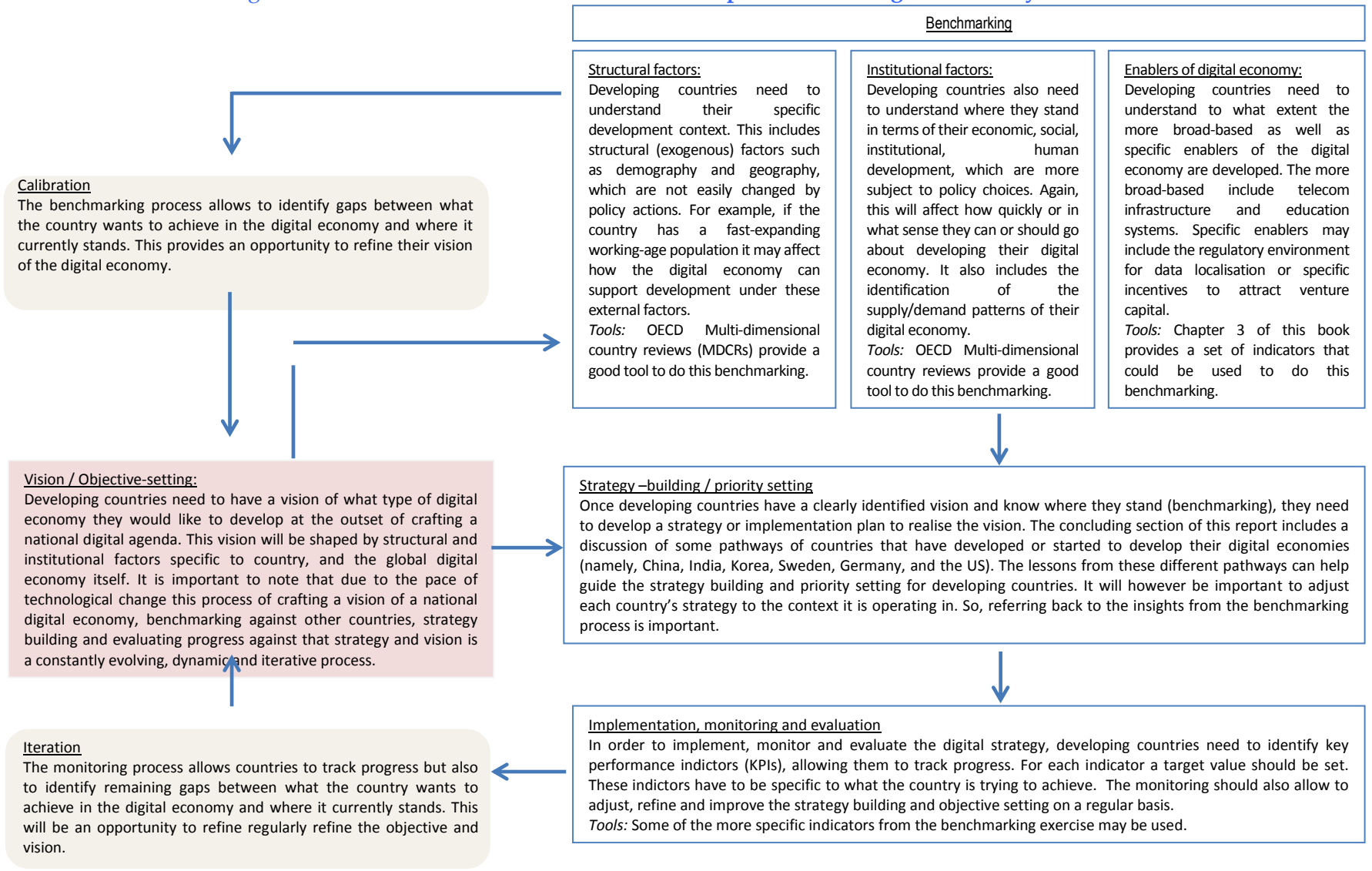
As the case of Sweden's venture capital industry evinces, the development of the venture capital industry is not just contingent of putting in place regulations to boost the development of venture capital industry, but also ensuring that there are no regulations which could impede the development of the industry.

Source: Lerner and Tag (2015).

Developing countries need a roadmap to develop their digital economies

Developing a national digital strategy requires carefully considering where a country currently stands in terms of its development, and the interaction effects between the various enablers of the digital economy. Because of the positive and negative interaction, implementing policies to grow the digital economy is not a straightforward task of implementing a checklist of policies in a sequential manner. Instead, the process of developing the digital economy is an iterative and dynamic one in which governments need to regularly review the progress of the digital economy and make adjustment either to policies designed to grow the digital economy, or other policies that may affect the efficacies of the first set of policies. This is compounded by the fact that the rapid technological advances may also be driving the need to update policies to ensure policy relevance. Singapore, for instance, has constantly pushed its technological frontiers by rolling out national initiatives in new ways to improve the productivity and living standards of its citizens (Box 16). Figure 14 provides a schema for the design process behind such a national digital strategy.

Figure 14. **A Potential Framework for the Development of the Digital Economy**



Box 16. **The Singapore story: From colonial outpost to smart nation**

Once a colonial trading post, Singapore now ranks as one of the most competitive economies in the world (World Economic Forum, 2015). Despite limited natural resources and challenging initial economic conditions, Singapore remarkably transformed from third world to first world economy in the past 50 years, and has built a strong foundation for a global, knowledge-based, and innovation driven economy. The ICT industry is an important sector in Singapore and will continue to underpin Singapore's socio-economic development and competitiveness. Today, ICT companies and activities provide fundamental linkages across all sectors of Singapore's economy, particularly in spearheading knowledge economy. Effective policy leadership and a coherent cross-sectoral vision, coupled with commitment to invest in an ultra-high-speed national broadband, are factors contributing to the country's success in maximising the economic and social returns from ICT.

Singapore's success in developing her ICT sector, infrastructure and talent, is the result of long-term planning and foresight. The government, cognizant of the importance of innovation and the knowledge-based economy, has long developed strategies to strengthen Singapore's ICT infrastructure to develop Singapore as a knowledge-based economy. Between 1980 and 2015, Singapore has implemented a six phase ICT master plan to also leverage the ICT infrastructure and talent to develop Singapore's knowledge-based economy.

In 1980, the government jump started digitalisation programmes in the economy with the National Computerisation Plan 1980 -1985, with a goal of raising productivity in the public sector. This first phase also helped to seed the very first cadre of computer professionals for the economy. The computerisation plan was hugely successful in boosting productivity and the government achieved a return of almost 2.8 dollars for every dollar spent on the programme (NCB 1992). This computerisation programme was subsequently expanded to the private sector in the second 5-year National Information Technology Plan (1986-1991).

With computers and digital technology permeating every aspect of the economy, Singapore then implemented the third phase of the master plan (1992-1999) to enhance national competitiveness and improve the quality of life for its citizens through digital technology (NCB 1992). The government focused on improving the communication infrastructure with the inclusion of broadband networks (Centre for Liveable Cities, 2014). The fourth and fifth phases of the master plans focused on convergence and connectivity respectively. In the fourth phase (2000-03), the National IT Plan (called "Infocomm 21") placed emphasis on convergence and developing a "savvy e-society and economy". This also coincided with the "dotcom" era, with the goal of transforming Singapore into an information society. This transitioned into the fifth National IT plan (2003-2006), called "Connected Singapore". In this phase, value-creation took centre stage, bringing connectivity to entrepreneurship and fostering creativity (Centre for Liveable Cities, 2014). Crucially, one of the underlying drivers of ICT adoption is the cost of telecommunications infrastructure and the extent of Singapore's connectivity to the region. Singapore's telecommunications market was fully liberalised (down to basic telephony services and lifting the cap on foreign ownership of telecommunications companies in Singapore) in 2000, although certain telecommunications services (such as mobile phone services, Internet access provision) had been opened up several years earlier. This phased approach gave regional competing economies an edge in attracting internationally competitive telecommunications players into their markets and to lay submarine cables to establish a network of connectivity to the region. Prior to liberalisation, infrastructure cost had been one of the factors that led companies to consider establishing their regional headquarters in countries other than Singapore.

The sixth and latest plan (2006 to 2015) focused on using information technology to facilitate inclusivity (Centre for Liveable Cities, 2014). It aims to connect businesses, individuals and communities and to provide them with the means to tap on global resources and capabilities.

Singapore's systematic approach and concerted efforts to develop her communications infrastructure and to harness the benefits of digital technology may be instructive to developing countries. In each phase of the development, clear objectives, along with defined targets were set to help the government keep track of its progress. Through systematic reviews and policy adjustments, the government was able to address problems that were impeding progress. Singapore also utilised a whole-of-government approach to implement the master plan. The lead agency for the development of the ICT sector works closely with other economic agencies like the Economic Development Board of Singapore, International Enterprise Singapore, Standards Productivity and Innovation Board, and A*STAR to ensure that the benefits of digital technology permeate all aspects of the Singapore economy. In addition, the Ministry of Law and the Attorney General's Chambers also contribute to the establishment of a legal infrastructure for digital economy.

Source: K.H., Tee (forthcoming).

Because of the complexity of the development process, envisioning what type of digital economy the country would like to achieve will be crucial in guiding the reiterative process of policy design, implementation and adjustment. This vision will also help to focus policy efforts and resources on specific areas within the digital economy. For example, if the vision of a country is to use digital economy to build a more inclusive society and productive economy, the government need to expend resources on incentivising basic research to drive technology innovation, but should instead direct resources and efforts towards boosting digital literacy and encouraging the adoption of latest technology invented abroad.

In developing this vision, developing countries also need to take into account their structural and institutional factors and digital enablers which could place constraints on what they can realistically achieve. Structural factors, such as demography and geography, are factors which are not easily shaped, even by policy. Institutional factors, such as economic, social and institutional environments, are more susceptible to influence by policies but may take a long time to change. To understand where the country can stands on these factors, governments need to benchmark their countries against other countries to identify their relative strengths and weaknesses. The OECD Multi-Dimensional country Reviews (MDCRs) are a useful tool to help with the benchmarking process. The digital enablers (covered in Section II of this paper) are most susceptible to policy influence and could help policy makers identify goals within the digital economy which are more easily achieved by the country.

Once developing countries have a clearly identified vision and know where they stand (benchmarking), they need to develop a strategy or implementation plan to realise the vision. Section II of the report touched on policies to develop digital enablers, which are most easily shaped by policy intervention. It will however be important to adjust each country's strategy to the context in which it operates. So, referring back to the insights from the benchmarking process is important. Developing countries need to have a vision of what type of digital economy they would like to develop at the outset of crafting a national digital agenda.

After implementing the policies, frequent monitoring is necessary to assess the effectiveness of the policies in achieving the vision. Thus, it is critical to identify and monitor suitable key performance indicators (KPIs) to track the policy progress. These indicators have to be specific to the country's goals. Governments should also set specific targets to define the success of the policies. Countries also need to make an effort to collect data in order to measure the advancements of their digital economies. This problem is particularly acute in developing countries which may not yet have an established system of collecting, managing and analysing data. The PARIS21 roadmap could provide a starting point for helping countries develop the agencies and systems needed to collect and manage the data.

The entire process of developing the digital economy is an iterative and dynamic one that would require policy refinements and adjustments. The monitoring process would reveal gaps between the policy target and reality and the areas that would warrant policy refinement or adjustment. At the same time, changes in technology may necessitate a new approach to doing things. To address these challenges governments may need to plan ahead and anticipate future

demands, or address current business challenges. The iterative process that some countries have used to implement their policies is examined in Annex 3.

IV. WRAPPING UP: GUIDING PRINCIPLES FOR DEVELOPING COUNTRIES' DIGITAL STRATEGY

This report makes a call for why the digital economy matters for developing countries and what they need to consider when developing a national digital strategy. The world is undergoing a digital revolution with significant implications for global economies and livelihoods. This revolution is predicated on the ever-increasing pace of technological innovation and diffusion. Digital technologies and their attendant applications are reshaping whole domains of human activity and are spreading across the world faster than previous waves of technological innovation. The digital revolution is thus too important for any country to overlook. As outlined in Section II, the digital economy can be harnessed for inclusive and sustainable growth: digital technologies make life easier for consumers and citizens, raise the productivity of workers and firms and help governments extend key services to those who need them most. However, this does not just happen randomly: governments must engage in strategic planning to maximise the development impact of digitalisation and ensure that its benefits are evenly distributed. Using the experience of leading economies in the digital space, Section III looked at some of the broad and generic enabling factors countries can develop and on which they can lay the foundations of their own digital economy. Laying the foundations of a successful digital economy requires strategic, iterative planning, as outlined by the design schema in Figure 19. Developing countries should use this design process as inspiration to launch their own digital strategy planning process.

This concluding section examines several key lessons developing countries can learn from other countries' digital experiences. Drawing on material and insights gleaned from Sections I and II, it provides some guiding principles around thinking about how to craft a national digital strategy that builds on top of the enablers of the digital economy.

Size matters, but it isn't everything: Finding a niche in the global digital economy through strategic planning

The size and central role played by platform companies are constituent features of the global digital economy. Section II (and Boxes 2 and 3) describes the logic of platform economics and how platform companies such as Google and Facebook have come to occupy such a vital position in the global digital ecosystem. The majority of the predominant platforms originated in the United States and China due to a combination of a long history of technological innovation, large domestic markets and policy decisions. In several key markets, such as online search and mobile advertising, platform companies predominate and create barriers to the market for potential new entrants. In addition, such companies tend to disrupt their non-digital counterparts and challenge incumbent business models.

Despite the challenges posed by size and incumbents, any country can find its niche in the global digital economy. That the world's largest and most successful digital platforms operate from the world's two largest economies is not accidental. However, it is important for developing countries to note that there are multiple entry points into the global digital economy and that size is not the only determining factor of success. Among others, the experiences of Estonia, Singapore and Sweden are instructive here: three countries with small domestic markets and few natural resources transformed themselves into global technology leaders through strategic policy decisions. In the aftermath of the Cold War, Estonia invested heavily in digitalising all aspects of government and digital literacy for the entire population. Such investment paid off, making government services more inclusive, attracting significant tracts of FDI and nurturing home grown digital start-ups, such as Skype and TransferWise, which have rocketed to global success (see Box 6). Through a series of national IT and digital strategic plans, Singapore evolved from a colonial outpost to one of the world's leading embodiments of smart cities (Box 16). In strong collaboration between academia and businesses, the Swedish government has successfully built up a critical competitive edge in the digital economy (Box 10). Rapid growth in the business process outsourcing sector has helped propel the Philippines to a greater vantage point in the global digital economy. These cases demonstrate that countries of all sizes can successfully integrate into the global digital economy and became key players in their own right.

Better together: Working with the private sector to grow the digital economy

One of the key challenges for developing countries as they embark upon a programme of digitalisation is unequal access to the digital technologies and services. For the digital economy to be truly inclusive, it must be accessible to all. Whilst the pace of technological diffusion across countries is increasing rapidly, it is not always matched by diffusion within countries. Sections II and III outlined some of the basic infrastructure and accessibility gaps that some developing countries are facing, such as non-existent or inconsistent Internet connections and unequal access to digital education. Overcoming these gaps in resource-constrained development contexts will significantly impact whether or not developing countries harness the digital economy successfully.

Some countries have already demonstrated innovative approaches to tackling this challenge in partnership with private actors. With Project Loon, Google is attempting to deliver reliable Internet coverage to geographically remote areas via helium powered balloons and LTE technology (Box 1). The Indonesian government is partnering with Google to bring Project Loon to its 130 plus islands where the Internet is either non-existent or prohibitively expensive. The Papua New Guinean government has teamed up with Matternet to use commercial drones to deliver key medical services to inaccessible parts of the country. And the Tanzania government is co-operating with Vodafone to scale up the latter's "digital school in a box" concept to provide digital education to refugees and nomadic peoples (see Section II). Although all these projects differ in scale, scope and complexity, they share the common theme of public-private partnership to achieve mutually beneficial digital goals. Moreover, advanced economies continue to foster

public-private partnerships to nurture the digital economy, as the examples of the Swedish triple helix model and the success of the Kista Science City attest (Box 10).

These partnerships attest to the reality that policy makers in developing countries will have to work closely with the private sector, NGOs and other civil society actors, to grow and protect their digital economy. Close co-operation with the private sector is required across a whole host of other areas of the digital economy, in addition to the issue of accessibility above. Effective regulation of the telecommunications sector requires policy makers to consider the benefits of competition versus scale. Should they mandate the sharing of network bandwidth through legislation like in the United States or follow an Open Access Network (OAN) model like in Singapore and Sweden? Crafting these policy regimes, along with others, such as those that govern network neutrality, generally require some input from the relevant private sector actors.

Investing smartly in the digital economy yields returns

The most digitally developed countries are those who have invested significantly and smartly in growing their digital economy. Estonia invested heavily in digitalising government services and providing children with a premium digital education (see Box 6). Sweden made major investments in its triple helix model, fostering close links between government, academia and business, and now boasts one of the world's leading ICT sectors (see Box 10). The United States and Germany are the top two countries in the world in terms of gross domestic expenditure on R&D (GERD) (Figure 12), and are global leaders in software development and precisions engineering/automation technology, respectively.

Another important lesson for developing countries is that there are different ways to distribute such funding on technological innovation and research. Sweden and Germany, for example, disburses public funding primarily through universities and research institutions, and companies tap into such funds through collaboration and joint projects (see Box 10 on Sweden). DARPA in the United States provides a much more flexible funding mechanism of solving specific military challenges through technological solutions (Box 12). To reiterate a constant theme of this report, multiple, heterogeneous paths exist to developing the digital economy and developing countries must find the route that best suits their local context.

Building the digital economy is a dynamic and iterative process

Finally, building the digital economy is a dynamic and iterative process which takes time and careful monitoring. Many countries have had to continually adapt and adjust their policies during the implementation phase to achieve their targets such as Internet or broadband coverage. Even countries which are at the forefront of the technology frontier have to continually adjust their policies to remain relevant in the rapidly evolving digital economy. Thus, to successfully develop their digital economies, developing countries should prepare to embark on a journey of continual learning and evolution. A key lesson from this report is the powerful capacity of the digital economy to transform developing countries' economies and societies. In many cases, digital technologies can be used to leapfrog stages of development; this has

profound implications for how countries think about not only their digital strategy but also their broader development strategy. However, whilst a growing digital economy ultimately raises societal welfare overall, its distributional outcomes can be uneven and take time to kick in. Moreover, the pace of technological change is always speeding up, and countries that pay scant attention to the digital economy or do nothing, will be left behind, as they struggle from flagging productivity, less efficient markets and increasing difficulty to attract top human capital. This report makes the call for developing countries to take the digital economy seriously, and to begin crafting a national digital strategy that will facilitate a flourishing digital economy and society for all.

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ANNEX A. DOWNLOAD SPEEDS REQUIRED FOR DIFFERENT DIGITAL SERVICE ACTIVITIES

Table A.1. **Download speeds**

Download speeds	Digital service activities
1-4 mbps	▪ Basic email ▪ Web browsing ▪ Music streaming ▪ Standard definition video ▪ Remove surveillance ▪ Telecommuting
4-6 mbps	▪ File sharing (small/medium files) ▪ Internet television services
6-10 mbps	▪ Online gaming ▪ Video on demand (for a single device)
10-15 mbps	▪ Telemedicine ▪ Remote education ▪ High definition Internet television services
15-50 mbps	▪ High definition video surveillance
>50 mbps	▪ Video conferencing with multiple users ▪ Remote supercomputing ▪ Real-time data collection ▪ Real-time medical image consultation

Source: Moton (2013), "How much Internet speed is right for you?", Yahoo! Homes, 13 February, www.yahoo.com/realestate/news/choose-the-best-Internet-speed-for-you-224440280.html (accessed 6 January 2016).

ANNEX B. ADDITIONAL COUNTRY CASE STUDIES

Germany – leverage core strengths to develop a niche in the digital economy

Germany is the largest economy within the European Union and the fourth largest economy in the world. Small-and medium-enterprises contribute significantly to the country's economy, accounting for about 70% of the country's employment. Manufacturing, value added remains a significant contributor to the economy, accounting for 22.5% of GDP in 2015 (World Bank, 2016b). The automobile, capital equipment and precision engineering industries are key industries within the manufacturing sector. Leveraging on its strengths in manufacturing, Germany is also poised to lead the world in the area of Internet of Things (IoT), with the national programme "Industrie 4.0," which aims to develop intelligent manufacturing systems.[19]

The way that Germany is building up a niche in the rapidly developing area of IoT is instructive for developing countries for two reasons. First, the German example shows how a country can leverage on its strength in other areas of the economy to develop a niche for itself in the digital world. Second, the systematic manner the German government used to assess the opportunities and devise a viable strategy shows how a country can proceed to plan and execute a nation-wide strategy to develop a niche in digital economy. Finally, the private sector involvement in this initiative evinces how a government can leverage the resources and expertise of the private sector to push the digital technology frontier.

Germany's technological leadership in the areas of automation and engineering make it well-placed to develop new production systems based on IoT. As of 2015, Germany has the third largest embedded systems market in the world, after United States and Japan, with an estimated total value of €20 billion (GTAI, 2015). Leveraging its core strengths gives Germany a leg-up over other countries in the development of smart manufacturing solutions. In addition, the solutions developed would also greatly benefit the German manufacturing firms.

[19] In the intelligent manufacturing system, also known as smart manufacturing, smart chips, sensors, tracking and communication devices are embedded into automated systems and physical objects to enable the systems to predict, identify and manage errors, in addition to managing the operations. This would ensure that defects and system errors can be quickly identified and rectified. The system is also expected to streamline work processes and reduce the level of work-in-progress inventory. Predictive analytics tools could be integrated with the system to forecast demand and schedule production and maintenance, or predict potential errors and take pre-emptive actions to prevent system errors or production down-time. Data analytics tools also offer the possibility of optimising production costs to reduce costs, improve energy efficiency, or reduce environmental pollution. The Boston Consulting Group (BCG) estimated that Industry 4.0 to yield productivity gains amounting to EUR 90 billion to EUR 150 billion between 2015 and 2025.

The systematic multi-stage process (Table B.1) to planning and implementing research agendas demonstrates the government's commitment to developing Germany as a leader in the emerging IoT field. By evaluating the opportunities, the German government is able to direct resources towards the most promising areas within the IoT field. By holistically examining the challenges of implementing IoT, beyond just the technical issues, the government is also able to identify potential challenges and put in place measures to address them before they arise. For example, the introduction of smart manufacturing would entail not just improvements in the automation systems, but also a reconfiguration of work processes and the implementation of better security systems. Through a systematic manner of planning and execution, the government has put in place measures to redesign the workforce for the future through training, and to promulgate cyber security measures for companies looking to implement IoT in the future.

Table B.1. **How Germany is developing its niche in IoT**

Policy Study	Outcomes and importance
National Roadmap Embedded System (2009)	***Getting started on embedded systems and IoT in manufacturing*** • Holistically examined the embedded system market in Germany, the potential applications of embedded systems, and specific research areas required to harness the different benefits of embedded systems • Provided recommendations on the research direction and budget for embedded systems • Provided recommendations on industry standards of interoperability
Recommendation for Implementing the Strategic initiative Industrie 4.0 (2013)	***Resolving issues with implementing IoT in manufacturing*** • Holistically examined all challenges involved in the implementation of IoT in a manufacturing setting • Provided recommendations on industry standardisation • Provided recommendations on specific areas of focus for research • Highlighted the need to strengthen and adjust regulatory framework, particularly on data and cyber security issues, to prepare for the implementation of IoT • Highlighted the changes to work organisation and design due to IoT and stressed the need for training and professional development to help workers cope with IoT
The New High Tech Strategy Innovations for Germany (2014)	***Extending beyond the manufacturing sector*** • Outlined an innovation strategy to develop Germany as a world leader in innovation • Identified other potential research areas, outside of the manufacturing setting, where IoT can be applied
Digital Agenda 2014-2017	***Preparing the society in general for IoT*** • Outlined ways to address social issues involved in the implementation of IoT on a broader scale and adoption of more digital technology • Identified infrastructural gaps and potential solutions to the gaps

Source: German Federal Ministry for Economic Affairs and Energy (2014), *Digital Agenda 2014-2017*, https://www.digitale-agenda.de/Content/DE/_Anlagen/2014/08/2014-08-20-digitale-agenda-engl.pdf?__blob=publicationFile&v=6.

The German government has also involved the private sector right from the beginning of this multi-stage national initiative. Starting with the National Roadmap Embedded System in 2009, the German government and industry representatives[20] jointly identified key research areas for the development of embedded systems. Subsequently, representatives from the industry and

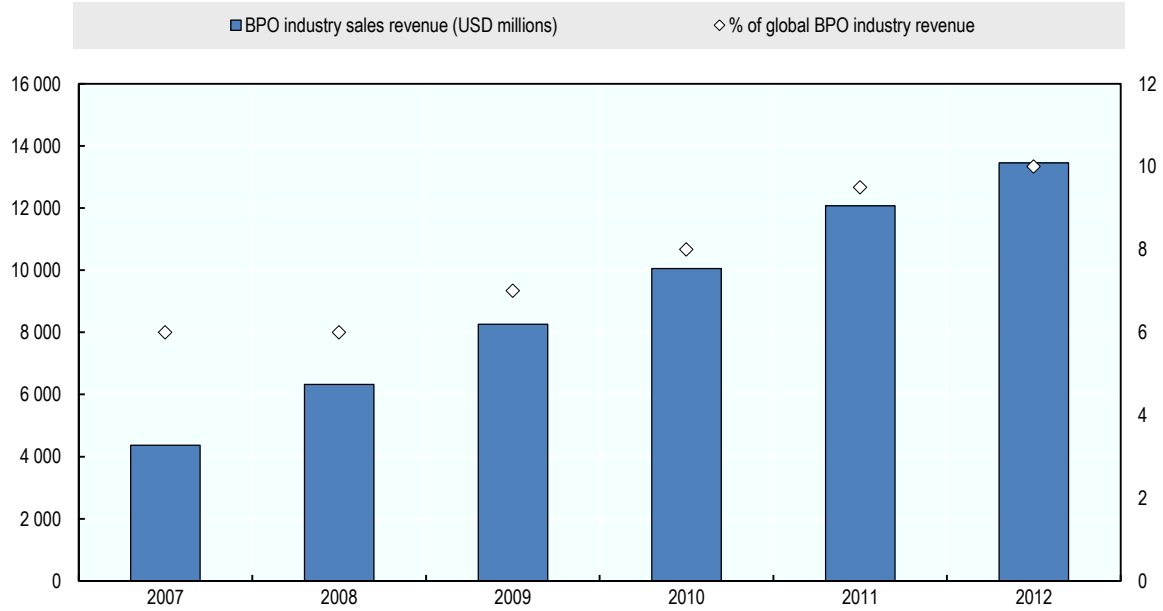
[20] The industry representatives were from industries such as auto construction, automation technology, machine and plant manufacturing.

academia were invited to join the government-led Industrie 4.0 Working Group, providing recommendations for the implementation of Industrie 4.0 in Germany. By involving the private sector in every step of the way, the government could ensure that the research agenda was commercially relevant and feasible. The involvement of the private sector and academia also provides an additional avenue for feedback on the progress of the initiative, allowing the government to make policy adjustments if necessary.

The Philippines – Capitalising on key advantages to build the digital economy

The Business-process Outsourcing[21] (BPO) industry in the Philippines is rapidly expanding, making the Southeast Asian nation with a population of 107 million a major rival to India, the current global leader in BPO. Indeed, BPO revenues in the Philippines grew at a compounded annualised average rate of 25.2% between 2007 and 2012, raising the industry revenues from USD 4.3 billion (or 2.9% of GDP) to USD 13.4 billion (or 5.4% of GDP). As a result, the country's share of the global BPO industry revenue nearly doubled from 6% to 10% over the same period (see Figure B.1). The rapid growth of the industry also led to rapid job creation. Direct employment grew from 272 000 (or 0.8% of total employment) to 770 000 (or 2% of total employment) over the same period, thus helping to ameliorate the problem of chronic high unemployment rates within the country.

Figure B.1. **The Philippines share of the global BPO industry has been rising**



Note: Sales revenue is based on nominal values. Percentage of global BPO industry revenue is computed based on nominal values in USD.

Source: Lee, et al (2014), "Business process outsourcing in the Philippines", https://lkyspp.nus.edu.sg/wp-content/uploads/2014/12/Business-Process-Outsourcing-in-the-Philippines.pdf (accessed 21 January 2016).

[21] Defined as the "delegation or handing over to a third party (external supplier) mediated via a contractual agreement, all or part of the technical, process and human resources, including management responsibility for transferred staff."

Although much of the country's success in the BPO industry has been attributed to the workforce's strong command of the English language and cultural proximity to Western countries, the government has played an important and crucial role in growing the industry through regulatory reforms and investment promotion policies. As the industry continues to develop, the government will play an even greater role in ensuring that staffing issues do not derail the development of the industry.

The Filipino accent is more easily understood and familiar to native English-speakers and is believed to have given the Philippines an edge over India in the BPO industry. Cultural proximity to the United States of America also made the Philippines and attractive destination for BPO as it meant that the workers could better understand and serve western customers.

However, it was the government's policy that ensured the country's potential in the BPO industry was fully realised. The liberalisation of the telecommunications industry in 1995 led to greater competition within the industry, thereby enabling more competitive long-distance call rates that underlie BPO call centres. The government also provided significant benefits such as tax holidays, tax exemptions on imported capital equipment and freedom to employ foreign nationals to investors in the BPO industry.

The establishment of the Philippine Economic Zone Authority (PEZA) agency in 1995 also played a great role in facilitating foreign direct investment in the BPO industry. PEZA was established to promote the Philippines as an investment destination for various industries including manufacturing and BPO, as well as to manage the special economic zones.[22] In addition to administering the tax benefits attached to an economic zone, PEZA also functioned as a one-stop shop for companies to apply for various business licenses and permits. The single point-of-contact helped improve business efficiency for companies looking to invest in the Philippines' BPO industry.

The government also played a crucial role in ensuring that problems such as a manpower crunch did not smother the growth of the growing industry in its nascent years. Noting that the demand for qualified personnel was exceeding the availability of qualified personnel, in terms of both English language and business skills, the government took active steps to address the high rejection rates in the BPO industry by launching programmes to make "near-hires"(or rejected applicants) more attractive to employers. Then-President Gloria Macapagal Arroyo launched the Industry-based Training for Work Scholarship (I-TWSP) to provide training for BPO applicants. The programme, which cost PHP 1.3 billion (USD 30.6 million) provided training to 65 000 BPO "near hires" by 2014, helping 70.7% of them to find employment within the industry.

Recognising the importance of data privacy to the BPO's clients, the government of the Philippines also enacted the Data Privacy Act (2012) to define the regulation concerning personal information. The act is based upon the European Union's guidelines on data privacy, and hence

[22] Companies within these special economic zones are granted special benefits such as tax holidays, tax exemption on imported capital, import and export fees, simplification of custom procedures and other benefits.

is one of the strictest laws on data privacy in the world. This move reflects far-sightedness as few other Southeast Asian Nations have adopted similarly strict standards of data privacy in the world. Neither has India, a key rival in the BPO industry, enacted a single legislation addressing all manners of data security issues.

Looking ahead, challenges for the Philippines' BPO industry abound. Despite the country's success in the industry, the country needs to move up the value chain on BPO services for two reasons. First, the country's cost-competitiveness will eventually be eroded as demand for labour continues to grow. As at 2012, the average salary of a BPO work in Cebu was about 50% more than that of a similar worker in Bangalore. Based on sheer population size, the Philippines, with a population of a mere 107 million simply cannot compete against India's population of 1.1 billion. Furthermore, the BPO sector was found to have very low inter-sectoral linkages (Asian Development Bank, 2007) both in terms of forward and backward linkages. This means that investment in the BPO industry had very little impact in the economy beyond the direct investment and job created. As with the development of the BPO industry, the government must take the lead in this to help the country transition towards higher value-add services.

South Korea – Grooming Local Champions for the Digital Economy

Between 1961 and 1990, the Republic of Korea (South Korea) was one of the fastest growing economies in the world. Within decades, South Korea has transformed its economy from an agrarian-based one to one that is based on high-technology industries and knowledge. Indeed, this rapid transformation has been dubbed the "Korean Miracle." This transformation process stands in stark contrast to Singapore's (see Box 11 of main report). Instead of making the attraction of foreign direct investment the priority, the South Korean government focused on developing indigenous capability in research and technology. The South Korean example thus provides an alternative model for developing countries that prefer to groom their own "local champions" rather than leverage the expertise of foreign multinational corporations in the areas of technology acquisition and innovation.

South Korea's *chaebols*[23] have played an important role in cementing the country's position in consumer electronics and subsequently digitally enabled consumer electronics. Driven by an export-oriented growth model and protected by a sheltered domestic market[24], the *chaebols* were compelled by market offices to allocate more resources towards more export-competitive

[23] Refers to large conglomerates based in South Korea such as Samsung, LG, Hyundai. They are similar to the *Zaibatsus* of Japan.

[24] The government sheltered the *chaebols* in the domestic market as part of the state-run development programme. Under this programme, the government would determine the markets where Korean firms could participate and restrict entry to that market to a select number of firms, which were chosen from a relatively small group of companies selected to be part of the state-run development programme. As FDI was very much restricted by various policies such as ownership restriction, repatriation restriction, technology transfer requirement, export requirement, this meant that the *chaebols* were rather protected in the domestic market of South Korea. In addition, many of these firms also benefitted from the state allocation of foreign funds that were essential for the purchase of capital equipment and plants in the early years of Korea's development.

industries. This precipitated a shift away from low value-add industries such as primary industries, textiles, shoes and home appliances that were reliant on low production costs. As the *chaebols* began acquiring technology know-how through a combination of technology licensing and reverse engineering, they began to develop a comparative advantage in high-technology industries such as semi-conductor, telecommunications equipment and automobiles, many of which either produced output for the digital products or required input from other digital products.

To encourage the *chaebols* to invest in technology innovation, the South Korean government has made liberal use of grant and tax credits, in addition to other support programmes such as procurement, technical consultancy, information technology transfer, etc. Based on a survey done in 2005, there were at least 250 small and large programmes to support research and development (R&D) and innovation undertaken by the private sector (Shin et al, 2006). Econometrics analyses have shown that the majority of these programmes, except for the procurement programme, have been effective in encouraging R&D.

The government's early efforts to develop the country's technology and research capabilities also endowed the country with a talent pool for technology-related R&D. The decision in the 1960s to establish public institutions dedicated to the pursuit of research and technology was rare among developing countries then. The institutions established then included the Ministry of Science and Technology, the Korean Institute of Science and Technology and the Korean Advanced Institute of Science. These institutes would play two key roles in helping South Korea develop its lead in digital technology: first, by helping industries absorb and assimilate new technologies, and second, by attracting established scientists and engineers from abroad.

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