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The economic impact of disruptions to Internet connectivity

A report for Facebook

October 2016

Contents

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1 Executive Summary

The Internet has become ingrained into the tasks that people across the world perform each day. From obtaining information on markets or health, to making mobile payments, the Internet has made each task that much easier. At the same time, disruptions to Internet-based services and infrastructure have become more common. These disruptions have widespread impacts on people and the economy with even partial disturbances affecting productivity, souring business confidence, and leading to lost opportunities.

The impacts of a temporary shutdown of the Internet grow larger as a country develops and as a more mature online ecosystem emerges. It is estimated that for a highly Internet connected country, the per day impact of a temporary shutdown of the Internet and all of its services would be on average $23.6 million per 10 million population. With lower levels of Internet access, the average estimated GDP impacts amount to $6.6 million and to $0.6 million per 10 million population for medium and low Internet connectivity economies, respectively.

Developments in the Internet and the services it supports have created an ecosystem around which people and businesses' daily lives revolve. From connecting with friends and businesses, to obtaining information or making sales, the Internet has made carrying out different tasks much easier and efficient. For businesses, the Internet has made day to day activities such as selling or purchasing less stressful and costly. Disrupting the Internet ecosystem therefore limits the opportunities for people and businesses, and hampers the economy. On a personal level, Internet disruptions can inhibit social interactions.

Globally, business to consumer e-commerce transactions amounted to $1.9 trillion in 2014. Across the world there is variation in the scale of nations' Internet ecosystems. Even in countries with medium levels of connectivity, between 69-95% of businesses are already online while a growing share of businesses are embracing the Internet in countries with lower connectivity. In medium and low connectivity countries, e-commerce makes up to 5.2% or 2.3% of GDP respectively, and in developed countries it reaches up to 5.7% of GDP.[2,3]

Despite the role of the Internet as a catalyst of economic activity, in recent times there have been a number of Internet disruptions instigated by public authorities. These have included temporary and complete shutdowns of Internet connectivity across a country,[4] targeted Internet blackouts in regions,[5] and the blocking of specific messaging and social media services.[6]

Deloitte have been commissioned by Facebook to explore how disruptions to Internet connectivity ordered by public authorities impact the economy, with an analysis that uses publicly available information. This study does not consider Internet disruptions that occur through traffic management, or technical faults encountered by network operators.

How disruptions to Internet connectivity impact the economy

People often experience disruptions to the Internet through an array of temporary disturbances rather than permanent shutdowns. However even partial disruptions have material economic impacts by hampering productivity, frustrating business confidence, and souring investment across sectors, leading to economic loss that ultimately affects people.

Temporary Internet shutdowns or reductions in the speed of web traffic lasting one or a few days impact the economy through temporary periods of reduced productivity and losses in time-sensitive transactions. Deals fall through and important industries are left sitting idle – all while the Internet is down. Disruptions prolong the time it takes for people and workers to communicate and deliver necessary information, limiting access to up-to-date information.

Table 1: Internet ecosystem metrics across groups of countries by Internet connectivity[1]

	Low	Medium	High
Internet penetration	<49%	49-79%	>79%
Average connection speed (mbps)	3.0	6.5	10.5
Businesses with Internet access	20%*	69-95%	78-95%
E-commerce as a % of GDP	0.3-2.3%	0.4-5.2%	0.8-5.7%
Average e-commerce size per capita	$40	$220	$1,250

*Limited data availability
Source: Deloitte analysis. See appendix for more details

[1] The thresholds are determined based on a sample of 96 countries. The ecosystem metrics are based on a smaller sample based on data availability.
[2] E-commerce Europe (2015a). All references are provided in full in the Bibliography section.
[3] OECD (2010)
[4] For example, in January 2011 Egypt shut down the Internet temporarily during a period of unrest. Iraq has shut down the Internet temporarily a number of times in 2015 and 2016. (The Telegraph, 2011; The Guardian, 2016)
[5] For example, residents of the regions of Jammu & Kashmir in India are reported to have collectively lost access to Internet connectivity for an estimated aggregate of 18 to 25 days over the last four years. (The Wire, 2016)
[6] For example, Algeria blocked Facebook and Twitter temporarily in 2016. Facebook Messenger and WhatsApp are blocked in Saudi Arabia. (The Washington Post, 2016; Deccan Chronicle, 2016)

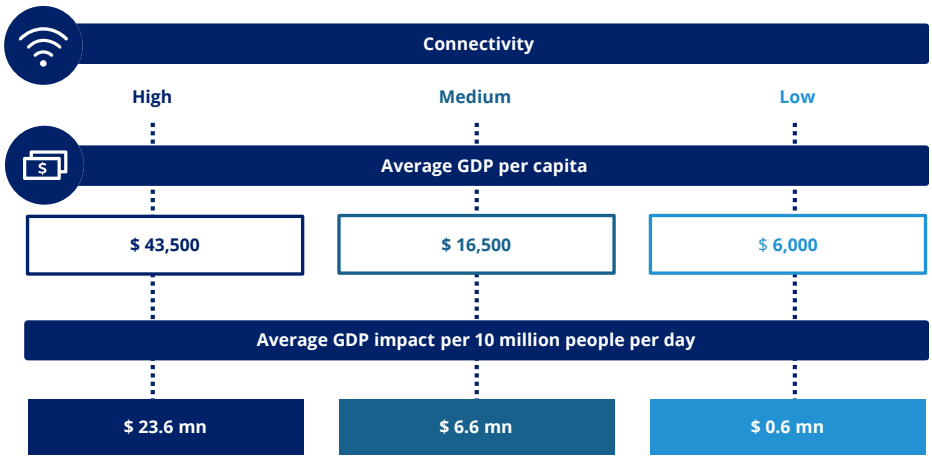
Delayed communications and the inability to execute day-to-day tasks reliant on Internet services lead to higher transaction costs and reduced output. For people and businesses, disruptions result in lost purchases, missed payments, misinformation, or lack of action.

Disruptions are sometimes applied to specific services like social media, instant messaging, or search rather than the whole Internet ecosystem. Blocking these services which people and businesses use daily has immediate impacts. Such disruptions make it more difficult for people to communicate with friends and family, discover products or obtain information generally. Businesses lose visibility with customers, and opportunities to interact with them, to obtain feedback and to receive orders.

Disruptions that are applied recurrently or last longer magnify the impacts on productivity arising from temporary shutdowns. They increase uncertainty in the business environment and force firms to move towards less optimal business models or more expensive suppliers that are not affected by disruptions to Internet connectivity. In response to this uncertainty, businesses may reduce investment and face higher costs.

The impact of Internet shutdowns is not widely researched and there are clear data challenges to this exercise. As far as this report is aware, this study constitutes the first effort to analyse the economic impact of Internet disruptions across countries with different connectivity levels under a common framework. Quantifying the impact of very specific types of disruptions would require a level of granularity which is beyond the information publicly available. Therefore, the estimates in this study are constructed as a platform to illustrate the potential order of magnitude of different types of disruptions. This study draws on estimates of the economic impact of the Internet measured in the academic literature over longer time periods, hence the estimates presented may represent an upper bound of the impacts of very short term temporary shutdowns. The impacts of more partial disruptions such as those concerning only particular services or regions in a country are expected to be a subset of the effects estimated in this report, while longer-term or recurring disruptions are likely to lead to much larger impacts.

Figure 1: Estimated GDP impact of a temporary Internet shutdown per 10 million people per day by level of connectivity



Source: Deloitte analysis. See appendix for more details

Estimated impacts of temporary disruptions to the Internet ecosystem

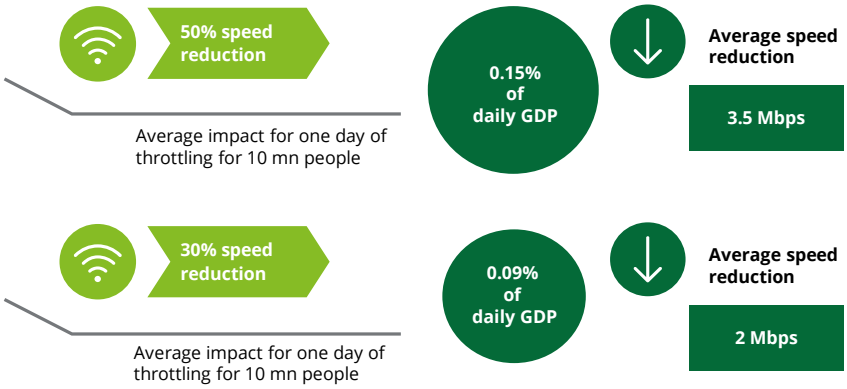
The magnitude of the impacts arising from disruptions to the Internet ecosystem vary by the means, length, and targeting of the disruption as well as a country's existing levels of Internet connectivity. Countries with a high level of broadband access are likely to exhibit more intense use of the Internet by businesses and consumers, a more mature ecosystem and the ability to handle greater volumes of time-sensitive transactions.

The average per day impacts of a temporary shutdown of the Internet grow larger as the level of connectivity and GDP increase. It is estimated that for a highly connected country, the per day impact of a temporary shutdown of the Internet and all of its services would be on average $23.6 million per 10 million population. With lower levels of Internet access and speed, the average estimated GDP impacts amount to $6.6 million and to $0.6 million for medium and low connectivity economies respectively.

The magnitude of these impacts can be illustrated further with some examples:

- In a country with high connectivity, with GDP per capita of $45,000, a population of c. 60 million people, and fixed broadband penetration of c. 35%, a temporary Internet shutdown could have an estimated GDP impact of c. $141 million per day of disruption. In this example, this is equivalent to 1.9% of daily GDP.
- In a medium connectivity country, with GDP per capita of $25,000, a population of c. 30 million people, and fixed broadband penetration of c. 15%, a temporary Internet shutdown could have an estimated GDP impact of c. $20 million per day of disruption. In this example, this is equal to 1% of daily GDP.

Figure 2: Average daily GDP impact of temporary throttling per 10 million people for a 50% and 30% decrease in broadband speed



Source: Deloitte analysis. See appendix for more details

- In a low connectivity country, with a GDP per capita of $6,000, a population of c. 40 million people, and fixed broadband penetration of c. 5%, a temporary Internet shutdown could have an estimated GDP impact of c. $3 million per day of disruption. In this example, this amounts to 0.4% of daily GDP.

Disruptions to Internet speed extend the time it takes for web pages to load or for notifications to be delivered. In the case of temporary disruptions implemented through reductions in Internet speed rather than complete shutdowns, the average estimated impact per day is less than the impact of temporary shutdowns, at 0.15% of daily GDP for a 50% reduction in speed. Larger reductions in speed would see this impact grow towards the magnitude of impacts of temporary shutdowns as certain services become potentially unusable.

As the Internet is adopted more widely and used more intensely across countries, Internet services become crucial for businesses and people. Overall, the estimates produced in this study and the evidence available in the public domain suggest that disruptions to Internet ecosystems can have economic consequences, and ultimately costs for a country's population. If disruptions become more frequent and longer-term in nature, the impacts are likely to be magnified.

2 Introduction

Internet connectivity has become an increasingly important part of individuals' and businesses' day-to-day activities across the globe through the services and applications that it enables.

Technological advancements in Internet connectivity have seen the creation of new markets, while existing industries have achieved efficiencies from more connected processes.

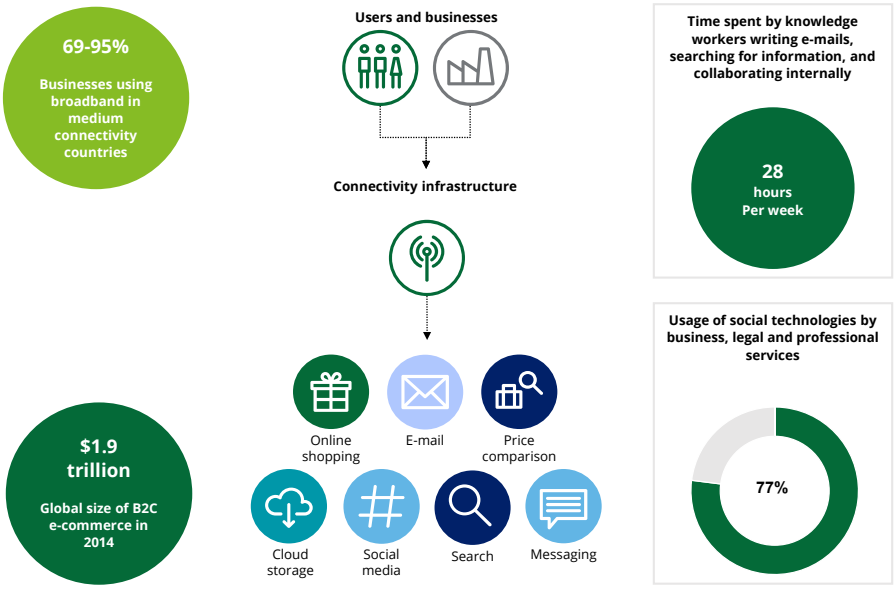
As such, disruptions in Internet connectivity have an adverse impact on the economy. Limiting the functions of a vital ecosystem like the Internet can materially affect productivity in both short and longer-term horizons. With the rise of interconnected devices, reducing access to the Internet has the same effect as pulling the plug on a machine: activity grinds to a halt.

This study investigates the key questions of how and to what extent disruptions in Internet connectivity impact the economy, providing a consideration of:

- The Internet ecosystem and the transmission mechanisms through which developments in connectivity are translated into impacts on the wider economy (Section 3).
- Different ways in which the Internet can be disrupted, and the potential economic impacts (Section 3).
- A quantification of the impact of disruptions to the Internet ecosystem on the economy (Section 4).

3 How disruptions in Internet connectivity impact the economy

Figure 3: The Internet ecosystem



Source: Deloitte analysis on MGI (2012); EIU (2016a); World Bank (2016); E-commerce Europe (2015a)

3.1 The impact of the Internet ecosystem on the economy

The Internet ecosystem includes a variety of users and businesses across all sectors of the economy and society that leverage online services and tools to make their products known, to communicate with friends and family, to access information, or to conduct transactions.

The services supported by the Internet have widened the economic opportunities for work, consumption, and leisure available to the people connected.

Businesses across the globe are increasingly reliant on different Internet-based services. For example, in medium connectivity countries, 69-95% of businesses use broadband Internet connections for their day-to-day activities, with one study finding that 70% of businesses are now using social technologies.[7]

Developments in e-commerce have promoted domestic and cross-border retail markets in both developed and developing countries. Countries with a highly developed Internet ecosystem have seen e-commerce make up as much as 5% of GDP,[8] while one estimate places the value of European e-commerce cross-border trade at over 8% of total online sales.[9] Emerging markets have also made large strides in e-commerce. 10% of Brazilian online shoppers purchased foreign products in 2014, while in Russia, 2.4% of total retail was made up of online sales in 2013.[10,11]

Many developing countries are expected to see high rates of growth in their online economies, with the BRICS nations already achieving a 57% growth in online sales in 2014.[12]

[7] Social technologies are defined as "IT products and services that enable the formation and operation of online communities, where participants have distributed access to content and distributed rights to create, add, and/or modify content." Based on a sample containing over 4,000 firms. (MGI, 2012)

[8] E-commerce Europe (2014, 2015)

[9] JRC Technical Reports (2015)

[10] IDB (2015)

[11] E-commerce Europe (2014)

[12] E-commerce Europe (2014)

Labour/capital productivity

The online digitisation of tasks directly enhances labour and capital productivity.

- E-mail services can be linked to higher levels of productivity among workers and businesses as workers are able to communicate more effectively and efficiently.
- In 2015, the number of business e-mails sent per user per day amounted to 122 globally.[13]

Information/transaction costs

Online services provide extensive and timely access to information relevant to both businesses and individuals. This can reduce transaction costs and make businesses more efficient.

- Access to dynamic information on weather conditions allows farmers to maximise crop yields and outputs. This has been found to lead to 33% higher profits for farmers.[14]
- In 2014, 52% of Senegalese adult Internet users used the Internet to obtain information on government and other public services, while 47% of Chinese users sought out online health information.[15]

Access to new markets

Connectivity across locations allows for businesses to reach new consumer markets through e-commerce and advertising platforms. The Internet facilitates cross-border trade and exports.

- Retailers and other businesses can reach customers in other parts of the country and across borders more easily leading to increased trade in goods and services.
- The Internet reduces the effect of geographical isolation from major export markets in developing countries by 65% as a result of lowering the costs of finding customers and accessing foreign markets.[16]

Financial Access

Key developments in financial and mobile technology requiring Internet connectivity have extended financial capabilities to a wider range of individuals and businesses.

- Mobile banking allows businesses and users to conduct transactions more easily, and to have immediate access to their financial information.
- In 2015, remittances to developing countries amounted to over $430 billion. Online companies are starting to offer money transfer services at lower costs than traditional operators, encouraging a cheaper and easier remittance process.[17]

Entrepreneurship and innovation

Internet services help reduce barriers to entry for entrepreneurs looking to start new businesses.

- Innovations in Internet crowdfunding have helped entrepreneurs gain access to capital to grow their ideas.
- Internet crowdfunding is having a profound effect on entrepreneurship in developing countries. In Kenya, an energy related project received over £50,000 from around 950 backers. 60% of the funds came from people on the entrepreneur's social media networks.[18]

Skills and specialisation

Internet connectivity allows individuals to develop their skills through broadening the access to educational materials. This enables them to learn and perform more specialist tasks.

- Online learning resources help make higher education more flexible, broadening the access and lowering the costs for students and workers.
- The online learning platform, Coursera, has a total of 11 million students with around a third located in the developing world.[19]

[13] Radicati Group (2015)
[14] Deloitte (2012)
[15] Pew Research Center (2015)
[16] Meltzer (2013)
[17] The Guardian (2015)
[18] Crowdfund Insider (2015)
[19] The Verge (2015)

How Internet connectivity impacts feed through to the wider economy

The Internet ecosystem has a transformational impact on both developed and developing economies, lowering the barriers for business activity, facilitating access to new markets, and helping businesses drive efficiency. These impacts contribute to economic prosperity.

This can be seen through a series of transmission mechanisms that translate developments in Internet connectivity and the services it supports into economy-wide effects. There is an extensive literature on these mechanisms and how they translate into economic growth. Studies have found:

- A strong positive relationship between broadband and productivity in developed and developing countries.[20, 21] Beyond Internet access, higher speeds in Internet connectivity have also been found to contribute to greater productivity.[22]
- A positive relationship between higher levels of broadband technology and investment, and the level of innovations produced by a firm, both within the production process and in the final good or service.[23, 24] Highly connected firms are well-equipped to restructure and reshape business processes and improve the goods and services sold in the economy.
- Fixed and mobile communication networks are positively linked with inward Foreign Direct Investment (FDI) in developing countries.[25] Extensive and reliable communication networks signal good quality infrastructure that instils confidence in the potential success of foreign investors.
- The Internet can expand markets and promote cross-border trade between countries.[26] In low and middle-income economies, firms in the manufacturing sector with broadband-enabled Internet access generate 6% more foreign sales than those without.[27]

Different transmission mechanisms work over different time horizons. For example, the impact of the Internet on entrepreneurship, skills, and specialisation will materialise over a longer time frame, while direct impacts on labour productivity or information and transaction costs have more immediate effects.

3.2 The economic impact of disruptions to Internet connectivity

This study considers the economic impact of disruptions instigated by public authorities.[28] These are not all uniform and do not usually occur as a complete and permanent shutdown of the Internet and its services. Instead, disruptions are often experienced through an array of more partial disturbances: they may last for two or three days as opposed to the whole year; may be applied through reductions in speed of all web traffic or specific services; or may be limited to certain regions in a country.

Restricting connectivity has the potential to reverse the impacts that the Interenet ecosystem has on the wider economy. Even partial disruptions can have material economic effects by impacting productivity, business confidence, and investment.

One-off short term disruptions

One-off temporary shutdowns or throttling of the Internet lasting for one or a few days lead to temporary periods of reduced productivity for businesses as a result of delays, the inability to execute day-to-day tasks, and losses in time-sensitive transactions.

For people, temporary disruptions make it harder to connect with friends and family, obtain information, follow educational courses or access medical services.

Recurrent and longer-term disruptions

When temporary shutdowns and throttling are implemented repeatedly over time or for longer periods, their impacts on businesses and people can be larger than those associated with one-off disruptions. For example, recurring and longer-term disruptions can shift consumers' behaviours and firms' business models to less optimal alternatives. Furthermore, these disruptions contribute to a higher level of uncertainty in the business environment and may affect investment, purchasing decisions and business confidence.

In addition, the longer term impacts of such disruptions may also propagate through a limitation of the avenues for entrepreneurship and innovation that the Internet offers, and reduced access to resources for skills, specialization, and knowledge. This could impact business investment and growth, as well as longer-term productivity.

Targeted disruptions

Disruptions may also be targeted at specific services or locations rather than the entire Internet ecosystem of a country.

[20] ITU (2012), Waverman et al (2009). 15 OECD countries between 1980-2007.
[21] Zaballos et al (2012). 26 countries between 2003-2009.
[22] Grimes et al. (2009). Firm level study looking at firms that upgraded from no broadband or dial-up-connection (128Kbps) to slow broadband (1Mbps), compared with 681 firms that did not upgrade at all. Internal firm productivity gain of 11.1%.
[23] Fornefeld et al (2008)
[24] Bertschek et al (2012)
[25] Lyndon and Williams (2005). 72 developing countries between 2000-2002.
[26] Choi (2010). Doubling Internet usage leads to a 2% to 4% increase in services trade for 151 countries between 1990-2006
[27] Clarke (2008). Between 1999-2005
[28] This study does not consider the economic impacts of Internet disruptions through traffic management by operators or technical failures.

Labour/ capital productivity

Information/ transaction costs

Access to new markets

Financial access

Temporary Shutdowns

A temporary shutdown of Internet connectivity infrastructure will impact all Internet services and platforms. This will impact the economy through a number of transmission mechanisms.

A temporary period of reduced labour productivity is expected as online business tools such as e-mail, cloud services, or messaging no longer function, making it harder for workers to perform their tasks. In the transport sector for example, the inability for services that rely on connectivity to operate, or the lack of up to date information, could cause delays in the shipping and the delivery of products or services. At a macroeconomic level, one estimate suggests that a one day delay in transporting products to their destination can reduce overall trade by more than 1%.[29]

Temporary unavailability of up-to-date information could raise transaction costs for businesses and consumers. Transactions requiring time-sensitive information may fall through. For example, time plays a crucial role in the world of financial trading. Shutdowns of online services communicating real-time exchange rate movements may lead to inadequate pricing or foregone opportunities for profit among traders. More widely, a survey of global executives in the healthcare, manufacturing, retail, transport and energy sectors finds that 38% have launched products or services that require real-time information to function and that all of these executives are looking to embed real-time information into their production processes.[30]

Depending on the length and frequency of the disruption, shutdowns may limit the opportunities for businesses to access markets and reach consumers. With websites offline and web pages down, customers are presented with a virtual 'closed' sign. Disruptions may lead to lost opportunities for traders reliant on the Internet for new business or for the provision of customer services. Some transactions will have to be made offline, leading to a potential productivity loss, while others may not be conducted, e.g. impulse purchases.

Individuals and businesses may need to use offline payment systems that take longer to complete than online processes, i.e. mail-in cheque vs. online checkouts. In the financial sector, products such as online banking services and currency exchange applications allow customers to make payments easily and react to real-time account information.[31] Periods of lost connectivity would cause people and businesses to use less efficient offline alternatives or to miss payments.[32] This could have far-reaching effects in developed and developing economies, as Internet banking applications have become a primary vehicle for people to save, transfer money, and purchase goods. For example, in Turkey, over $200 billion of financial transactions were performed through Internet banking in just one quarter in 2012.[33]

The impacts of disruptions in Internet connectivity may be mitigated to the extent that some transactions or opportunities can be delayed or through anticipating customer demands for a short period of time. However, the longer the disruption the lesser the opportunity to delay without losses.

[29] Djankov et al. (2006)
[30] EIU (2016)
[31] ibid.
[32] The Telegraph (2016)
[33] Daneshgadeh and Yildirim (2014)

Throttling

Disruptions in Internet connectivity by public authorities are sometimes implemented through 'throttling', i.e. reductions in the speed of Internet access rather than complete shutdowns.[34]

Throttling extends the time it takes for a web page to open up, or for a user to access web tools. This can lead to a frustrating Internet experience, as people are kept waiting or are unsure if websites have processed their actions. It translates into economic effects through similar transmission mechanisms to shutdowns albeit with potentially different magnitudes. For example, speed reductions prevent tasks from being performed efficiently and can lead to lower Internet usage as businesses and people seek out alternatives due to long waiting times. This could increase transaction costs while lowering labour and capital productivity.

If throttling causes speeds to fall below certain levels, some services may become unusable and impacts are likely to mirror those of temporary shutdowns. For example, the recommended speeds for Voice over Internet Protocol (VoIP) communications are upwards of 300 Kbps. Other online productivity tools require constant and even greater connection speeds to function smoothly. Cloud computing and data storage services require large amounts of bandwidth to move, share, and backup files used on a daily basis. As an illustration, a company consisting of 50 employees, whether in business services, finance/insurance, healthcare, or professional/technical services, could require speeds ranging from 38 Mbps to 64 Mbps.

Access to new markets

Labour/ capital productivity

Disruptions in specific regions in a country

Disruptions are sometimes applied in a localised area or region rather than across a whole country.[35] The same impacts seen from temporary shutdowns can be expected for the businesses in the area affected by the disruption. However, there are some additional considerations.

Competition
Affected businesses may see even greater competition as their customers switch to suppliers outside the region. The scope for this impact on a particular region may be greater than with a country-wide disruption due to lower barriers to trade within than between countries.

Supply Chain
The impact of a disruption may leak outside of the region affected through impacts on the supply chain.

Disruptions in regions that contain specialised industries and sectors may lead to supply shortages of specialised products and services to other parts of the country. For example, an Internet disruption at a parts manufacturing hub may affect its ability to accept orders from upstream assembly plants, impacting the wider supply chain. When two General Motors parts plants had to shut down their operations, there were shutdowns of more than 100 other parts plants, which caused the closure of an additional 26 assembly plants, leading to vacant dealer lots for months. [36]

[34] Internet access has been reportedly throttled in Iran during the presidential elections in 2013. (The Washington post, 2013)

[35] Internet services have been blocked for some hours in Haryana, a region of India. (The Indian Express, 2016)

[36] Snyder and Shen (2006)

Labour/ capital productivity

Information/ transaction costs

Access to new markets

Entrepreneurship and innovation

Disruptions to specific services

Some temporary shutdowns and throttling disruptions are targeted at Internet-based services such as social media, communications services, search, news or others.[37] Disrupting these has economic impacts for businesses across a range of sectors, and affect many people who use them for communicating with their friends or to obtain information.

Communication services
When services such as instant messaging, emails or Voice over Internet Protocol (VoIP) are unavailable, either less efficient or more costly alternatives need to be used or the communication may not take place. This will likely result in a temporary period of productivity losses and increased transaction costs. More broadly, business relationships can be damaged following periods of repeated communication disruptions, with vendors and suppliers hesitant to do business due to a lack of confidence.

Social media
Social media services provide platforms for firms to reach new and existing customers. They provide visibility of firms to potential customers, information about their products and services, and opportunities for businesses to obtain customer feedback. Disruptions to these services may lead to lost opportunities for businesses if customers miss important company updates, if brand information cannot be shared with friends who may be considering a purchase, or if advertising spend cannot be targeted to the most relevant customers. For some entrepreneurs and small business owners, online channels to new markets are vital to their livelihoods.

Aside from the impact on businesses, people's ability to share digital content, organize and create social events, communicate with friends or network with other professionals is hampered.

Search
People and businesses use search tools to quickly access information on the web. Online search tools help businesses obtain information and consumers find suppliers. Similar to the impacts from disruptions to social media, impacts are likely to entail increased transaction costs or foregone business opportunities. For example, longer amounts of time may be spent looking for information required for tasks or transactions.

For people, search engines make a wealth of information available at the click of a button. Without search tools, people would face greater difficulty in obtaining information whether on the weather forecast, price comparisons, education courses or health symptoms and treatments.

[37] Facebook was blocked in Vietnam during a weekend while VoIP calls were blocked in Morocco. (Techcrunch, 2016; Middle East Eye, 2016)

4 Estimated impacts of disruptions to the Internet ecosystem

The magnitude of impacts of Internet connectivity disruptions depends on the breadth and depth of a country's Internet ecosystem. In countries with a more developed infrastructure for Internet access by people and businesses, the Internet ecosystem contributes to a greater proportion of economic activity.

An indicative grouping of countries into low, medium, and high connectivity bands based on Internet access and speeds highlights the different levels of development of the Internet ecosystem across economies. Even in countries with lower connectivity, the Internet ecosystem enables a growing share of economic activity. For example, e-commerce can represent 0.3% to 2.3% of GDP in low connectivity countries, 0.4% to 5.2% in medium connectivity countries and up to 5.7% in high connectivity countries.[38] To account for these differences, estimates of the economic impact of Internet disruptions have been calculated for different connectivity groupings.

4.1 Approach and methodology

Estimates of the economic impacts of Internet disruptions are based on the empirical economic literature on the impact of Internet connectivity on GDP. The impact of Internet shutdowns is not widely researched and there are clear data challenges to this exercise. Quantifying the impact of very specific types of disruptions would require a level of granularity of data which is beyond the information publicly available.

The estimates in this study are constructed as a platform to illustrate the potential order of magnitude of different types of disruptions. By drawing on estimates of the economic impact of the Internet measured in the academic literature over longer time periods, the estimates in this study may represent an upper bound of the impacts of very short term temporary shutdowns.

To approximate the effects of temporary disruptions of Internet connectivity this study applies estimates based on the impact of broadband usage and speed on the economy. These measures have been selected as they are likely to be reflective of marginal changes in productivity that would be associated with changing the intensity of usage and quality of broadband rather than longer-term structural changes in the economy. See the appendix for further details.[39]

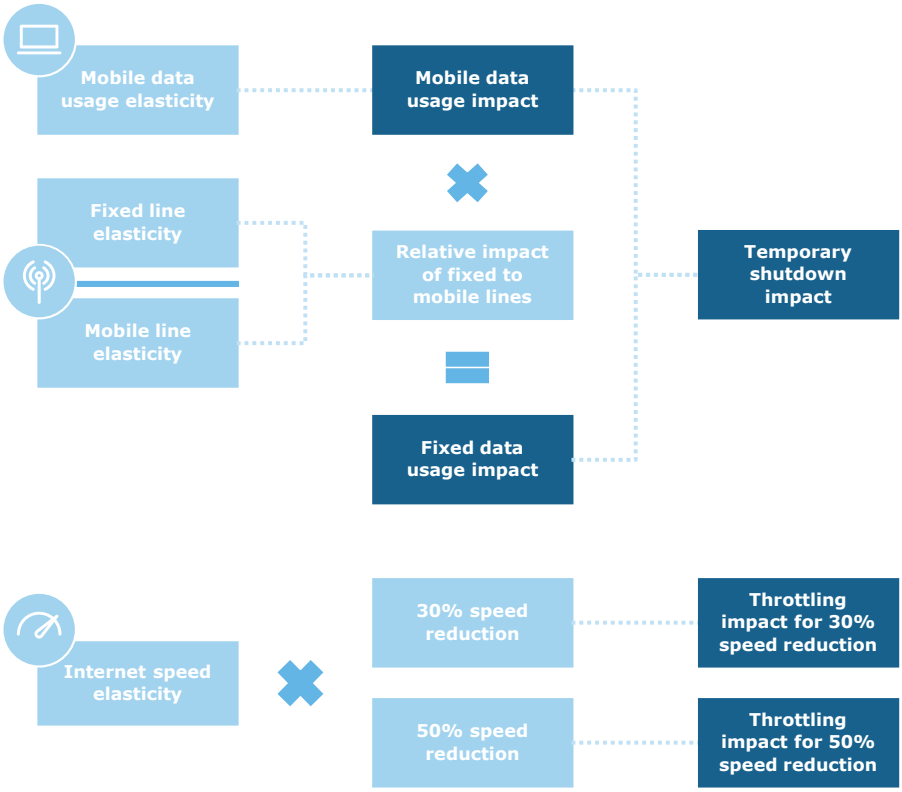
Table 2: Internet ecosytem metrics across groups of countries by Internet connectivity

	Low	Medium	High
Internet penetration	<49%	49-79%	>79%
Average connection speed (mbps)	3.0	6.5	10.5
Businesses with Internet access	20%*	69-95%	78-95%
E-commerce as a % of GDP	0.3-2.3%	0.4-5.2%	0.8-5.7%
Average e-commerce size per capita	$40	$220	$1,250

*Limited data availability
Source: Deloitte analysis. See appendix for more details

[38] E-commerce Europe (2014, 2015a, 2015b, 2015c, 2015d, 2015e, 2015f)
[39] The appendix shows a comparison of this study's results with estimates based on other approaches followed in the literature to measure the economic impact of the Internet. These comparisons demonstrate that the estimates used in this study are more conservative, in line with the objective of analysing the impact of temporary disruptions to connectivity.

Figure 4: Approach to estimating temporary shutdown and throttling impacts



Estimates of the economic impact of temporary Internet shutdowns are produced for different connectivity groups using a combination of metrics from the literature:

- **Mobile broadband data usage elasticities.** These measure the impact of increasing mobile broadband data usage on GDP per capita growth across a sample of 14 countries.[40] Each of these countries is allocated to the connectivity groupings produced in this study based on their existing levels of Internet penetration and speed.
- **Fixed line and mobile line elasticities.** These measure the impact of increasing the number of fixed and mobile lines on the average annual real GDP growth.[41]

The first group of elasticities is used to estimate the impact of a shutdown in terms of mobile data usage, while the latter is used to scale this impact to include fixed data usage impacts. Fixed impacts are calculated by taking the ratio of the fixed line to mobile line elasticities, adjusted for differences in fixed penetration across countries, and applying that ratio to the calculated mobile data usage impact. The appendix describes the methodology in detail.

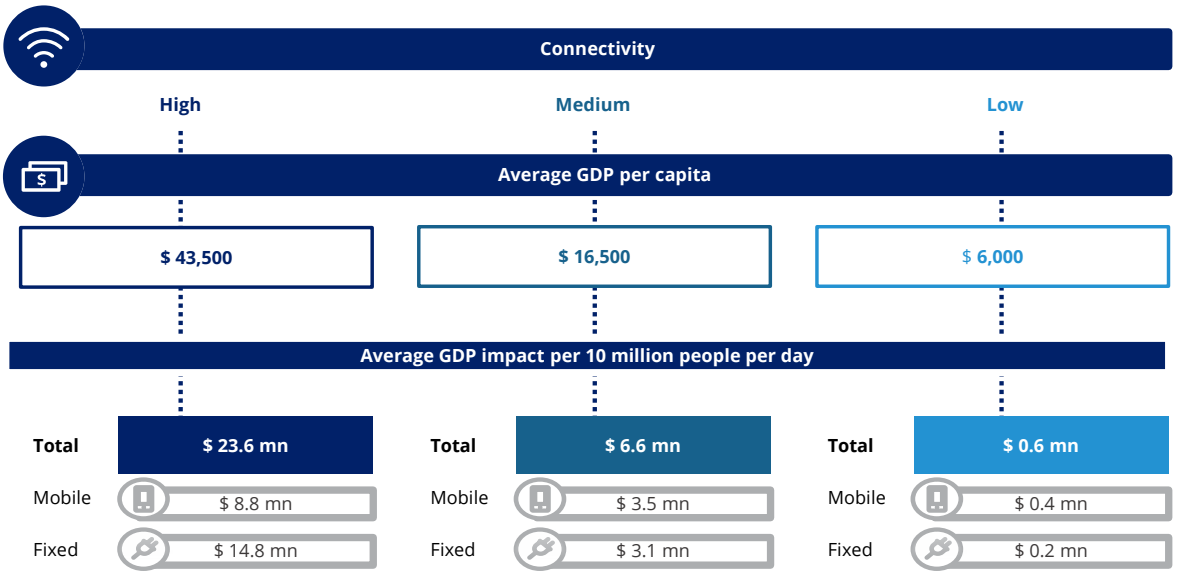
The estimates are calculated and reported as GDP impacts per day of disruption and as an average for each connectivity grouping to provide an indication of the magnitude of impacts as connectivity increases.

The impact of throttling on GDP is also estimated. This analysis uses an Internet speed elasticity based on a study of the effect of Internet speeds on annual GDP growth.[42] Two illustrative scenarios are considered - a reduction of broadband speed of 30% and a reduction of 50%.

The impacts of more partial disruptions such as those concerning only particular services or regions in a country are expected to be a subset of the effects estimated in this report, while longer-term or recurring disruptions are likely to lead to much larger impacts.

[40] Deloitte (2012b). See appendix for more details.
[41] Deloitte (2014a). See appendix for more details.
[42] Rohman and Bohlin (2012)

Figure 5: Estimated GDP impact of a temporary Internet shutdown per 10 million people per day



Source: Deloitte analysis. See appendix for more details.

4.2 The quantitative impact of temporary Internet disruptions on the economy

Temporary shutdowns

The results reported below are indicative of the estimated GDP impact associated with Internet shutdowns for countries within the different connectivity groupings.

A temporary Internet shutdown in a high connectivity country is estimated to have a GDP impact per 10 million people per day of $23.6 million on average. The average impact in a medium connectivity and low connectivity country would be an estimated $6.6 million and $0.6 million of GDP respectively on average.

The magnitude of these impacts can be illustrated further with some examples:[43]

- In a country with high connectivity, with GDP per capita of $45,000, a population of c. 60 million people, and fixed broadband penetration of c. 35%, a temporary Internet shutdown could have an estimated GDP impact of c. $141 million per day of disruption. In this example, this is equivalent to 1.9% of daily GDP.
- In a medium connectivity country, with GDP per capita of $25,000, a population of c. 30 million people, and fixed broadband penetration of c. 15%, a temporary Internet shutdown could have an estimated GDP impact of c. $20 million per day of disruption. In this example, this is equal to 1% of daily GDP.
- In a low connectivity country, with a GDP per capita of $6,000, a population of c. 40 million people, and fixed broadband penetration of c. 5%, a temporary Internet shutdown could have an estimated GDP impact of c. $3 million per day of disruption. In this example, this amounts to 0.4% of daily GDP.

As may have been expected, the differences in magnitude of impacts across connectivity groups are driven by the level of development in a country's Internet ecosystem and infrastructure, which translate into higher sensitivity of GDP to changes in Internet usage and more extensive fixed and mobile connectivity typically. The higher the intensity of use of the Internet, the more likely businesses and individuals will be reliant on a constant connection for their activities. Businesses in higher connectivity countries will have wider access to advanced productivity tools, while people will rely on more Internet-based products and services in their day to day activities. Consequently, as connectivity increases in a country, disruptions to these services have a greater economic impact.

The estimates can be broken down into impacts of disruptions to fixed and mobile Internet. Temporary shutdowns to fixed broadband have the highest impact in high connectivity countries amounting to $14.8 million of the $23.6 million total impact, due to more extensive fixed infrastructure in these countries. In medium connectivity countries, temporary shutdowns to fixed and mobile broadband are estimated to have a similar impact at $3.1 million and $3.5 million, respectively. In low connectivity countries the impact of temporary shutdowns to mobile broadband is estimated to be double ($0.4 million) the fixed broadband impact ($0.2 million), due to reliance on mobile infrastructure in economies with lower connectivity.

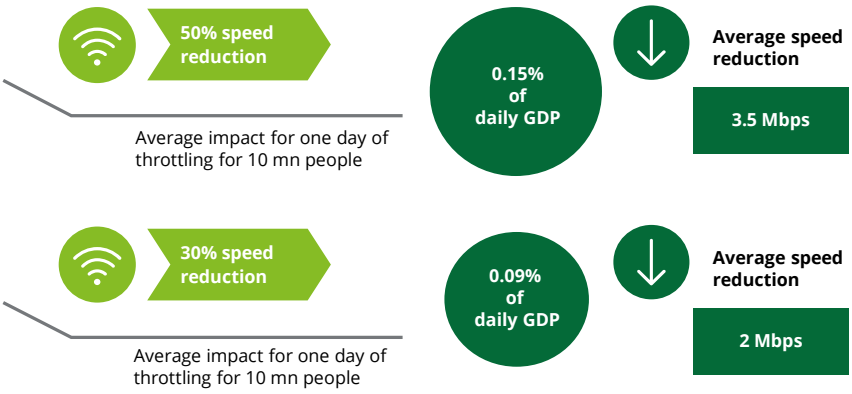
[43] Figures have been rounded.

Throttling

On average, a temporary 30% reduction in speed leads to an estimated impact of 0.09% of daily GDP.[44] Lowering the speed further, i.e. by 50%, leads to a greater impact of 0.15%. These estimates, produced for illustration, are based on the simplifying assumption that a unit reduction in broadband speed has a homogeneous economic impact, i.e. they do not account for potentially different impacts depending on a country's initial level of speed.

In principle, reductions in Internet speed below particular levels may render certain services unusable and therefore these estimates may underestimate the total impact, but this is beyond the granularity of data available for this study and a question for further research.

Figure 6: Average daily GDP impact of temporary throttling per 10 million people for a 50% and 30% decrease in broadband speed



Source: Deloitte analysis. See appendix for more details

Box 1: Recurrent and longer-term disruptions

Confidence and business investment

Recurrent disruptions create unpredictability in the business environment. Whilst not specific to Internet disruptions, a study finds that within a sample of over 10,000 firms in the USA, doubling uncertainty (measured by an uncertainty index[45]) leads to an average fall in quarterly investment rates of 8.7%. For context, the 2008 financial crisis tripled the index. In 2015, investment as a proportion of GDP was reported to be 20% in the US.[46]

Depending on their frequency and length, disruptions in connectivity can create uncertainty in the policy environment and may trigger falls in investment and business confidence.

Productivity and transaction losses

Firms affected by disruptions to their Internet capabilities can sometimes experience short-term shareholder losses. One study on the impact of denial of service during cyber-attacks which interrupt a firm's Internet portal and ability to conduct online business finds that disruptions are associated with short-term reductions in a firm's market value, as investors anticipate poorer firm performance by selling shares.[47]

Recurrent disruptions can also lead to customers and businesses choosing unaffected alternatives, i.e. offline suppliers or business models, to regain a level of certainty and be able to carry on with their activities. As a result, the immediate impacts of shorter disruptions are magnified and can materialize in longer-term productivity losses, to the extent that online options were initially chosen for their ease of use and greater efficiency than the alternatives.[48] For example, a study examining cloud adoption in small and medium sized businesses (SMBs) finds that SMBs using cloud technologies grow on average 26% faster than SMBs that do not.[49]

4.3 Recurrent and longer-term disruption impacts

When disruptions become recurrent or longer-term in nature, the impacts are expected to extend beyond the estimates of the impacts of temporary shutdowns. These types of disruptions are expected to lead to a wider set of impacts than temporary productivity or transactions losses, affecting confidence and business investment.

[44] Given the unavailability of country-specific elasticities for this analysis, the estimates are presented as averages across the countries in the sample.

[45] The uncertainty index comprises a number of components including the frequency of key terms in articles related to uncertainty The other components are tax, government spending and monetary policy changes. Average fall in quarterly investment rates of 8.7% relative to the average in the sample. (Gulen and Ion, 2015; Baker et al., 2016)

[46] World Bank (2015)

[47] Cashell et al. (2004)

[48] ibid.

[49] Deloitte (2014)

4.4 Service-specific and regional impacts

Businesses and individuals use a range of Internet services for their day-to-day activities. This ranges from bespoke applications for complex production processes for large firms, to messaging and social media services used by businesses, including many SMBs for their flexibility and ease of access. Disrupting these services affects the daily activities of individuals, business owners and workers, by hampering production, inhibiting communication or blocking access to information.

Box 2: Disrupting Internet-based messaging services

Instant messaging services are increasingly used as a multi-purpose communication channel by individuals and businesses. In recent years, the functionality of instant messaging has increased beyond conveying text–based information to include services such as the sharing of multimedia content, mobile payments, marketplace services, and bot messaging.[50]

In 2015, there were over 1.4 billion users of Internet-based mobile messaging applications, representing 75% of the global smartphone base, and 3.2 billion instant messaging accounts worldwide. These accounts are used by people and businesses.[51,52]

The increasing array of multimedia capabilities has encouraged people to share more widely with their social circles and in a range of different mediums. In the UK, the average adult devotes 25 minutes daily to sending messages, photos, or videos over web-based messaging applications, while in India, users can spend on average close to 40 minutes a day using an online messaging service.[53] These social impacts are typically not captured by economic impact estimates.

Beyond the popularity of these services as a means to communicate with friends and family, businesses across sectors have begun to adopt mobile messaging platforms to connect with customers and streamline their processes.

Entrepreneurs and SMBs are increasingly using Internet-based messaging as a core component of how they serve clients. This is being used to secure orders and contracts, share photos of products, and exchange financial details for online payments, across different types of businesses, ranging from real estate agents to restaurant owners.[54] Consequently, disruptions to these services could undermine businesses operations. For example, an Internet disruption that occurred just days before Mother's Day this year meant that some florists could not receive orders on what is traditionally one of their most busy periods, while certain restaurant owners also reported reduced delivery orders and sales.[55]

Larger firms are beginning to adopt messaging bots in customer service communication, where a computerised system communicates with consumers on behalf of the firm. Leading technology firms are launching software development tools to design a tailored service-bot in business-to-consumer messaging. By one estimate, "tens of thousands" of developers are creating chatbots for Facebook Messenger, with 10,000 business bots already active on Facebook.[56,57]

More widely, in the healthcare sector, doctors and patients have begun to use online messaging services to arrange consultations or to ask urgent questions on health and diet. Patients gain enhanced access to healthcare advice while doctors are able to interact more easily, and schedule their time better.[58,59]

Disruptions to these services can result in missed social interactions, poorer service, and foregone revenues.

[50] FSD Kenya (2016)
[51] eMarketer (2015)
[52] The Radicati Group (2016)
[53] Ofcom (2016), Similar Web (2016)
[54] See for example: G1 (2016); Link (2016); News Portal (2016)
[55] G1 (2016)
[56] Business Insider (2016)
[57] Facebook (2016a)
[58] JJ (2016); Link (2016)
[59] G1 (2016); Portal News (2016); Link (2016)

Box 3: Disrupting regional e-mail services

Modern production processes are often connected through specific web-based services, like e-mail communications or internal networks. Disruptions can cause these connected production processes to falter, with consequences for both the affected sector and the rest of the supply chain.

One study finds that within the manufacturing sector, Internet outages affecting specific services may impact the delivery stage of the production process and cause losses in revenues.[60] This direct effect is compounded by indirect effects on the wider supply chain as the delivery of manufactured components required for the output of other industries is delayed. The study estimates that for every dollar of revenue lost by the affected sector, 0.66 cents are lost in interconnected sectors both within and outside the region.[61]

In the Midwest region of the USA, the study estimates that a 10-day Internet shutdown for the electrical and automobile parts sectors could have a total impact of over $20 million and $65 million (on average $2 million and $6.5 million per day), respectively. This impact is greater towards the end of the period of shutdown, reflecting the extent to which disruptions that last longer have a greater impact.[62]

Box 4: Disrupting social media

In January 2016, there were 2.3 billion active social media users, almost one third of the world's population. Of this overall figure, 6% of users are connected from Africa (129 million), 22% from the Americas (522 million), 52% from the Asia-Pacific region (1211 million), 17% from Europe (393 million) and 3% from the Middle East (63 million). This has created a growing platform and network of users who can find and communicate with friends anywhere in the world, and that businesses can also tap into as they expand.

Social media enables worldwide and direct connectivity and is one of the key tools that people use to communicate and keep up-to-date with distant friends and relatives. It also acts as a platform for individuals to interact with news and information releases, ranging from new product launches to global events. For example, Facebook reported over 270 million unique users having 1.5 billion interactions related to the 2016 Olympics and is planning to use its live platform to host interactive presidential debates.[63,64]

Disruptions to social media limit online interactions not only between people, but also with businesses. Social media acts as an online store front for many businesses, particularly SMBs. As of 2016, there are 60 million monthly active business Pages on Facebook globally.[65] Pages enable firms of different sizes to engage with customers on the latest product updates and demand trends, and receive feedback on existing products and services. Over 3 million companies globally actively use Facebook's targeted advertising system, with 90% of marketers citing benefits such as increasing exposure and traffic.[66,67]

This usage extends to smaller businesses with one source indicating that 80% of North American SMBs used social media in 2013, of which 94% used it primarily for marketing with 60% noting that social media had enabled them to attract new customers.[68] From October to November 2015, Cornerstone, a shaving product company started by an entrepreneur in 2013, used Facebook's social media platform for a series of advertising campaigns which are reported to have resulted in double the monthly increase in conversions and a 25% reduction in costs per sale. In another advertising campaign ran on the same platform, Monoqi, a retailer in lifestyle products, was reported to have achieved a 49% increase in their return on advertising investment.[69]

Disrupting social media platforms can limit social interactions and cut off many businesses from their customers, hindering growth and leading to losses in revenues for those businesses.

[60] Dynes et al. (2006)
[61] ibid
[62] ibid
[63] Facebook (2016b)
[64] The Wall Street Journal (2016)
[65] Facebook (2016a)
[66] Deloitte (2015)
[67] SocialMedia Examiner (2016). Survey of 5,086 participants conducted in Jan 2016.
[68] LinkedIn (2014)
[69] Facebook (2016c, 2016d)

Box 5: Disrupting search

The ubiquitous use of online search has spread beyond the consumer domain and has become a core part of day-to-day business activities. In 2016, there were 6.6 billion searches a day worldwide.[70]

People turn to online search tools for a variety of tasks such as finding products, keeping up-to-date with the latest news or looking for information on medical conditions and treatments. Moreover, online search tools play a role in learning and education, providing timely information and resources to students, teachers, and the population more generally.

For businesses, online search constitutes an important productivity tool. Search has become a vital tool for managers, investors, and entrepreneurs engaged in daily work activities. By one estimate, 40% of global web traffic dipped when Google suffered a five minute outage.[71] With search comprising an increasingly larger share of knowledge workers' tasks, disruptions can hinder employees' productivity.

As a consumer and sales tool, search engines promote purchases both online and offline. 'Research Online Purchase Offline' defines the sales of products where a customer initially researches products online and then purchases them in a traditional brick-and-mortar store. For example, people may use online search tools to research local bars and restaurants before making a choice on where to go.

By one estimate, 50% of US consumers compared products, prices and features online, with 24% looking for opinions, reviews and online advice.[72] In 2016, more than 2 billion searches were conducted on Facebook worldwide, looking up businesses, people, and other miscellaneous searches.[73] Businesses specialising in niche goods rely on search to be matched with target consumers. For example, QueBarato is a website operating in Latin America and the US. It has 4.8 million listings per day generated by individuals and small businesses, across a range of sectors, for jobs, real estate, and vehicles among others.[74]

[70] Smart Insights (2016)
[71] SkyNews (2016)
[72] Consumer Barometer with Google (2014/15)
[73] Facebook (2016a)
[74] McKinsey & Company (2011)

5 Appendix

5.1 The segmentation approach

The analysis of temporary shutdowns makes use of three stylised connectivity groupings, high, medium, and low, to calculate a range of estimated impacts.

There are several means of measuring connectivity levels across countries. The segmentation approach considers two key measures:

- The percentage of individuals using the Internet, i.e. 'Internet penetration'; and[75]
- Average connection speed.[76]

96 countries are ranked first according to their level of Internet penetration. If two countries have the same percentage of individuals using the Internet, the average connection speed is used as a second ranking criteria (i.e. countries with the same level of Internet penetration but faster connection speeds are ranked higher).

After the countries are ranked, they were divided into the three connectivity groupings: the high group is the top 30% of the sample, the medium group is the next 40%, and the low group is the bottom 30%. This provides the thresholds of penetration and speed that define the connectivity groupings.

Other key characteristics (e.g. e-commerce as a % of GDP) of each connectivity grouping demonstrate the breadth and depth of the Internet ecosystem within the group, which typically grows with increasing levels of connectivity.

Table 3: Country profile cards

	Low connectivity	Medium connectivity	High connectivity
Segmentation criteria			
Internet penetration	below 49%	between 49% and 79%	Greater than 79%
Average connection speed	3.0 Mbps	6.5 Mbps	10.5 Mbps
Other characteristics			
Business access to Internet	20.4%*	69 to 95% (avg: 84%)	78 to 95% (avg: 88%)
E-commerce as a % of GDP	0.3 to 2.3% (avg: 1.0%)	0.4 to 5.2% (avg: 1.3%)	0.8 to 5.7% (avg: 2.5%)
E-commerce as a % of total wholesale and retail trade	2.4%*	3.6 to 9.7% (avg: 6.9%)*	11.7 to 19.3% (avg: 15.5%)*
E-commerce average size	$9 billion ($40 per capita)	$44 billion ($220 per capita)	$77 billion ($1,250 per capita)
Fixed broadband penetration ranges from	0.2-23.2% (avg: 6.2%)	1.4-35.2% (avg: 19.2%)	9.9-42.5% (avg: 30.8%)
Mobile cellular penetration ranges from	64-158% (avg: 113%)	79-323% (avg: 135%)	81-178% (avg: 127%)

*Limited data availability.
Source: Deloitte analysis. All statistics are based on selected countries based on data availability.

[75] ITU (2016)
[76] Akamai (2016)

5.2 The estimation approach: temporary shutdowns

5.2.1 Economic literature

The approach to quantifying the impact of temporary shutdowns is based on a review of empirical studies of Internet impacts on the economy. Box 6 summarises key quantitative metrics of the relationship between Internet connectivity and economic performance.

Considering the temporary nature of the disruptions quantified in this study, the estimation methodology is based on broadband usage and broadband speed elasticities. Internet penetration elasticities are associated with longer-term structural changes in the economy. Approaches based on national accounts and expenditure reflect the Internet's current contribution to output rather than to productivity.

This study uses 3G mobile data usage elasticities from the economic literature, which have been calculated using an econometric approach. These show that doubling mobile data usage increases GDP per capita growth by 0.5 percentage points on average.[82] The elasticities are estimated for 14 countries across a range of development and income levels for the period 2005 to 2010.[83] The 14 countries for which elasticities are available are allocated to each connectivity grouping based on the thresholds.[84]

Another study estimates the elasticity of GDP with respect to both fixed and mobile lines through econometric analysis using data from 38 countries, measured across a 10 year (2003-2012) period. The elasticity of GDP to fixed lines is 0.088 showing that within the sample of EU and OECD countries, a 10% increase in a country's total fixed lines would increase the average annual growth rate of real GDP by 0.88%. The elasticity of GDP to mobile lines is 0.06.[85] Within the same sample, a 10% increase in a country's mobile lines, increases the average annual growth rate of real GDP by 0.6%.

Box 6: Estimates of the relationship between Internet connectivity and economic performance in the literature

A number of studies in the literature have quantified the relationship between Internet connectivity and economic performance.[77] Depending on the approach, the estimates presented in these studies capture different impacts of the Internet on the economy and would therefore have a significant impact on estimates of the impact of any Internet disruption.

Elasticities can be interpreted as measures of the responsiveness of the economy to changes in the Internet ecosystem.

Source: Deloitte analysis

- **Internet usage elasticities:** Internet usage refers to the quantity of data transmitted and received by each Internet connection. One study estimates the relationship between mobile data usage and GDP per capita growth. According to this analysis, a doubling of mobile data usage can have a positive impact on GDP per capita growth ranging between 0.03 and 1.42 percentage points across countries over one year. [78]
- **Broadband speed elasticities***:* Broadband speed refers to the amount of data that a connection can retrieve and send each second. The higher the speed, the faster each task will be completed, with some tasks needing a minimum speed. A number of studies have analysed how economic variables respond to changes in broadband speed. These analyses show that faster broadband speeds can generate wider benefits for the economy in the short to medium-term.[79] The estimated elasticities of annual GDP to a 10% increase in broadband speed vary substantially across studies, ranging from 0.03% to 0.98%.
- **Internet penetration elasticities:** Internet penetration refers to the proportion of the population that has access to an Internet connection. The largest part of the literature estimates the relationship between different measures of economic output (e.g. nominal GDP, real GDP, GDP growth rate) and broadband penetration rates (fixed, mobile or both). For example, different studies estimate that a 10% increase in fixed broadband penetration can increase GDP by 0.9 to 1.5 percentage points over one year.[80]
- **National accounts approach:** A series of studies quantify the economic contribution of the Internet to GDP using national accounts data, such as measures of spending by the private and public sector, as well as investment and trade. These analyses are based on estimates about the proportion of spend across sectors related to the Internet.[81] The estimated impacts are specific to each country and range from 0.6% to 6.3% of annual GDP.

[77] These studies include Chu (2013), Czernich et al (2011), Koutroumpis (2009) and Qiang et al (2009).
[78] Deloitte (2012b)
[79] These studies include: Rohman and Bohlin (2012), Deloitte (2012b), Forzati and Mattsson (2012), Katz et al (2010).
[80] These studies include: Chu (2013), Czernich et al (2011), Koutroumpis (2009) and Qiang et al (2009).
[81] McKinsey (2011, 2012, 2013), Boston Consulting Group (2010, 2011)
[82] Deloitte (2012b)
[83] These studies include: Rohman and Bohlin (2012), Deloitte (2012), Forzati and Mattsson (2012), Katz et al (2010).
[84] Deloitte (2012). China falls in the medium connectivity group; Mexico, South Africa and India fall in the low connectivity group.
[85] Deloitte (2014a)

5.2.2 Estimation Approach

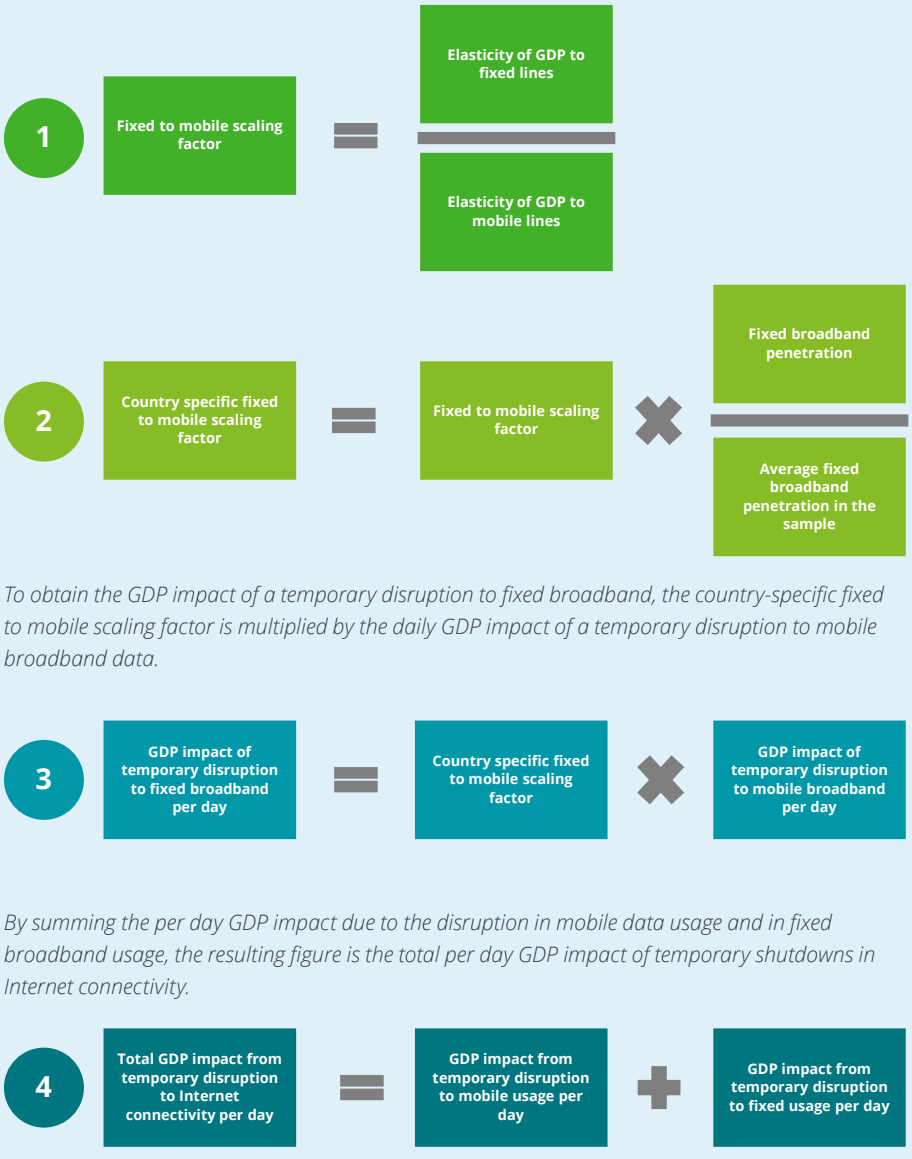
To estimate the GDP impact of a temporary disruption to mobile broadband, 3G mobile data usage elasticities have been used. These are relevant to different connectivity groupings and have been divided by 365 to yield an upper bound estimate of the impact on GDP per capita growth of a temporary disruption to mobile broadband, expressed on a per day basis.[86] This impact is then expressed in US dollars per capita by multiplying the coefficients by GDP per capita.

To estimate the impact of disruptions to fixed broadband, the impacts of mobile data usage are extended using the mobile penetration elasticity (0.063) and fixed penetration elasticity (0.088) in the study referenced earlier. The ratio of the fixed to mobile penetration elasticities (fixed to mobile scaling factor) is applied to the impact of the disruption of mobile broadband usage to determine the GDP impact of a temporary disruption to all Internet connectivity (mobile and fixed) per day.[87]

A country-specific fixed to mobile scaling ratio is calculated by multiplying together:

- The fixed to mobile scaling ratio given by the sample in the econometric study;[88] and
- The ratio of fixed broadband penetration in the particular country in this study's sample and fixed broadband penetration in the sample of countries included in the econometric study.[89]

Figure 7: Calculating the country-specific fixed to mobile scaling factor



To obtain the GDP impact of a temporary disruption to fixed broadband, the country-specific fixed to mobile scaling factor is multiplied by the daily GDP impact of a temporary disruption to mobile broadband data.

By summing the per day GDP impact due to the disruption in mobile data usage and in fixed broadband usage, the resulting figure is the total per day GDP impact of temporary shutdowns in Internet connectivity.

Source: Deloitte analysis

The approach of scaling up mobile data usage impacts rather than using fixed broadband penetration elasticities is followed to try to capture the more marginal impacts of temporary disruptions, rather than longer term impacts associated with access to infrastructure.

The implicit assumptions of this approach are as follows:

- A 100% reduction of mobile data usage will have the same but negative impact as a 100% increase (i.e. a doubling). That is, this assumes the elasticity is linear, having the same marginal effect when quantifying both the economic benefits derived from mobile data usage and the economic losses suffered from mobile data disruptions. The same applies to all coefficients used.
- Mobile data usage coefficients can be interpreted as the impact of a drop to zero of mobile data usage over one year.

[86] Deloitte (2012b)
[87] Deloitte (2014a)
[88] Deloitte (2014a)
[89] Deloitte (2014a)

- Dividing these elasticity coefficients by 365 yields an upper bound estimate of the impacts on GDP per capita growth of a temporary shutdown to mobile broadband per day.
- Mobile data and fixed broadband usage are spread equally throughout one year.
- Broadband and other forms of communication that are possible with a line have a similar economic impact.
- The intensity of use of mobile and fixed connections in this study's sample is similar.

Quantification of the fixed to mobile scaling factor relies on the fixed to mobile communication elasticities ratio, which assumes a similar relationship between fixed and mobile in the shorter and longer term.

5.2.3 Sense-checking and Comparison

A review has been undertaken to confirm that estimates are within a reasonable order of magnitude relative to the existing literature, using Internet penetration elasticities and estimates in the literature based on national accounts data. The results of this comparison demonstrate that the estimates in this report are more conservative, in line with the objective of analysing the impact of temporary rather than longer-term disruptions to connectivity.

McKinsey (2011b, 2012, 2013) studies quantify the contribution of the Internet to the economic performance of several countries, expressed as a percentage of GDP, based on national accounts data on private and public consumption, investment and trade. This approach captures the expenditure on Internet-enabled goods and services. Estimates based on McKinsey are therefore larger than the estimates used in this study because they reflect impacts on output, which are typically larger than productivity impacts.

Internet penetration elasticities are based on Chu (2013). This study estimates the elasticity of real GDP per capita to broadband penetration, yielding a higher impact relative to the approach used in this study. The difference in magnitude is likely due to the penetration elasticity capturing a longer-term relationship between the variables. Chu (2013) estimates an elasticity of real GDP per capita to broadband penetration of 0.063% based on a sample of 201 countries. Other empirical estimates of the impact of broadband penetration on GDP report higher elasticities.

Table 4: GDP impact of temporary Internet shutdowns per 10 million people per day (million $)

Connectivity category	This study's approach to estimate the impact of temporary disruptions (million $)	National accounts approach (million $)	Penetration elasticities approach (million $)
High	23.6	45	75.2
Medium	6.6	7.1	28.3
Low	0.6	2.2	10.5

Source: Deloitte analysis; the second column is based on McKinsey (2011b, 2012, 2013); the third column is based on Chu (2013). The estimates based on penetration elasticities use a single average elasticity for the three connectivity groupings and hence they may overstate the impact in low connectivity countries and understate it in high connectivity countries.

5.3 The estimation approach: throttling

To quantify the GDP impact of a disruption in connectivity due to throttling:

- The study uses an Internet speed elasticity defined as the elasticity of the GDP growth rate to broadband speed, including both mobile and fixed broadband.
- This elasticity has been estimated by Rohman and Bohlin (2012) on a sample of 34 OECD countries and panel data from 2008 to 2010.
- The use of this elasticity implies that a doubling of broadband connection speed generates a 0.3% increase in GDP growth rate.
- The average broadband speed in the sample considered in Rohman and Bohlin (2012) is 8.3 Mbps, which is approximately the same connection speed as that in the 14 countries on which this study's estimates are based.
- The average GDP per capita in the sample considered in Rohman and Bohlin (2012) is $28,000.

This elasticity is applied to GDP to estimate the impact of throttling over one year. These estimates have then been converted on a per day basis by dividing the total impact by 365. Two hypothetical disruption scenarios have been analysed: a reduction of broadband speed of 30% and a reduction of 50%.

The estimation of the economic impacts of throttling is based on the same sample of 14 countries that have been included in the analysis of temporary shutdowns. The results reported in section 4.2 are the averages calculated on this sample for both scenarios.

The implicit assumptions of this approach are as follows:

- Using the elasticities to quantify the GDP impact of a reduction in Internet speed assumes a linear relationship between both variables, as with the approach to temporary shutdowns.
- The effects estimated by the elasticity have an impact on GDP in the short term.
- As for temporary shutdowns, the analysis assumes Internet usage is spread equally throughout one year.

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