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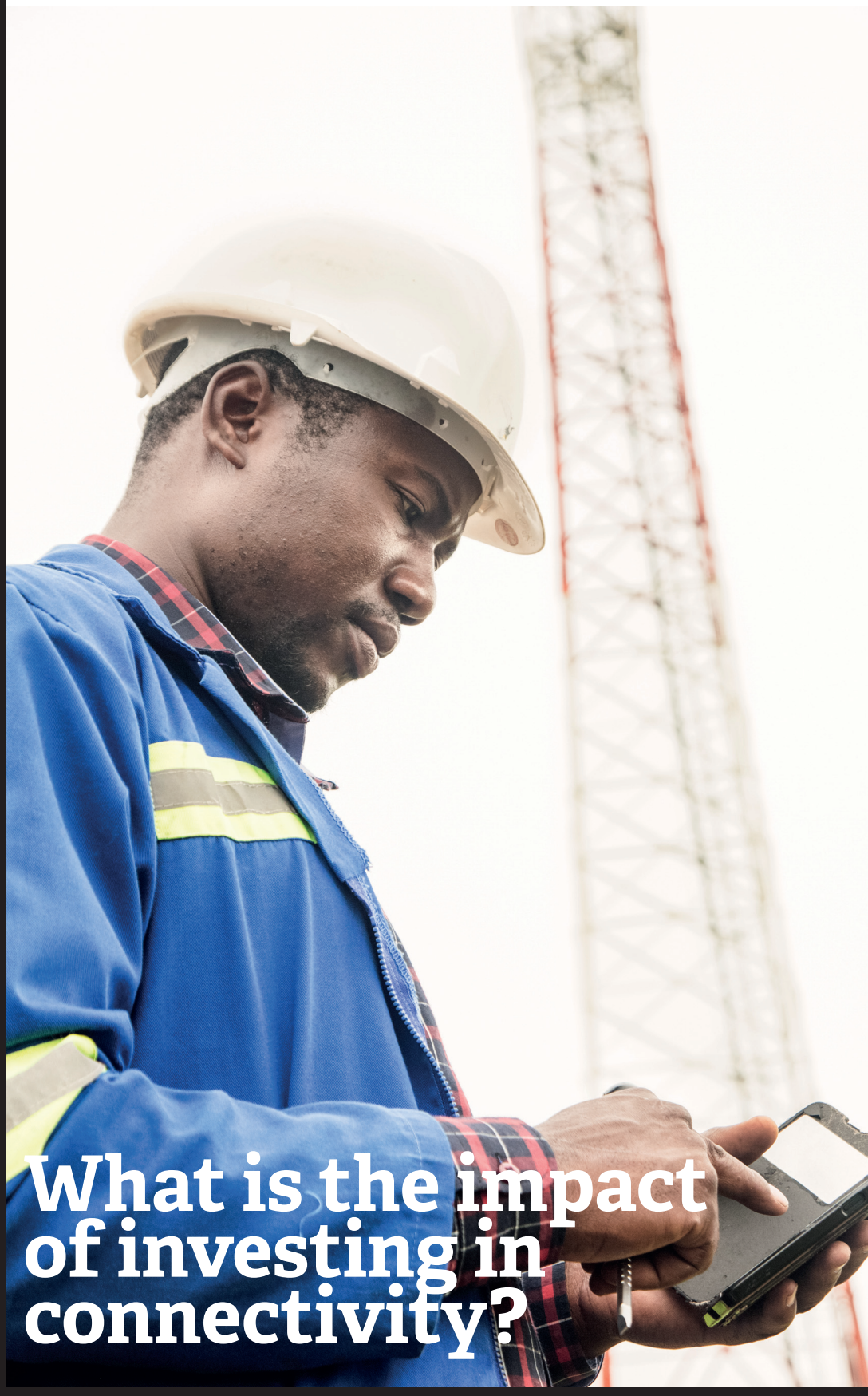

What is the impact of investing in connectivity?

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Abstract

Connectivity is essential for human survival and wellbeing. As a result, the gradual adoption of digital communications during the past decades has had a profound socioeconomic impact on our lives.

Affordable access to fixed and mobile networks has reduced information asymmetries, increased economic output, improved our capabilities and helped the delivery and automation of previously cumbersome tasks. The local implications from this technological disruption are not always identical across regions. Like other disruptions, the increase in connectivity challenges existing productive inputs such as labour, infrastructure and institutions. This report outlines the well-evidenced key effects that result from connectivity across the economy, society, institutions, and the areas where evidence is thin or still lacking. The report then outlines the properties of a well-functioning connectivity system, against which researchers could benchmark the status of connectivity interventions across the world, as well as some of the emerging risks policy-makers and investors should mitigate.

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Foreword

CDC is pleased to publish this impact evidence review by Dr. Pantelis Koutroumpis, Lead Economist at the Programme of Technological and Economic Change at the Oxford Martin School. Dr. Koutroumpis has established himself as a world expert on connectivity, with a broad range of relevant publications to his name over the past decade, so he is well placed to guide us through the evidence.

CDC's Insight series is designed to provide businesses and investors with a guide to the most relevant evidence for emerging markets, sector by sector. The importance of connectivity in contributing to the economy is widely accepted, indeed hardly questioned. Yet we could not find a clear synthesis of rigorous evidence on the topic to help us inform our strategy or drive impact across our investments. We hope this review fills that gap and will be useful for other investors in a similar position. It is important for robust evidence reviews to flag negative as well as positive impacts, and to be upfront about issues where the evidence is weak or missing. Dr. Koutroumpis certainly doesn't hold back on either front, setting those in this sector hefty challenges – which we relish.

CDC's experience in connectivity goes back to a 1997 investment in Indian cellular, just two years after the first ever call was made in the country in 1995. As the pioneering work of Rob Jensen cited in this review shows, connectivity has had transformational impacts all through the Indian economy in the decades since. In 1998 CDC was also privileged to catch the wave in African connectivity, investing in the company that went on to become Celtel, contributing to the astonishing leapfrogging of mobile communications, digital payments and off-grid appliances in Africa. Today, CDC has US$700mn invested in connectivity with over 100 companies across Africa and South Asia, backing specialist investment management firms like Convergence Partners in Johannesburg, infrastructure builders like Irrawaddy Green Towers in Yangon and a major new partnership with Liquid Telecom to build out digital transmission network in some of Africa's poorest countries.

We work with these businesses to evaluate and maximise their impact. Our recent impact study of wireless broadband provider Poa International Limited in Kenya, which we've backed through our investment in venture capital firm Novastar, can be found at the end of this report.

Oxford Martin School has been at the forefront of pioneering research that addresses global challenges. Recent work on artificial intelligence and development by school senior fellow and ex-CDC board member Professor Ian Goldin shows that there are constantly-evolving considerations in this crucial sector. We hope this evidence review will be the first step of our collaboration on what technological and economic change means for development in Africa and South Asia.

Alex MacGillivray
Director of Evaluations
CDC Group plc

Introduction

Analysing the impact of connectivity has been central to economic and policy discussions for more than three decades. As a general-purpose technology, digital communications have triggered significant changes across sectors, reshaped entire industries and reorganised our everyday lives. These changes came about once services became affordable, allowing billions of people to get connected and enabling data-driven firms and platform-based business models to emerge, spanning the entire spectrum of the economy.

While the impact of connectivity is mainly focused on developed economies, digital communications can revolutionise the lives of poor people, stimulate development and prosperity and accelerate progress towards the Sustainable Development Goals (SDGs). In fact, the least developed economies experienced the highest growth rates in mobile adoption between 2012 and 2017, exceeding a 50 per cent compound annual growth rate (ITU, 2017). The rapid expansion of mobile phone use and Internet access in developing countries offers unique opportunities to stimulate growth, jobs and financial inclusion. However, significant challenges remain. Over 3.5 billion people around the world[1] lack access to the Internet and risk being left behind in a digital world. Meanwhile, other aspects of the global economy may provoke negative impacts of Internet access, including risks of harmful concentrations of power, issues around data privacy and security, and increasing inequality within and across countries (the so-called 'digital divide').

The importance of connectivity is widely accepted, but thoroughly understanding and accurately estimating its impact in different socioeconomic contexts are difficult challenges. Without this evidence it is hard to inform public or private investment decisions that provide wider coverage and speeds. This work aims to fill this gap with an approach that acknowledges the interests of the involved parties. This paper aims to support policy makers, development finance institutions and private investors that could play an important role in extending connectivity infrastructure in countries that are lagging behind through their unique ability to provide patient capital and take higher risks than traditional investors.

In this paper we:

- introduce the concept of connectivity as an enabling technology (Section 1);
- provide an overview of the state of connectivity, infrastructure availability and adoption across countries (Section 2);
- describe the different parts of the connectivity value chain (Section 3);
- review the latest evidence from literature on the impact of connectivity focusing on economic growth, job creation and other social outcomes (Section 4); and
- summarise the key dimensions of a well-functioning connectivity system based on our review of the evidence in different contexts (Section 5).

Combining the inputs from a well-functioning connectivity system and its links to the value chain generates a roadmap for investments and other interventions. We hope this paper will be useful for those investing in connectivity systems as well as other stakeholders such as companies, governments and researchers.

50%

The least developed economies experienced the highest growth rates in mobile adoption between 2012 and 2017, exceeding a 50 per cent compound annual growth rate

3.5 billion

Over 3.5 billion people around the world[1] lack access to the Internet

1 Data from world internet stats (December 2017)

01

Connectivity as an enabling technology

Economists have struggled to understand the technological aspects of various disruptions that have happened over the centuries. Unlike micro-innovations which incrementally affect output or efficiency of existing infrastructures, general-purpose technologies – like the Internet – fundamentally change the mix of productive inputs and affect regions unequally because conditions differ vastly between places. Connectivity has many uses that practically affect most aspects of our everyday lives.

We define communications networks as general-purpose technologies that enable core economic activities to be carried out. Just as the electric grid, transport system and other networks are necessary for everyday activities, digital networks are needed in the production of goods and services. Communications networks exchange information, in the form of digitised data, to facilitate applications from exchanging text messages to developing artificial intelligence algorithms or transforming manufacturing using 3D printing. The impact of new services using this infrastructure is often confused with the impact of the infrastructure itself (as well as the applications developed on top of it). Identifying the relative impact of each component is complex but necessary to inform connectivity investment planning.

In mainstream economics literature, technological change is no longer treated as an external shock, like extreme weather events or epidemics.[2] Instead it is deeply rooted in the social, political, institutional and economic priorities of each country in a process often referred to as 'endogenous'. Technological change affects economic output, job creation and market transformation and, in turn, is affected by these changes – the economic and social dynamics along with policies and regulations that shape the digital ecosystem in each region. Modelling this two-way relationship is essential in this research. The key characteristic of digital communications is that they enable the exchange of information for a number of everyday activities and services. They can improve efficiency – in terms of the time and effort required for certain tasks – and boost productivity for small and large firms. As several studies show, a higher adoption of fixed or mobile access has a measurable impact on economic output (Koutroumpis, 2009; Czernich et al, 2011, Gruber and Koutroumpis, 2011).

Technological change affects economic output, job creation and market transformation and, in turn, is affected by these changes.

2 The endogenous approach was introduced by Schumpeter in the 1950s.

It is important to understand how connectivity investments create different impacts in different contexts. This can help inform which impacts and experiences from developed economies may be relevant for developing ones. The same connectivity investment can have a different impact (e.g. on output, jobs, welfare) in different conditions and countries. The process must be understood to extrapolate the growth potential of developed economies into developing ones. Similarly, connectivity affects the local economy and context where it is deployed, for example, a higher speed in fixed or mobile connections may have an immediate and significant role for the services sector yet no significance for construction and industry. The economic complexity of a region, including the breadth of products and services it produces, can be facilitated by this change, suggesting that a more dynamic view of the underlying context should be considered.

Use of the Internet is increasing across the world but some places, including several African and Asian countries, are still left behind.

02

The state of connectivity

Internet access through fixed or mobile networks has increased dramatically in recent decades. The highest growth rates are now reported in developing countries, which previously lagged behind wealthier ones. Use of the Internet is also increasing across the world but some places, including several African and Asian countries, are still left behind.

Before exploring how connectivity affects various socioeconomic outputs, in this section we provide a snapshot of the current state of connectivity across countries, focusing on speed, affordability and adoption. Using data from Ookla Speedtest (2018), Akamai (2017) and the ITU (2018)[3] we analyse the average speeds used to connect to the Internet as a basic indicator of connectivity infrastructure availability across countries, based on fixed line access (Figure 1). The leading countries include South Korea, Japan, the Nordics and most of the high-income economies across the world, while most South Asian and African countries appear to be lagging substantially behind.

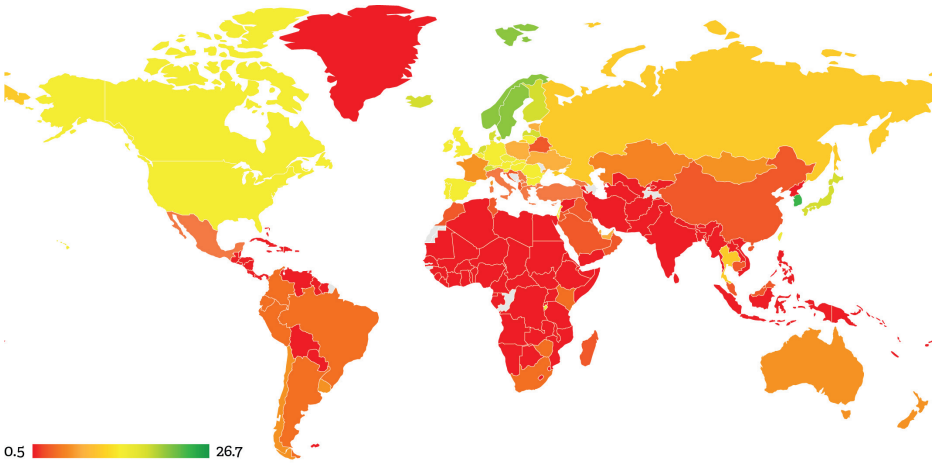

Figure 1: Fixed line average connection speeds (Mbps) in Q1 2017 (Source: Akamai, 2017)

3 The affordability figures use International Telecommunication Union (ITU) methodology to determine the cheapest handset-based prepaid broadband plans for mobiles (i.e., the cheapest plan providing at least 1 GB of broadband data over a 30-day period from the largest mobile network operator in each country). Gross national income (GNI) per capita data is from the World Bank, 2017. The reported data come from the Alliance for Affordable Internet.

While these metrics mainly account for fixed line access speeds we further look into the mobile connection speeds and their prices, as these have been sourced from the use of smartphones across the world and the key operators. Figures 2a, 2b, 3a and 3b compare the average mobile connection speeds by country, the affordability of every gigabyte (GB) used through a mobile connection, and overlay the regional and country average. Figure 2a looks into the Asia/Pacific region where Bangladesh, India, Indonesia and Nepal appear far behind the regional and global average. In terms of affordability, Nepal, Bangladesh, China and Cambodia are clear outliers compared with the rest of the region, with the price of a GB close to 4.5 per cent of the gross national income (GNI) per capita.

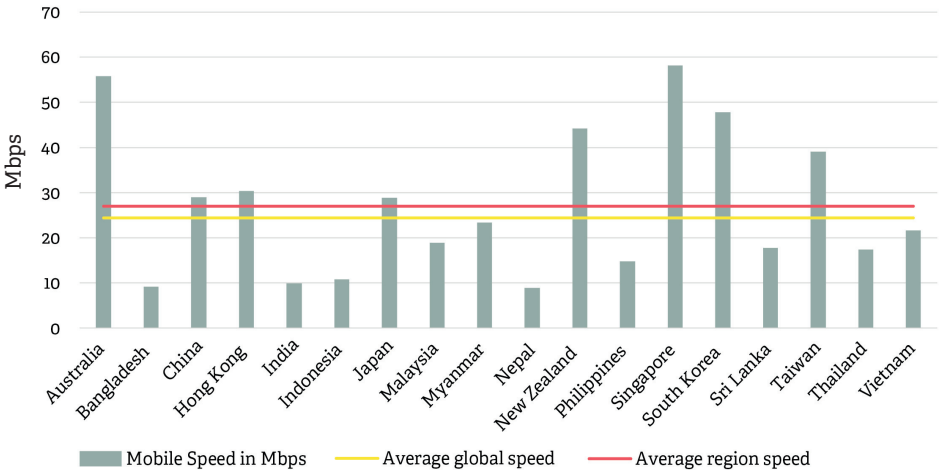

Figure 2a: Average mobile speed (Mbps) in Asia/Pacific in November, 2018 (Source: Ookla Speedtest, 2018)

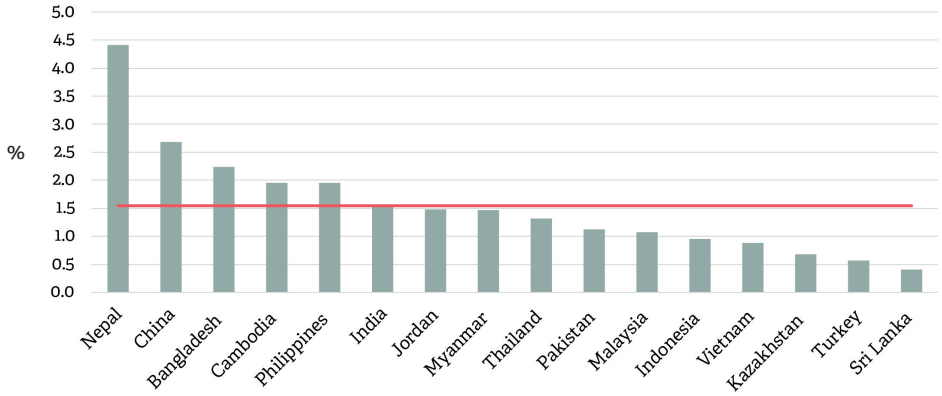

Figure 2b: 1 GB price as per cent of Gross National Income in Asia in 2017. (Source: ITU, 2018)

We then look into Africa (Figures 3a and b) where Ghana, Senegal and Tanzania are also lagging behind the Middle East & Africa. The affordability concerns are much stronger in Africa with some operators in countries such as Benin, Burkina Faso, Gambia, Malawi, Mali, Sierra Leone, Uganda, Zambia and Zimbabwe charging much more than 10 per cent of GNI per capita for 1 GB of data.

Operators in some countries charge more than 10 per cent of GNI per capita for 1GB of data

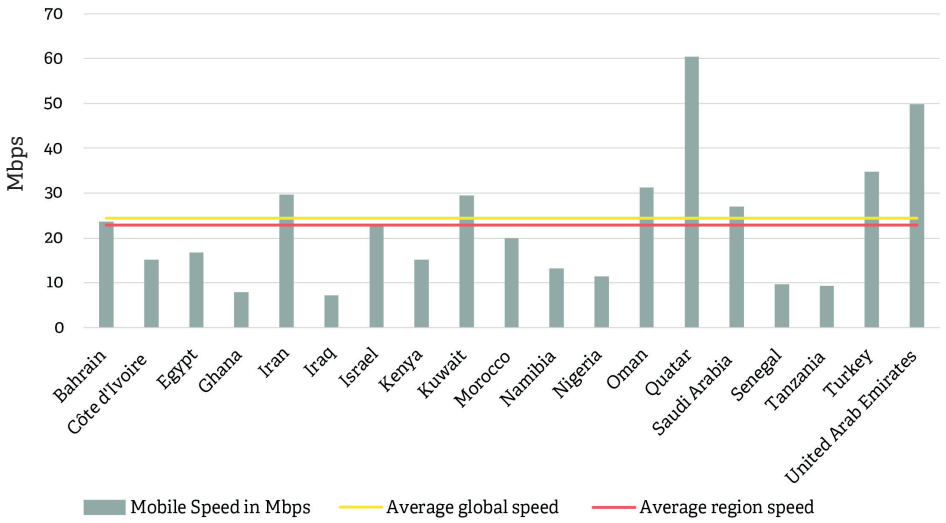

Figure 3a: Average mobile connection speed (Mbps) in Africa and Middle East in November, 2018 Q1, 2017 (Source: Ookla Speedtest, 2018; Akamai, 2017)

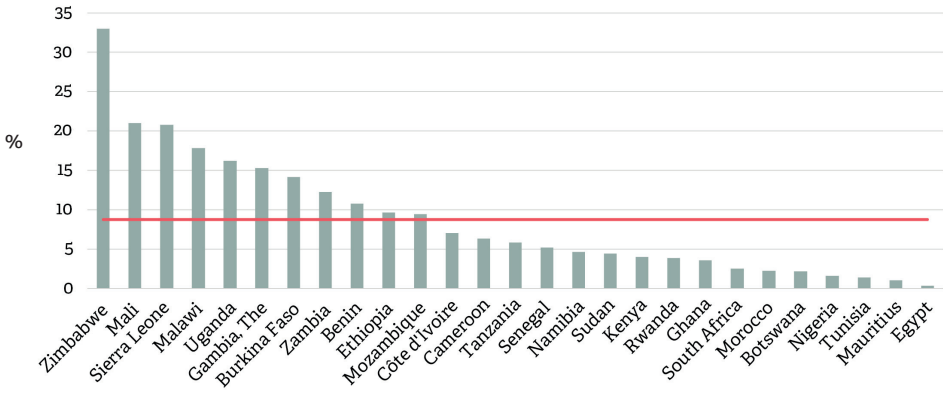

Figure 3b: 1GB price as per cent of GNI in Africa in 2017. Source: ITU, 2018

While the availability of connectivity infrastructure is essential, it alone is not enough to guarantee impact. Adoption and integration are critical, and can be assessed by looking at Internet use; Figure 4 provides a global map of Internet use rates.[4] Looking at global use of the Internet in 2016[5] we see that the high-income economies experience high levels extending to more than three-quarters of their population. The lowest adoption rates are concentrated in several African and Asian countries. Surprisingly, these countries are not the same as those lagging behind in terms of speed. This indication strengthens our view that more detailed analysis is needed before engaging in further investments or other interventions. Many countries in Latin America and Asia report high levels of Internet adoption despite very low connection speeds – suggesting that relying on a single indicator alone may not provide a clear enough picture. The bottlenecks in adoption appear in several African and Asian countries for which further analysis is needed to help identify the actual reasons for these effects.

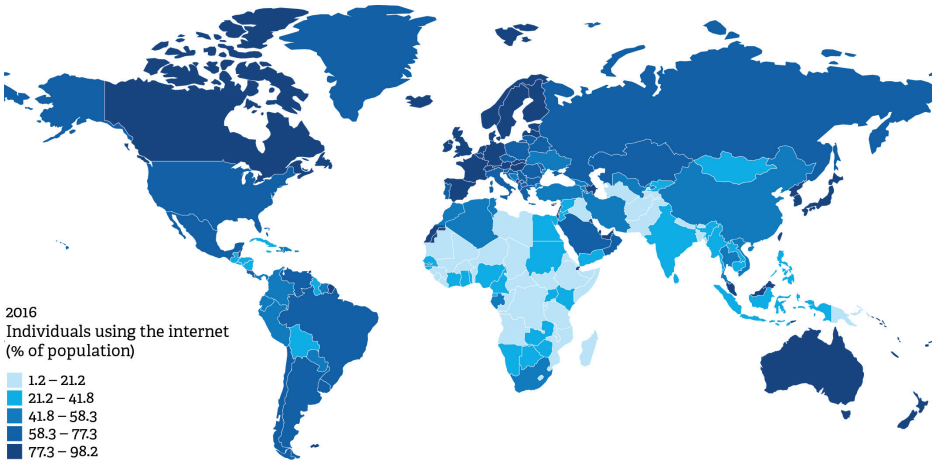

Figure 4: People using the Internet globally in 2016 (Source: World Bank, 2018)

4 The definition of Internet use in this metric is the following: Internet users have used the Internet (from any location) in the last three months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.

5 The more recent 2017 data was not available for all countries as of December 2018.

03

The connectivity value chain

Understanding the impact of connectivity is a deeply regional exercise. There is no one-size-fits-all approach in these investments as local context, the skills and culture of the population, local institutions and the openness to international trade can all have a significant effect on the impacts of connectivity. In this section a conceptual investment framework is described that includes the social aspects, market and investment conditions along with the institutional environment and the local infrastructures.

Here we analyse the connectivity value chain and interconnections of network infrastructure with the local market and institutional conditions. Combined with the elements of a well-functioning connectivity system, this can help to inform connectivity investment decisions.

3.1 Embedding the economic and social context in connectivity

Connectivity services aim to provide a seamless integration of different network and computational components to improve the overall experience of their users. However, the ecosystem of operators, firms and individuals covers several markets, each of them with individual dynamics and characteristics. The value chain in communications networks consists of four parts:

- last mile connections;
- national backbone;
- international networks; and
- content (data and applications) transmitted over the networks.

In each part there are three layers that represent the supply-side determinants for each level:

- investment conditions;
- market conditions; and
- institutional environment.

These layers can affect the impact of investments on each part of the value chain. For example, investing in high-speed broadband services in an uncompetitive market could possibly lead to high prices and lower adoption rates. An identical investment in an uncertain regulatory environment would discourage use through, for example, high charges, customer lock-in and traffic shaping.

Beyond the impact seen by the connectivity industry itself, wider economic conditions can affect and be affected by these investments. In our analysis we depart from a singular focus on technology and try to incorporate the demand side effects resulting from the use of technology as well as the benefits derived from these investments in a broader – regional or national – context. This includes the:

- industrial mix or economic complexity in each economy;
- education levels in the labour market; and
- institutional quality on a national level.

In particular, the economic complexity of a region – defined by the number and magnitude of different sectors that contribute to its economic output – can further affect the impact of connectivity. For example, a mainly agricultural region could experience a lower magnitude of effects than a services region (i.e. based on tourism or outsourcing services). Similarly the education levels play a key role in the use of connectivity as highly skilled people can search and use a wider range of information that is available on the web. Institutions also matter in this context, as the enabling potential of improved access requires a legal and practical oversight for the resolution of disputes and the protection of intellectual property and intangible assets that are often exposed in the public domain. And investing in mobile broadband in a country that facilitates new firm creation and is open for trade will have a higher impact than in regions with burdensome regulations – other things being equal. Similarly, the economic outcomes of these investments will be higher in places with a high level of skilled people or a well-functioning government.

Beyond the impact seen by the connectivity industry itself, wider economic conditions can affect and be affected by these investments.

3.2 A dynamic perspective on connectivity impacts

Implementing this framework for investment appraisal requires that the impact pathways are described for each layer separately (firms, markets and institutions). Each layer is scored on its actual performance and then the scores of each becomes a function of the scores in each sector. We can formulate the effects of each investment in three broad time categories: short term (0 –3 years), medium term (3–10 years) and long term (10+ years). This breakdown helps understand how the investment can affect the local conditions and make more informed decisions about the timing and impact of each intervention.

For example, local firms will benefit from investments in the short term, depending on previous investments in infrastructure, the market they operate in and local institutions. Local jobs will also be affected by these parameters. In the medium and long term the local economic conditions and labour dynamics will also play a crucial role. Computing these scores for each phase and the relative changes they can bring into other investments, markets and institutions will drive the impact pathways for this analysis. We aim to provide a range of impacts based on other layers and phases that will help guide the decision-making process.

The transformative impact of broadband technology on economic growth has been widely recognised.

04

Evidence of connectivity impacts

The evidence for the impact of connectivity across different facets of the economy and society is large and diverse. Since the main focus of the literature has been developed countries, extrapolating these findings to elsewhere may not be the right way forward. Focusing on the evidence gaps and the implications in local labour markets is essential for assessing the impact of connectivity across regions.

This section presents a review of the literature on the impacts of connectivity investments, focusing on three key types: economic growth, job creation and social outcomes. Evidence gaps are also discussed.

4.1 Economic growth

The transformative impact of broadband technology on economic growth has been widely recognised. This impact is achieved by reducing information transaction time and connecting the entire digital ecosystem in a seamless manner.

Broadband adoption increases economic growth

Several influential papers have found remarkably close estimates of the positive link between infrastructure use and GDP. Two studies, both looking at samples of developed economies, show that the addition of 10 broadband lines for every 100 people increased GDP – one by 0.7–1.0 per cent (Koutroumpis, 2009) and the other by 0.9–1.5 per cent (Czernich et al, 2011). Using a different methodological framework and a broader dataset, the World Bank reported estimates of GDP growth as 1.38 percentage points for developing countries and 1.21 percentage points for developed countries (Qiang and Rossotto, 2009). The European Investment Bank (Gruber et al, 2014) found an annual impact of 1.36 per cent from broadband adoption. Similarly, the impact of mobile access on GDP growth has been estimated to contribute 0.11 per cent annually for developing countries and 0.20 per cent for developed countries, looking at a sample of 192 countries for the period 1990–2007 (Gruber and Koutroumpis, 2011).

0.11%

The impact of mobile access on GDP growth has been estimated to contribute 0.11% annually for developing countries

These findings for mobile access are much lower than those for fixed broadband from the World Bank due to differences in methodology – Gruber and Koutroumpis (2011) (with methodology similar to Koutroumpis, 2009) disentangle the dual impact of wealthier countries investing in telecommunications infrastructure from the effect of the infrastructure itself.

Broadband investment improves international competitiveness and trade

The adoption of broadband networks can also increase economic growth through an increase in exports; it improves productivity, which increases competitiveness and the ability to attract foreign direct investment. Badran (2012) found that affordable, quality broadband is essential for a country to be competitive and strongly correlated with such investment. The export-driven economic growth of many Asian economies is seen as being due to advancements in broadband infrastructure and other high-tech capabilities, alongside appropriate policy reforms. An OECD (2016) study of 27 developed and 66 developing countries found a 1 percentage point increase in Internet use is correlated with a boost in exports of 4.3 percentage points (Clarke, 2006).

Increasing broadband speeds affects growth with diminishing returns

Moving beyond coverage and adoption, there is increasing focus on the quality of broadband delivery, particularly speed and reliability (Gruber, 2014; Ahlfeldt, 2017; Rohman, 2012; Rohman, 2013). This is particularly relevant in remote areas where people are connected by large distances and copper cables, which reduce both the quality and reliability of connections. Moreover, poor backbone infrastructure leads to further service deterioration in remote regions. Research shows a general consensus that basic connections are necessary for most of the population, and high speed connections positively contribute to economic growth but with diminishing returns. Gruber et al (2014) report significant effects on GDP growth in EU countries from basic speed adoption (higher than 1 megabits per second (Mbps)), but only marginal effects from higher speeds. Rohman and Bohlin (2013) support this view, showing that the speed levels necessary to realise these positive effects appear at 2–4 Mbps for OECD countries and 0.5 Mbps for Brazil, India and China. They also indicate that the highest effects appear at the speed range of 4–8 Mbps and that doubling broadband speed contributes 0.3 per cent to GDP growth.[6,7] Looking at 35 OECD countries, Ofcom (Koutroumpis, 2018) reports that increasing broadband speeds from 0.78 Mbps to 12.8 Mbps between 2002 and 2016 resulted in an average 0.08 per cent GDP growth. They also point to diminishing returns on speed and an upper speed threshold that increases over time as new applications appear that make the higher speeds necessary; this has increased from 3 Mbps in 2010 to 9.8 Mbps in 2016. Translating this finding for developing countries suggests that an internationally competitive speed across all – economically feasible – areas within a country will reduce the digital divide, compared with a selective upgrade with internationally competitive speeds that most people will not be able to use productively.

People highly value broadband connections

While the evidence on the economic impacts of speed is nuanced, it is clear that people highly value faster connections. Looking at broadband speeds and the willingness of subscribers to pay for service access in the US, Rosston et al. (2011) found that the average household is willing to pay about $20 per month for a reliable service and $45–48 for an increase in speed – almost twice the amount actually paid for Internet access. Ahlfeldt et al (2017) used a UK micro-dataset to link broadband speeds with a capitalisation effect on property prices. They indicate that a basic connection (8 Mbps) is worth 2.8 per cent of the property price and 3.8 per cent for a fast connection (24 Mbps), supporting the finding around diminishing returns of speed. These last two studies find remarkably close estimates for consumer willingness to pay for a change from basic to fast connection using very different empirical strategies. [8]

The export-driven economic growth of many Asian economies is seen as being due to advancements in broadband infrastructure and other high-tech capabilities, alongside appropriate policy reforms.

6 The authors also suggest that diminishing returns exist.

7 SQW (2013) showed that faster broadband speeds are expected to add £17 billion to the UK annual gross value added by 2024 (average of 0.07 percentage points to real annual GVA growth)

8 Turning the monthly effect into a perpetuity with a 5 per cent interest rate yields $11,520 for the change from basic to fast connection in Rosston et al (2011) and $12,540 in Ahlfeldt et al (2017).

Other research attempted to estimate the value of digital services that are provided for free, such as search engines, online maps, social media, e-mail and others. In a recent experiment, Brynjolfsson et al (2018) estimated that the value of search engines to the average user in the US amounts to more than $17,000 per year in 2017. Another group of researchers looked at the value that consumers place on their Internet connections as a proxy for this use. By looking at time spent on the Internet, Goolsbee and Klenow (2006) saw an increase in consumer welfare ranging from 2 per cent to 3 per cent of full income, or $2,500 to $3,800.

Speed metrics often involve the download capacity of the 'last-mile connection'. However, speed of loading is determined by the location of the content itself, not just the capacity of the connection. A server based in a different continent will require more time to transfer data to subscribers regardless of the download capacity they have. This highlights the importance of content delivery networks as a function of the speed that people experience when using the Internet. This is particularly relevant for investments in data centres and content-demanding applications such as video and data retrieval.

Broadband replaces financial networks

Money-transfer services are increasingly important in developing countries, with many depending heavily on remittances (sometimes exceeding 20 per cent of GDP). Traditional transfer payment services are relatively costly, often more than 10 per cent of the remittance amount. The World Bank (2006) estimated that reducing transfer charges by 2–5 per cent could increase the flow of remittances by 50–70 per cent. The mobile money industry processes more than $1 billon every day and generates revenues of $2.4 billion with more than 690 million subscribers globally. Two-thirds of adults in Kenya, Rwanda, Tanzania and Uganda actively use mobile money (GSMA, 2017). Mobile telecommunications firms, such as Smart in the Philippines and Safaricom and Vodafone in Kenya, now provide mobile transfer services at a fraction of the original costs, which facilitates transfers and reduces the burden on senders and recipients.

National financial services can also benefit from increased broadband adoption. Branchless banking can dramatically reduce the cost of delivering financial services to poor people relative to traditional channels. It also helps address the two key issues of access to finance: roll-out costs (physical presence) and transaction handling costs. This cost reduction significantly increases people's access to formal finance, in particular in rural areas where many poor people live (Ivatury and Mas, 2008). Likewise, it is also possible to make micropayments in the form of transfers of mobile data or airtime minutes. Safaricom – the largest mobile operator in Kenya – launched M-PESA, a mobile service for money transfer, in 2007. At that time only 10 per cent of the population (around 3 million people) had access to financial services (Beck et al, 2007). The service allowed unbanked customers to transfer money to mobile users and non-users alike, turn cash into airtime at local dealers and make payments through their M-PESA accounts. By May 2009, the service had 6.5 million users dealing with more than 2 million transactions a day. At the same time, the banked population in Kenya rose to 6.4 million.[9] A similar product was launched in April 2008 in Tanzania by Vodacom; products from competitors Zantel and Zain followed, such that all three major mobile operators in the country provide such services.

50-70%

The World Bank (2006) estimated that reducing transfer charges by 2–5 per cent could increase the flow of remittances by 50-70 per cent.

9 Figure from Kenya Broadcasting Corporation, 2009

4.2 Employment and business outcomes

Investment in infrastructure leads to job creation both directly and indirectly. Initially, the construction process affects local labour demand. Once networks are available and used, the transition of previous activities to this new infrastructure can lead to a process called 'creative destruction', which affects the types and numbers of jobs available.

Broadband investments increase employment, mainly in the information and communications technology (ICT) sector

The effect of broadband networks on job creation has been a key debate from the very early days of deployment; overall, the impact of Internet access on jobs has puzzled researchers. It has been shown that some service-providing sectors benefit from wider Internet adoption, but this is not consistent across other sectors. It is possible that an upgrade in one region may, in turn, create jobs in adjacent regions. A study using US data found that communities with broadband availability experienced 1–1.4 per cent growth in employment and a 0.5–1.2 per cent increase in the number of establishments (Gillett et al, 2006). This effect was more pronounced for businesses in IT-intensive sectors. Another study reported a positive link between broadband adoption and employment across US states, showing that for every 1 percentage point increase in broadband penetration, employment increases by 0.2–0.3 per cent per year (Crandall et al, 2007).

This evidence reflects a developed country context and may be difficult to extrapolate – more evidence is needed in developing countries. Recent causal evidence from 12 African countries shows that employment increased by 4.2–10 per cent over the last decade due to an increased number of sea cables (Hjort, 2017). This was driven by the establishment of new companies and increases in productivity and exports. The findings suggest that expanding digital infrastructure in countries that lack adequate access may be among the greatest employment-creating opportunities in Africa.

Findings suggest that expanding digital infrastructure in countries that lack adequate access may be among the greatest employment-creating opportunities in Africa.

Kolko (2012), using ZIP-code level data and a robust economic framework, found that increasing broadband availability led to growth in employment – but not wage – in ICT sectors in the US. He found that these effects are higher in low-density areas. Using a firm-level dataset, Forman et al (2012) contradicted these findings. They showed that advanced Internet is associated with significant wage and employment growth in locations with concentrated IT use, high incomes, high population density and high skill levels, but there was little evidence of this outside of these locations.

Fabritz (2013) analysed detailed municipal data in Germany and, in alignment with Kolko (2012), found a positive but small effect of asymmetric digital subscriber line (ADSL)-enabled houses on employment growth, mainly concentrated in rural areas. Looking at US neighbourhoods, Whitacre et al (2014) found that broadband adoption has a stronger link with economic outputs, income and employment growth than broadband availability. Using a dataset on ADSL2+ coverage and local firms in Italy, Canzian et al (2015) showed that broadband availability was linked with high increases in annual sales and company value, but it had very limited effects on employment growth. DeStefano et al (2014) looked at broadband use of firms in the UK and found that use affects firm size but not productivity.

4.3 Social outcomes and governance

This section looks beyond economic growth and focuses on some of the broader social impacts associated with improved connectivity, including those around good regulatory practices and governance.

Information access has a positive effect on happiness and subjective wellbeing with diminishing returns

Research demonstrates that information access has positive effects on welfare and subjective wellbeing. Using data from Europe, Kavetsos and Koutroumpis (2011) found that fixed broadband access and mobile use can significantly enhance individual happiness: a 10-line increase (per 100 people) in mobile adoption is equivalent (in subjective wellbeing terms) to a 2–3 per cent increase in GDP per capita.[10] Graham and Nikolova (2013) also showed that technology access is positive for wellbeing, but with diminishing returns. They too point to signs of increased stress and anger among cohorts for whom access to the technologies is new. Moreover, they examine the impact of wider inclusion in sub-Saharan Africa through network adoption. They show that wellbeing levels are higher in countries with higher levels of access to mobile banking.

Digital inclusion has the potential to improve access to banking, education, health, agriculture and governance

Digital access can provide a wide range of applications that affect different social outcomes. This section presents some examples of these impacts, which depend on the design of the interventions, the context in which they are applied and the implementation practice.

Digitisation facilitates financial inclusion in low-income countries in a way that was paved by M-PESA, a mobile service for money transfer. This digital transformation brings people into the formal money system and lowers transaction risks and cost. It has been shown to enable a reduction in people living in extreme poverty of up to 2 per cent (Suri, 2017). Jack and Suri (2014) conducted a randomised controlled trial in Kenya and found that income shocks reduced consumption of non-mobile money users by 7 per cent more than mobile money users. Mobile money has also enabled access to a wide range of other services, including pay-as-you-go off-grid solar.

In a similar vein, access to the Internet has enabled a range of new business models in education, such as open online courses (4,500 in India alone). Aker et al (2012) provide evidence from a phone-based programme in Niger, which improved adult learning outcomes in writing and maths relative to the standard curriculum. Evidence on the impacts of broadband access on school performance from the UK and Portugal was not as supportive and found that Internet access may increase time spent on distracting activities (Faber et al, 2016; Belo et al, 2013).

The literature on mHealth is also mixed, although models are still in the early stages of development (Black et al, 2011). The evidence suggests that telemedicine can be effective for remote populations in developing and developed economies, for instance, and may in fact be favoured by patients (Hanson et al., 2017).

Internet access can increase farmers' access to information on the weather, crop selection, pest control and farm management. Research from Muto (2008) and Jensen (2007), who studied the impact of mobile phones on perishable crops in Uganda and fisheries in India, found that it led to less waste, higher profits and improved market efficiency. Jensen and Miller (2017) further found significant productivity effects at the sectoral level among boat-builders when boat-buying fishermen gained better information on boat quality. Cole and Fernando (2016) ran an Internet-based evaluation of a low-cost mobile-based agricultural advice service provided to Indian farmers and showed that the service increased yields by 9–28 per cent for different crops. Each $1 spent on the service yielded roughly $10 in private returns.

Research demonstrates that information access has positive effects on welfare and subjective wellbeing.

10 A 10 per cent increase yields 0.65 per cent impact on GDP.

When implemented effectively, e-governance (for example online tax returns and mobile money social security) has the potential to reduce corruption and distribution costs, improve communication with citizens and increase trust in the government. For example, a large-scale randomised evaluation of an e-governance reform of a social welfare programme in India showed that the programme decreased distribution costs by 24 per cent due to reduced leakage (Banerjee et al, 2016).

Countries with better overall governance have consistently scored higher in telecommunications quality.

Overall governance is linked to digital governance

Koutroumpis and Waverman (2011) constructed an index that benchmarks telecommunications quality and links it to overall governance (as measured by the political transparency metrics) for 142 countries. Countries with better overall governance have consistently scored higher in telecommunications quality. The Telecommunications Regulatory Governance Index consists of five components: regulatory transparency, independence from the government, resources to the regulator, enforcements to licensees, and market conditions. Excluding the 'enforcement to licensees' variable, all components are significant predictors of the political transparency in a country. The exclusion of 'enforcement to licensees' seems to be linked to a classic 'de jure' but not 'de facto' sanction setting that can co-exist in politically corrupt states. This finding suggests that connectivity investments should also look into wider institutional characteristics that may directly affect their social and economic impact.

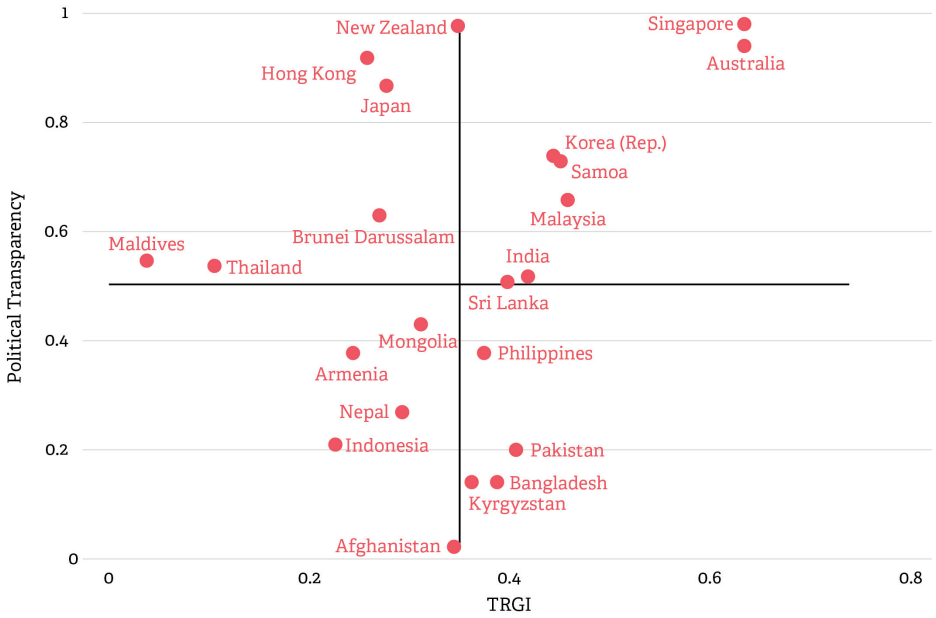

Figure 5: Telecommunications Regulatory Index and political transparency in the Asia/Pacific region (Koutroumpis and Waverman, 2011)

Regulating access to incumbents' networks increases adoption and speeds

Other regulatory aspects aimed at enhancing competition, promoting a level playing field among operators, supporting an arms-length regulator from the government and incentivising entry have been found to be generally positive in the literature. Nardotto et al (2015) show that opening-up existing infrastructure to entrants, through so-called 'local loop unbundling', has a positive effect on broadband adoption, which drops once the market reaches maturity and has significant gains on quality (an 18 per cent increase in average download speeds). Gruber and Koutroumpis (2013) support that intra-platform competition on the incumbent's legacy infrastructure (that is, the existing copper network in many countries) accelerates adoption of broadband, whereas competition over different access technologies does not.

The importance of different regulatory effects – such as the mandatory unbundling of the incumbent network – shows that simple interventions (and relatively low cost at the local exchange level) have a long-lasting effect compared with expensive ones (building a new network to compete with the incumbent).

4.4 Evidence gaps

Despite the evidence presented in the previous sections, there are still gaps in the literature that need careful consideration and would benefit from further research.

Evidence is lacking from developing countries on the impact of broadband on economic and social development. This gap in data impedes infrastructural investments and the deployment of high-speed networks in places that may benefit from them the most. This is discussed by Celtel's founder when trying to invest in African countries' mobile networks (Ibrahim, 2012). His attempts to build telecommunications networks in the region were mainly driven by the perceptions of investors for the continent which resulted in a lack of adequate supply: "Financial institutions didn't see Africa the way they saw India and other emerging markets. They thought it was too poor and too risky." Understanding the local environment and needs was crucial in the success of this endeavour. The typical approach – or a business as usual investment attitude – would not have worked. Ibrahim considered this and followed a different strategy: "many African consumers can't afford monthly contracts, so we created prepaid cards that offered cellular service for just a few dollars."

Few studies assess the long-term relationship between broadband speed and firm productivity. There are no clear links between the benefits of digital infrastructure (such as job creation or losses, increased outputs and the establishment of new firms) and the redistribution process from these changes (Forman et al, 2012).[11] The inequality in wage growth associated with connectivity investments in the US suggests "that internet technology followed the skill-biased pattern observed with previous generations of IT" along with other local factors that shape local markets including education, population size, industry composition and income (Forman et al, 2012). This is a key concern for policy makers and investors as the local conditions and their effects are often a result of a wider set of inputs, as indicated in Section 3. The economic benefits from digitisation do not imply that the social welfare effects follow a similar trend. In fact, there is evidence that points to the opposite direction, mainly originating from increasing use of social media that is related to feelings of loneliness, depression or envy (Verduyn et al, 2015; Appel et al, 2016; Mujcic and Oswald, 2018; Twenge et al, 2018; Hunt et al, 2018; Aranda and Baig, 2018). In fact, there is increasing support in terms of a 'moderate' use of technologies as a welfare improving mechanism, especially for out-of-work usage (Koutroumpis, 2019).

The gradual increases in access speeds and quality have shifted resources from local to shared infrastructures (Infrastructure as a Service (IaaS), Software as a Service (SaaS), etc.) This change may have an impact on the productivity estimates for ICT firms as equipment is not purchased and used as before, and it increases the dependency towards a faster and more reliable network. This may link other service delivery parameters (such as latency) to be factored in future studies.

4.5 Key risks to impact

Here we introduce the key impact risks associated with investment in broadband infrastructure across the themes of impact, namely economic growth, job creation and social outcomes. As the adoption of new technologies increases, the risks of negative repercussions from this use can be expected to grow.

Evidence is lacking from developing countries on the impact of broadband on economic and social development.

11 DeStefano, T. (2014). Causal Relationship between Information Technology and Firm Performance in the UK.

Reduced competition

Telecommunications markets often form oligopolies due to significant economies of scale, entry barriers (for example, spectrum rights and capital-intensive equipment) and increased competition. An investment that supports an existing operator may distort the competitive landscape and have effects on the price, quality or type of services offered. To lessen this requires careful consideration and adoption of international best practices. For example, even if the origin of the investment is private, open access network deployment, state-aid evaluation practices adopted in the EU and inviting all market participants to have the option to benefit from this intervention (either rural or for quality improvements) could be considered.

Loss of unskilled jobs

Broadband networks increase the rate of automation throughout the economy, which can reduce the demand for low-skilled or repetitive jobs. While there is some contradicting evidence about this hypothesis, and the impact of automation can affect local communities differently depending on the context, it still requires a set of mitigation options. One of these is the parallel investment in the development of digital skills to make sure that any lost jobs will be replaced with others in the new ecosystem. Investment in skills and measures that help reduce inequality through national or regional redistribution schemes (tax or other) are key aspects in this transition.

Privacy and cybersecurity

Online criminal activities ranging from spam/phishing e-mails to ransomware and cyber warfare have been estimated to cost the global economy $445 billion or 0.6 per cent of global GDP annually (Centre for Strategic and International Studies, 2014). The availability of personal data online and the increased profiling of users on these networks has been found to mobilise large groups quickly (for example in the Arab Spring), and the spread of fake news and extremist views has affected political outcomes in these countries, as in Myanmar and the Facebook mediated material (BSR, 2018).

Mental health and addictive behaviour

The use of digital devices has been linked to a range of emerging psychological conditions ranging from loneliness, to misery to envy, but there is still no consensus on the definition of a 'disease' that originates from this type of use only. Apart from the extensive use of social media that is linked to the aforementioned conditions, other types of addictive behaviour from the ease of access to gambling portals have also emerged. There are no easy ways to mitigate the social repercussions of information availability and misuse. For example, some mobile phone vendors have included in their standard operating systems an application that monitors the time spent with the phone and the specific activities within this use. This helps people compare themselves with their historic use, spot uncommon behaviour and – possibly – allude to social norm effects when the level of use changes dramatically. Still this is only one 'soft' intervention but there is room for further improvements with a set of specific priorities that deal with each aspect.

So to conclude, the risks in a digitally connected world are diverse and significant. These risks range from the local market conditions for access and associated services that affect the level and type of engagement to the repercussions in the job market for skills. And the actual use of digital networks poses threats to data privacy, political control and addiction to the technology itself.

05

Conclusions

As this report uncovers, making informed connectivity investment decisions requires an understanding of multiple dimensions of connectivity. Here, we conclude by summarising six key elements of a well-functioning connectivity system. They help us to understand the impacts of increased connectivity and guide the rationale for further interventions or investments in a systematic and data-informed manner. We recommend these to investors and policymakers to maximise the impact of connectivity investments.

1. **Network availability/coverage:** The existence of a network infrastructure is a good proxy for the investments that are already in place for firms and individuals to use. If a technology is already available there is no clear need to replicate or change it unless other technological, regulatory or market conditions necessitate it. Moreover, firms and individuals need to be covered by the connectivity system (fixed/mobile) in their areas of work/residence to enjoy the full range of the benefits.
2. **Network quality (speed, latency):** The type of infrastructure that is available can be pivotal for its use by firms and individuals. This is particularly interesting at the national and regional level as the distribution of available speeds can have significant effects on local development.
3. **Access cost (price per MB or minute):** Firms and individuals need to have access to cost-effective services. The cost can be estimated using an internationally set standard, for example the percentage of the median average income needed for a standard connection.
4. **Network competition (regional or national):** The level of competition has been linked to connectivity adoption and quality of services offered. This suggests that firms and individuals have the option to choose from more than one operator and avoid being locked in.
5. **Network regulation (dispute resolution):** Firms and individuals need to be able to report operators that charge excessively (outside the contractual arrangements or without explicit consent from the user side), provide inferior service quality or engage in anticompetitive practices (lock customers in).
6. **Privacy and security:** Firms and individuals need to have full control of their personal information shared over the telecommunications infrastructure. In the EU this is partly covered by the General Data Protection Regulation (GDPR), but in developing countries this has not been explored extensively. Trust in telecommunications infrastructures is an essential precondition for integrating digital access into other parts of the economy. Users need to be reassured that their data will be stored in a way that does not put them at high risk of a breach should the systems of the operators be compromised.

References

Ahlfeldt, G., Koutroumpis, P. and Valletti, T. (2017). Speed 2.0: Evaluating access to universal digital highways. *Journal of the European Economic Association*, 15(3), 586-625.

Akamai (2017.). State of the Internet. Available at: https://www.akamai.com/uk/en/about/our-thinking/state-of-the-internet-report/.

Aker, J.C., Ksoll, C. and Lybbert, T. (2012.). Can Mobile Phones Improve Learning? Evidence from a Field Experiment in Niger. *American Economic Journal: Applied Economics*, 4(4), 94-120.

Appel, H., Gerlach, A.L. and Crusius, J. (2016). The interplay between Facebook use, social comparison, envy, and depression. *Current Opinion in Psychology*, 9, 44-49.

Aranda, J.H. and Baig, S. (2018, September). Toward JOMO: the joy of missing out and the freedom of disconnecting. In Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services (p. 19). ACM.

Badran, M. (2012). The Impact of Broadband Infrastructure on Economic Growth in Some Arab and Emerging Countries. *Topics in Middle Eastern and African Economies* 14 (September), 278-320.

Banerjee, A., Duflo, E., Imbert, C. et al. (2017). E-Governance, Accountability, and Leakage in Public Programs: Experimental Evidence from a Financial Reform Management Reform in India. *NBER Working Paper.*, No. 22803.

Beck, T., Demirgüç-Kunt, A. and Levine, R. (2007). Finance, inequality and the poor. Journal of economic growth, 12(1), 27-49.

Belo, R., Ferreira, P. and Telang, R. (2013). Broadband in school: Impact on student performance. Management Science, 60(2), 265-282.

Black, A.D., Car, J., Pagliari, C. et al. (2011.). The Impact of eHealth on the Quality and Safety of Health Care: A Systematic Overview. *PLOS Medicine*, 8(1):), e1000387.

Brynjolfsson, E., Eggers, F. and Gannamaneni, A. (2018). Using massive online choice experiments to measure changes in well-being. *NBER Working Paper*, No. 24514.

BSR, 2018. Human Rights Impact Assessment: Facebook in Myanmar.

Canzian, G., Poy, S. and Schuller, S. (2015). Broadband diffusion and firm performance in rural areas: quasi-experimental evidence. *Institute for the Study of Labor (IZA).* Discussion paper 9429.

Center for Strategic and International Studies (2014). Net Losses: Estimating the Global Cost of Cybercrime. *Economic impact of cybercrime II.*

Clarke, G. and Wallsten, S. (2006). Has the Internet Increased Trade? Evidence from Industrial and Developing Countries. *Economic Inquiry*, 44 (3), 465-84.

Cole, S.A. and Fernando, A.N. (2016). 'Mobile'izing Agricultural Advice: Technology Adoption, Diffusion and Sustainability. *Harvard Business School Working Paper,* No. 13-047.

Crandall, R.W., Lehr, W. and Litan, R.E. (2007). The effects of broadband deployment on output and employment: A cross-sectional analysis of US data. *Issues in Economic Policy (The Brookings Institution)*, Number 6.

Czernich, N., Falck, O., Kretschmer, T. and Woessmann, L. (2011). Broadband infrastructure and economic growth. *The Economic Journal*, 121, 505-32.

DeStefano, T. (2014). Causal Relationship between Information Technology and Firm Performance in the UK.

Faber, B., Sanchis-Guarner, R. and Weinhardt, F. (2016). Faster broadband: are there any educational benefits?. *CentrePiece – The Magazine for Economic Performance (Centre for Economic Performance, LSE)*, No. 480.

Fabritz, N. (2013). The impact of broadband on economic activity in rural areas: evidence from German municipalities. *IFO Working Paper (IFO Institute for Economic Research at the University of Munich)*, No. 166.

Forman, C., Goldfarb, A. and Greenstein, S. (2012). The Internet and Local Wages: A Puzzle. *American Economic Review*, 102(1), 556-75.

Gillett, S.E., Lehr, W.H., Osorio, C.A. and Sirbu, M.A. (2006). Measuring Broadband's Economic Impact. Final Report Prepared for the US Department broadband's economic impact. *ESD Working Papers (Massachusetts Institute of Commerce, Economic Development Administration National Technical Assistance, Training. Research, and Evaluation Project, 99-07 Technology, Engineering Systems Division*), ESD-WP-2006-02.

Goolsbee, A. and Klenow, P.J. (2006). Valuing consumer products by the time spent using them: An application to the Internet. *American Economic Review*, 96(2), 108-113.

Graham, C. and Nikolova, M. (2013). Does access to information technology make people happier? Insights from well-being surveys from around the world. *The Journal of Socio-Economics*, 44, 126-139.

Greenstein, S. and McDevitt, R.C. The broadband bonus: Estimating broadband Internet's economic value. *Telecommunications Policy*, 35(7), 617-32.

Gruber, H. and Koutroumpis, P. (2011). Mobile telecommunications and the impact on economic development. Economic Policy, 26(67), 387-426.

Gruber, H. and Koutroumpis, P. (2013). Competition enhancing regulation and diffusion of innovation: the case of broadband networks. *Journal of Regulatory Economics*, 43(2), 168-95.

Gruber, H., Hätönen, J. and Koutroumpis, P. (2014). Broadband access in the EU: an assessment of future economic benefits. *Telecommunications Policy*, 38, 1046-58

GSMA, 2017. State of the industry report on mobile money. Available at: https://www.gsma.com/mobilefordevelopment/sotir/.

Hanson, R., Goetz, C., Truesdell, M. et al. (2017). Telemedicine vs Office visits in a Movement Disorder Specialty Clinic: Comparative Satisfaction of physicians and patients. *Neurology*, 88(16 Supplement), P4-003.

Hasbi, M. (2017). Impact of Very High-Speed Broadband on Local Economic Growth: Empirical Evidence. *14th ITS Asia-Pacific Regional Conference, Kyoto 2017: Mapping ICT into Transformation for the Next Information Society 168484, International Telecommunications Society (ITS)*.

Hunt, M.G., Marx, R., Lipson, C. and Young, J. (2018). No More FOMO: Limiting Social Media Decreases Loneliness and Depression. *Journal of Social and Clinical Psychology*, 751-768.

Hjort, J. and Poulsen, J. (2017). *The arrival of fast internet and employment in Africa* (No. w23582). National Bureau of Economic Research.

Ibrahim, M. (2012). Celtel's Founder on Building a Business on the World's Poorest Continent. *Harvard business review*, 90(10), s41-44.

ITU, 2017. ICT Facts and Figures. Available at: https://www.itu.int/en/ITU-D/Statistics/Pages/facts/default.aspx.

Ivatury, G. and Mas, I. (2008). The early experience with branchless banking.

Jack, W. and Suri, T. (2014). Risk sharing and transactions costs: Evidence from Kenya's mobile money revolution. *American Economic Review*, 104(1), 183-223.

Jensen, R. (2007). The digital provide: Information (technology), market performance, and welfare in the South Indian fisheries sector. *The quarterly journal of economics*, 122(3), 879-924.

Jensen, R. and Miller, N. (2017). *Information, demand and the growth of firms: Evidence from a natural experiment in India*. Working Paper.

Kavetsos, G. and Koutroumpis, P. (2011). Technological affluence and subjective well-being. Journal of economic psychology, 32(5), 742-753.

Kolko, J. (2012). Broadband and local growth. *Journal of Urban Economics*, 71, 100-13.

Koutroumpis, P. (2009), The economic impact of broadband on growth: a simultaneous approach. *Telecommunications Policy*, 33(9), 471-485.

Koutroumpis, P. (2018). The economic impact of broadband: evidence from OECD countries.

Koutroumpis, P. (2019). Technology and happiness: the value of disconnecting. Working paper

Mujcic, R. and Oswald, A.J. (2018). Is envy harmful to a society's psychological health and wellbeing? A longitudinal study of 18,000 adults. *Social Science & Medicine*, 198, 103-111.

Nardotto, M., Valletti, T. and Verboven, F. (2015). Unbundling the incumbent: Evidence from UK broadband. Journal of the European Economic Association, 13(2), 330-362.

Ookla Speedtest (2018) Available at: https://www.speedtest.net/global-index

Qiang, C.Z.W., Rossotto, C.M. and Kimura, K. (2009). Economic impacts of broadband. *Information and communications for deveopment 2009: Extending reach and increasing impact*, 3, 35-50.

Rohman, I.K. and Bohlin, E. (2012). Does broadband speed really matter as a driver of economic growth? Investigating OECD countries. *International Journal of Management and Network Economics*, 2(4), 336-56.

Rohman, I.K. and Bohlin, E. (2013). Impact of broadband speed on household income: comparing OECD and BIC. *24th European Regional Conference of the International Telecommunication Society, Florence, Italy*, 20–23 October 2013.

Rosston, G., Savage, S. and Waldman, D. (2011). Household demand for broadband internet service. *Communications of the ACM*, 54(2), 29-31.

SQW. (2013). UK broadband impact study. *A Report to the Department for Culture, Media and Sport.*

Suri, T. (2017). Mobile money. Money. *Annual Review of Economics*, 9, (1), 497-520.

Suri, T. and Jack, W. (2016). The long-run poverty and gender impacts of mobile money. *Science*, 354 (6317), 1288-1292.

Twenge, J.M., Martin, G.N. and Campbell, W.K. (2018). Decreases in psychological well-being among American adolescents after 2012 and links to screen time during the rise of smartphone technology.

Verduyn, P., Lee, D.S., Park, J. et al. (2015). Passive Facebook usage undermines affective well-being: Experimental and longitudinal evidence. Journal of Experimental Psychology: General, 144(2), 480.

Waverman, L. and Koutroumpis, P. (2011). Benchmarking telecoms regulation – the telecommunications regulatory governance index (TRGI). Telecommunications Policy, 35(5), 450-468.

Whitacre, B., Gallardo, R. and Strover, S. (2014), Broadband's contribution to economic growth in rural areas: moving towards a causal relationship. *Telecommunications Policy*, 38, 1011-1023.

Appendix

poa! Internet

Lean Data study

This impact study of wireless broadband provider Poa International Limited in Kenya, which we've backed through our investment in venture capital firm Novastar, is an example of our work to measure the impact of our investments in connectivity.

Company:	Poa International Limited
Sector:	ICT
Geography	Kenya
Fund:	Novastar Ventures East Africa Fund

Headline impact

- The majority of poa! Internet home broadband customers recorded quality of life improvements due to increased affordability of internet services and a more reliable internet connection. This allowed them, among other things, to work or study from home.
- Users report being better informed about the world and having access to information as the greatest benefits of internet access at home.
- Improved access to unlimited data has changed the way students and teachers use the internet for teaching and learning.
- Students using poa! Internet at school are more likely to benefit from information and communications technology (ICT) training during school hours and made more use of internet for private purposes, including accessing educational content.
- However, there was no evidence that the internet was being used to enhance learning outside of ICT training. Improvements in school ICT infrastructure may be needed to translate better internet access into enhanced student achievement.

Company overview

poa! Internet provides wireless broadband in low-income and rural communities in Kenya. The service is delivered through a Wi-Fi network, and this technology has allowed poa! Internet to bring more affordable internet access to underserved individuals and small businesses. poa! offers both public "street" internet access and internet to the home and small businesses.

Customers receive unlimited data packages, free content and access to online services such as job boards and marketplaces. poa! has also provides free internet access to selected community institutions, including schools, in return for these facilities hosting the infrastructure used to provide the street service.

Poa International Limited is a portfolio company of Novastar, a venture catalyst firm that has received investment from the CDC Impact Fund and the European Investment Bank's Impact Financing Envelope.

I was spending 6,000 per month on internet but now I only spend 1,500, and also the internet has almost become a basic need, so, yes the quality of my life has changed.

poa! Internet user

poa! Internet

Research focus

Information and communications technology (ICT) can have a positive impact on the lives of individuals and can help accelerate economic and social development. Yet 4.4 billion people around the world are still unconnected and many more are poorly served.

poa! aims to provide fast, affordable and unlimited access to the internet to underserved communities. In East Africa, low-income and rural populations face particular barriers to accessing the internet. Even where people are able to overcome the prohibitive costs of mobile data to afford the service, they often face a poor user experience, relying on a slow 2G service or limited amounts of 3G/4G.

Wi-Fi technology can reduce the cost of providing mobile data coverage, making it possible to increase affordability. This allows poa! Internet to offer internet packages at lower prices than leading cellular operators and to make its service available in places which other technologies can't reach or which operators have chosen not to serve.

In 2017, poa! Internet launched a new home service and was keen to understand how access to internet was affecting early adopters of the product, and the potential to expand the service to peri-rural areas. At the same time, poa! is considering how to develop its street internet service and wanted to understand the impact it has on schools hosting Wi-Fi infrastructure.

This involved carrying out research in two stages. The first used Acumen Lean Data to explore customer feedback and satisfaction with the poa! home service. The second investigated the effect of poa! Internet on ICT uptake and usage in schools. This research component was led by a Fellow under an EIB – Global Development Network Joint Programme. The study involved:

- A phone survey with a representative sample of 312 poa! Home customers
- A survey of school authorities and students in 18 schools in Nairobi and Kiambu Counties, split into a two groups treatment schools (those with a poa! connection) and control schools (those without a poa! connection).

Research was conducted over a six-month period from January to July 2018.

>56%

Over half of poa! Home broadband users (56%) say that their quality of life has "very much improved" because of poa!

Yes, the world has become closer to my home. I access internet both at home and workplace, I am now more informed.

poa! Home broadband user

Research findings

Part One: Home broadband

Users of reliable and affordable internet access at home see an improvement in their quality of life

- Over half of poa! Internet Home broadband users (56%) say that their quality of life has "very much improved" because of poa!. A further 31% say that it has "slightly improved". The main improvements that respondents listed are reduced expenditure on accessing internet (30%), and improved reliability of internet access, enabling them to work or study from home (29%).
- The unlimited poa! Internet home broadband service was seen as a superior alternative to purchasing data bundles or going to cyber cafes.

Internet access improves perceptions of connectivity

- When asked about how poa! Internet is affecting users across various impact related dimensions, "informed about the world" and having "access to information" were rated as the most important effects. Customers also scored poa! highly in the dimensions of providing entertainment and generating income.

poa! Internet

Part Two: Wi-Fi services

poa! in schools improves access to information and increases the likelihood of regular internet use

– The students appreciated improved internet availability (reported by 60% of students), improved access to information (51%) and improvements in the availability of teaching and learning materials (44%).Students in schools receiving poa! internet are 29% more likely than students at non-participating schools to use internet daily, 39% more likely to report receiving internet training during school hours and 40% more likely to receive online educational content. The analysis underlying these results controlled for age and basic household characteristics, but the differences may reflect other differences between the two groups.

But internet use remains limited, and no impact can be traced on student achievement

– Despite increased access to ICT resources, this has yet to translate into changes in the classroom. Only 1 in 5 students reported an increased use of the internet as a teaching and learning resource, and fewer than 1 in 10 reported the use of online courses. The study found no evidence that provision of poa! internet had increased the probability that students received educational internet content at school. Nor were they more likely to report improved general ICT-related skills and knowledge.

The real impact of poa! Internet may be under-stated

– Internet infrastructure primarily drives impact indirectly through enabling human capital, economic and social development across an economy. These changes cannot be captured through surveys alone. For example, while customers may experience some immediate cost-savings and a productivity boost, the impact on entrepreneurship, skills, and employment will only materialise in the medium term.

– The research in the schools revealed a high level of enthusiasm amongst students and school authorities. However, the full benefit of improved internet access can only be felt if appropriate hardware and capacity is in place. Students need access to computers or other devices if they are to access the internet as a learning tool – the research showed that currently many can access only for a few minutes at breaktimes or after class – and teachers need to be trained in how to make use of the internet for educational purposes. Furthermore, the school management need the appropriate capacity to keep an ICT system functioning.

60%

of students in poa! schools reported improved internet availability

poa! Internet is used to undertake research in all subjects. ICT including the Internet is used by students to undertake project work. Students use the Internet in order to get high scores/ marks during examinations both at school and national levels. poa! Internet is cheap and fast.

Educators in schools using poa!

poa! Internet

What happened next?

These findings gave poa! new insights into their customers, their preferred content, and the ways in which the company could improve their home and street services.

poa! Internet is currently expanding the number of Wi-Fi hotspots to improve coverage of the poa! Internet street service. This will reduce the need to partner with schools to host their infrastructure. poa! Internet management is seeking ways to continue developing its schools service, potentially involving partnerships with NGOs and others philanthropic organizations. Such partnerships could make it possible, in addition to providing free Wi-Fi, to cover some of the ICT infrastructure and capacity needs of the schools. This could catalyse an even greater impact for schools and students in these underserved communities.

At the rate at which the world is changing with technology... you risk being left behind. It has generally made life easy and enjoyable.

poa! Internet user

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