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ECONOMIC AND SOCIAL BENEFITS OF INTERNET OPENNESS

2016 MINISTERIAL MEETING ON THE DIGITAL ECONOMY

BACKGROUND REPORT

2016 MINISTERIAL MEETING
THE DIGITAL ECONOMY:
INNOVATION, GROWTH
AND SOCIAL PROSPERITY

OECD
BETTER POLICIES FOR BETTER LIVES

FOREWORD

This report provides the backdrop for the discussion in Panel 1.1 "Economic and Social Benefits of Internet Openness" of the OECD Ministerial Meeting on the Digital Economy, 21-23 June 2016, Cancún (Mexico). It presents a framework for understanding and analysing Internet openness, the factors that influence it, and its effects. It also presents initial qualitative and quantitative evidence on the effects of Internet openness on trade, innovation and entrepreneurship, and macroeconomic performance, and social wellbeing.

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* Mr Huston has revised and consolidated the essays he wrote for the OECD into one longer piece, which is available at www.potaroo.net/ispcol/2015-10/open.pdf.

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TABLE OF CONTENTS

FOREWORD....2

EXECUTIVE SUMMARY....5

OVERVIEW....8

1. INTERNET OPENNESS: DEFINITION AND SHAPING FORCES....15

1.1 What does Internet "openness" mean?....15
1.1.1 Open versus openness....15
1.1.2 Openness at a glance....17
1.2 What are the benefits of Internet openness?....18
1.2.1 Economic benefits of Internet openness in international trade....18
1.2.2 Innovation and entrepreneurship....19
1.2.3 Macroeconomic performance....21
1.2.4 Social wellbeing....22
1.2.5 The challenges of Internet openness....23
1.3 What factors are affecting the Internet's openness?....24
1.3.1 Framework for analysis....25
1.3.2 Stakeholder objectives that affect openness....26
1.3.3 The objectives are driving actions and conditions that affect openness....27

2. TOWARDS MEASURING THE BENEFITS OF INTERNET OPENNESS....33

2.1 Introduction....33
2.2 Benefits of Internet openness for trade....35
2.2.1 The Internet and trade....35
2.2.2 Internet openness and trade....36
2.3 Benefits of Internet openness for innovation and entrepreneurship....42
2.4 Macro-economic benefits of Internet openness....44
2.5 Social benefits of Internet openness....46
2.5.1 Improved medical research and healthcare....47
2.5.2 Greater Educational Opportunities: MOOCs....48
2.5.3 A platform for greater self-expression....49

NOTES....50

REFERENCES....52

ANNEX A: RECOMMENDATION OF THE OECD COUNCIL ON PRINCIPLES FOR INTERNET POLICY MAKING....62

ANNEX B: ELEMENTS OF INTERNET OPENNESS....64

B.1 Technical openness....64
B.2 Economic openness....65
B.3 Social openness....66
B.4 Other facets of openness....67

ANNEX C: ADDITIONAL ACTIONS AND CONDITIONS THAT AFFECT OPENNESS....69

C.1 The slow transition from IPv4 to IPv6....69
C.2 International law enforcement co-operation....69
C.3 The lack of international legal procedural interoperability among laws concerning the Internet....70

C.4 Competitive markets 71
C.5 Traffic management and net neutrality 72
C.6 Fragmentation of technical standards versus technical interoperability....75
C.7 Mass data collection and analysis by the private sector....76
C.8 Summary – the impact on Internet openness....76

ANNEX D: GLOBAL DATA FLOWS – A MEASUREMENT CHALLENGE FOR STUDIES OF INTERNET OPENNESS 78

D.1 The interlinked world – building a new snapshot of data flows 79
D.2 Insights from information on Google searches 82
D.3 Insights from information on YouTube watch hours 85
D.4 From description to measurement? 90
D.4.1 Location, location, location 90
D.4.2 Where to from here?....93

ANNEX E: THE INTERNET, INNOVATION AND ENTREPRENEURSHIP....95

E.1. Enabling knowledge flows 95
E.2 Providing a platform....98
E.3 Supplying essential inputs 100
E.4 The ICT sector as an innovator 102

ANNEX F: ICTS, THE INTERNET AND MACROECONOMIC PERFORMANCE....104

ANNEX G: SOME ADDITIONAL SOCIAL BENEFITS OF OPENNESS 106

G.1 Better transportation services....106
G.2 Helping asylum seekers 106
G.3 Facilitating political speech and freedom of assembly 107

ANNEX NOTES 108

EXECUTIVE SUMMARY

The Internet is the backbone of the digital economy, it underpins much of the world's social activity, and it is a powerful catalyst for innovation, economic growth and social well-being. Organisations such as the OECD have concluded that there is a link between the Internet's catalytic role and its origins as a system designed to be "open" by default. But there has been a persistent concern over the past several years that the Internet is becoming less open. Governments are facing conflicting pressures: meet certain public policy objectives in ways that may make the Internet less open, and reap the social and economic benefits that come with a more open Internet.

To make more informed choices, policy makers and other stakeholders need better evidence on the effects of Internet openness as well as the impact of their decisions on openness. While the benefits of openness can be dispersed and are sometimes difficult to measure, abuses of openness can be very visible – the use of social media for disseminating hate speech, for instance. Correcting such abuses may lead to many different kinds of policy interventions, actions, and conditions that affect how open (or closed) the Internet is and may unintentionally reduce its benefits.

This report aims to begin filling the evidence gap and to set a path for future research. It proposes a definition of Internet openness to frame the analysis, broadly describes the types of benefits and challenges that can result from openness, and identifies stakeholder objectives that translate into impacts on different layers of the Internet and affect its overall openness. The report also offers initial quantitative evidence on the effects of Internet openness on trade, innovation and entrepreneurship, and macroeconomic performance, as well as qualitative evidence on social matters. For each component, ideas for possible next steps on research and analysis are offered.

The key messages of the report are:

- **Openness is vital for reaping the Internet's potential benefits.** The Internet is fundamentally designed to be open and global, which has enabled it to be an engine of economic growth and innovation. It is therefore important to gain insight into the pressures and trends affecting its openness. Although the term "the Open Internet" is widely used, it means different things to different people. A more useful notion is "Internet openness", which reflects that the Internet can be open in multiple ways and to varying degrees. The dimensions of openness include technical, economic and social factors, such as market conditions, governance, legal environments and procedures, and human rights. Support for Internet openness is grounded in the 2011 OECD Principles for Internet Policy Making, which identified a suite of mutually-reinforcing goals for promoting the openness and dynamism of the Internet.

- **Internet openness is widely recognised to boost international trade.** Global value chains are the reality of today's trading environment, with inputs sourced worldwide and stages of production shifting from location to location to complete a final product. Trans-border data flows over the Internet enable firms to co-ordinate their participation in global value chains and have empowered even tiny firms to enter the trade arena.

- **Internet-enabled innovation and entrepreneurship requires openness.** Openness underpins the ability of the Internet to act as a connector on a massive scale. This is what provides opportunities to share, access and co-ordinate knowledge, leverage platforms for new ventures, and source inputs ranging from finance to professional services.

- **The creativity, cost savings and new business models enabled by the Internet's openness can boost productivity and growth.** Internet openness is crucial for supporting the enhanced knowledge diffusion needed to help innovations spread through economies and close the productivity gap between leading and lagging firms.

- **Internet openness strengthens and provides new opportunities for enriching social wellbeing – some of which feed back into economic benefits.** The communication channels created and the open exchange of ideas, knowledge, creativity and opinions spurred by Internet openness can enable more educational opportunities and skill development. They can also allow better tracking of epidemics/disease outbreaks and other improvements in public health functions, as well as underpin more transparent governance, civic engagement, self-expression and consumer empowerment. Together, these and the many other social benefits of openness can lead to more democratic, creative, and innovative societies.

- **The dynamism of the Internet depends in large part upon its openness. But ensuring Internet openness presents challenges.** Bad actors sometimes take advantage of the Internet's openness when conducting malicious activities – for instance by using it to broadcast extremist views or facilitate criminal conduct, human rights abuses, breaches of digital security, unauthorised uses of personal data, infringements of intellectual property, or anti-competitive behaviour (although "closedness", the opposite of openness, presents some of those challenges, too). Virtually all stakeholders have a common interest in deterring or minimising such activities, but they do not always agree on how that should be done.

- **Countries and other stakeholders may have different preferences concerning Internet openness,** depending on their objectives and their assessment of the benefits and challenges that come with preserving openness. Broad public policy objectives that can affect Internet openness in one way or another include protecting competition, consumers and privacy, and promoting economic development, cultural preservation and Internet access. The Internet is fundamentally designed to be open and global by the Internet technical community. Furthermore, openness is influenced by the multi-stakeholder process that drives much of Internet policymaking, as well as by business decisions taken in the private sector and by Internet-user behaviour. Consequently, individual countries do not determine openness unilaterally. Yet they do have goals that lead to a variety of policy actions and conditions that can affect openness, too, such as mandating data localisation and blocking anticompetitive mergers. Policymakers should bear in mind the effects of their actions on openness so that they can fully reap the benefits of engaging in the digital economy.

- **The global, interconnected nature of the Internet means that international and multistakeholder co-operation is vital for formulating effective and flexible policies and practices for the digital economy.** Those policies and practices should help to preserve the fundamental openness of the Internet while meeting important public policy objectives. Countries have a common interest in considering the ramifications that policies or practices affecting Internet openness have both on their domestic economies and others. But currently, decisions on these actions are made without sufficiently robust data. In particular, while some quantitative information on cross-border data flows is available, policymakers need more substantive and

nuanced evidence on the broader impacts of different openness policy choices on both domestic and international economic and social goals.

- **Future research on Internet openness needs to advance on two fronts: better data and deeper policy analysis.** This study takes a first step towards measuring global data flows as a proxy for Internet openness, with the ultimate aim to link these to key indicators of trade, innovation and macroeconomic performance, as well as social wellbeing. It also begins to analyse the impact of various actions and conditions on Internet openness. Next steps could be to:

  - Develop methodology and data to measure the multiple dimensions of Internet openness;

  - Continue building a dataset of global data flows accompanied by infrastructure data, with the collaboration of private sector;

  - Further elaborate and assess the impacts of decisions or actions taken by governments, the private sector, civil society or Internet users on openness; and

  - Further elaborate and assess the effects of more or less openness on trade, innovation/entrepreneurship, macroeconomic performance, and social wellbeing.

The Internet is critical for countries seeking to improve economic and social outcomes. Ill-informed decisions affecting Internet openness could weigh heavily on future trade, innovation and productivity performance and on people's ability to leverage the Internet for personal advancement. The OECD will continue to support multistakeholder efforts to better understand and harness the benefits of the Internet for all.

OVERVIEW

"As divergent forces tug at the internet, it is in danger of losing its universality and splintering into separate digital domains", *The Economist* stated. That was now more than five years ago (The Economist, 2010a). The OECD's 2008 Seoul Ministerial Declaration and its 2011 *Council Recommendation on Principles for Internet Policy Making* (IPPs) both recognised the link between the Internet's open, distributed, and interconnected nature and its catalyst role for economic growth and social wellbeing. Not only is there a positive relationship between the Internet's open nature and trade and knowledge flows that support innovation, but that open nature also contributes to social wellbeing in a host of ways, such as by facilitating the exchange of knowledge, ideas, interests and viewpoints on a broad scale. However, the danger that the 2010 *Economist* article identified has persisted as various stakeholders, including governments, look for ways both to preserve and promote Internet openness and to address a wide variety of other challenges.

A key question for policy makers is how to achieve broad public policy objectives such as protecting competition, consumers and privacy, with balanced approaches that also protect Internet openness, while working with and taking into account the needs, desires and roles of all stakeholders. The IPPs (Annex A and OECD, 2014a) promote openness on the grounds that it leads to economic and social benefits. Nevertheless, some important public policy objectives, e.g. public safety and economic development, call for actions that can lead to varying degrees of openness. Because the Internet is a globally interconnected "network of networks", the probability that interventions will have unintended consequences is higher than it would otherwise be. Setting and implementing policies affecting openness can therefore be a challenging undertaking.

1. Openness is vital for reaping the Internet's potential benefits

The Internet is fundamentally designed to be open and global, which has enabled it to propel economic growth, innovation and social wellbeing. It is therefore important to understand what openness is and to gain insight into the pressures and trends affecting its openness. Although the term "the Open Internet" is widely used, it means different things to different people and it suggests that the Internet has only two possible conditions: open or closed. "Internet openness" is a more useful term because it reflects that the Internet can be open in multiple ways and to varying degrees. The dimensions of openness include technical, economic and social factors, such as market conditions, governance, legal environments and procedures, and human rights. Support for Internet openness is grounded in the 2011 OECD Principles for Internet Policy Making, which identified a suite of mutually-reinforcing goals for promoting the openness and dynamism of the Internet.

It is well known that certain technical elements of the Internet's architecture, such as publicly available and commonly adopted data transport protocols, are vitally important for opening the Internet to devices and users on a massive, efficient scale. Indeed, the open nature of the technical foundation of the Internet is critical to the Internet's "identity". The Internet is what it is today largely because of its technical openness. Actions and inactions that restrict technical openness have the capability to weaken the Internet's security, flexibility and stability, and to curtail the economic and social benefits that it can bring. But Internet openness is also influenced by an array of economic, social and other elements, such as privacy rights, regulatory transparency, security, competition, and user empowerment. Therefore, a broad definition of Internet openness is necessary.

Technical openness includes factors such as the end-to-end principle, the use of consistent voluntary technical standards for data packet switching, interoperability, a consistent address space, and a uniform convention for domain names. Economic openness involves accessibility, the ability to consume and supply Internet services on a cross-border basis, and regulatory transparency. Social openness corresponds to a respect for human rights, such as privacy, freedom of opinion and expression, freedom to associate, the right to education, and freedom from discrimination. Digital security is an important factor that cuts across the technical, economic and social dimensions. The components of openness are explained in greater detail in the paper.

2. Internet openness constantly fluctuates

The Internet has rarely, if ever, been either fully open or fully closed. To be absolutely open – if such a state is even possible – would require the end of arrangements that are critical for economic or social reasons, such as having to pay for hardware and Internet access. Absolute closure, on the other hand, would transform the Internet into nothing more than a series of isolated nodes, at which point it would cease to be a network at all. The reality is that the Internet has degrees of both openness and closedness, which are in a constant state of flux in several dimensions.

3. Although there are legitimate reasons for setting certain boundaries, drifting away from a general preference for Internet openness is economically and socially costly

In terms of policies affecting openness, data localisation requirements, for example, are difficult to implement and effectively act as trade barriers that could lead firms to reorganise operations, including participation in global value chains. Such requirements may also reduce technology diffusion and restrict services to end-users. Additionally, promoting ICT standards that are unique to a particular country ultimately harms that country's consumers and businesses by potentially raising domestic prices and reducing economies of scale in global markets.

4. Internet openness is widely recognised to boost international trade

There are a number of channels by which Internet openness can have positive effects on international trade. At a basic level, openness facilitates trade by making it easier for suppliers to connect with customers in other countries, improving logistics control, and making it possible to complete transactions and deliver products, services, and payments faster and more efficiently. Internet openness also plays a crucial role in oiling the wheels of global value chains. Today a large chunk of trade is in intermediate goods and services, with inputs sourced globally and stages of production shifting from place to place. Internet openness boosts the abilities of firms of all sizes and nationalities to find a niche in global trade by enabling them to co-ordinate their participation.

Because seamlessly moving data over country borders is a critical part of how global value chains operate, small frictions could multiply into large barriers. A number of studies have expressed concern that too stringent data regulations could stifle trade, essentially resulting in greater production inefficiencies at a global level. Reduced technology diffusion is another concern if trade is choked. The costs are likely to fall more heavily on small firms which have less capacity to duplicate data management systems across countries and navigate complex regulatory requirements. It may also impact negatively on development in emerging economies if services such as finance grow more slowly.

5. Internet-enabled innovation and entrepreneurship requires openness

Internet openness benefits innovation and entrepreneurship by cementing the Internet as a venue for creativity. It does this in a number of ways – by boosting knowledge flows that support innovation, by underpinning the Internet as a platform on which entrepreneurs can construct new businesses and

commercialise their ideas, and by enabling new avenues for businesses to obtain inputs, thereby lowering entry barriers and freeing up resources for innovative activity. People can share, access and co-ordinate knowledge in ways that were previously not possible, with benefits for collaborative research, public service delivery and business activities. The Internet's end-to-end design principle makes it open to new applications and, combined with a competitive market and an absence of gatekeeping, means lawful new services can bubble up. This dynamism makes the Internet a crucible for innovation, which is nourished by the availability of finance, business services and marketplaces online.

In particular, free flows of data and information accompanied by trust in the network, both of which reflect openness, are vital for extracting the benefits of the Internet for innovation and entrepreneurship. Furthermore, accessibility and free choice of applications and services (which are facets of openness) are an important part of this because they stimulate competition and the incentive for investment in innovation and development. In addition, the open availability and wide adoption of Internet standards and protocols further plough the path to innovation by providing a foundation on which new and improved products, services and processes can be built.

6. Openness can unleash productivity and may be critical for future growth performance

The spur to trade, innovation and entrepreneurship enabled by Internet openness should translate into better macroeconomic performance through boosts to productivity and growth. Enhanced competitive pressures, access to new technologies and methods, and increased creativity and dynamism can all bring benefits at the aggregate level.

Looking ahead, these channels between Internet openness and productivity may prove crucial for future economic performance. Slowing productivity growth at a global level is driven by a large body of lagging firms that are falling further and further behind the global frontier (OECD, 2015f). Innovations are not spreading through economies, and to kickstart the knowledge diffusion machine it is crucial to expand global connections (via trade, investment, participation in global value chains, etc.), boost experimentation at the firm level, improve resource allocation, and increase investment in innovation. Internet openness can have a positive effect on all these diffusion mechanisms and, moreover, may also be a crucial tool for keeping the global productivity frontier on an expansion path.

7. Internet openness strengthens and provides new opportunities for enriching social wellbeing

Internet openness contributes to social wellbeing in a host of ways, such as creating new opportunities for people to connect with one another and giving them greater access to education. Openness also offers new options for tackling social challenges like healthcare and ageing, and facilitating the exchange of knowledge, ideas, interests and viewpoints on a broad scale. In addition, Internet openness strengthens the quality of democracy in societies.

8. But openness also comes with real challenges that must be addressed

Internet openness brings a number of challenges, too. A major one is that criminals take advantage of the free flow of information that goes hand in hand with openness to co-ordinate and carry out their activities. Likewise, the free flow of information can disseminate content that is universally, or almost universally, considered harmful and condemned. Other challenges of Internet openness include greater potential for fraud, loss of or reduced control over privacy and personal data, and digital security breaches.

The principles of conflict of laws and legal jurisdiction also pose a challenge for the borderless Internet. Such challenges are particularly striking in the context of investigating incidents and applying sanctions, as law enforcement powers are territorial in nature while the Internet is not. These challenges

may arise in a vast array of areas such as taxation, public regulatory law, criminal law, civil law, data protection.

Challenges related to conflict of laws and legal jurisdiction can arise in the context of business arrangements, as well. As Internet openness has led to more cross-border commercial relationships, the potential for legal uncertainty about which jurisdiction's laws apply has increased, too. This can be the case regardless of whether the relationship is a contractual one, such as between private companies and their customers living in other countries, or one that involves non-contractual obligations, such as between e-commerce traders and intermediaries. The complexity and, in some cases, the opaqueness of these arrangements, may contribute to the legal uncertainty.

9. Stakeholders have a variety of broad objectives to which Internet openness is relevant

Stakeholders including governments, businesses, civil society, the Internet technical community and consumers have various goals and interests that translate into effects on Internet openness. Their diverse (and shared) objectives include national security, public safety, economic development, human rights and fundamental freedoms, promoting culture and local or national values, locality and independence, cybersecurity, and enhanced Internet access.

10. Those objectives drive actions and conditions that affect Internet openness

A great many types of actions, inactions, and conditions can influence the Internet's openness. Among them are mandatory data localisation, filtering and blocking, surveillance of online activities, market competition, fragmentation of technical standards, and the slow transition from IPv4 to IPv6 (which are protocols that identify devices on a network).

11. Bridging the evidence gap requires measures of Internet openness

Studying Internet openness is made more difficult by the lack of off-the-shelf measures of openness. In the absence of indicators, it is difficult to quantify how Internet openness affects areas such as trade, growth and wellbeing.

One of the main goals of this work was to begin to bridge this evidence gap by starting to collect and use data on global data flows obtained from companies with global reach and thereby to explore whether "global data flows" could serve as a good indicator. The decision to use data flows as an initial indicator for openness was based on the prominence given to the global free flow of information in the IPPs and the fact that data flows are the practical consequence of this information exchange.

At the time of writing, information was available on Google Internet searches and YouTube uploads and downloads, and PayPal had provided data on financial flows over its payments platform. Neither constitutes an ideal proxy for global data flows, but they are an important first step and provide valuable insights into Internet usage patterns. In particular, the Google information reveal an almost universal trend of users increasingly accessing content outside their home country, which could signal a widening variety of information and knowledge flowing across borders. The PayPal data, in turn, show the Internet is enabling significant cross-border financial transfers across a large suite of countries.

Work will continue on gathering data, but in the interim, the search for evidence on how Internet openness affects trade, innovation and macroeconomic performance has had to rely on reviewing existing literature. Evidence has been funnelled – first looking at the impact of the Internet, then Internet openness (if possible) and finally highlighting any new insights from the data available to the OECD.

12. Existing analysis supports the positive link between openness and trade

International trade and Internet openness is perhaps the most studied of the areas considered in this report. Literature on the Internet and trade highlights the importance of digitally-deliverable services in countries' trade activity. A third of US exports in 2011 were digitally-deliverable services, and EU and US exports in general incorporate significant amounts of digitally-deliverable services used as intermediate inputs. The importance of the Internet in trade is highlighted by the following estimates:

- US trade costs in digitally-intensive sectors are 26% lower than they would be without the Internet.
- Developing countries could save 2-3% on trade costs with greater use of Internet-based data and document processes.

13. New data highlight the range of industries and countries reliant on data flows

Data show that the now defunct Safe Harbor framework governing data flows between the European Union and the United States was used by a wide variety of firms, with firms from 103 different industries certifying to Safe Harbor at some point from 2000 to mid-2015. Over half the firms had fewer than 100 employees, highlighting how data flows matter for SMEs.

The importance of free flows of data for trade is also supported by work on the OECD's Services Trade Restrictiveness Index (STRI), which shows service trade restrictions hit services exports twice as hard as imports. The computer services sector appears particularly sensitive to increases in restrictions – imposing a few new restrictions decreases exports by 6.5% and imports by 2%. Furthermore, increased restrictions in the computer and telecommunications service sectors are associated with decreased exports of manufactured goods, such as motor vehicles, capital goods and some consumer goods.

Restrictions on data flows can also affect the financial flows underlying international trade. PayPal data from 2013 clearly show the extent to which countries around the world are bound through financial flows and, with around USD 120 million in daily transfers on this platform alone, show the potential magnitude of disruption should Internet-based flows be constrained to any great degree.

14. There are many indications of an Internet-innovation link

A growing body of literature points to the importance of the Internet in enabling knowledge flows that support innovation and its role as a platform on which entrepreneurs and existing firms can construct new businesses and commercialise their ideas. It also highlights how the Internet has spawned new avenues for businesses to obtain inputs – from capital to software – which lower the hurdles for market entry and free up resources for innovative activity. And of course, the ICT sector whose technology feeds and leverages off the Internet is itself a source of innovation. For instance[1]:

- Entrepreneurs point to the key role of digital technologies in supporting large-scale open innovation amongst geographically-dispersed collaborators.
- Almost 50% of adult OECD population made online purchases in 2013.
- Almost 40% of large firms in the OECD use cloud computing services. Use of technologies such as the cloud is not just happening in "digital" firms, but across the board – retail, manufacturing, finance, and business services. Cloud computing services allow firms to leverage the Internet to obtain inputs more flexibly and at a lower cost, giving them greater financial manoeuvrability and higher quality inputs, which support their innovative efforts.

- 85% of young entrepreneurs say new technologies are critical or important to support and enable innovation in business processes.

- The computers and electronics sector outstrips, by a large margin, other industries in terms of its share of the top corporate R&D players in the world.

15. More work is needed to explore the impact of openness on innovation

Quantitative evidence directly linking Internet openness, innovation and entrepreneurship is thin. Additional data and analysis is needed. This study began to explore how the Internet affects knowledge flows, provides a platform and resources, and forms part of the wider ICT innovation environment. An additional entry point may be to consider how openness affects particular drivers of innovation such as workforce skills, diversity and knowledge creation (OECD, 2015e).

16. Recent studies indicate the potential impact of openness on productivity

A positive link between ICTs and productivity is now relatively well-established, but evidence is limited on the link between Internet openness and macroeconomic performance. One recent study found that administrative regulatory barrier's like those that regulate data flow's dampen total factor productivity (by almost 4% in one estimation) and suggested constructing a data regulation index to explore this further (van der Marel et al., 2015). Other work has focused on cloud computing, suggesting that the change in firms' cost structures could boost growth and jobs – perhaps creating up to several hundred thousand new small- and medium-sized enterprises in the European Union alone (Etro, 2010).

Evidence on the links between trade, GVC participation and productivity provides indirect support for the hypothesis that Internet openness boosts productivity. More connected countries learn from the global productivity frontier more effectively and get a resultant boost in their own productivity growth (OECD, 2015f). To the extent that Internet openness indeed supports trade and firms' entry into global value chains, it could play an important role in improving productivity across the board.

17. Many examples qualitatively demonstrate the contributions of Internet openness to social wellbeing

Attempting to quantify openness' effects on social wellbeing is quite challenging because of differing opinions on what counts as a social benefit and how strong the social benefits of a given factor are. However, it is possible to build a case that social benefits from Internet openness exist and are meaningful. The examples discussed include some ways in which openness leads to improved medical research and healthcare, greater educational opportunities, and better opportunities to exercise freedom of expression.

18. The global interconnected nature of the Internet means that international and multistakeholder co-operation is vital for formulating effective and flexible policies and practices

One observation that comes through clearly from the data and analysis in this report is that the Internet ties countries tightly together. The Internet's infrastructure and the way in which data flows across its component networks creates a global digital interdependence, as does the way in which users are increasingly accessing foreign content. As a result, domestic policy actions and conditions can create international spillovers, both positive and negative. Countries therefore have a common interest in considering the repercussions of policies affecting Internet openness not just on their own constituents, but on those of the global community.

19. Future research on Internet openness needs to advance on two fronts: better data and deeper policy analysis

This study has taken a series of first steps in analysing Internet openness – offering a definition, a framework for thinking about the range of actions and conditions that impact Internet openness, attempting to measure global data flows as a proxy for Internet openness, and reviewing evidence on the link between Internet openness and trade, innovation and macroeconomic performance, as well as social wellbeing.

Given the stakes and challenges involved in grappling with Internet openness issues, further research seems essential. It should advance on two fronts: better data, and deeper policy analysis.

- Methodology and data to measure the multiple dimensions of Internet openness (technical, economic, social) would provide stakeholders with a richer picture of the state of openness and how it changes in response to changes in policies, actions and conditions. A focus on quantitative evidence where possible would increase objectivity and would complement existing qualitative indices.

- A particular effort to build a dataset of global data flows accompanied by infrastructure data, with the collaboration of private sector, would provide a valuable indicator to use in a quantitative study of the links between Internet openness and trade, innovation and entrepreneurship, and macroeconomic performance (such as productivity). Two complementary approaches, each including Internet infrastructure data, could be envisaged: tracking flows by location; and identifying hot-spots of data flow intensity. Casting data flows in the context of "global data chains", in a manner similar to global value chains, could help highlight the connections between data and value creation.

- Further elaborate and assess the impacts of public and private sector influences on openness.

- Further elaborate and assess the effects of more or less openness on trade, innovation/ entrepreneurship, macroeconomic performance, and social wellbeing will be a logical extension of data collection work. But other avenues for future research are also available, such as case studies of Internet-based firms as well as more "traditional" firms (e.g. in manufacturing) that are affected by changes in Internet openness. Unravelling the channels through which openness affects innovation, in particular, could be assisted by such firm-specific studies.

1. INTERNET OPENNESS: DEFINITION AND SHAPING FORCES

To help policy makers reach more informed decisions about Internet openness, part 1 of this report proposes a definition of Internet openness to frame the analysis and then broadly describes the types of benefits, along with some of the challenges, that can result from openness. Next, it identifies a suite of stakeholder objectives that relate to Internet openness. It then looks at the way those objectives translate (or can translate) into actions, inactions and conditions that affect openness at different layers of the Internet. This provides the backdrop for part 2 of the report, which turns to some initial evidence of the economic and social impact of changes in Internet openness. Along the way, part 1 also sets out ideas for further research that could be conducted on Internet openness and its connection to economic and social effects.

1.1 What does Internet "openness" mean?

1.1.1 Open versus openness

Although the term "open Internet" is used frequently, it has no universally accepted definition. It is a convenient phrase, like "level playing field", that glosses over complexities. It tends to be used under the presumption that everyone agrees on its meaning, but they do not. To some "open Internet" refers to technical considerations (e.g. global interoperability of transfer protocols). To others, it means an Internet that respects human rights (such as freedom from online censorship). Alternatively, it can be used interchangeably with other terms that do not have a universally adopted definition, either (e.g. "net neutrality"[2]), or it may be intended to refer to some other consideration (such as geographically and/or demographically broad access to the Internet). As a result, the term causes confusion.

Furthermore, speaking about an "open Internet" suggests that the Internet can be only fully open or fully closed. Even if one considers only technical aspects, the binary view does not correspond with how the Internet actually works. The Internet is a layered arrangement consisting of a physical access and transport infrastructure, an agreed set of packet and transport protocols, a domain name system, an IP address system, and applications/content. Together, the layers enable data flows that travel between user devices located at the edges of the network. Depending on the conditions at each of those layers, the technical character of the Internet may be more – or less – open. Some of the technical conditions make the Internet more open while others make it less so. Some even do both simultaneously. Certain conditions have stronger effects than others, and they can also affect more than one kind of "open" at the same time. But they do not simply turn the Internet from "open" to "closed".

For example, one condition that affects how open the Internet is at the IP address layer is the shortage of IP addresses that has arisen due to the limitations of IPv4, a protocol that identifies devices on a network. The shortage of available IP addresses makes it harder to connect more users and devices to the Internet (a closing effect). Therefore, a workaround solution – called network address translators, or NATs – was introduced. NATs allow multiple devices to share the same IP address. Many of the boxes that provide fixed broadband Internet access and WiFi in homes have NATs built into them, enabling all of the Internet-connected devices within the home to use the same IP address. Carrier-grade NATs, or CGNs, are supersized NATs that allow many homes and other end sites to share small pools of IP addresses. CGNs make the Internet more open by allowing more users and devices to connect to the Internet. However, they

cannot provide unlimited access, and in any event, CGNs simultaneously make the Internet less open by hiding or anonymising user activity, which reduces accountability. Consequently, CGNs neither fully open nor fully close the Internet, but they do affect how open it is.[3]

In fact, the Internet has rarely, if ever, been either fully open or fully closed. To be absolutely open – if such a state is even possible – would require the end of arrangements that are critical for economic and social reasons, such as having to pay for hardware and Internet access, and enforcing child pornography laws. Total closure, on the other hand, would transform the Internet into nothing more than a series of isolated nodes, at which point it would cease to be a network at all.

The reality is that the Internet has degrees of both "openness" and "closedness" along many vectors. Therefore, the question to ask is not whether the Internet is open or closed, but how much openness or closedness it has, and in what dimensions. In fact, Internet openness is always in a state of flux, continuously becoming more open in some dimensions and more closed in others.

Accordingly, it is more helpful to study Internet openness with a graduated, multidimensional space in mind than with a basic open-or-closed perspective. That is why the report avoids the oversimplifying term "open Internet" and refers to "Internet openness" instead. It is also why this chapter adopts a broad view of Internet openness, one that goes well beyond a purely technical angle and encompasses economic, social, and other factors. That view is grounded in many of the ideas expressed in the IPPs (OECD, 2014a), though this report goes into more detail on what openness means than the IPPs do. Indeed, the concept of openness presented here is broad enough that, while the report aims to explore all of the most important elements of openness, it cannot cover every aspect of it.

Brief descriptions of the three main categories of openness, i.e. technical, economic and social, are presented here while the more detailed elements of openness are included in Annex B. Even these brief descriptions make it clear, though, that Internet openness does not mean lawlessness or inaction. It is something that stakeholders collectively and purposively craft.

Technical openness increases when openly available protocols are used consistently to receive and send data flows across interoperable layers of the Internet, relying on a consistent IP address system and a uniform convention for domain names. Thus, for example, the more consistently devices connected to the Internet use TCP/IP (Transmission Control Protocol/Internet Protocol, the basic communication language of the Internet), the greater technical openness is. On the other hand, the more non-standard data flow control algorithms are used, the less technical openness there is.

Economic openness varies with the ability of users to get online and to use the Internet to enhance their economic opportunities and put them to productive uses. For instance, economic openness increases as broadband infrastructure grows, but it decreases when access providers lack competition and charge higher prices or provide poorer service as a result.

Social openness is positively related to the ability of individuals to use the Internet to broaden their non-pecuniary opportunities, such as keeping in touch more easily with family and friends, becoming more informed about topics of interest to them, or expressing themselves. As an illustration, social openness increases when laws curtailing political expression are eased. It decreases when access to online educational material is eliminated because a government decides to block the entire platform through which the material is available.

From a practical standpoint, openness corresponds to people's ability to do more things online, whether it is starting a business, creating new services or revolutionising existing ones, expressing opinions, raising capital, sharing knowledge and ideas, conducting research, interacting with government or using a map.

1.1.2 Openness at a glance

For convenience, Table 1 sets out the elements of openness that are discussed in more detail in Annex B.

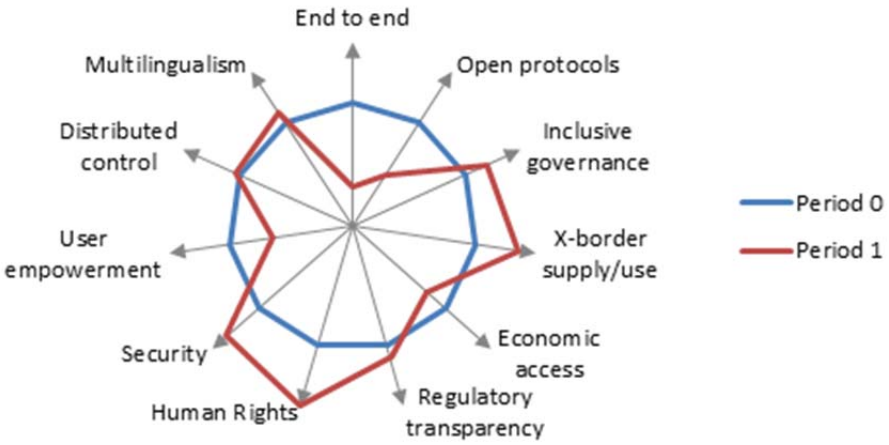
Table 1. Elements of Internet openness

Technical	Economic	Social	Other
End-to-end principle ➢ *consistent use of open standards* ➢ *interoperable* ➢ *consistent address space* ➢ *uniform convention for domain names*	Cross-border supply and consumption	Respect for human rights, e.g.: ➢ *freedom of expression* ➢ *freedom to associate* ➢ *privacy* ➢ *freedom from discrimination* ➢ *education*	Digital security ➢ *availability* ➢ *integrity* ➢ *confidentiality* ➢ *but with some vulnerability*
Open protocols for core functions	Economic accessibility		Empowerment of users over data sent and received
	Regulatory transparency, certainty and capacity		Distributed control Inclusive governance
			Multilingualism

It is also possible to express the idea of openness diagrammatically. Figure 1 depicts a basic multidimensional view of Internet openness. The many technical, economic, social and other elements from Table 1 that contribute to openness are depicted as individual vectors. The values along each vector are set to a common reference point in period 0. In period 1, some values are assumed to increase while others are assumed to decrease. That is done simply to illustrate the concept; the figure is not based on real data or intended to reflect measurements or even casual impressions of actual openness.

The total circumference of the resulting polygon for a given period represents overall openness in that period. Thus, the change in the total circumference of the polygon from period 0 to period 1 reflects the change in overall openness. This is a highly simplified approach because of the indexing in period 0 and the implication that measures of openness can be compared across different dimensions.

Figure 1. A simplified, hypothetical visualisation of Internet openness over time



A major project worth exploring in the future would be to come up with methodologies for measuring and indexing the vectors in Figure 1 so that they could evolve from arbitrary schematics for conceptual purposes into data-based representations of actual openness.

1.2 What are the benefits of Internet openness?

Internet openness delivers numerous, substantial benefits to individuals, businesses, governments and other organisations. It is not always possible to quantify those benefits, but it is possible to identify them and to provide illustrative examples. This section describes four main types of benefits in a mostly qualitative fashion, leaving quantitative evidence to Chapter 2 of the report.

1.2.1 Economic benefits of Internet openness in international trade

There is a growing literature on the positive effects of the Internet on trade and the potential costs to trade of policies that introduce frictions to "business as usual" data flows on the Internet. Internet openness facilitates international trade for existing businesses by making it easier for suppliers to connect with existing consumers who are located beyond the borders of the supplier's home country (or countries) and by improving logistics control. Openness can also boost trade by providing access to a wider customer base via e-commerce. And it enables new firms to enter more geographic markets and (for the most efficient ones) to enter global value chains (GVCs). At the same time, Internet openness and digitisation make it possible to complete transactions and deliver products, services, and payments faster and more efficiently by replacing some physical trade with online trade (in books and music, for instance – or with more complex products via online shipment of designs followed by local production such as with 3D printers).

GVCs are central to the trade and Internet story. Behind aggregate trade data lie a huge number of intermediate trade flows, with inputs sourced globally and stages of production shifting from location to location to complete a final product. Both goods and services may be produced in GVCs – electronics and cars are common examples where design, raw material, production and marketing inputs are spread across countries. One can also think of aircraft, clothing, film animation, law briefs and medical advice being created in GVCs. The rise of GVCs has been made possible in part by technological advances, notably the information management systems that allow firms to co-ordinate their participation in GVCs. The combination of GVCs and the Internet has not only enabled firms in developing countries to more easily engage in international trade (by specialising in one stage of a chain, e.g. auto electronics), but also small- and medium-sized enterprises (SMEs), as digital platforms enable even tiny firms (micro-multinationals) to connect with global suppliers and purchasers.

Given the pervasiveness of GVCs, seamlessly moving potentially large amounts of data across countries is an essential part of supporting intermediate and final trade flows and allowing firms to participate in GVCs. In other words, reductions in Internet openness could create significant impediments to trade. Small frictions may multiply into large barriers, especially if production is split into stages that entail numerous border crossings where imposed frictions multiply. The Swedish National Board of Trade suggest that policies such as data localisation requirements (where firms are either forced to store data and locate data centres within a country's borders, or have restricted ability to move and process data across borders) could lead a firm to reorganise its GVC, either moving or closing parts of its operations, with service to end-users being restricted in some cases (2015: 14-15). Ezell *et al.* (2013: 46-47) make a similar point, noting that localisation barriers to trade, including restrictions on data, undermine firms' ability to participate in global networks because the barriers raise costs and reduce technology diffusion. The Software Alliance (BSA, 2014) additionally highlights the trade-dampening effect of country-specific technology standards and other forms of "digital protectionism," such as nationally-oriented IT procurement.

Internet openness is especially important for enabling smaller firms to engage in international trade. Nicholson and Noonan (2014) comment that while localisation requirements can make cross-border trade difficult for large companies, they may make it "practically impossible for small businesses that cannot afford to implement separate systems and standards in every country in which they do business". Moreover, these firm-level impacts can sum to significant negative outcomes for countries. Kaplan and Rowshankish (2015) note that as banks reduce their operations in countries with more stringent data regulations, financial services will grow more slowly, with potentially adverse consequences for development. There are also more general concerns that policies enacted to reduce Internet openness could create a "slippery slope" for additional interventions and possibly non-tariff barriers (such as local content requirements, or efforts to promote "indigenous innovation" via IP restrictions).

1.2.2 Innovation and entrepreneurship

The openness of the Internet's development has enabled platforms and tools that facilitate creativity, experimentation, and scale without mass. The accompanying light-handed regulatory approach has enabled serendipitous innovation, where new entrants need not "seek approval" prior to launching new lawful services. This stimulates a flourishing market for ideas, including via social networks and through promoting innovation around new devices and services that challenges the status quo. Crucially, the Internet allows global knowledge sharing and collaboration, and can also help break down the barriers to transfer of tacit knowledge, thus spurring innovation.

The literature on the relationship between the Internet and innovation and entrepreneurship points to the importance of the Internet in enabling knowledge flows that underpin innovation. The literature also highlights the Internet's role as a platform on which entrepreneurs and existing firms can construct new businesses and commercialise their ideas. Furthermore, the literature explains that the Internet has spawned new avenues for businesses to obtain inputs – from capital to software – which lower the hurdles for market entry and free up resources for innovative activity. Finally, the ICT sector whose technology feeds and leverages off the Internet, is itself a source of innovation.

The Internet, as a connector on a massive scale, provides the opportunity to share, access and co-ordinate knowledge in ways that were previously not possible. Knowledge sharing was the impetus behind the creation of the Internet, albeit amongst an initially small group of research institutions. Research-oriented, knowledge-sharing networks running on the Internet remain. These help facilitate collaborative research on a global scale, with publications, patents, researchers, and academic and research institutions taking on international dimensions and drawing benefits from cross-border knowledge flows. In addition, governments can leverage the Internet to co-ordinate and use public sector data to improve efficiency and service delivery to citizens. Firms, too, from multinationals with diverse R&D and production locations to small firms tapping into local universities and research institutions, can leverage the Internet to share knowledge. The general expansion of access to knowledge (e.g. via Google, Wikipedia, YouTube, online education sites) to a broader range of people can also stimulate innovation. Meltzer (2015) states:

> *The Internet has provided an opportunity for people to connect and share ideas in a space and time essentially free of transaction costs. Significantly, it has been the open nature of the Internet – the freedom to connect, share information and exchange ideas – that has underpinned the innovation which has created new businesses such as those based on social networking and crowd funding.*

The Internet also provides a platform for innovation, open to anyone that wishes to leverage it for their own venture. There are several aspects to this that are frequently mentioned – first, that the Internet enables "innovation at the edges", second that it enables "serendipitous" (or unexpected) innovation and third, that it allows "permission-less" innovation. The term "innovation at the edges" references the Internet's end-to-end design, whereby the core network provides general-purpose system services (sending

packets of data) and is indifferent to the various applications that may be implemented in software on computers attached to the "edge" of the Internet (Blumenthal and Clark, 2001). Maintaining a preference for end-to-end design makes the Internet more flexible, general and open to innovative new applications. These innovations can challenge the status quo, and can bubble up from unexpected quarters (the serendipitous idea), including from very small firms (e.g. the case of micro-multinationals). Finally, permission-less innovation captures the idea that market entrants need not seek approval prior to launching lawful new services, and that this lack of gatekeeping can, in a competitive and dynamic market, lead to a flourishing arena for ideas, be it through social networks or through promoting innovation around new devices and services. Daigle (2015: 9) points to the creative destruction built into the Internet, saying "Systemically, the Internet supports and fosters approaches that are useful; old, outdated or otherwise outmoded technologies die away". A current example of this is the growth of peer platforms that enable service exchanges between peers, monetising personal assets or selling time and skills, and which are an increasing competitive presence in traditional markets such as hotel accommodation (OECD, 2016d).

As a source of inputs to entrepreneurs and established firms, the Internet is also becoming increasingly valuable, offering a conduit to finance, services and marketplaces. In a way, the Internet is taking outsourcing to its extreme, allowing firms to fully concentrate on their competitive advantage. This not only benefits existing firms by improving efficiency and providing head-space for new innovative activities, but also makes it easier for entrepreneurs to muster the resources to take their ideas through to commercialisation. The new phenomenon of micro-multinationals[4], for instance, is underpinned by the availability of business services via Internet platforms (Mettler and Williams, 2011), and SMEs can also reap significant rewards from boosting their digital savvy (Mettler and Williams, 2012). Internet-based crowd financing (i.e. investment capital through collaborative venture funding platforms), digital utilities (i.e. computing and communication functions such as storage and processing capacity), professional services (i.e. specialised labour via on-line marketplaces), micro-manufacturing (i.e. the ability to send designs via the Internet to contract manufacturers, even for tiny production runs), innovation marketplaces (i.e. sites for trading intellectual property rights), and e-commerce platforms help firms design, develop and deliver their products and services worldwide.

Lastly, the ICT sector itself is a generator of innovation, offering increased computer power and performance and new tools. The ICT sector was relatively resilient to the 2007-09 global economic crisis, although has yet to retain its pre-crisis levels in some countries, and is an important venue for R&D and patenting. Advances in ICT will underpin data-driven innovation – for instance, the main enablers of the Internet of Things[5] are big data, the cloud, machine-to-machine (M2M) communication and sensors (OECD 2015c: 244).

Attainment of these outcomes relies crucially on Internet openness – free flows of data and information accompanied by trust in the network are essential for the Internet to contribute to innovation and entrepreneurship. In a recent study, young entrepreneurs in G20 countries identified international mobility of data accompanied by adequate protection of personal data as a key issue, saying that this was "one of the success factors of entrepreneurs who develop international businesses, and a critical element for entrepreneurs to get access to the right data" (Accenture 2013: 36). Commentators have argued that innovation in industries such as ICTs, energy, life sciences, aerospace and scientific instruments could be especially impeded by limits to data mobility, since such industries do best serving large markets in a competitive environment (Ezell et al., 2013). Limiting scale economies enables weaker firms to remain in the market, thus reducing returns to more efficient firms and eroding their ability to invest in innovation. At the same time, security and privacy standards are necessary to support innovation on the Internet – in Estonia, the X-Road data exchange framework enables access to publicly-held data in a high-trust environment and has spawned the development of numerous new Internet businesses, including Skype (Hofheinz and Mandel 2014).

It was noted earlier that one of the elements of openness is economic accessibility, which describes the degree to which Internet consumers and providers are free to choose the types of applications and services they use and offer. The more freedom of choice they have, the more open the Internet is considered to be. One of the benefits of choice is that it is essential for competition, which stimulates investment in innovation and development by providing pressure to expand and diversify the ways in which the Internet can be used. Similarly, the distributed control approach to managing the Internet makes it possible for different providers to reach the most efficient, market-based solutions for their particular situations.

Furthermore, the open availability and wide adoption of Internet standards and protocols has made innovation easier, cheaper, and faster by obviating the need for every innovator to start from square one. Instead, most of the Internet's evolution occurs through incremental improvements. Novel products and applications frequently need not require designing a new network, nor do they require inventing and adopting a new network protocol or a new transport protocol. Instead, new tools and services can be constructed on the foundation of existing tools, services, standards and protocols, and they will all be interoperable across the network. If one wishes to develop an IP-based voice service, for example, one can use an open standard called the Opus codec rather than developing a whole new codec (Internet Society, 2014). This model enables obvious efficiencies in the process of making the Internet more useful and more valuable. The result is that today's Internet is virtually unrecognisable from the perspective of the early 1990s. Yet the Internet today still uses the same technology components from that time, including the Internet Protocol, TCP and UDP (User Datagram Protocol) end-to-end transport protocols, the domain name system (DNS), and even many of the same application protocols. Those standards paved the way for fast Internet growth by lowering the cost of entry for new networks. There are now more than 40 000 different networks connected to the Internet (Berners-Lee, 2014).

1.2.3 Macroeconomic performance

The creativity, cost savings, and new business models enabled by the Internet's openness can reveal themselves at the macroeconomic level through boosts to productivity and growth. Enhanced international trade offers opportunities for improving productivity across an economy, for instance through firms' exposure to and adoption of new methods and the effects of heightened competition (see OECD 2015f: 48). In addition, the innovation and entrepreneurship spurred by Internet openness can boost dynamism, a key ingredient for improved economic performance. Indeed, OECD work on data-driven innovation highlights the Internet's potential to provide new sources of growth to economies (OECD, 2015a). The discussion in the preceding sections thus suggests that the Internet, and its openness, can have real impact at the macroeconomic level.

Recent OECD work on the future of productivity (OECD, 2015f) allows us to dig a little deeper to propose specific channels that may exist between Internet openness and macroeconomic performance. The work was based on the observation that productivity growth has slowed in OECD countries but quickly discovered an important nuance – the globally most productive firms have enjoyed continued robust productivity growth in recent years while the performance of laggard firms is dropping further and further behind. With productivity anticipated to be the main driver of future growth and prosperity, the analysis sought to explain why so many firms lag and how the problem can be addressed. It found that a slowing of the pace at which innovations spread through the economy is a major blockage to closing the productivity gap. To achieve more effective knowledge diffusion, four factors are essential (OECD, 2015f, 3):

- Global connections need to be expanded, via trade, investment, participation in GVCs, and mobility of skilled labour;

- Firms, especially new entrants, need to be able to experiment with new technologies and business models;
- Economies need to make the most of scarce resources by allowing resources (labour, capital and skills) to flow to the most productive firms; and
- Investment in innovation is required so that economies can absorb, adapt and reap the full benefits of new technologies. This includes not just investment in R&D, but also skills and organisational know-how.

It is not hard to envisage ways in which Internet openness can positively affect each of the four knowledge diffusion factors listed above. The two preceding sections gave some specific examples relating to trade, GVCs, business models and access to capital. Internet openness could also help countries capitalise on the already promising role of Internet platforms in efficiently linking supply and demand, including in the labour market, and thus help resources flow to their best use. And Internet openness allows firms to leverage their investments in information technology and data analytics to share information across the firm for improved management and ultimately improved productivity.

In addition, Internet openness could help operationalise a number of the policy directions to achieve these diffusion factors. For example, improvements in the organisation of basic research are considered crucial for pushing out the global productivity frontier and compensating for inherent underinvestment in this sphere of research (OECD, 2015f, 18). An Internet whose openness allows for efficient collaboration of researchers across institutions and countries and for the sharing of data and knowledge is clearly a crucial instrument in policy makers' toolkit. Similarly, Internet openness could boost governments' efforts to support lifelong learning by offering workers a wider range of options through which to update their skills.

It is quite possible then that maintaining Internet openness could help economies address the productivity performance of lagging firms. As a welcome side effect, in the process this could contribute to more inclusive growth. With observed rises in wage inequality reflecting the increased dispersion in average wages paid across firms, raising the productivity of lagging firms via better diffusion could contain increases in wage inequality (OECD, 2015f, 47).

Internet openness may also be an important factor in keeping the global productivity frontier on an expansion path. In particular, Internet openness – and the resulting global flows of data – may be a crucial feature supporting the digitalisation of economies. Digitalisation holds enormous potential to reboot economies' productivity and growth performance, though it comes with certain challenges for labour markets and perhaps existing regulatory systems. In a report for the Confederation of Swedish Enterprise, Blix (2015) concludes that the digital revolution will likely improve the quality of life and efficiency of work, as well as transform our leisure time. He sees faster and cheaper production flowing from network effects, increasing returns to scale and 3D printing, as well as greater efficiency and competition from increased price transparency and more global access (ibid.: 76). This contributes to more efficient and better use of resources, with clear macroeconomic results. But, as noted by Blix (ibid.: 69), "A digital revolution without global reach would not generate the leverage that is the elixir of life to digital platforms".

1.2.4 Social wellbeing

Beyond creating new sources of economic benefits like jobs and a greater selection of products and services, Internet openness enables many opportunities for enriching social wellbeing. Such opportunities include the new ways in which people can connect with one another thanks to Internet openness. The interoperability aspect of openness helps Internet users to stay more closely in touch with family and

friends, no matter how far apart from one another they are. And it does so more affordably and in a richer variety of ways (such as email, instant messaging, and video calls) than previous networks have done.

Likewise, Internet openness creates more opportunities for anyone who can get online to have access to education. In particular, e-learning can reduce the cost and increase the availability and quality of education in developing and developed countries alike — provided that there is enough openness.

Internet openness also presents new options for tackling social challenges such as healthcare and ageing. Because openness means that connected devices can communicate with each other across distances near or far using common standards and protocols, openness allows applications like remote healthcare and even remote surgery. People can monitor their own conditions with connected devices and play a more active role in their own health.

In addition, openness facilitates the exchange of knowledge, ideas, interests and viewpoints on a broad scale. In doing so, it democratises the spread of information and its influence, not just by widening formal education's reach, but by providing users with more choices for learning informally about virtually any topic, including current events, politics, business, technology and popular culture. In particular, Internet openness unlocks access to new sources of news, information, opinion and entertainment from other cities, countries, cultures, and perspectives, which is especially valuable where the ownership concentration of local traditional media is high and the diversity of viewpoints is low.

Internet openness does not only open up opportunities to passively receive information; it also helps people to share and use it actively. Where there is sufficient openness, the Internet gives the great majority of its users a more powerful platform for propagating and testing their ideas, knowledge, creativity and opinions, and for making improvements in their societies. These factors, in turn, can lead to a host of follow-on benefits, from a more democratic society to a more innovative and creative one (OECD, 2014a: 20). (They can also lead to some drawbacks, which are addressed in the next sub-section.)

In fact, by increasing accessibility, facilitating freedom of expression, and making it easier to communicate with one's elected representatives, Internet openness can lead to greater civic engagement, more government transparency, and a more informed and vocal public. In short, Internet openness strengthens the quality of democracy, which is a core OECD value.[6]

1.2.5 The challenges of Internet openness

Although this paper focuses primarily on the positive aspects of Internet openness, the challenges need to be acknowledged, too. Just as openness facilitates the free flow of information for innovation, trade, and self-expression, it can also facilitate unauthorised uses of personal data, violations of privacy rights, or digital security breaches leading to the theft of identity and trade secrets. Among the most prominent challenges on the minds of policy makers today is the use of the Internet to promote and carry out terrorism around the world.

Similarly, while openness and freedom of expression are mutually reinforcing, there can be negative uses of free expression. Consequently, openness can amplify those negatives, which include for instance terrorist execution videos, hate speech (e.g. racism, xenophobia, homophobia), and paedophilia.

Another area of concern for some is Internet services that use business models that depend on monetising the value of user data (e.g. "free" email, search engines, social media, and video sharing applications, but also some fee-based services). Users may not realise that even though they might not be paying with traditional currency, they are nevertheless "paying" with their personal data (OECD, 2015a: 216-227). Even if they do realise it, there is no easy way for them to determine what their data is worth. That raises the question of how users can decide, in an informed manner, how much of their data to

surrender in exchange for the "free" services. The scope of the revised OECD Recommendation of the Council on Consumer Protection in E-Commerce[7] expressly covers non-monetary transactions, a change intended to reflect the emergence of such services.

Even when products and services are not financially free, they can of course still raise privacy and security concerns. Those concerns may become more prominent as the Internet of Things (IoT) develops. While openness is helping to make the IoT work and improve, one implication is that a great deal more private data is being collected, stored and sent than was previously possible. Consider fitness trackers, for example. These devices can improve users' health by keeping track of their activity level, calorie intake, heart rate, etc., and by motivating them to meet fitness goals. However, fitness trackers also store and send users' health data over the Internet, sometimes sharing it with other applications operated by third parties. How best to address the privacy and security issues raised by the IoT is one of the subjects of the OECD's 2016 Ministerial (Panel 2.2).

One facet of Internet openness is greater access, which results in users being connected to a larger network. However, that can also expose them to more online intrusions (e.g. hacking, identity theft), fraud, extortion, ransomware, denial-of-service attacks, online bullying, and a variety of other dangers. Likewise, it can facilitate intellectual property infringement (OECD, 2015h). Those activities threaten economic and social wellbeing by exposing personal and private data, harming financial and public infrastructure, threatening public safety, subverting human rights, and depriving businesses of the fruits of their innovation and investment.

Furthermore, openness is capable of affecting competition both negatively and positively. Elements of openness such as standardised protocols and well-tailored regulations can spur competition by making it easier for new firms to enter markets (or at least by not standing in the way). However, the very large scale and the network effects that Internet openness enables in some markets can lead to less competition, at least in a static (price effects) if not a dynamic (innovation effects) sense. While firms with market power may rise and fall in Schumpeterian fashion, they might also hold on to dominant positions for lengthy periods (OECD, 2012b). However, Internet openness is, on the whole, good for competition.

1.3 What factors are affecting the Internet's openness?

The Internet's technical and cultural roots strongly tended toward openness. Since then, the Internet has evolved very substantially from an academic research project in the 1970s, to a largely commercial network in the 1990s, and then to a stage for the explosive growth of the digital economy and social media in the 2000s and beyond. The OECD's *Digital Economy Outlook* (2015c) shows the extensive growth that has taken place around the world in Internet bandwidth, accessibility, usage, and the diversity of purposes for which it is used.

Some changes are clearly positive, such as the wider reach of the Internet and its growing contributions to economies (OECD, 2015c). But changes that affect the Internet's core open properties may be problematic. Much of the Internet today operates in a way that is consistent with the model of an open, unified and accessible public resource. Daigle (2015) notes that the Internet's general properties (which she describes as global reach and integrity, general purpose, permission-less innovation, access, interoperability and mutual agreement, collaboration, reusable building blocks, and no permanent favourites[8]) are fundamental to the Internet's success and that its evolution to date has left them fairly intact.

That does not mean that the entire Internet environment operates as a fully open, unified and accessible public network. Many pressures are limiting the Internet's openness. A number of significant ones are explored in section 1.3.2 below, along with other pressures that tend toward greater openness, or that can have mixed effects.

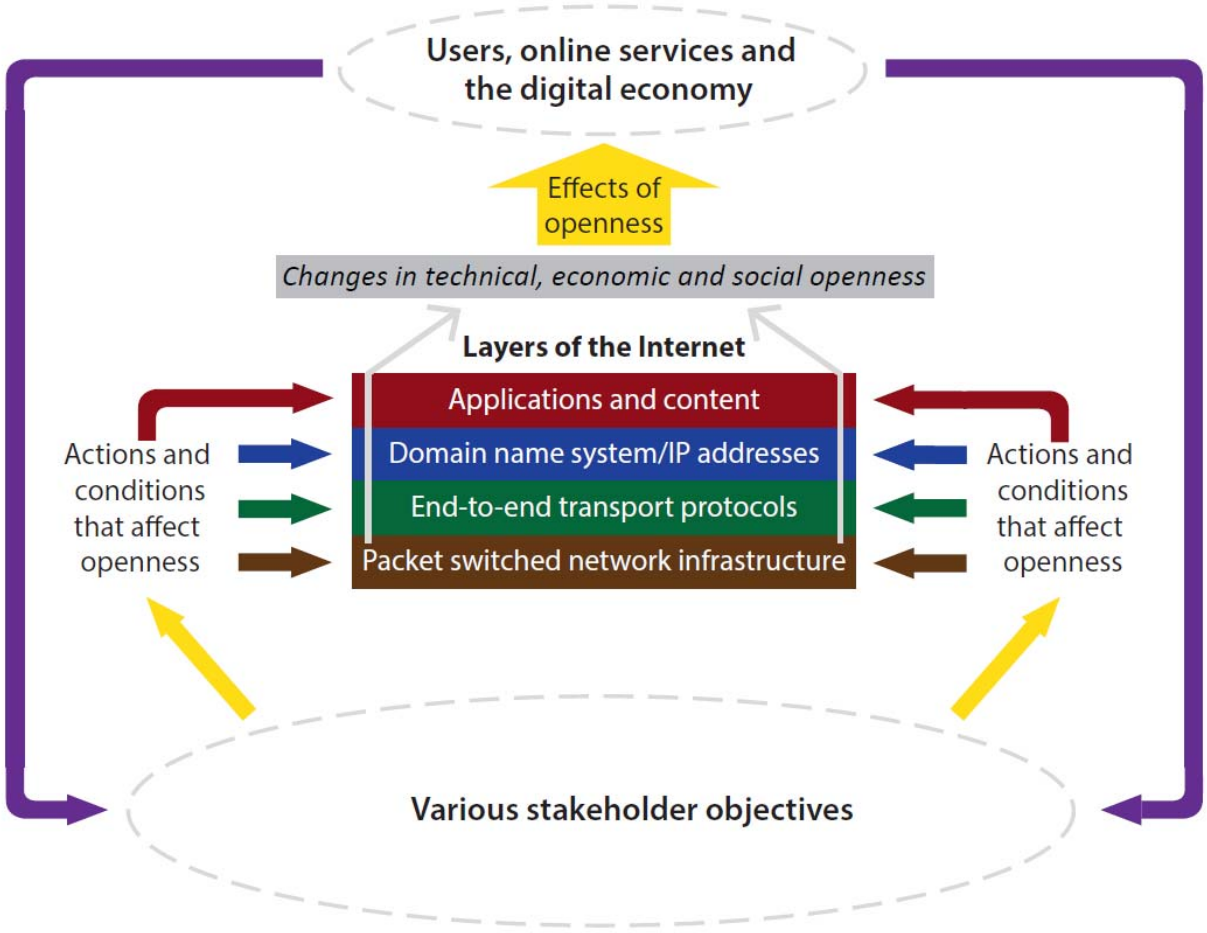
These pressures now exist across all of the technological and functional layers that make up the Internet. Some of them result from decisions based on technology considerations, such as the desire to make efficient use of high capacity transmission systems. Others are an outcome of the Internet's growth, such as the pressures on IPv4 from more and more users and the rise of the Internet of Things. Still others, like filtering and blocking, stem from concerns such as a desire to preserve national values.

The paper now proposes a framework for analysing Internet openness and the forces that are affecting it. It then turns to a description of various public and private objectives and challenges that have a bearing on Internet openness. This is followed by a discussion of some of the ways in which those challenges are translating into public and private actions (and inactions), and how those actions/inactions affect openness at different layers of the Internet.

1.3.1 Framework for analysis

Figure 2 introduces the framework that organises the subsequent discussion of the factors that reduce or enhance Internet openness by affecting different levels of the Internet.

Figure 2. A basic framework for analysing Internet openness



Source: OECD and Geoff Huston.

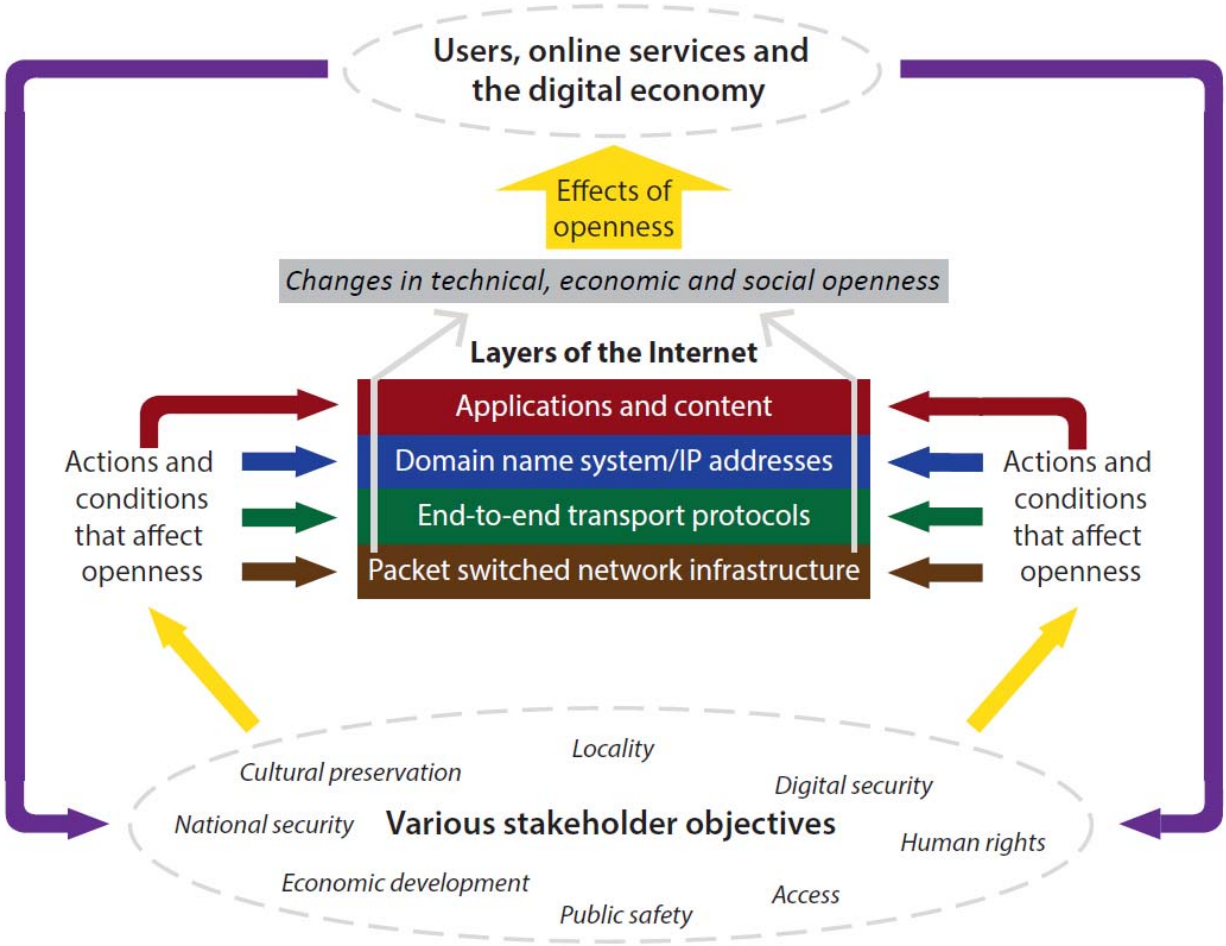
The Internet itself sits at the centre of the Figure and is depicted as a stack of layers: physical network infrastructure, interoperable protocols, the DNS, and applications/content. The objectives of multiple stakeholders – governments, the private sector, civil society, the Internet technical community, consumers, etc. – are outside of the network, but they lead to various actions and conditions that affect one or more layers of the Internet. Those effects lead to fluctuations in technical, economic and/or social openness, which in turn affect users, services, and the digital economy. Those latter effects ultimately inform the objectives at the bottom of the diagram, forming a continuous feedback loop.

1.3.2 Stakeholder objectives that affect openness

This sub-section identifies and describes a suite of broad objectives that affect the Internet's openness. Some objectives, in the end, lead to less openness while others lead to more. Certain others result in actions that can lead to either greater openness or greater closedness, depending on how extensively they are implemented.

These objectives are now included in the oval at the bottom of the framework diagram.

Figure 3. Internet openness framework, including policy objectives



Source: OECD and Geoff Huston.

The objectives are:

- *Economic development*. A host of public and private objectives are concerned here, including boosting trade, managing digital security risks, promoting a carefully balanced intellectual property rights framework, developing local and national businesses, creating jobs, fostering Internet entrepreneurship and innovation, and fighting poverty.

- *Human rights and fundamental freedoms*. This category includes rights and freedoms that have been universally adopted, such as those which can be found in the Universal Declaration of Human Rights, or nearly universally adopted, such as mass censorship. Consecutive resolutions of the United Nations Human Rights Council affirm the principle that rights that people have offline must also be protected online, in accordance with international human rights legal obligations. Fundamental values such as protecting children from abuse are highly relevant, as well.

- *Preserving and promoting culture and local/national values*. This category includes objectives such as preserving or increasing content in local languages, promoting domestically produced content, and reducing content that is locally or nationally considered to be harmful enough to merit censorship, but is not universally considered to be harmful. Examples of the latter type of content are hate speech, advertisements of Nazi paraphernalia, and gambling web sites.

- *Locality and independence*. This term refers to a desire to ensure that elements of the Internet that are located within a jurisdiction are, to the extent feasible, self-standing and not unduly reliant on external resources that lie outside national purview. Different jurisdictions may have widely varying ideas about what "unduly" means in this context.

- *Access*. This objective is simply to make Internet access available for as many people as possible. However, "access" does not necessarily mean a costless connection to the Internet. It means that the equipment and infrastructure required for enabling connections to the Internet are available, albeit usually for a fee. Furthermore, access has both demand side and supply side components. In other words, it also refers to the ability to participate in markets for Internet-related goods and services as a supplier.

- *Public safety*. This term encompasses domestic law enforcement, emergency services, and the ability to maintain a country's critical functions in case of crisis.

- *National security*. This term refers to the aim of protecting the state and its citizens against threats and crises at the national level through a variety of means, including political, diplomatic, economic, and military means.

- *Digital security*. This category refers to the aim of ensuring the availability, integrity and confidentiality of digital interactions to ensure trust.

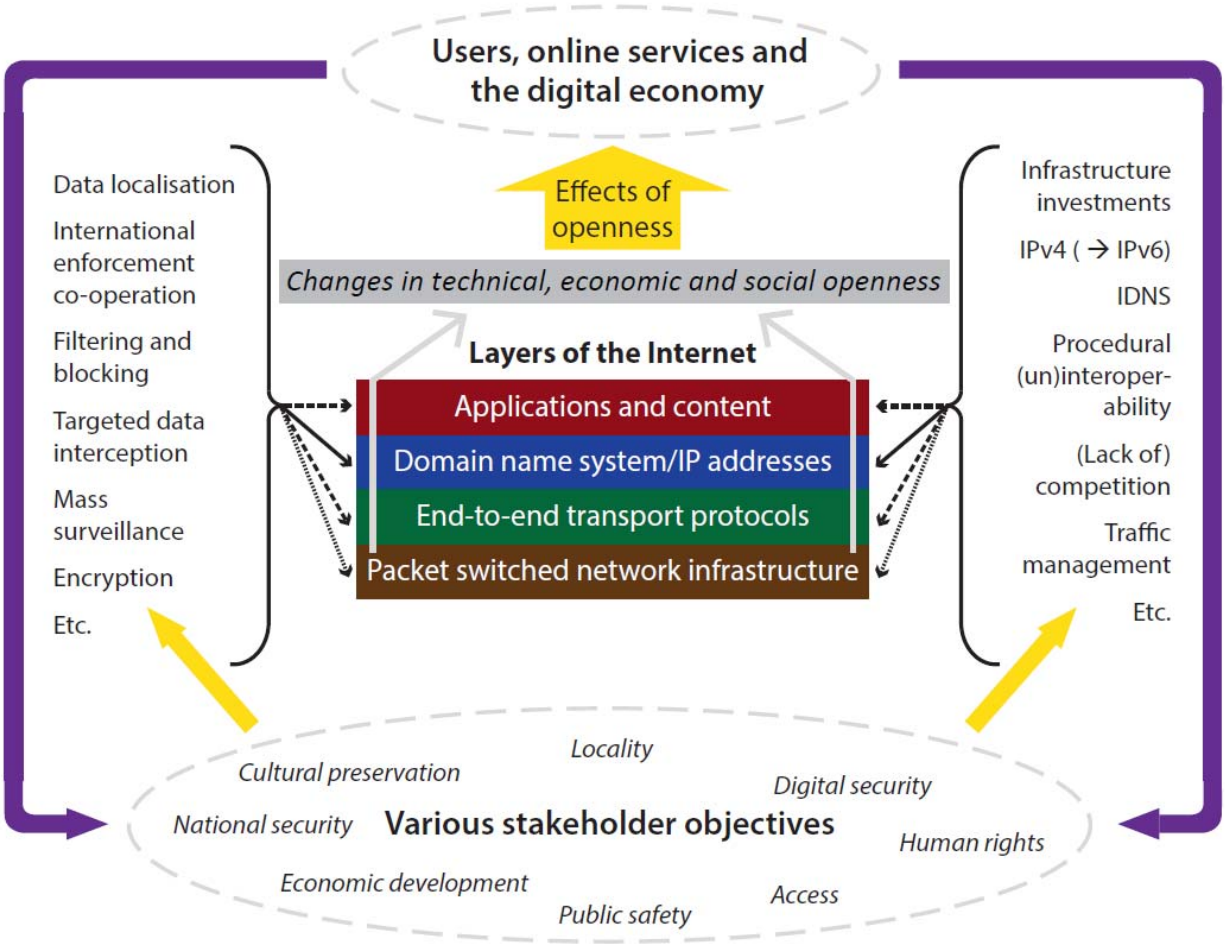
1.3.3 The objectives are driving actions and conditions that affect openness

This part of the paper examines a small sample of the ways in which various stakeholder objectives translate into actions that can affect Internet openness and what those effects are. This topic is a potential candidate for further study in the future, so several more actions and conditions are discussed in a briefer fashion in Annex C. Additional factors could be covered in future work. Annex C includes some effects on openness that result from passive stances or general conditions rather than from particular actions. A prototype of a table indicating the points at which each action/condition affects overall openness, and whether

the expected impact is positive or negative, also appears in Annex C. Note that the information in the table is tentative and serves mainly as an illustration of what potential future work could solidify and/or extend.

A wide variety of policy interventions, inactions, and conditions can affect the Internet's openness, and collectively they can do so via any of the Internet's layers. To illustrate that, another version of the framework appears below, now with many (but not all) types of influences included.

Figure 4. Internet openness framework, with some of the actions and conditions that affect openness



Source: OECD and Geoff Huston.

1.3.3.1 Mandatory data localisation

Mandatory data localisation policies aim to restrict trans-border data flows. These policies may take the form of national routing requirements, requirements that data be stored on domestic servers, certain actions involving Internet exchange points, and mandatory international gateways. Data localisation restrictions may arise due to concerns about unauthorised foreign access to domestic citizens' personally-identifiable information, to valuable commercial data (economic espionage), or to sovereign data (e.g. data related to national defence and security, justice, or taxation). Alternatively, such restrictions may come about for mercantilist or protectionist reasons. For example, a requirement that data centres and cloud services remain localised may be based on the belief that such actions will protect domestic IT industries and create jobs.[9]

However, while some of the motives behind mandatory data localisation can certainly be legitimate, it does make the Internet more closed, it may not achieve the desired results and indeed can cause unexpected harms. Localisation policies can restrict openness at the infrastructure layer by forcing businesses to use domestic data centres and/or routing pathways, which restricts competition and therefore efficiency. Data localisation policies can also restrict openness at the applications layer when applications are prohibited from sending or storing data across borders. All of this restricts the free flow of information.

Furthermore, data localisation does not necessarily lead to more privacy or security. In support of this view, Carl Bildt (2015) has pointed out,

> Ensuring the protection and integrity of data is indeed a vital issue. But this has very little to do with where data are stored... Chinese and Russian hackers routinely penetrate secure industrial and government networks in the US and Europe. And several countries are tapping underwater cables carrying the world's communications. So what problem does data localisation actually solve?
>
> The solution to privacy concerns lies not in data localisation, but in the development of secure systems and the proper use of encryption. Data storage actually means the continuous transfer of data between users, with no regard for Westphalian borders. Security in the digital world is based on technology, not geography.

There are economic drawbacks, as well. Atkinson and Miller (2015) found that when a government tries to achieve growth by forcing customers to use the domestic IT industry, Internet adoption and use typically declines.

Moreover, although national routing requirements (and regulations that essentially require domestic routing by forcing Internet service providers to buy transit services from only one or two domestic providers) are implemented for the purpose of ensuring that as much domestic voice and data traffic as possible remains within national borders, forcing that outcome under penalty of the law would undercut the efficiency gains of the Internet. Evidence on the local nature of Swedish data flows (Aben, 2015) suggests that the degree of market competition for communication services is the main factor in determining whether local data tends to stay local. That raises the question of whether enhancing competitive pressure might achieve the goal of keeping data flows more local, but without the potential distortions of mandating national routing. The potential distortions include higher costs and slower transit speeds, stemming from domestic operators that may be less efficient than foreign alternatives.

In addition, requiring businesses to keep their data local eliminates their ability to take advantage of cross-border competition. Data centres located in other countries may have lower prices or higher quality due to a variety of factors, including scale economies, cheaper power, and lower taxes. In large countries like the United States, one can see the effects of those cost factors even within a nation's borders. Rather than being distributed uniformly among the states, data centres tend to be clustered in states with cheap electricity and low taxes (Berners-Lee, 2014), and in states with large pools of qualified IT specialists.

Another way of thinking about that is to consider the waste of being forced to duplicate hardware costs. Mandatory data centre localisation raises costs in comparison to what firms would otherwise incur, which will tend to result in higher prices for consumers.

Box 1. Example of a Data Localisation Law

Russian Federation

Recent amendments to Russian Law on Personal Data No. 152-FZ (frequently referred to as "Federal Law No. 242-FZ") established personal data localisation requirements and went into effect on 1 September 2015.

Article 18 (5) of the law states that "[d]uring collection of personal data, including via the 'internet', the personal data operator must ensure that recording, systematisation, accumulation, storage, adjustment (updating, alteration), and retrieval of the personal data of Russian citizens is performed using databases which are located in the territory of the Russian Federation, except as provided in items 2, 3, 4 and 8 of Article 6 (1)" (Russian Law on Personal Data No. 152-FZ, as amended by Federal Law No. 242-FZ).

Thus, the law requires data operators to store the personal data of Russian citizens using databases that are located in Russia, unless certain exemptions apply (e.g. when processing of such data is performed in accordance with international agreements of the Russian Federation or is for the purposes of journalist, scientific, or other creative activity). In accordance with the official clarifications of the Ministry of Telecom and Mass Communications of the Russian Federation, data localisation requirements apply only to data "collected" (i.e. such data should be received by personal data operators directly from the data subject), and only to data collected in Russia. The data localisation obligations do not impose any restrictions on the trans-border transfer or duplication of relevant personal data, but general provisions on trans-border personal data transfer continue to apply.

The Law on Personal Data defines "personal data" as any information which directly or indirectly relates to an identified or identifiable individual ('data subject').

Source: Ministry of Telecom and Mass Communications of the Russian Federation.

1.3.3.2 Filtering, blocking, content takedowns and domain name seizures

Filtering and blocking mechanisms screen and prevent access to certain content. They are terms of art that typically refer to denials of access to content, resulting from government or network owner decisions. Those decisions may be based on a variety of concerns that the content raises, including economic development, consistency with local or national laws or values, political stability, and commercial interests. So, for example, the particular concern may be something such as copyright protection or illegal or offensive content.

Content takedowns and domain name seizures involve removing information from the Internet altogether, as opposed to leaving it online but impeding access to it. Takedowns focus on the use of services by third parties, not the site itself, and thus may affect only part of what is available on a site. A domain name seizure, on the other hand, takes the entire domain offline. Takedowns and seizures can result from policy objectives including economic development, political stability, and public safety, among others.

To be sure, filtering, blocking, takedowns and seizures can have a deleterious effect on openness because they make content and services unavailable. An obvious example is blocking by authoritarian governments who do not want their citizens to be exposed to external sources of information such as foreign news sites, Twitter, Facebook, and Google. Another example is one telecom service blocking access to another's (which raises net neutrality issues, the subject of Section C.5 in Annex C).

On the other hand, some implementations of these measures are widely considered to be necessary because they screen out or remove content (such as child abuse) that would undermine fundamental or universal values. Consider the following example of online misconduct, in which a misleading photo appeared in media reports on the conflict in Myanmar in 2012. A picture of Buddhist monks standing next

to a pile of corpses showed up on websites in Muslim countries, embedded in news reports about violence that was taking place between Buddhists and Rohingya Muslims in Myanmar. However, the photo had been taken in 2010 in eastern Tibet, where local monks were engaged in relief work after an earthquake struck. After Tibetan authorities wrote to the website ColumPk.com in Pakistan, the photo was taken down within a day (GlobalResearch, 2012). One could argue that takedowns actually increase openness in such cases by raising the trustworthiness of what people see and read online.

Thus, while measures such as filtering, blocking, takedowns, and domain name seizures can have undeniably harmful effects on Internet openness in many instances, in other cases the measures are appropriate. There are plenty of examples of Internet content that warrants screening or removal according to widely, if not universally, recognised values. These include malware and spam, for example.

Furthermore, content takedowns are sometimes requested for the purpose of enforcing intellectual property rights. In such cases, content is removed from the Internet not because of anything to do with the point of view it expresses, but because it is legally protected (typically by copyright) and the person who made the material available on a web site is legally considered to have used the protected material in an unauthorised manner.

Then there are types of content that fall into a more ambiguous category for which there is no consensus on what to do. Attempts to suppress those types of content can easily spill over into legitimate content, potentially causing both social and economic harms. For instance, some nations have tried to block all “pornography”, which is difficult to define precisely. Some block Internet hate speech, which is also challenging to pin down.

Yet it is important for takedowns, filters, etc. to be well-tailored to the problem they are meant to address. If an approach is too broad or ill-defined — for example, if an entire web service is blocked or its domain name is seized even though only a small part of the service involves the type of content that violates a law — then the net effect is more likely to be closing. An example of an overly broad approach occurred in 2014. Though not required by law to do so, major Internet service providers (ISPs) in the United Kingdom began to filter pornography. However, among the United Kingdom’s 100 000 most visited Internet sites, nearly 20% – including many harmless ones such as a Porsche car dealership site, two feminist websites, and a blog about the Syrian War – wound up being blocked by at least one ISP (Garside, 2014; Woollacott, 2014).

Even so, the effects on openness of efforts to filter pornography in the United Kingdom seem but a small glitch in comparison to some approaches taken elsewhere. Some governments occasionally cut off access to the entire Internet in an effort to control speech or prevent social unrest. For example, after India’s High Court decided to implement a law banning the slaughter of cows and the sale of beef, the government feared misuse of Internet services “by anti-social elements to create communal tension” (The Indian Express, 2015). Consequently, it banned Internet services for three days in the Jammu and Kashmir regions.

Efforts to control access have technical implications that must be considered. For example, seizing domain names may take innocent subdomains offline. Filtering is also likely to be technically ineffective, because of the potential to work around the blockages. Filtering and redirection also conflict with the way the infrastructure is supposed to work, leading to fragmentation of the global network and essentially acting as a “man-in-the-middle” attack. These actions negatively affect the technical side of Internet openness.

1.3.3.3 Surveillance by governments

Government surveillance can take two main forms. Targeted data interceptions are aimed at specific individuals or organisations and result in the collection and analysis of data in varying levels of detail, ranging from metadata (that is to say, data about the data rather than the underlying information itself) to the full text

of emails, social media posts, instant messages, documents, etc. Targeted interceptions may be motivated by law enforcement needs, but they may also be spurred by geopolitical interests or economic espionage.

Targeted interceptions can reduce the openness of network infrastructure. Generally, when countries want to use hardware to perform targeted interceptions, they tend to do so in an opaque manner, such as by setting up “grey” or “black” rooms (also called “tap rooms”) in Internet traffic carriers’ buildings. Cables running in and out of the network are added so that data connected with the target no longer travels only to its intended recipient(s), but to the government, as well. That conflicts with end-to-end Internet network infrastructure, so it reduces Internet openness. Furthermore, when such interceptions come to light, trust can be damaged, which at least in principle can have a closing effect by making people less likely to use and rely on the Internet as much as they otherwise would.

The other main kind of government surveillance is bulk collection (see White House [2014]), which is sometimes referred to as mass surveillance. Rather than focussing on the communications of specific individuals, these programmes affect the communications of large groups of people and the main purpose tends to be protecting against terrorists and criminals or maintaining national security. In simple terms, although the process varies, it can involve collecting content and/or metadata in Internet communications and then scanning that information for key words, dates, contacts, and information about the computer systems generating and handling the data. While the programmes may be subject to a variety of legal oversight regimes within a particular country, the communications of citizens, regardless of location, can be affected. One drawback, therefore, is that the collection and analysis of information performed through these bulk programmes may lead to concerns about users’ privacy rights as well as their political and social freedoms.

In addition, this type of surveillance reduces openness because it can cause (meta)data to travel to persons other than the intended recipient(s). At least in some cases, countries have performed such surveillance in ways that affect the transport protocols layer. Some countries, for example, have reportedly conducted digital surveillance by using fake SSL (secure socket layer) certificates that lead users to believe they are on genuine web sites, e.g. social media, email or search sites, whereas they are actually on a fake site. The result is that users can reveal their passwords, emails, posts and other details to government monitors (Alghoul, 2015; Schneier, 2015). Other countries have used more sophisticated techniques, but those techniques can affect openness at the infrastructure layer. This is the case, for example, when information is collected about Internet communications from the servers operated by Internet service providers or from domain name system resolvers.

Surveillance can also be carried out via the applications layer. For example, in 2009, malware called GhostNet was found on the computers of political, economic, and media organisations in 103 countries. GhostNet turned out to be a Trojan operation targeting personal computers. It was delivered through email attachments that, when opened, placed malware on the user’s computer. That malware then fed information back to a sophisticated surveillance network run by a computer in one country (Schneier, 2015). No matter what layers of the Internet are involved, though, when any type of surveillance programme is carried out in secret and is then discovered by the public, trust in the Internet can decline. (See Centre for International Governance Innovation and Ipsos (2016) for a survey finding that global citizens are increasingly worried about how their personal data is handled by governments, and CIGI and Ipsos (2014) for a survey finding that 43 % of users were avoiding websites and applications that they did not avoid one year earlier.) In addition, if the surveillance is conducted by one government on citizens of other countries, the temptation for target countries to implement mandatory data localisation policies may grow.

2. TOWARDS MEASURING THE BENEFITS OF INTERNET OPENNESS

This part of the report aims to begin filling the evidence gap on the economic and social benefits of Internet openness. It summarises insights from selected literature on the empirical links between the Internet, Internet openness and three important economic policy interests – international trade, innovation and entrepreneurship, and macroeconomic performance. It offers new insights drawing on data related to the Safe Harbor Framework and PayPal-mediated financial flows, and suggests possible future research agendas. It also offers a short qualitative discussion of the potential social benefits to be obtained from Internet openness.

2.1 Introduction

The preceding discussion leaves no doubt that Internet openness-related policy concerns are – or should be – high on the agenda of many countries. Governments are feeling conflicting pressures to heighten their intervention on the one hand, and to further open (or avoid new restrictions) on the other. A wider palette of evidence would help governments and other stakeholders to make more informed policy choices in response to these pressures and to better navigate the political economy challenges that arise in the Internet arena due to the often diffuse benefits and concentrated costs. It would also help evaluate the impacts of Internet openness – are we getting the benefits and prosperity we hope for? The analysis here aims to start filling the evidence gap.

There is no easy off-the-shelf solution to measuring Internet openness and thus no simple way to link it concretely to economic indicators of interest. As described in Chapter 1, Internet openness has many dimensions and each one could be a valuable target of future measurement work. For this project, we chose to focus efforts on better understanding and measuring global data flows on the Internet. This choice was based on several factors:

- First, data flows are the everyday consequence of our use of the Internet. As noted earlier, from a practical standpoint, Internet openness corresponds to our ability to use the Internet to do more things online. The manifestation of this online activity is data flows, be they configured as emails, social network posts, research datasets, videos or any other of the myriad ways in which we can use the Internet.

- Second, data flows are a highly policy-relevant variable. As digitalisation progresses and countries attempt to harness the benefits, understanding data flows is essential – data and data analytics are the core asset of today's technology firms and increasingly a key asset for "traditional" firms. Data flows are also the force behind cloud computing, whose services have put sophisticated computing power within the reach of even tiny firms.

- Third, as pointed out by the first OECD Principle for Internet Policy Making – "promote and protect the global free flow of information" – the Internet economy, as well as individuals' ability to learn, share information and knowledge, express themselves, assemble and form associations, depends crucially on the global free flow of information (OECD 2014a: 21).

For these reasons, seeking quantification of global data flows seems highly worthwhile.[10]

The OECD has begun to work with global companies in an attempt to build a dataset depicting global data flows on the Internet. Data obtained to date lack the geographic precision or representativeness required to be a reliable proxy for global data flows but they provide a fascinating glimpse into Internet usage patterns. Information on Google searches and YouTube viewing reveal there is an almost universal trend of users increasingly accessing content outside their own country, which could be interpreted as signalling a geographically (and maybe intellectually) wider variety of knowledge and information flowing across borders. Data provided by PayPal on financial flows over its payment system show that the Internet is enabling significant cross-border financial transfers on a daily basis, not just between developed countries but also with emerging economies. Other data show the importance of Internet infrastructure in shaping data flow patterns and the extent of global interdependence. Annex D provides more detail on these aspects, concluding with possible next steps to provide policy makers with better measures of global data flows and Internet openness (see Box 2 below for a summary).

Box 2. Measuring global data flows: possible next steps

One possible approach to measuring global data flows is to construct a global data flow dataset that more accurately tracks geographical start and end points as well as important waypoints en route. Ideally the dataset would include information on the types of flows. This approach would essentially seek to build a data flow dataset that could more easily be married with economic datasets, which are typically organised by country. Possible additional data and information sources to assist with this include:

- actual traffic data, both aggregate and in certain sub-categories;
- further flow data from firms;
- information on the location of .com sites;
- information on the location of key data centre sites and their through-put; and
- information on barriers to data flows, to be used in constructing proxies for modelling purposes.

This could be complemented by voluntary national statistical collections of traffic data. Establishing a consistent cross-country methodology for collection of ISP data could enable analysis using domestic network traffic as a proxy for Internet openness, with coverage eventually expanding to cross-border data flows.

Another approach is to identify hot-spots of data flow intensity (and, where possible, identify hot-spots of data-flow value) and overlay these with data showing the intensity and value of various economic performance variables (related to trade, innovation, entrepreneurship, productivity, etc.). In some ways, this approach would cast data flows as global data chains – taking inspiration from global value chains in the trade space – with intensity (and value) varying across different parts of the chain. Possible additional data and information sources to assist with this include:

- Density of data infrastructure: density and composition of players at IXPs; density of interconnection agreements at IXPs; bandwidth at IXPs; IPv6 deployment by region;
- Analysis of value added of certain Internet-related activities, similar to Trade in Value Added (TiVA) analysis.

As an immediate contribution, in this part of the report we focus a quantitative lens on three policy interests where Internet openness can have important effects – international trade, innovation and entrepreneurship, and macroeconomic performance. For trade, where evidence is the most developed, a

three-pronged approach is taken: first, summarising insights from selected literature on empirical links between the Internet and trade; second, narrowing the focus to literature on Internet openness and trade; and third, looking for new insights and proposing ideas for a future research agenda. This three-pronged approach proved helpful as a way of gradually focusing the field of vision towards reasonable estimates of the benefits of Internet openness but was also unavoidable from a practical perspective, due to the still scarce nature of studies specifically on Internet openness. For innovation and macroeconomic performance, existing evidence predominantly relates to impacts of the Internet. Finally, we also look qualitatively at the effects of Internet openness, on social wellbeing. In each case, we focus on the benefits of Internet openness, acknowledging that this is a partial picture but one that begins filling an important void in policy makers' knowledge base.

There are four crucial points to keep in mind while reading part 2 of the report:

- The Internet as experienced by many people today is not friction-free, nor should we expect it to be. As set out in the OECD's *Recommendation on Principles for Internet Policy Making* (OECD, 2014a), it is important to maintain and enhance the open nature of the Internet, but this does not mean a lack of protection for privacy, security, children online, intellectual property, and so on.

- Whether a certain policy or private sector action is regarded as a friction or a facilitator of Internet openness can be a matter of degree but also a matter of societal preferences. We seek to shed light on the economic and social benefits of openness so that policy makers can better assess their options. We do not make policy recommendations.

- Focusing on the economic and social benefits of Internet openness is not intended to downplay the challenges for countries' industrial structures and labour markets as the Internet disrupts (sometimes long-standing) patterns of economic activity. The issue of jobs and skills in a digital world is another key focus of the 2016 Ministerial (see OECD, 2016a and 2016b).

- The analysis is exploratory and further work, including collaboration with firms, is essential. The evidence and illustrative cases shown here provide both a base and a path for future analyses. The 2016 OECD Ministerial is an opportune moment for leading policy makers to set a course for further quantitative work in this area.

2.2 Benefits of Internet openness for trade

There appears to be a consensus that the Internet has a positive influence on trade, with many commentators suggesting there are potential costs to trade arising from policies that introduce frictions to "business as usual" data flows on the Internet. This is not to say that there are no challenges – indeed, some issues can be amplified in the online environment. On balance, the Internet is seen to be a positive force for trade, putting the onus on governments, firms and civil society to achieve their objectives in ways that do not turn off the trade tap.

Here we attempt to put some numbers around the arguments for benefits, including new insights from data on the US-EU and US-Switzerland Safe Harbor Frameworks (see Box 3 later for details of the Frameworks) and from Paypal data. The decision by the Court of Justice of the European Union on 6 October 2015[11] and subsequent developments makes the Safe Harbor data especially pertinent to the current study.

2.2.1 The Internet and trade

Studies show the Internet is playing an important role in domestic and international trade of goods and services. For example, up to 34% (or USD 627.8 billion) of total US export value in 2011 was from

"digitally-deliverable services", namely business, professional and technical services, royalties and license fees, insurance services, financial, services and telecommunications (Nicholson and Noonan, 2014). These services were regarded as having the potential to be delivered digitally and holding strong opportunities for digital technology to transform relationships between buyers and sellers.[12] Using the same categorisation of digitally-deliverable services, Meltzer (2014: 16) looked at trade between the United States and the European Union and found that more than half of the services provided by each partner and used as intermediate inputs to the other's total exports of final goods were digitally-deliverable.[13] At a more disaggregated level, eBay studies of technology-enabled small businesses have found that over 95% of eBay commercial sellers engage in exporting, reaching on average between 24 to 39 international markets (eBay, 2013). These figures are significantly higher than for traditional exporters – for instance, traditional South African firms typically reach fewer than five international markets while their eBay counterparts reach on average 30 markets.

Several studies have taken the next step to empirically establish a positive relationship between the Internet and trade. For example, the USITC estimated the trade costs of US imports and exports in digitally-intensive sectors[14] were 26% lower than they would be absent the Internet (USITC 2014, Chapter 3). Modelling the impact on digital trade of these lower international trade costs suggested increases in US real GDP of 0.0 to 0.3%, real wages of 0.9% and aggregate employment of 0.0 to 0.5 million FTEs. The USITC's model simulations further suggested that removing foreign barriers to digital trade in digitally-intensive industries would boost US GDP by 0.1 to 0.3%, as well as raising real wages and employment (USITC 2014, Chapter 4). Studies using gravity models have similarly suggested the Internet stimulates trade. For example, Freund and Weinhold (2004) found a 10 percentage point increase in the growth of web hosts in a country led to a 0.2 percentage point increase in goods export growth, by cutting the fixed costs of market entry.[15]

While not specifically targeted at describing the Internet's impact, evidence from the OECD's work on trade facilitation clearly shows the positive effect of the Internet on trade. This work estimated the impact of addressing specific hurdles in the trade and border procedures in 107 countries at various stages of development (Moïsé and Sorescu, 2013). It found that measures to harmonise and simplify documents, and to use automated processes could reduce trade costs for low income countries by 3% and 2.3% respectively. Such measures are increasingly about using the Internet to simplify and speed processes, using electronic data exchange and web-based documents. This points to the powerful effect of the Internet in economic development, and is underscored by a survey of young entrepreneurs that showed the importance of digital technologies for international expansion was significantly greater for entrepreneurs in economies at a lower level of development (Accenture & G20 YEA, 2014).

2.2.2 Internet openness and trade

Most of the evidence on Internet openness and trade has highlighted the negative effects of fragmentation arising from policy decisions. In a study on the potential external trade impact of the European Union's proposed General Data Privacy Regulation, ECIPE (2013) suggested that significant losses would be borne by EU and US firms. Noting that the UNCTAD estimates around half of all services trade is enabled by the ICT sector, including cross-border data flows, ECIPE concluded that around USD 600 billion (or EUR 465 billion) of EU services trade could depend on the openness of the digital economy (representing nearly six times the total EU exports of cars). Model estimates suggested that revoking the Safe Harbor Framework (see Box 3) enabling data flows between the European Union and the United States could reduce US services exports to the European Union by 0.2-0.5%. ECIPE speculated that SMEs would be most affected by the policy change, as they would be least able to establish subsidiaries in the European Union or to negotiate model contracts with business partners. For EU firms, the estimates suggested a drop in services exports of 0.6-1.0%, due to a loss of competitiveness.

Box 3. Safe Harbor Framework

In 1998, the European Commission's Directive on Data Protection took effect, prohibiting the transfer of personal data to non-EU countries that did not meet the EU "adequacy" standard for privacy protection. Personal data is defined by the Directive as "any information relating to an identified or identifiable natural person ('data subject')" where an identifiable person is "one who can be identified, directly or indirectly, in particular by reference to an identification number or to one or more factors specific to his physical, physiological mental, economic, cultural or social identity" (EU, 1995).

The approach to privacy protection differs in the European Union and the United States, and the United States was not considered by the European Union to meet the standard required by the Directive. To provide a means for US firms (including counterparts of European businesses or US subsidiaries of European firms) to comply with the Directive and thus enable transfers of personal data from the European Union, the US Department of Commerce collaborated with the EU to develop a voluntary "Safe Harbor" framework, which came into effect in 2000. A similar framework was established in 2009 for US-Swiss data transfers.

Firms wishing to benefit from the Safe Harbor framework were required to self-certify on an annual basis, agreeing to comply with seven Privacy Principles regarding: notice; choice; onward transfer; access; security; data integrity; and enforcement. Having done so, firms were deemed to provide "adequate" privacy protection and all EU member states were bound by this finding of adequacy. This meant that Member State requirements for prior approval of data transfers were either waived or automatically approved, with any subsequent claims brought by EU citizens heard in the United States.

The framework applied only to US firms under the jurisdiction of the Federal Trade Commission or US air carriers and ticket agents subject to US Department of Transport jurisdiction. Firms such as financial institutions, telecommunications carriers, and non-profit organisations are generally not under the jurisdiction of either the FTC or DOT and thus were not able to use the Safe Harbor framework.

After reviewing the functioning of the Safe Harbor framework, the EC issued a set of 13 recommendations in late 2013 (EC, 2013). These related to transparency, redress, enforcement, and access by US authorities. The EC called on US authorities to identify remedies by mid-2014.

However, the EC and US were still working on updating the Safe Harbor framework when, on 6 October 2015, the Court of Justice of the EU issued a decision in a case involving Facebook (stemming from an individual's complaint to the Irish Data Protection Authority) declaring the EC's adequacy finding for the Safe Harbor framework invalid. The Court found that a mass surveillance program in the United States invalidated the EC's approval of the Safe Harbor mechanism. The Court reasoned that Safe Harbor did not adequately protect EU citizens' fundamental rights because it did nothing to guarantee that US authorities (including law enforcement) would access EU data in a manner that is strictly necessary and proportionate, and because EU citizens had no means to seek redress from US authorities.

The Court also held that each of the European Union's national data protection authorities has the independent power to investigate complaints, even in the face of a finding by the EC that a third country or arrangement like Safe Harbour is "adequate" to enable transfers of personal data from the European Union to the third country. That aspect of the ruling undermined the certainty of EU-wide validity of Commission adequacy decisions, opening up the possibility of diverging approaches by different data protection authorities in the European Union.

Subsequent discussions between EU and US officials resulted in the announcement on 2 February 2016 that a new transatlantic data transfer agreement had been reached. The EU-US Privacy Shield is not yet legally binding but aims to provide an accountable regime for data transfers.

Source : See www.export.gov/safeharbor/; EU (1995); Case C-362/14, *Maximillian Schrems v Data Protection Commissioner*, Court of Justice of the European Union, available at: http://curia.europa.eu/juris/document/document.jsf?text=&docid=169195&pageIndex=0&doclang=EN&mode=req&dir=&occ=first&part=1&cid=125031 ; Bracy (2016).

Policies and actions affecting Internet openness are perceived differently by firms in different sectors and of different sizes. The USITC found that localisation requirements, data privacy and protection

requirements, and IPR infringement were most often perceived by large firms as a substantial or very substantial obstacle, while for SMEs the biggest barriers came from customs compliance, IPR infringement and uncertain legal liability (USITC 2014, Chapter 4). As an example of sector specificities, large content firms and SMEs in digital communications most frequently identified IPR infringement as an obstacle, while large digital communications firms and SMEs in finance pointed to localisation requirements. In the financial sector, executives at global financial institutions noted that data location regulations restrict how firms handle and transmit customer data across borders, including over their private networks (Kaplan and Rowshankish, 2015). This not only creates additional organisational complexity, but lowers efficiency – one case study showed the data on-shoring expenses incurred by a bank's foreign subsidiary came to around 3% of income over a seven-year period.

As the Internet continues to permeate all parts of economies, the costs of reductions in Internet openness may rise. The Swedish National Board of Trade (2015) suggested that the impacts of data restrictions would grow over time as the digitisation of production processes becomes increasingly sophisticated. Data is already flowing over GVCs, but as businesses make more use of cloud solutions, the Internet of Things, big data, and 3D printing, the amount of data that needs to move to ensure optimal production and GVC set-up will grow. The Board's focus on the production part of the value chain highlights that data transfer is not just the domain of large tech companies, but also "normal" smaller firms. The Board concluded that "regulations that hinder data from moving cross-border will become more disruptive" (ibid.: 5). Interviewees for the study said data localisation barriers were the most intrusive form of data protection regulation.

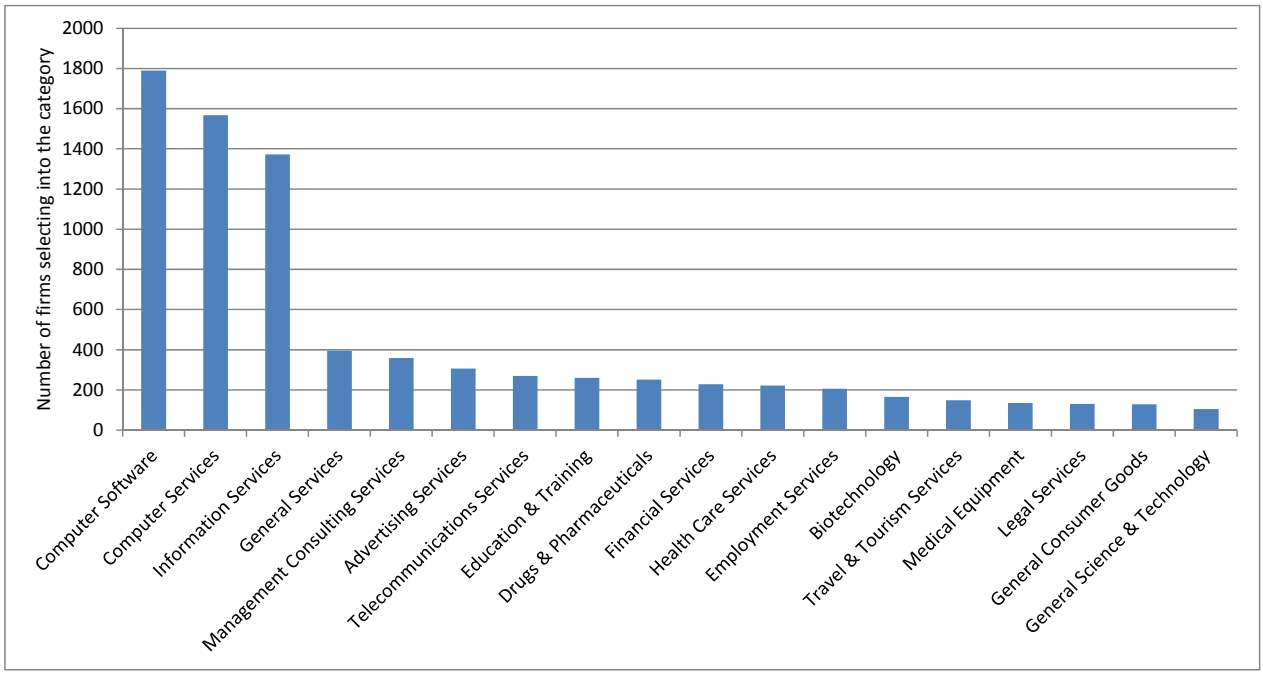
New insights

As an input to this study, the US International Trade Administration (ITA) provided the OECD with data on the firms involved in the EU-US and Switzerland-US Safe Harbor Frameworks. With the recent decision by the Court of Justice of the European Commission to strike down these Frameworks, these data take on added interest in demonstrating the extent of trans-Atlantic data flows.

The data provided by the US ITA reinforce that Internet openness matters for a wide (indeed, unpredictable) range of businesses. From 2000 (when the first Framework, applying to trans-Atlantic transfers of personal data from the European Union, came into effect) until June 2015, 5 234 companies were certified, though not all remained current throughout the period. A glance at the variety of industries from which the firms were drawn suggests that personal data transfers across borders are ubiquitous. Figure 5 shows the industries from which more than 100 firms had joined Safe Harbor since 2000. In the certification process, firms could self-select up to four industry categories to describe themselves, thus the data likely include some double-counting (e.g. this seems likely for the biggest categories "computer software", "computer services" and "information services"). Nevertheless, Figure 5 shows that firms involved in industries such as education, health, financial and legal services all had a need for cross-border data transfers – it is not only technology firms. In fact, 103 different industry categories had firms certify to Safe Harbor, including some surprising categories such as "lawn and garden equipment" and "jewellery".

Figure 5. Key industries involved in EU-US Safe Harbor Framework

Current and non-current firms



Note: Only industries for which more than 100 firms self-identified into the industry category. Firms could self-select into up to four industry categories, therefore the data likely include some double-counting.

Source: Data provided by US Department of Commerce, International Trade Administration, 2 June 2015.

Safe Harbor attracted a mix of small and large firms, both in terms of employees and sales.[16] Just over half the firms currently or previously registered with Safe Harbor had fewer than 100 employees, with around a quarter having over 500 employees. This highlights the importance of cross-border data flows to SMEs. Just under 60% of firms reported sales of up to USD 25 million, while 34% reported sales of over USD 50 million, reinforcing the point that a variety of businesses made use of the Framework for trans-Atlantic data flows. With fewer resources than large firms to dedicate to other compliance routes (such as bilateral agreements), SMEs may have found Safe Harbor particularly valuable.

Firms involved in the Framework had a positive opinion of its worth. A voluntary survey taken by Safe Harbor firms in the period 1 June 2014-1 June 2015, administered by the United States Department of Commerce, provided some insights into the benefits as seen from the private sector perspective. The results cannot be regarded as statistically robust, but of those that answered, over 75% indicated that the Framework helped them boost US exports and jobs, and over 70% believed Safe Harbor was 'important' or 'critically important' for business opportunities in Europe. The partner country identified the most frequently by firms in the Framework was the United Kingdom, followed by Germany, France and the Netherlands. In a commentary, the Future of Privacy Forum suggested that in some instances, this reflects the headquarters location of large European firms whose US subsidiaries have certified to the Framework (e.g. Bayer (Germany), Alcatel-Lucent (France) and AstraZeneca [United Kingdom]) (FPF, 2014).

Unfortunately, the Safe Harbor data provided by the United States ITA do not allow a calculation of the volume of sales and number of employees immediately affected by the Court of Justice decision to invalidate the Framework. However, recent work by the OECD using its Services Trade Restrictiveness Index (STRI) provides insight into the potential effects of this policy move which, in practice, increases

restrictions on data flows. The OECD's STRI framework, which covers 40 countries and 18 service sectors, focuses on restrictions to foreign entry, movement of people, competition, regulatory transparency and other discriminatory measures. Results from STRI analysis offer a complement to the study by ECIPE mentioned above, which posited a fall in services exports of up to 1% if Safe Harbor ceased to operate.

A striking finding of the STRI analysis is that countries with more restrictive service sectors import and export fewer services, with the effect on exports twice that on imports (Nordås and Rouzet, 2015). The impact on imports is a logical result of closing the market, while the effect on exports is posited to be due to a loss of competitiveness amongst local service firms that are constrained to use more expensive service inputs in their own businesses. In aggregate for the 12 sectors in the analysis, the results implied that an increase in the STRI of 1 basis point (a more restrictive regime) would reduce exports by 0.6% and imports by 0.3%.

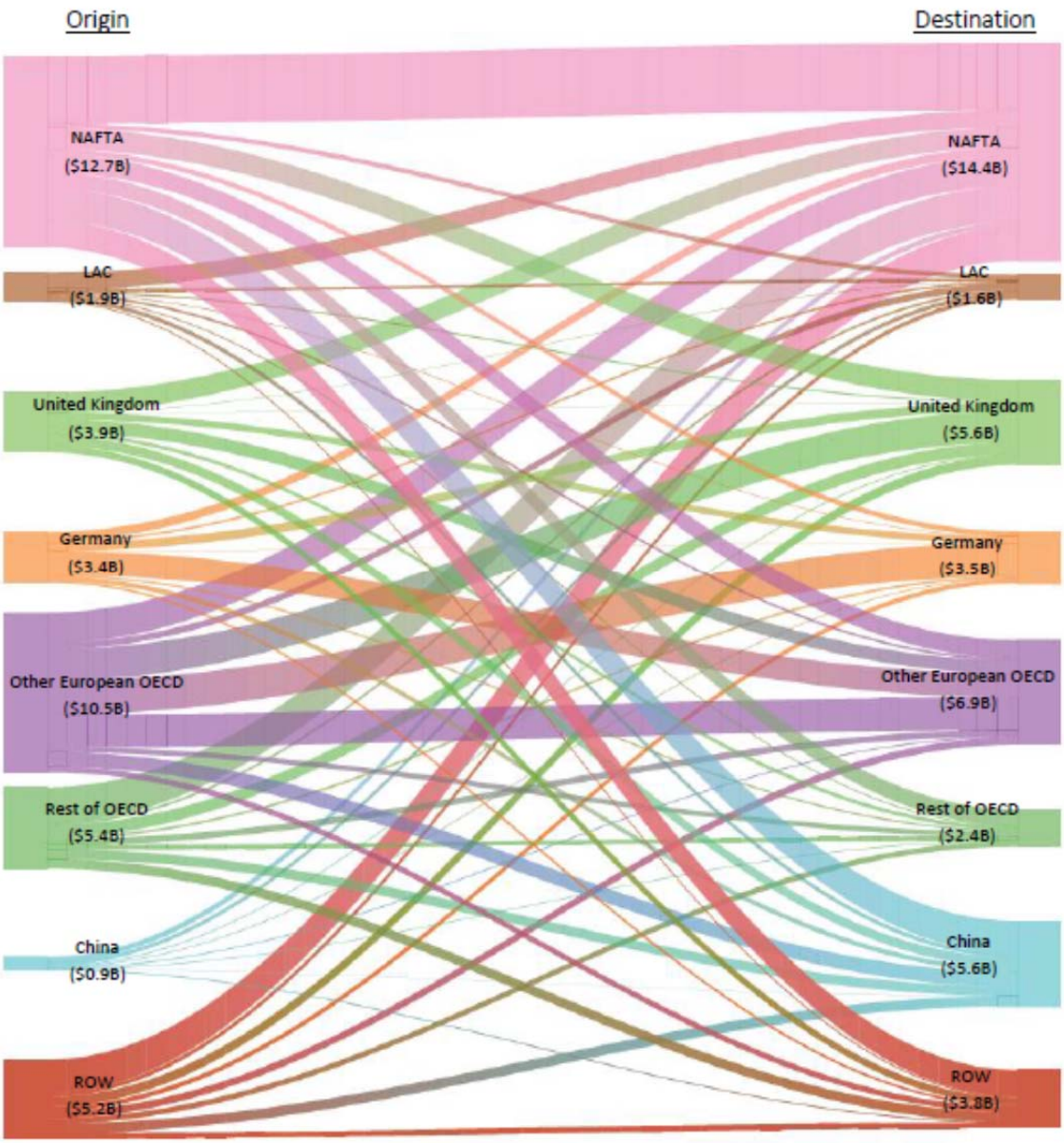
Given the strong apparent representation of ICT-related firms in Safe Harbor, it is interesting to look at the sector-level results that emerged from the STRI study. For the 'computer and related services' sector, the study implied that a 5 basis point increase in restrictions (equivalent to imposing a few restrictive regulations) would decrease computer services exports by 6.5% and imports by 2%.[17] A similar increase in restrictions in the telecommunication services sector would generate a decrease in exports of 1.4% and a statistically insignificant increase in imports.[18] Exports in the computer services sector, followed by the banking sector, were the most sensitive to restrictions of all the 12 sectors in the study.

Another notable finding is that increased restrictions in the computer and telecommunications service sectors may negatively affect goods exports. Nordås and Rouzet (2015) explored how services trade restrictions related to exports of certain manufactured goods, and found that increased restrictions in these two ICT-related sectors were related to a drop in exports of motor vehicles, capital goods and some consumer goods. While the authors were cautious not to infer causality, they noted the results were in line with expectations and commented that it was unsurprising that restrictions to telecommunications would have a negative effect, given the shift of many business functions to the Internet.

Restrictions on data flows may not only affect goods and services trade but also disrupt the financial flows that take place in support of that trade. Cross-border financial transfer data for 2013 from PayPal clearly show the global dimensions of Internet-based financial flows. Grouping countries into regional groups, Figure 6 shows that while the largest flows typically involve NAFTA countries (Canada, Mexico and the United States), significant flows also took place between Germany, the United Kingdom and other European OECD countries. For the regional groupings, in each case, the extra-region flows exceed intra-region flows, highlighting the global nature of the flows. As the data comprise a mix of B2B, B2C and remittance (C2C) flows, they are likely strongly related to trade activity and are one (probably tiny) partial indicator of the magnitude of possible disruption that could occur in a scenario where Internet data flows are dampened. Cross-border financial flows on PayPal in 2013 represented USD 43.8 billion – an average of USD 120 million per day. (Further discussion of the PayPal data can be found in Annex D.)

Figure 6. Paypal cross-border financial flows - a snapshot of 2013

USD billions



Note: The figure shows cross-border financial flows that took place during 2013. Origin is the location of the PayPal account holder sending funds, while Destination is the location of the PayPal account holder receiving the funds. NAFTA comprises Canada, Mexico and the United States. LAC comprises Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, the Plurinational State of Bolivia (hereinafter, "Bolivia"), Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay and the Bolivarian Republic of Venezuela (hereinafter, "Venezuela"). Other European OECD comprises Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden and Switzerland. Rest of OECD comprises Australia, Israel, Japan, New Zealand, Korea and Turkey. ROW comprises 151 other countries and territories in which flows occurred. See Annex D for further detail.

Source: OECD calculations, based on data provided by PayPal.

Ideas for a research agenda

The importance of data flows for business activity and international trade underscores the need to develop an operational measure of global data flows to proxy Internet openness. Possible research avenues for achieving this are discussed in Annex D – in essence, the goal is to better track start- and end-points of data flows as well as important way-points and/or to build greater insights into data hot-spots. The location of data – both stocks and flows – matters because of the increased value that is now derived from data. In a world of GVCs and data-driven innovation, it is essential that we improve our understanding of where data is flowing, in order to shed light on where value is being created and who is capturing that value. The co-operation of the private sector will be invaluable in any such exercise, both to provide data and to provide a "reality check" on our interpretation of patterns and trends.

It would also be useful to develop "policy variables", i.e. indicators of changes in the policy environment that can be linked to Internet openness and to trade. For instance, one stream of work at the OECD is investigating the impact of data localisation on trade, through the use of a computable general equilibrium model. Early stages of this work have focused on identifying current regulation that requires local data storage, or which sets conditions on cross-border data flows. Compiling indicators such as this by country and with a measure of stringency, provides essential information for any quantitative study. Connected to this, improving the metrics around privacy and digital security risk, e.g. collecting robust data on the extent of collection and use of personal data, as well as security incidents and their consequences, could provide a useful backdrop, given that such concerns are an important driver of data regulations.

Other avenues for further research that extend the work presented here could include: developing the analysis of firms that used Safe Harbor to attempt to identify more clearly their size, business activity and duration of their certification; identifying firms or industries that did not make use of Safe Harbor, with a view to understanding why; and assessing the employment impact of estimated changes in exports and imports resulting from increases in the STRI related to the computer and related services sector.

Ultimately, progress on the Internet openness and trade research agenda would not only help illuminate the benefits and costs of different policy settings on openness, but also provide valuable information for those policy makers dealing with specific trade policy issues. Are trade agreements keeping pace with the changing face of trade in the online world? Are new entrants to the trade environment – notably small, even micro, firms – facing any unexpected barriers related to customs, shipping and logistics, or cross-border dispute resolution? These questions and more could be enlightened by better quantitative evidence on the links between Internet openness and trade.

2.3 Benefits of Internet openness for innovation and entrepreneurship

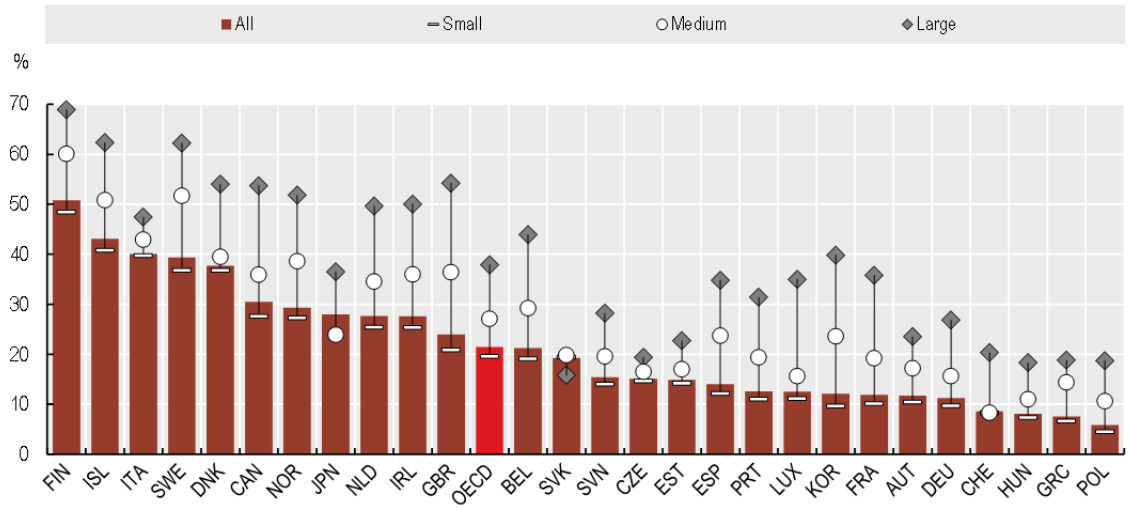
At an observational level, evidence of the innovative and entrepreneurial impact of Internet openness is all around us today. Much of our computing and smartphone environments rely heavily on open source technologies. The Unix operating system, originally developed at AT&T Bell Labs in the 1970s and distributed as open source by the University of California at Berkeley after it rewrote its own version of the code, was vital to the development of Android as well as Apple's iOS and Macintosh operating systems. The implementation of the TCP/IP protocol suite by the Computer Systems Research Group at the University of California at Berkeley in the 1980s was made available as open source, and its availability was one of the reasons behind the rapid adoption of TCP/IP as the common computer networking protocol in the 1990s. Subsequent "open" implementations of popular applications, such as BIND for the DNS and Apache for Web servers, added further momentum to the open source approach.

At a quantitative level, there exists an array of indicators and relationships that together strongly support the role of the Internet in enabling innovation and entrepreneurship. Some shed light on the knowledge flows that support innovation, others on the platforms on which entrepreneurs and existing

firms can construct new businesses and commercialise their ideas. Some indicators show how the Internet is supplying new avenues for businesses to obtain inputs (thereby lowering the hurdles for market entry and freeing up resources for innovative activity). There are also numerous indicators on ICT sector innovation, whose technology both feeds and leverages off the Internet. To give one example, Figure 7 shows that a significant share of firms is now using cloud computing services. Such services allow firms to reduce their capital expenditure, take a more flexible and scalable approach in meeting their IT requirements, and represent a significant Internet-based input that firms can leverage in their business activities. Finland, Iceland and Italy lead in terms of the share of total enterprises using cloud computing services, while Canada, the Nordics and the United Kingdom have high levels of use amongst large firms. Further examples of indicators on the Internet and innovation and entrepreneurship are discussed in Annex E.

Figure 7. Enterprises using cloud computing services, by size, 2014

As a percentage of enterprises in each employment size class



Note: Cloud computing refers to ICT services used over the Internet as a set of computing resources to access software, computing power, storage capacity and so on. Data refer to manufacturing and non-financial market services enterprises with ten or more persons employed, unless otherwise stated. Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249) and large (250 and more). See chart notes for additional country notes.

Source: OECD, ICT Database; Eurostat, Information Society Statistics Database, July 2015. In OECD (2015b) http://dx.doi.org/10.1787/888933274459.

However, quantitative evidence that specifically highlights the role of Internet openness in stimulating innovation and entrepreneurship is scarce. One rare example comes from Dalberg, which found a positive correlation between Internet openness and innovation outputs by plotting countries' scores from the Freedom House Freedom on the Net index and the Global Innovation Index (Dalberg, 2014: 44). While caution needs to be applied in interpreting simple correlations, Dalberg's study highlighted the importance of knowledge dissemination, collaboration, and cross-pollination of ideas, and noted how the Internet plays a role in adoption of innovation as well as creation of new opportunities. For its part, the Economist (2010b) noted that because the Internet is an open platform, rather than one built for a specific purpose, anybody can build a device or develop an application that connects to the Internet as long as they follow a few technical conventions. They commented, "In a more closed and controlled environment, an Amazon, a Facebook or a Google would probably never have blossomed as it did" (The Economist, 2010b).

Alongside building a measure of Internet openness, as described in the discussion above on trade, are there steps we can take to help shed light on the relationship between Internet openness, innovation and entrepreneurship? The discussion here and in Annex E has been structured around the way in which the

Internet affects knowledge flows, provides a platform and resources, and forms part of the wider ICT innovation environment. Another entry point may be to identify specific drivers of innovation and entrepreneurship and consider the paths by which Internet openness affects those drivers, with a view to augmenting the suite of potential links to test. The OECD's updated Innovation Strategy (OECD 2015e: 29) concludes that innovation thrives in an environment that is characterised by the following features:

- A skilled workforce that has the knowledge and skills to generate new ideas and technologies, bring them to the market and adapt to technological change across society. Mobility is considered to play an important role in meeting skill needs. Diversity is a common theme – whether in terms of the wide range of skills that are relevant to innovation, the role of multidisciplinarity in undertaking innovative activities, the various training environments for skills acquisition, or the importance of international mobility for circulating knowledge and diverse views.

- A sound business environment that encourages investment in technology and knowledge-based capital, enables innovative firms to experiment with new ideas, technology and business models, and helps firms achieve scale.

- A strong and efficient system for knowledge creation and diffusion, which pursues fundamental knowledge and diffuses it through mechanisms such as human resources, technology transfer and knowledge markets. International co-ordination is crucial since knowledge creation and innovation are global endeavours.

- Policies that encourage firms to engage in innovation and entrepreneurial activity.

Any analysis must be backed up with ongoing efforts to improve our measurement tools. The digital economy is making traditional measures of innovation inputs and outputs less comprehensive – where once R&D, patents and licenses gave a reasonable indication of the resources devoted to innovation and its outputs, ICTs and the Internet have made it essential to capture things like knowledge-based capital inputs (such as software and data) and innovation in the form of new business models and digital content. We can, and are, working to improve indicators (see for example OECD 2014c, 2015b and 2015c) and this work should continue.

2.4 Macro economic benefits of Internet openness

In part 1, we posited that Internet openness not only has a positive effect on productivity and growth through its trade- and innovation-boosting effects, but that it also holds significant potential to push out the global productivity frontier and help repair the knowledge diffusion machine that enables all firms and countries to capitalise on new innovations developed at the frontier. Qualitatively these arguments are compelling, but we do not yet have a direct quantitative link that provides a "smoking gun". Nevertheless, there are some indicators and data that help us begin building the evidence base. To start, there appears to be a positive (and likely causal) relationship between ICTs and productivity and the Internet and productivity (see Annex F). There are also a handful of studies that are suggestive of a positive relationship between Internet openness and productivity and other macroeconomic variables.

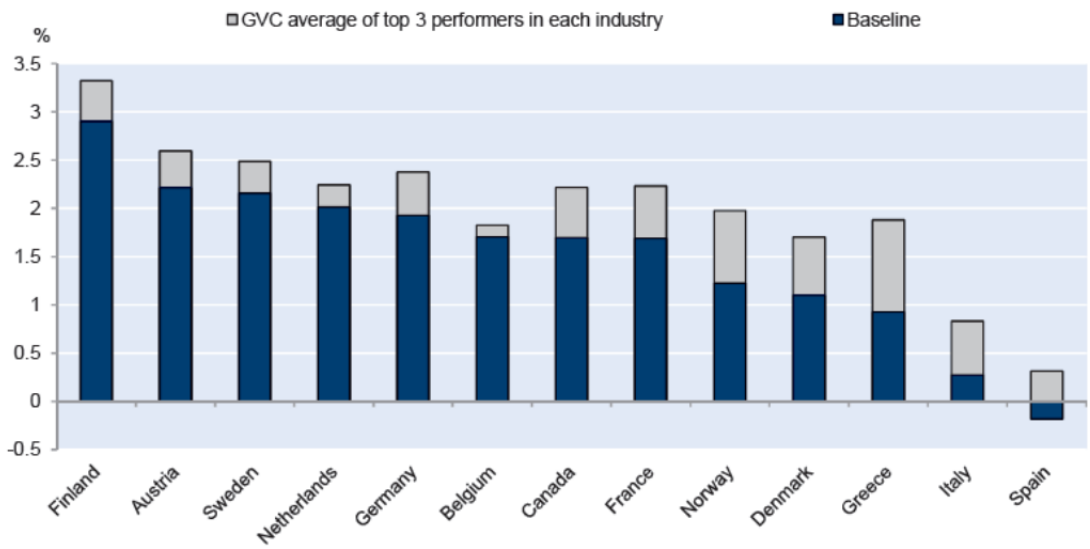
With direct relevance to Internet openness, a study by van der Marel et al. (2015) finds that administrative regulatory barriers of the type that are used to regulate data flows dampen total factor productivity (TFP) and increase prices in sectors that use data-processing services most intensively. The study looked at the prevailing (or considered) regulatory barriers to data services in the European Union, Brazil, The People's Republic of China (hereafter, "China"), India, Indonesia, Korea, Russia and Viet Nam. Assessing the type of barrier used, they then took two different subsets of the OECD's Product Market Regulation (PMR) Index plus the PMR Index in its entirety, to construct three indices. These were then combined with an assessment of the data intensity of user industries to construct composite indices – Data Regulation Linkages (DRLs). The estimations found that a one standard deviation change in DRL (focusing on administrative regulations)

decreases TFP on average by 3.9%. While the study is subject to a number of caveats, it is an important first step, and the authors suggest constructing a robust data regulation index would be a logical next step.

Turning to growth, Etro (2010) suggested that the economic impact of cloud computing could be substantial, with changes in firms' cost structures potentially contributing to a boost in growth and jobs through the effect on firm creation. In particular, Etro estimated the creation of around one million jobs and several hundred thousand new SMEs in the European Union. He recommended governments should support rapid adoption of cloud computing, with a key concrete intervention being agreement on unrestricted flow of data across borders. Meanwhile, in 2011 the OECD estimated that Egypt's five-day Internet shutdown imposed direct economic costs of USD 90 million (USD 18 million a day), without considering the indirect costs to sectors affected by the shutdown (e.g. e-commerce, call centres, tourism) (OECD, 2011).

Recent OECD work on the future of productivity provides indirect evidence of the possible impact of Internet openness on productivity. The work estimated the gains to MFP growth that could result from increasing GVC participation for a number of OECD countries. In all cases this was positive, and for Spain, could make the difference between slowing MFP and growing MFP (Figure 8). To the extent that Internet openness can boost firms' participation in GVCs, this could have a significant positive impact on national productivity performance. Participation in GVCs also helps boost an economy's ability to learn from the global productivity frontier – Figure 9 shows that assuming a 2% acceleration in MFP growth at the frontier, the estimated gain to annual MFP growth would be 0.06 percentage points higher in the country with the highest levels of GVC participation compared to the country with the weakest GVC participation. In other words, more connected countries are learning from the frontier more effectively and enjoying a resultant boost in their own productivity growth. Figure 9 shows that the benefits of trade with leading firms have an even stronger potential effect on learning – a potential boost of 0.33 percentage points to annual MFP growth for the country with the highest level of trade with the frontier. If Internet openness indeed supports trade and GVC participation, as evidence strongly suggests, then this has the potential for real gains at the macroeconomic level.

Figure 8. Estimated gains to MFP growth associated with raising GVC participation

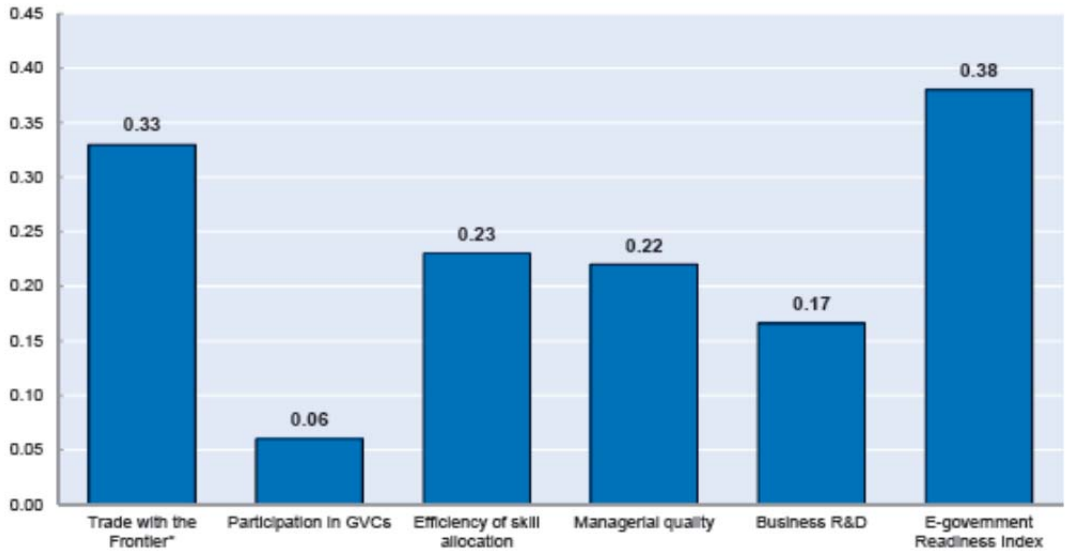


Notes: The figure shows the predicted average MFP growth (baseline based on actual GVC participation) and a counterfactual average MFP growth based on raising GVC participation in each country to the average GVC participation for the top three performers in each industry for any given year for the manufacturing sector. Industry level productivity is aggregated using country-specific industry value added shares. The estimates are calculated from a regression that controls for country*year and industry fixed effects and is based on a sample of 15 countries for the period 1990-2007.

Source: OECD 2015f: 57.

Figure 9. Learning from the global frontier is shaped by key structural factors

Percentage difference in frontier spillover effect between maximum and minimum value of each structural variable, assuming 2% MFP growth at the frontier



Notes: Trade with the global frontier measures the intensity of trade with the productivity leader in each manufacturing industry (Minimum: Austria, Maximum: Canada). GVC Participation (Minimum: Canada, Maximum: Belgium) is defined as the sum of the share of imported inputs in a country's exports (backward) and of its exports used as inputs in other countries' exports (forward). Efficiency of skill allocation (Minimum: Italy, Maximum: Belgium) is based on the percentage of workers who are over- or under-skilled and managerial quality (Minimum: Italy, Maximum: Finland) is proxied by the average literacy proficiency scores of managers. Business R&D is defined as the ratio of business R&D expenditures to value added (Minimum: Australia, Maximum: Sweden). The E-government readiness index (Minimum: Greece, Maximum: the Netherlands) measures the capacity of governments to deliver e-government services for citizens and businesses.

Source: OECD 2015f: 56.

As with the discussions on trade and innovation and entrepreneurship, the logical next steps for further work on the effect of Internet openness on macroeconomic indicators such as productivity cluster around constructing indicators of Internet openness as well as policy variables. There is clear interest by countries in improving their productivity performance, spurring growth and creating jobs, and work on Internet openness and its effects could dovetail well with wider interest in the impacts of digitalisation.

2.5 Social benefits of Internet openness

This section of the paper concerns the non-pecuniary benefits of Internet openness to society. There are many types of benefits in this category that could be explored. Here is a short list of examples:

- greater civic participation
- more government transparency
- improved access to education
- upgraded capacity to conduct research
- greater reach and power of personal expression, which can now be fluid across borders

- the possibility for communities of unprecedented size to interact across borders via social media
- enabling a wave of non-profit activities and services that create social value, such as Wikis
- improved collective intelligence and knowledge through crowd collaboration, feedback, and product reviews
- better use of open data, making possible new applications that provide public service functions, such as weather and traffic apps, demographic information and climate change statistics.

The challenge is not in finding social benefits to measure; it is in measuring them at all. Quantifying these benefits is more difficult than quantifying economic statistics because things like civic participation and transparency cannot be counted with standard units like a euro or a dollar. For the same reason, it is far easier to calculate the tangible financial losses that Wikipedia inflicted on traditional encyclopaedia companies, for example, than it is to measure the intangible social benefits that Wikipedia has given to its users (The Economist, 2013a). Nearly half a billion people visit Wikipedia every month (Wikipedia, 2016) for information about everything from travel destinations, to medicines, to research for school projects, but one would be hard pressed to quantify how valuable that free information is.

Making matters more difficult, people do not necessarily have consistent perspectives on what counts as a social benefit. For example, Internet openness has been helping asylum seekers to make the treacherous journey from the Middle East to Europe (this is discussed in more detail in Annex G). Although the right to asylum appears in the Universal Declaration of Human Rights (1948, Art. 14), in practice people have varying views about whether welcoming asylum seekers is socially beneficial. In contrast, one is on far safer ground when assuming that everyone prefers a higher income to a lower one, other things being equal. Furthermore, even if everyone could agree that helping refugees to find safe homes in Europe is a good thing, the problem of quantifying *how good* it is would remain.

Therefore, we have not attempted to quantify openness' social benefits in this paper. Nevertheless, by discussing a few examples here and outlining more in Annex G, the paper begins to build a case that social benefits from Internet openness exist and are meaningful. These examples are evidence even though they are not necessarily reducible to numbers. This could be a fruitful area for more work in the future.

Note that some of the benefits discussed here and in Annex G involve the Internet of Things. That is the subject of Ministerial Session 2.2. The background paper supporting that session is entitled "The Internet of Things: Seizing the Benefits and Addressing the Challenges" (OECD, 2016e).

2.5.1 Improved medical research and healthcare

Internet openness brings several types of health-related benefits, including – potentially – better medical research. For example, the United States Centers for Disease Control are using social network analysis to better understand and stem the spread of communicable diseases (Center for Data Innovation, 2013). However, the OECD recently concluded that the Internet's potential to advance medical research is still largely untapped. While acknowledging that the Internet "has not only transformed expectations about global knowledge transfer and data sharing but also the timescales on which they occur" and that "[r]apid access to shared resources has led to extraordinary growth and development in many fields from basic science to big business", the OECD found that "with the exception of the accomplishments in genetics, medical research has largely failed to capitalise on these opportunities. Instead, the field has followed traditional models of research where unique data are the primary commodity available to generate funding and subsequently publications" (OECD 2015d: 105-06).

Nevertheless, the potential for data collected via the Internet to advance medical research is undisputed. It derives from the ability to acquire and analyse biological, clinical/medical and population-based data to investigate the interaction of numerous factors for the purpose of validating existing concepts and identifying new approaches for addressing diseases. The data could be acquired from, among other sources, Internet-based sources such as retail/credit card transactions, mobile phone usage, and Internet-based cognitive game applications (OECD 2015d: 105; Anderson & Oderkirk 2015: 41).

Before the Internet's potential to enhance and hasten medical research through broad and deep data linkages can be fully realised, privacy and the general security of the data must be addressed. "When data are linked, the combined dataset provides more information about the data subjects than the original unlinked datasets. Thus, the resulting linked data could cause more harm to data subjects if lost, stolen or otherwise misused" (OECD 2015d: 110). Modern encryption techniques and transparent consent procedures have been used to address those challenges in nearly all studies on dementia, for example, and they are supported by modern ethics review boards (Anderson & Oderkirk 2015: 29).

Other benefits include reducing costs, increasing access to health information and health care (such as the "e-seniors" internet portal in France), and improving the quality of care (Deetjen, et al, 2015; OECD (2013c) and Castro, 2008).

2.5.2 Greater educational opportunities: MOOCs

Internet openness's impact on education can be seen in more developments than can be covered here. (For more information on this topic, see Correa, 2008.) One of the most significant is MOOCs: massive open online courses, designed for unlimited participation and open access via the Internet. E-learning can reduce the cost and increase the availability and quality of education in developing and developed countries alike. For example, Khan Academy is a non-profit MOOC. According to its website, its mission is to provide a free, world-class education for anyone, anywhere. That means that anyone who has an Internet connection can learn early childhood math all the way through differential equations, basic microeconomics to game theory, and many more subjects by logging onto khanacademy.org and watching Khan's lectures, which are offered in 60 languages and have been downloaded more than 500 million times.

However, it is possible for people to take advantage of MOOCs only where there is enough Internet openness. When countries block YouTube, for instance, they cut off access to Khan Academy and many other MOOCs. (Khan uploads its lectures to YouTube and must be viewed through that platform.) YouTube is currently blocked or has been blocked in several countries (Berners-Lee, 2014).

Traditional universities are also offering courses online, sometimes for free or at a greatly reduced price. (See e.g. www.edx.org.) Governments have gotten involved, as well. (See e.g. www.france-universite-numerique.fr/moocs.html.)

The enhanced educational opportunities brought by the Internet are an example of how social benefits can also enable economic benefits (see Box 4). Greater educational opportunities are not only a non-pecuniary social benefit, but they lead to better economic outcomes by contributing to innovation and productivity.

Box 4. Links between the social and economic benefits of openness: A historical example

It is important to recognise that the social benefits of openness can reverberate within a country and lead to economic benefits. In particular, some of the social benefits of openness, such as greater freedom of expression, promote more than human rights; they promote innovation, as well. That is because innovation depends greatly on knowledge sharing and collaboration, so restrictions on freedom of expression online can inhibit sharing and collaboration.

Box 5. Links between the social and economic benefits of openness: A historical example (cont.)

That principle has long applied in the offline world, as well. Holland became a 17th century economic and intellectual powerhouse in part by granting more personal freedoms to its inhabitants than other European nations did at the time. Because of those freedoms, Dutch intellectuals had greater liberty to discuss and develop their ideas than did their counterparts in other European countries, where the Church had imposed very substantial restrictions on their ability to express and exchange ideas.

In fact, the Dutch Republic's openness to new ideas gave it another competitive advantage: It attracted many talented individuals from other countries, including intellectual giants like the political scientist John Locke, the philosopher Baruch Spinoza, and the mathematician/philosopher René Descartes. During an era when Galileo Galilei was imprisoned in Rome for publishing a book explaining that the Earth orbited the sun, Holland's more open and tolerant view of human rights made it a hotbed of innovation and creativity. It wound up producing many innovations that profoundly changed modern civilisation, and Holland prospered as a result. The microscope, telescope, sawmill, pendulum clock, stock exchange, and first publicly traded multinational corporation (the Dutch East India Company) were all invented in Holland during that period, along with many more scientific and commercial products and ideas. Incidentally, 17th century Holland also produced some of the world's most famous painters, including Rembrandt and Vermeer.

The period became known as the Dutch Golden Age because of Holland's emergence as a world leader in trade, science, military might, and art. There is a powerful lesson in this historical example for all countries in all eras. If anything, it applies more strongly in the Internet context because that is where so much of today's knowledge and information sharing takes place — or can take place if it is permitted and encouraged.

Source: Sagan (1980).

2.5.3 A platform for greater self-expression

Internet openness also gives people a more powerful platform for expressing and propagating their creativity. A surprising example of this comes from China, where certain aspects of openness are helping large numbers of people to express themselves, and even more people to read what they have to say. The Chinese site Qidian.com is the world's leading self-publishing platform, with 1 million registered writers and 100 million paying members. On Qidian alone, 880 000 books had been written or were in the process of being written as of 2013 (Hui, 2013). Qidian and its impact are enabled by technical and economic Internet openness.

To be sure, there are also substantial economic benefits to self-publishing e-books, at least for the most popular Chinese writers. In 2012, the top 20 online authors in China earned incomes from their e-books ranging from USD 320 000 to USD 4.2 million (Bai, 2013). In late 2013, the Chinese company Tencent Holdings announced that it was investing USD 65 million to purchase the rights to best-selling e-books in China (Lee, 2013). However, given the very low amount paid per page view, the vast majority of authors on Qidian do not make much money for their efforts. Unless they achieve very large followings, authors would have to write hundreds of thousands of words per month in order to survive only on their income from Qidian (Hui, 2013). Yet online literature is flourishing in China.

Clearly, pecuniary gain is not what is motivating most of Qidian's authors. Instead, part of the appeal is that budding authors have more freedom online than they do in the physical print medium. "Restrictions on traditional publishing surely take some of the credit — compared to the difficulty and cost of publishing a print book in China, which also needs to go through rounds of editing supervised by the government, the Internet provides a much larger and freer space" (Hui, 2013). Another factor could be Qidian's ability to help writers to share their ideas and creativity with readers whom they would never have been able to reach without the Internet because the possibility to publish in traditional media like books and newspapers is simply unavailable to most authors (which incidentally is true both in and outside of China). So even if their e-novels are not read so widely as to make them rich, online writers are still able to reach a wider audience than they otherwise would, and Qidian is a win for self-expression in China. "Internet writing has been nothing short of a revolution for Chinese literature. It has allowed myriad voices to be heard" (The Economist, 2013b).

NOTES

1 Supporting information for these points is set out in Annex E and Figure 7.

2 See, e.g., US Federal Communications Commission (2015), in which the term "open Internet" takes on essentially the same meaning as "net neutrality".

3 To alleviate the depletion of IPv4 addresses, a new standard called IPv6, which can accommodate vastly more addresses, has been introduced. Adoption of IPv6 has been relatively slow, though. This issue is discussed further in Annex C, section C.1.

4 The term micro-multinational is not well-defined and should not be automatically equated with small multinational enterprises (MNE). Micro-multinationals may simply be small exporters, whereas the term MNE typically comprises "companies or other entities established in more than one country and so linked that they may co-ordinate their operations in various ways" (OECD 2008: 12). In Mettler and Williams, micro-multinationals are discussed in terms of start-ups, typically small service-driven companies.

5 The Internet of Things is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data. The Internet of Things allows objects to be controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems.

6 A commitment to democracy is expressed in a number of important OECD documents. It is, for example, one of the requirements for accession to the Organisation: "The OECD Membership is committed to fundamental values, which candidate countries are expected to share. . . . Accepting these values . . . is a requirement for membership. . . . These fundamental values include a commitment to pluralist democracy based on the rule of law and the respect of human rights" (OECD, 2013: 2). Furthermore, the OECD's Mission Statement says "The common thread of our work is a shared commitment to market economies backed by democratic institutions and focused on the wellbeing of all citizens" (see www.oecd.org/about/.) Several other OECD documents describe the OECD as an institution that "brings together 34 governments of countries committed to democracy" (see, e.g., the "About Us" page for the June 2011 Internet Economy programme: www.oecd.org/document/61/0,3746,en_21571361_47081080_47122493_1_1_1_1,00.html).

7 Forthcoming as C(2016)13.

8 "No permanent favourites" means that there is healthy competition, both in the marketplace and in the marketplace of ideas. In a competitive market, good products, services, and ideas can be overtaken by better products, services, and ideas, paving the way for innovation and evolution. In that environment, success depends not on legally-granted, protected status but on continued quality, relevance, and usefulness. Yahoo, for example, was displaced by Google as the leading search engine in the United States, just as MySpace was displaced by Facebook.

9 Please note that this paragraph does not encompass voluntary localisation choices, such as setting up mirror sites for the purpose of improving the user experience. Some content data networks (e.g. Akamai, which operates hundreds of data centres) will store a copy of their clients' web pages whenever those pages are visited, caching them in one of their data centres if it is nearer to the requester's physical location than the location where the original content is stored. That way, the next time someone requests that web page, their request can be fulfilled with one of the cached copies or by the original page, depending on which one is nearer to the requester. Mirroring speeds up page delivery.

10 Several arguments are sometimes put forward to question the choice of data flows as a valid measurement goal. The first is that data flows between countries are the result of numerous factors (consumption

preferences, languages, cultural factors, etc.) and that measuring them may give little direction to policy makers. The second is the status of China, which has achieved unquestionable economic success at the same time as having a relatively more closed Internet ecosystem. The third is the view that consumers care more about service and content than data flows, i.e. if consumers receive better service then they will not mind restricted data flows. The fourth is that information on global data flows alone says little about the value of that data, i.e. it cannot describe the respect of fundamental rights. On the first argument, we would contend that most global flows – trade, investment, people – are driven by multiple factors but that there is still significant information value to be derived from their measurement. On the second argument, we would contend that China's scale has up to now allowed it to benefit from the Internet even with restricted external linkages. But the counterfactual will never be known, and fewer restrictions may have boosted domestic innovation and trade beyond what has already been achieved. And we do not know the dynamic effects of having a relatively more closed Internet. On the third argument, we would contend that while it is true that consumers care about content, applications and their content tend to be transient while data flows remain as the raw material of Internet activity. The fourth argument is certainly true and it is one of the reasons why future work should aim to uncover more about the types of data flows and their value.

11 See http://static.ow.ly/docs/schrems_3OHQ.pdf for the full opinion of the court.

12 Since there are no data that indicate whether these services were actually delivered digitally, the authors describe the figure of 34% as an upper-bound estimate. Nevertheless, as the analysis was based on input-output data, the figure represents the value of these services throughout the supply chain, not just in final exports, and thus captures the important role of digitally-deliverable services in the production of intermediate inputs.

13 In 2009 the United States incorporated USD 41 billion of imported services into its total goods exports, of which USD 15 billion was from the European Union and, in turn, USD 8.9 billion (or 59%) of which was digitally-deliverable – this equated to almost 1% of the total value of US goods exports. Looking at the opposite flow, total EU goods exports in 2009 incorporated USD 27 billion of imported US services, of which USD 14 billion (52%) was digitally-deliverable – this similarly equated to just under 1% of the total value of EU goods exports. The shares were similar for services exports – around 0.5% of total US exports of services were digitally-deliverable services inputs from the European Union, while 1.1% of total EU services exports were digitally-deliverable services inputs from the United States.

14 The study identified seven digitally-intensive industries, each encompassing a number of specific sectors. The industries were content, digital communications, finance and insurance, manufacturing, retail trade, other services, and wholesale trade (USITC, 2014: 31).

15 Freund and Weinhold's measure for the growth of web hosts is based on counts of country code domain names. They note that there is not necessarily a strong correlation between a host's domain name and its actual location, but argue that the content of a country-coded website is likely aimed at that country and is thus a reasonable proxy of that countries Internet usage and thus Internet development in that country.

16 When certifying or recertifying, firms did not necessarily fill in all required fields on the certification form, so the sample sizes of the data provided by the US ITA differed slightly according to the variable in question. Caution should be applied in interpreting the results.

17 This sector includes consultancy services related to hardware installation, software implementation services, data processing services, database services and "other". A description of the STRI in this sector can be found in Nordås *et al.* (2014a).

18 This sector includes voice telephone services, packet and circuit switched transmission, telegraph, telex, fax, email, voice mail, electronic data exchange, and online information / data processing. A description of the STRI in this sector can be found in Nordås *et al.* (2014b).

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ANNEX A: RECOMMENDATION OF THE OECD COUNCIL ON PRINCIPLES FOR INTERNET POLICY MAKING

December 2011

THE COUNCIL,

HAVING REGARD to article 5 b) of the Convention on the Organisation for Economic Co-operation and Development of 14th December 1960;

HAVING REGARD to Rule 18 b) of the Rules of Procedure;

HAVING REGARD to the Declaration for the Future of the Internet Economy (The "Seoul Declaration") of 18 June 2008 [C(2008)99], which recognises that the Internet provides an open, decentralised platform for communication, collaboration, innovation, creativity, productivity improvement and economic growth;

HAVING REGARD to the Recommendation of the Council concerning Guidelines Governing the Protection of Privacy and Transborder Flows of Personal Data [C(80)58/FINAL], the Recommendation of the Council concerning Guidelines for the Security of Information Systems and Networks – Towards a Culture of Security [C(2002)131/FINAL], the Recommendation of the Council on Broadband Development [C(2003)259/FINAL], the Recommendation of the Council on the Protection of Critical Information Infrastructures [C(2008)35];

RECOGNISING that, at the OECD's High Level Meeting on The Internet Economy: Generating Innovation and Growth held in June 2011, representatives of OECD Members, Egypt, the Business Industry Advisory Committee to the OECD (BIAC) and the Internet Technical Advisory Committee (ITAC), agreed to the Communiqué on Principles for Internet Policy-Making (the "Communiqué");

RECOGNISING that this Communiqué, building on the Seoul Declaration, highlighted that the strength and dynamism of the Internet depend on its ease of access through high speed networks, on openness, and on user confidence; that the Internet allows people to give voice to their democratic aspirations and that any policy-making associated with it must promote openness and be grounded in respect for human rights and the rule of law;

On the proposal of the Committee for Information, Computer and Communication Policy:

I. RECOMMENDS that, in developing or revising their policies for the Internet Economy, Members, in co-operation with all stakeholders, take account of the following high level principles as explained in the Communiqué:

1. Promote and protect the global free flow of information;
2. Promote the open, distributed and interconnected nature of the Internet;
3. Promote investment and competition in high speed networks and services;

4. Promote and enable the cross-border delivery of services;
5. Encourage multi-stakeholder co-operation in policy development processes;
6. Foster voluntarily developed codes of conduct;
7. Develop capacities to bring publicly available, reliable data into the policy-making process;
8. Ensure transparency, fair process, and accountability;
9. Strengthen consistency and effectiveness in privacy protection at a global level;
10. Maximise individual empowerment;
11. Promote creativity and innovation;
12. Limit Internet intermediary liability;
13. Encourage co-operation to promote Internet security;
14. Give appropriate priority to enforcement efforts.

II. RECALLS that the Communiqué on Principles for Internet Policy Making, which is attached for information purposes, provides context and support to Members and stakeholders in their effort to implement effective and compatible approaches for Internet policy making, both at the national and international levels;

III. INVITES

Members to:

- Disseminate this Recommendation throughout their government and to all partner stakeholders, including business, civil society, the Internet technical community and other international forums, and;
- Consult, co-ordinate and co-operate at national and international levels, through multi-stakeholder processes, towards the effective implementation of the Recommendation;

Non-Members to take account of and adhere to this Recommendation and collaborate with Members in its implementation;

IV. INSTRUCTS the Committee for Information, Computer and Communications Policy to:

- Promote the dissemination of this Recommendation;
- Assist Members and non-Members in its implementation through a multi-stakeholder process.

ANNEX B: ELEMENTS OF INTERNET OPENNESS

B.1 Technical openness

A core feature of technical openness is the **end-to-end principle** (Saltzer *et al.*, 1981; Blumenthal, 2001). The intended role of an open switched network that follows the end-to-end principle is limited to carrying individual data packets from source to destination. It does not alter or interfere with the packets; it just transports them, and it does so without favouring one stream of packets over another. All user access and all functions and services that populate the network are provided by devices that sit outside of the network itself. These devices communicate among themselves in a manner that is largely opaque to the network. In other words, the network should not replicate functions that can be performed by communicating end systems.

Like most elements of openness, the end-to-end principle is not an all-or-nothing, absolute requirement, though. Rather, it is a principle that in practice, may be followed to a greater or lesser degree in a network. The more it is followed, the more openness the network has. Stakeholders may thus prefer, or aspire to, an ideal of a fully end-to-end network, but just because a network might not be 100% end-to-end in practice does not mean there is no openness in the network. Thus, the end-to-end principle is not to be confused with a set of network engineering constraints. Various services may operate in ways that are not precisely aligned to it. However, the extent to which particular network components can successfully operate while not adhering exactly to these broad precepts is bounded by the ability of other network components that operate according to these principles to successfully interoperate with them.

In an open switched network, the end-to-end principle requires the **use of consistent technical standards**. That means all active, packet switching elements in the network use a uniform interpretation of the contents of each packet, supporting precisely the same protocol specification (in the case of the Internet, this is the Internet Protocol [IP]). Consistency also means that all connected systems inside the network are able to communicate by using the same transport protocols. The Internet has commonly adopted two end-to-end transport protocols, the Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP). While many other transport protocols have been defined, common convention in the Internet has settled on TCP and UDP as the two “universal” end-to-end transport protocols. The more consistently that connected systems around the world communicate by using these protocols, the more Internet openness increases.

Consistent technical standards contribute to another feature of technical openness, **interoperability**. Each layer of the Internet provides services to the layer immediately below it. Interoperability means the ability to use any layer of the Internet is not restricted in arbitrary technical ways. (It does not mean that such use is necessarily free of charge, though.) Furthermore, interoperability implies that there are no inherent or arbitrary technical restrictions interfering with anyone’s ability to provide goods and services at any layer, whether it is transmission capacity, switching, domain names, or applications. Interoperability leads to greater freedom of choice: the freer consumers are to choose the devices, applications and services they use, and the freer providers are to choose the types of devices, applications and services they offer, the more open the network is deemed to be.[1]

The end-to-end principle also demands **a consistent address space**. That means every destination on the Internet is reachable from any other location on the Internet, which requires all destinations to have their own IP address that everyone else can reach. IP addresses must therefore be allocated and administered such that each address is uniquely associated not only with a single network, but with a single device within that network. The network itself cannot resolve clashes where two or more devices are using

the same address, so the responsibility for ensuring that all addresses are used in a manner that is unique is left to the bodies who administer address allocation and registration[2, 3].

The next requirement of the end-to-end principle is a **uniform convention for domain names**. The DNS is the combination of a common convention for creating names and a consistent mechanism for translating domain names that are easy for humans to use into a format that is usable by computers ("DNS name resolution"). In other words, the DNS allows people to use familiar strings of letters, such as www.oecd.org, when referring to service points connected to the Internet, instead of numeric IP addresses and transport protocol port numbers, such as 194.66.82.11. For the DNS to work properly, certain rules have to be followed when creating the names and each name has to be tied to a single IP address.

Whenever someone types a domain name into a browser, there is a DNS query. The DNS directs the query to servers that try to identify the correct IP address for the desired destination. Regardless of where and how a DNS query is generated, the response should reflect the current state of the authentic information published in the DNS. The implication here is that the DNS uses the name space derived from a single and unique root zone, with all name resolvers answering name queries using information within that uniquely rooted name space. If that does not occur, then when a user types www.oecd.org, for example, into a browser, he or she might be directed to the wrong web page or get no direction at all, which would severely undermine the Internet's utility.

The more closely and consistently the end-to-end principle is followed, the greater the likelihood that no matter where data originates and what path it takes as it travels across the Internet, it will arrive intact at the intended destination – and only that destination.

Finally, technical openness increases with the adoption of **open protocols**, at least for a number of core Internet functions. Open protocols are openly available, meaning they are not encumbered by restrictive claims of control or ownership. A number of open, commonly defined application-level protocols have already been adopted for core services. For example, applications that pass email messages are expected to use the SMTP protocol and browsers are expected to use the HTTP protocol. Other network-wide functions, including data transfer, instant messaging, and presence notification, among others, are also supported by open protocols.

The open nature of the technical foundation of the Internet is critical to the Internet's "identity". The Internet is what it is today largely because of its technical openness. Policy actions and inactions that restrict technical openness (such as by affecting the DNS, delaying the adoption of IPv6, or mandating or encouraging the use of proprietary or closed non-standard transport protocols) have the capability to weaken the Internet's security, flexibility, and stability.

B.2 Economic openness

The Internet's economic openness corresponds to the ability of people, businesses and organisations to get online and to use the Internet to increase their economic opportunities and capitalise on them. Increasing one's economic opportunities via the Internet depends, first and foremost, on having **economic access** to the Internet. Economic accessibility increases as the infrastructure necessary for connecting to the Internet improves in quality, becomes more widely available, and is priced more competitively. In other words, the better markets for Internet service, computers, smartphones and other connecting devices function, the more open and inclusive the digital economy will be. Economic access requires investment in electricity and broadband infrastructure as well as sound competition policy (OECD, 2014a: 7, 19-20) applied all along the digital value chain. In addition, economic access depends on users having the financial means to afford it (whether markets are performing competitively or not). Therefore, incomes and income distribution are relevant factors, as well.

The access aspect of economic openness goes beyond simply being able to connect to the Internet. It also refers to the degree to which entrepreneurs — from individuals to global companies — can capitalise on the economic opportunities enabled by the Internet. That, in turn, depends partially on the Internet-related obstacles that entrepreneurs face. The obstacles may include, for example, over-inclusive or anticompetitive regulations (e.g. unnecessarily broad censorship policies or skewed telecom regulations that were drafted so as to favour incumbents).

Moreover, certain conduct by private firms can have a restrictive effect on economic access (and thus on openness), too. For example, if a platform owner makes it unreasonably difficult for a third party to sell an app in the platform's app store, that will limit the third party's economic opportunities online. Conversely, the fewer unreasonable barriers there are to legally selling applications, products, content and services on the Internet, the more economic opportunities (and openness) there will be. Similarly, if a dominant search engine's algorithm (whether intentionally or not) systematically minimises the choices that users see and lacks enough transparency to enable regulators to understand how it functions, that can limit economic access. Both examples underscore the importance of sound regulatory and competition policies.

Economic openness also refers to reducing barriers to the consumption and supply of services over the Internet on a **cross-border** basis. The fewer unjustifiable barriers there are that prevent users from accessing, generating, and selling the lawful content, applications and services of their choice, regardless of the jurisdiction they are coming from or going to, the more economically open the Internet is considered to be (OECD, 2014a: 7). Opinions can differ regarding the justifiability of various barriers. For example, some countries view the preservation of national values to be a legitimate and justifiable reason to implement barriers to cross border data flows. Accordingly, they might prohibit various types of hate speech, with the result that the flow of information on the Internet is restricted. Other countries do not share that view and consequently do not enact laws against hate speech. Note that privacy and security enhancing measures are not deemed to be barriers to openness when they balance fundamental rights, freedoms and principles and comply with the OECD's Privacy Guidelines (2013) and Digital Security Risk Recommendation (2015).[4] Indeed, such measures (discussed further below) are considered to enhance openness.

Economic openness also depends on **regulatory transparency, certainty and capacity**. The clearer laws, rights and regulations concerning the Internet are, and the fairer the process for enforcing them is, the greater regulatory transparency and certainty are (OECD, 2014a: 10). Even when laws restrict openness, the easier they are to understand, the easier it is to comply with them. Regulatory transparency and certainty increase economic openness by reducing one of the risks of doing business as either a buyer or a seller in the digital economy: the risk of violating applicable laws or being unable to defend one's rights adequately. Thus transparency and certainty also reduce the level of risk tolerance needed for firms to enter and innovate in Internet-related markets. Finally, regulatory capacity also affects openness because a regulator can do its job well only if it has the necessary resources.

B.3 Social openness

The Internet's social openness corresponds to the ability of individuals to use the Internet to broaden their non-pecuniary opportunities, such as meeting new people and exchanging knowledge and ideas with them, keeping in touch more easily with family and friends, expressing themselves to a potentially wider audience than they would otherwise be able to reach, becoming more informed about topics that are meaningful to them, gaining a better understanding of what their elected representatives in government are doing, and becoming more active in their communities.

The protection, promotion, and enjoyment of all **human rights** is closely connected to the Internet's social openness. Consecutive resolutions of the United Nations Human Rights Council affirm that all human rights apply online just as they do offline. Human rights include, for example, **freedom of opinion and expression, freedom to associate, privacy,** and **education** (UDHR, 1948, Arts. 12, 19, 20, 23, 26; UNHRC, 2012). To see how human rights can bear on social openness, consider **freedom from discrimination** (UDHR, 1948, Art. 2), which is particularly relevant in the context of access. If individuals are being denied access to lawful content and services online on the basis of their race, colour, sex, language, religion, political or other opinion, national or social origin, etc., there is an obvious negative effect on social openness. Conversely, the more access that individuals have to lawful content and services online without interference based on those factors, the more socially open the Internet is. Interestingly, the relationship between human rights and Internet openness is mutually reinforcing. Not only does respect for human rights generally enhance openness, but openness facilitates human rights (OECD, 2014a: 20).

B.4 Other facets of openness

Certain elements of openness do not fit neatly within the categories of technical, economic or social openness. They may cut across some or all of the categories, or they may just have different natures altogether. One such cross-cutting element is the **empowerment** of individuals to understand, object to, and control how their personal data is used online, as well as to control the information they receive online (OECD, 2014a: 12). Empowerment corresponds with the degree to which Internet users are provided with useful, comprehensible information about the privacy ramifications of their online activities as well as the degree to which they can determine those ramifications. Are there laws, regulations or industry codes of conduct in place that require online services to inform users about what personal data is being retained and how it will be used? Are there procedures that permit users to raise objections? To what extent do users have control over how their data is used? Note that in this context, more openness for some stakeholders may imply less for others. For example, more openness for business in the form of greater freedom to use the personal data of its customers may imply less openness in the form of lower transparency, awareness, or control for individuals. Conversely, more openness for individuals in the form of greater empowerment over their personal data may imply less openness for businesses.

The level of empowerment also depends on how much control users have over the amount and type of information they receive via the Internet. Are their email accounts flooded with spam? Are they able to block mail from certain accounts? Can they protect their children from content they consider to be harmful? Empowerment is relevant because it fosters trust in the Internet.

The IPPs envision a co-operative effort on empowerment, in which governments, the private-sector, the Internet technical community and civil society "work together to provide the capacity for appropriate and effective individual control over the receipt of information and disclosure of personal data" (OECD, 2014a: 25). The inclusion of the word "appropriate" reflects that a measured, but not absolute, degree of control over one's personal data is desirable.

Thus, there can be too much or too little empowerment, with the ideal amount being somewhere in between the two. For example, great strides in medical research can be made with data that are collected via the Internet. If the data are suitably de-identified, the danger to personal privacy presented by their collection and use could be low while the benefits for human health could be high. If users were able to invoke a blanket refusal that prevented any of their personal data from being used in any manner, no matter how many measures were taken to strip out personally identifying tags in the data, though, the result could be considered a net loss for society.

Although Internet openness catalyses a host of economic and social benefits, it can also expose users to online intrusions, fraud, extortion, ransomware, intellectual property theft or infringement, denial-of-

service attacks, and a variety of other dangers. Those online activities threaten economic and social wellbeing by exposing personal and private data, harming financial and public infrastructure, threatening public safety, subverting human rights and depriving businesses of the fruits of their innovation and investment. What is needed to combat these threats and to preserve the Internet's ability to carry global data flows safely is **digital security**. Security is therefore another element of openness, and it cuts across all three dimensions: technical, economic and social.

Digital security has three main components (OECD, 2015a: 208-09):

- *Availability*: the accessibility and usability of data upon demand by an authorised entity
- *Integrity*: the protection of data quality in terms of accuracy and completeness
- *Confidentiality*: the prevention of data disclosure to unauthorised individuals, entities or processes

All else being equal, the more effective network and information systems' digital security measures are, the more users will trust and rely on those systems. Any notion that digital security must always be viewed as a closing element is incorrect. Digital security may require some degree of closure at a technical level, but the reason for establishing technical security measures is often to increase economic and social openness. Consequently, instead of viewing digital security as a closing factor, a better way to look at it is to recognise it as an element that contributes to openness, provided it balances fundamental rights, freedoms and principles and complies with the OECD's Digital Security Risk Recommendation (2015).

This is not to say that absolutely airtight digital security would always be optimal (even if it existed, which it does not). Some degree of intrusion could be justified on grounds such as law enforcement needs. In addition, stronger security comes at a financial cost, so individuals and businesses may opt for a lower level of security for some or all of their activities. Furthermore, any degree of Internet openness necessarily implies a certain amount of vulnerability. Internet security risks cannot be eradicated as long as the component networks remain interoperable and have any ability to communicate with one another. Therefore, achieving the lowest possible level of digital security risk would require cutting oneself off from the Internet altogether, which would have an obvious closing effect.

An additional cross-cutting facet of openness is **multilingualism**. If the Internet cannot accommodate a language, people who can communicate only in that language will not be able to enjoy the social and economic benefits that people who speak other languages have. Furthermore, the online contributions that could have been made by people who are linguistically blocked will be unavailable to everyone.

One of the most important characteristics of openness is **inclusive governance**. This means that decisions about shared principles, norms, rules, procedures, and programmes that shape the ways in which the Internet is used and evolves are made not just by one group, but by governments, the private sector, the technical community, and civil society working collaboratively and on equal footing in a multistakeholder, bottom-up and transparent process. Inclusive governance is important not only for legitimacy, but also for addressing challenges in an efficient and effective manner, especially in light of the high degree of interdependence among Internet stakeholders.

Finally, Internet openness also involves **distributed control and co-ordination**. The Internet is not centrally managed. It depends on the voluntary participation and collaboration of many people and organisations to oversee its independent components and make the Internet work. While the various participants need to follow the Internet's widely adopted interconnection protocols and standards, the distributed control arrangement allows them to organise and operate their particular parts of the Internet largely in the manner of their choosing.

ANNEX C: ADDITIONAL ACTIONS AND CONDITIONS THAT AFFECT OPENNESS

C.1 The slow transition from IPv4 to IPv6

For the Internet to function as intended, every device needs its own unique IP address. But the original IP address architecture, IPv4, can accommodate only about four billion addresses and that supply is now essentially exhausted. That problem led to the development of NATs and CGNs, which are innovative solutions that were described in section 2.1.2. While NATs and CGNs increase openness by making it possible to connect more users and devices to the Internet, they also decrease openness by reducing user accountability.

On the positive side, software engineers have developed an IP address architecture called IPv6 that can accommodate a number of addresses that is so large that few people have ever heard of anything like it: 340 undecillion, which is 340 with 36 zeros after it. That is 252 addresses for every star in the known universe. The full adoption of IPv6 will eliminate the need for NAT and ameliorate its impact on openness. Unfortunately, IPv6 comes with a significant drawback: it is not backwards-compatible with IPv4. Therefore, the rate of IPv6 adoption has been slow.

C.2 International law enforcement co-operation

Countries occasionally make agreements or arrangements to help one another to enforce their laws. For example, the London Action Plan on spam is an arrangement among more than two dozen governments and public agencies. Its purpose is to promote international spam enforcement co-operation and address spam-related problems, such as online fraud and deception, phishing, and dissemination of viruses. The Budapest Convention on Cybercrime is an international treaty ratified by nearly 50 nations that aims to address Internet and computer crime by harmonising national laws, improving investigative techniques, and increasing international co-operation. The Global Privacy Enforcement Network, an informal network of privacy authorities from nearly 50 jurisdictions, fosters cross-border co-operation.

Those agreements and arrangements concern laws that affect Internet openness. By facilitating the enforcement of the laws, the agreements and arrangements also affect openness. Whether the effect is opening or closing depends on the objectives and impacts of the laws and regulations concerned. Co-operating to reduce online fraud, computer viruses, and phishing, for example, should help to increase citizens' trust in the Internet and therefore can be expected to have an opening effect, which would potentially take place at the DNS and applications layers. On the other hand, co-operating to enhance mass surveillance of domestic and foreign citizens can interfere with the end-to-end principle and damage trust, so it may be expected to have the same closing effects as mass surveillance by individual governments.

Another kind of international law enforcement co-operation can be expected to have an opening effect at the infrastructure layer. When countries co-operate in enforcing their privacy laws even when the laws are not harmonised, the countries are less likely to impose data localisation requirements. The European Union's now-invalid Safe Harbor arrangement with the United States (discussed in Chapter 2) was an example. Although it was not primarily designed for promoting law enforcement co-operation, Safe Harbor did involve a commitment by the United States Federal Trade Commission to enforce the commitments made by participating US companies who agreed to implement privacy protections that the European Commission found to comply adequately with European privacy protection laws. With that understanding in place, Safe Harbor gave the European Union the confidence necessary to allow European citizens' data to be sent to and stored on servers in the United States. Accordingly, Internet companies doing business in Europe did not have to set up European data centres if they preferred to use data centres located in the United States (or any other country with which the European Union had a similar arrangement). Businesses could choose the EU-compliant location that was most efficient for them, which is a feature of openness.

C.3 The lack of international legal procedural interoperability among laws concerning the Internet

All countries have laws and legal procedures that concern the Internet. The variation in legal procedures combined with the fact that the Internet is borderless creates a problem: Governments and private parties are sending many requests (and demands, in some cases) to Internet businesses based in other countries, asking them to remove online content, seize domain names, or provide information about users. The problem being highlighted here is not about whether such demands and requests are based on sound and necessary laws or regulations. Instead, regardless of the merits of the laws, the problem is that these requests and demands, which vary in nature and require very different approaches in terms of evidence requirements and the speed of action required, come from many different jurisdictions, including those where the recipients have no offices, no employees, and no data storage facilities. Furthermore, the request or demand often comes in the form of an email message that simply claims to be from a company or a government agency in a certain country. It is not always clear that the sender is who it claims to be, that it has legal authority to make its demand, or how any conflict of laws between jurisdictions should be resolved. Documents may have to be translated and it is burdensome, to say the least, to have to keep track of changing laws in more than 190 countries. As a recent report by the Swedish National Board of Trade (2015: 3) noted, "Especially problematic for e-traders is the assessment of whether their national rules, or those of the consumers, will apply in a cross-border transaction. This may concern a wide variety of issues: the marketing of products, the handling of customer data or the formulation of the terms and conditions in sales contracts."[5]

Even if none of those things turn out to be problematic in a particular case, it can be expensive for companies to do the work necessary to reach that conclusion and to go through different processes every time they receive one of these requests or demands. For some smaller firms, assiduously handling every one of them would make it impossible to remain in business. Consequently, they may decide either to stonewall the requester by refusing to act unless a lawsuit is filed in the recipient's jurisdiction, or to just comply with the request without any resistance. Both outcomes tend toward decreasing openness: If a country finds that its laws are being systematically ignored by foreign companies, it will be more likely to resort to data localisation; alternatively, if recipients acquiesce every time they receive a request, knowledge sharing, innovation, and human rights may be damaged.

In the future, further work could centre on building evidence about whether Internet start-ups are being denied venture capital funding when the nature of their business (e.g. social media) makes it likely that they will receive a lot of these foreign demands/requests. In the course of preparing the present paper, we came across some sources indicating that VCs are denying funding for such businesses because the cost of complying with the demands/requests is so high that it destroys the start-ups' profitability. That means the problem of procedural uninteroperability may be having negative effects on innovation, employment, and GDP as well as on social wellbeing. The problem is less severe for large multinational Internet businesses, which have the resources necessary to process these requests, but it is more serious for start-ups and SMEs.

Box C.1. The Internet & Jurisdiction Project: Enabling multi-stakeholder co-operation to improve procedural interoperability

How to address the tension between the cross-border Internet and the patchwork of national jurisdictions is one of today's biggest digital policy challenges. Globally available content and services have created unprecedented social and economic benefits and enabled innovation at an international scale. However, preserving the Internet's global character and avoiding a fragmentation of global online spaces and services requires the development of innovative co-operation mechanisms that are as transnational as the network itself.

The Internet & Jurisdiction Project is a pioneering global multi-stakeholder process that engages over 100 key stakeholders from around the world, including governments, major Internet companies, technical operators, civil society groups, leading universities and international organisations (such as the OECD). It fosters a neutral dialogue process among the different actors to build trust and enable the development of operational solutions needed for a global Internet.

A first outcome of this innovative cooperation effort is a multi-stakeholder framework for transnational due process. The number of cross-border requests for domain seizures, content takedowns and user identification from public authorities in one jurisdiction to private entities legally incorporated in other jurisdictions is rising, while a common procedure to submit and handle them efficiently has not been developed. In the absence of legal harmonisation of national laws, the Internet & Jurisdiction framework will provide a "multi-stakeholder policy standard" for such requests. Legal interoperability will be achieved through procedural interfaces that guarantee due process across borders and provide mechanisms for small and large intermediaries that operate cross-border online spaces and services.

The IPPs endorse the development of voluntary codes of conduct through multi-stakeholder processes, such as the Internet & Jurisdiction Project (OECD, 2014a, p. 9).

Source: Paul Fehlinger, Manager, Internet & Jurisdiction Project.

C.4 Competitive markets

An example from Kenya illustrates both how competition increases economic openness and how that translates directly into benefits for businesses and consumers alike. When Kenya liberalised its telecommunications market, Telkom Kenya's monopoly over the Internet backbone ended and two new firms entered, injecting competition into the country's market for Internet access. As a result of that and other pro-competitive policies, bandwidth availability increased and service costs to operators declined. In fact, their rates dropped by some 90% and those savings were passed along to consumers, who also benefited from wider geographic access. The number of Internet users in Kenya more than doubled during the year after liberalisation. "Today, thanks largely to a liberal market approach complemented by proactive and effective policymaking, Kenya is a regional hub for tech and Internet start-ups and has attracted substantial investment from employers like IBM and Microsoft" (Dalberg 2014: 18).

Competition can have other types of positive effects on openness, as well. During the Egyptian revolution of 2011, protesters were organising, keeping each other informed, spreading their message, and publicising police violence through a variety of online applications. The government responded, among other ways, by cutting off Egypt's connections to the rest of the Internet. That would have been very difficult to do in most OECD countries, where competition (and the distributed control model of the Internet) has given rise to many links to the world beyond national borders. But in Egypt, where the Internet service provider (ISP) market was not especially competitive, those links were controlled by just a few large firms, which made the intentional disconnection more feasible (Berners-Lee, 2014).

Thailand's military government had planned, until recently, to reduce from ten to one the number of gateways from that country to the Internet precisely because it would have made it far easier for officials to

censor and conduct surveillance on Internet traffic in and out of Thailand (Bernard, 2015). The plan was discarded, though, over concerns about stifling competition and the attendant effects that would have on free speech, Internet speeds, and users including online businesses (Lefevre & Macfie, 2015).

Cowie (2014) estimated the risk of disconnection faced by each country, based on the number of its domestic autonomous systems that buy international data transit services directly from foreign providers. The more such domestic autonomous systems there are, the more conduits there are to the outside world and thus the harder it is to disconnect a country's population from the rest of the Internet. He found an especially high risk of disconnection in, e.g. Myanmar, the Democratic People's Republic of Korea (hereinafter, "DPRK"), the Syrian Arab Republic (hereinafter, "Syria"), Tunisia and Yemen; a moderate risk in, e.g. Belarus, Bolivia, The Islamic Republic of Iran (hereinafter, "Iran"), the Lao People's Democratic Republic (hereinafter, "Lao PDR"), Namibia, and Pakistan; and a low risk in, e.g. Algeria, Chile, India, Mexico, Korea, and Turkey. Most OECD countries are considered to be at an even lower risk of disconnection, i.e. "resistant to disconnection".

C.5 Traffic management and net neutrality

A key element in discussions of Internet openness, data traffic management and "net neutrality" has been the question of how to ensure and encourage innovation, competition and investment. For some this has come to be understood as a choice between where innovation should occur and where machine intelligence ought to be placed. For others it is an issue of ensuring safeguards in the absence of sufficient competition. That being said, the issues are complex and multifaceted. In the United States, for example, considerations included consumer protection, mitigating gatekeeper power, and ensuring that the virtuous cycle was protected.

A great deal of the value of the Internet has come from innovation from its edges. This occurs because it has what are called open endpoints. In contrast to systems of closed endpoints, such as the telephone network prior to liberalisation, an open system decentralises the prerogative for innovation. By doing so it opens this possibility to any creator, who may be anywhere, and changes the relationship between innovation and infrastructure. The dissociation of some of the revenues from some applications and services (the pricing for which is sometimes modest or supported by business models such as advertising) from the provisioning and upgrading of infrastructure (for which the costs can be substantial) is one of the elements at the heart of the net neutrality debate in some countries.

When people speak of the 'layered' architecture of the Internet, they refer in part to this dissociation of applications from data transport. For some the issues can be seen as ones where different networks exchange traffic and have different interpretations of the value they each bring to commercial negotiations. Some networks send more traffic than they receive and vice versa. This raises the question of what would happen if a carrier had an incentive to create shortages of capacity. What if it could offer a special deal for some sorts of traffic, to prioritise it or even block part of it, such as an advertising component, at the expense of others?

It helps to think of the issue of net neutrality as a question of traffic management procedures, which may or may not be allowable. Packets flow over the Internet freely, except where network congestion takes place. Packets that wait too long are dropped. High levels of packet loss degrade some services to the point of non-functionality. Hence net neutrality can be about how to respond appropriately to congestion and packet loss. Some actors may have concerns about how best to manage their networks in the face of rapidly increasing loads. Ultimately, expanding capacity is the best solution to the issue of increasing traffic though some parties may use a variety of non-technical practices to tilt the competitive playing field in their favour.

Box C.2. Traffic management regulations - a sample from OECD jurisdictions

Canada

In 2009, Canada was one of the first governments to deal with net-neutrality/traffic management measures through its agency, the CRTC. In brief:

- No hard and fast rules were adopted as to which types of traffic management procedures were acceptable;
- Investment in network capacity was held to be the primary means of escaping the need for Internet traffic management procedures (ITMPs);
- Application-specific ITMPs were held to degrade or prefer one application, class of application, or protocol over another and would therefore warrant investigation.
- In contrast, economic ITMPs would generally not be considered unjustly discriminatory, as they link rates for Internet service to end-user consumption.
- Technical and economic management measures must be disclosed to the affected public.
- In the case of an ITMP that results in any degree of discrimination or preference, the carrier would have the burden of proof of showing why they were minimally discriminatory, and minimally harmful to others, and why economic approaches alone could not solve the problem.
- ITMPs used only for network security, or used temporarily to address unpredictable traffic events (e.g. traffic surges due to global events and failures on part of an ISP's network), were excluded from the ruling.
- Special provisions were made to ensure that ITMPs imposed by the carrier on itself would not have greater and discriminatory effects on carriers who leased access from the larger carrier.

The Canadian regulatory commission's decision has been accepted by carriers and users alike.

United States

The United States Federal Communications Commission (FCC) issued its net neutrality decision in February 2015 and came to similar conclusions:

- Blocking or throttling of lawful content, applications, services or devices was prohibited.
- Paid prioritisation was prohibited;
- A general conduct rule was adopted prohibiting unreasonable interference with or disadvantaging the ability of edge providers and consumers to reach one another;
- Reasonable network management was allowed as an exception to the blocking, throttling, and general conduct rule.
- A 2010 transparency rule was enhanced, requiring accurate disclosures of network management practices, network performance, and commercial terms.
- Further, the FCC extended its oversight to Internet traffic exchange practices of broadband Internet access providers, ruling that terms of the traffic exchange must be just and reasonable.
- It excluded from its order services running over the broadband infrastructure that are not broadband Internet access services, such as Voice over Internet Protocol, cable TV, services provided to enterprises, and health monitoring.

Both the FCC and the CRTC established their rules on the premise that some networks had incentives to discriminate in the absence of these rules. Both were predicated on the notion that new applications would drive demand for bandwidth, which consumers would purchase from access providers, thus creating a virtuous circle of investment, innovation and customer demand.

Europe

The situation in Europe is somewhat different. On 25 November 2015, the European Parliament and the Council adopted open internet rules. The rules entered into force on 29 November 2015 and will apply as from 30 April 2016:

- End-users shall have the right to access and impart the content of their choice;
- Prohibition to block, slow down or discriminate traffic;
- Obligation to treat all internet traffic equally, without discrimination, restriction or interference;
- Reasonable day-to-day traffic management to optimise overall transmission quality is compatible with equal treatment of traffic if justified by technical requirements and independent of the origin or destination of the traffic and of any commercial considerations;
- No monitoring of the specific content of traffic;
- Possibility to provide services other than Internet Access Service, optimised for specific content, applications or services and subject to strong safeguards to avoid detriment for the internet access service (services other than Internet Access Service can be provided only if there is sufficient network capacity to provide them in addition to any internet access service; provision of these services must not be to the detriment of the availability or general quality of internet access services for end-users)
- Obligation for national regulatory authorities to monitor and enforce compliance with the open internet rules. BEREC, the body of European telecoms regulators, will have to issue guidelines for the implementation of the obligations of national regulatory authorities in order to contribute to the consistent application of this Regulation.

Critically, points of interconnection could also be made subject to discriminations. The current system of 'bill and keep' is highly efficient, private and unregulated. A national government or large ISP could choose to require payments at international gateways. These arrangements for interconnection are currently unregulated, are not transparent when they involve transit or paid-peering since they are commercially negotiated, and could be made to be unrelated to costs. If many countries did this, it could result in a series of walled gardens, rather than the Internet's current model for traffic exchange, which has flourished due to its encouragement for each network to minimise its costs. Each network has accomplished this by paying reasonable fees for transit or deciding it can more efficiently build its own facilities and bypass bottlenecks with peering.

Some of the choices made on this issue represent judgments that innovation is likely to occur more at the edge of networks than at their centre. Regulatory authorities appear to have come to an approach to net neutrality/traffic management that seeks to repress the incentives to monetise network congestion, in favour of innovation and ensuring their positions cannot be abused in terms of cross border traffic exchange.

Source: Timothy Denton.

"Zero-rated Internet" consumer offerings can also be considered under the heading of traffic management. Zero-rating occurs when a mobile network operator or ISP does not charge end users for data traffic used by certain applications or services on their network under an access plan that would otherwise limit or charge for data.

Internet.org is an example of a zero-rated service. Aimed at users in less-developed countries, it provides free access to a limited range of Internet content and services. Internet.org's effect on Internet openness is both positive and negative. On the one hand, it increases access by giving people who would otherwise not be able afford Internet access at all a way to connect. On the other hand, what they are connecting to is only part of the Internet and that part is determined by the commercial operator; the rest is sealed off unless the user upgrades to a paid access plan.

C.6 Fragmentation of technical standards versus technical interoperability

Some companies have incentives for using proprietary transit protocols when they send data across the Internet. Their motive, at least in some instances, is to try to use a disproportionate share of the available bandwidth for their own communications without experiencing packet loss (which occurs when packets of data travelling across the Internet do not reach their destination). See Box C.3. for more details.

Box C.3. Non-standard flow control algorithms

The end-to-end principle assumes that TCP is the predominant protocol used by hosts connected to the Internet. In particular, it assumes that the data flow control algorithm used by all TCP implementations behaves in very similar ways across the Internet. That algorithm relies on the aggregate outcome of the TCP flow control protocols to provide a fair-share allocation of common network resources so that an approximately equal proportion of those resources is devoted to each active flow. In other words, no flows are more important than any others.

Specifically, each TCP session will both impose pressure on and respond to pressure from other concurrent sessions in trying to reach a point where the network's bandwidth is shared equally across the concurrent active flows. Packet loss occurs when there is too much pressure, so a flow will gradually increase its sending rate until the onset of packet loss, at which point it will immediately halve its sending rate. It will then gradually probe with increased rates until the next packet loss event. TCP implementations that use a different flow control algorithm normally fare worse, as their efforts to put more pressure on other flows often result in packet loss in their own flow.

However, there has been a significant body of research into flow control algorithms and some have emerged that appear to be able to secure a greater relative share of network resources without the self-damage problem. These algorithms are capable of exerting "unfair" pressure on other concurrent TCP flows, consuming a disproportionate share of network resources. Examples include Akamai's FAST, Google's QUIC, and some Linux distributions using CUBIC.

Source: Geoff Huston.

Countries sometimes introduce proprietary protocols and standards, too – ones that are not interoperable with the Internet beyond their own borders. In some cases, their objective in doing this is to promote domestic firms. For instance, China has adopted or sought to develop its own standards across a range of ICTs even when consensus-driven international standards already existed. These actions appeared to stem from a desire to aid domestic producers by disadvantaging or blocking foreign competitors, reducing the royalties paid for foreign technologies, and creating a stream of royalties that foreign sellers must pay in order to sell compliant products. For the purpose of this report, the most relevant area in which this approach has been used is with respect to Internet protocols, though it has also been used in mobile telephony, wireless local area networks, audio/visual codecs, the Internet of Things, and more (Ezell & Atkinson, 2014: 2).

The results of such strategies can be different from what was intended, though. By using indigenous rather than global technology standards,

> China risks engendering a "Galapagos Island" effect, isolating its ICT technologies and markets from global norms . . . [It also] increases the risk that China's ICT enterprises won't gain access to non-Chinese markets, essentially dooming them to irrelevance. Thus, while indigenous standards may seem like a good idea in the short run by boosting domestic market share held by Chinese firms, they represent a fundamentally bad idea in the long run as they make it much harder for Chinese firms to achieve the global scale so critical for success in ICT industries (Ezell & Atkinson, 2014: 1).

Moreover, developing fragmented standards that are unique to a particular country ultimately harms that country's consumers and businesses – and everyone else's, too. That happens for several reasons. First, it raises the prices that domestic customers pay because having to comply with an idiosyncratic, nation-specific standard raises fixed costs for importers. In turn, those higher costs will reduce usage. Second, customers in other countries suffer as well because the fragmentation of standards breaks global markets apart, reducing scale economies and raising costs. That drives prices higher but does not necessarily increase profitability because demand shrinks. That, in turn, can harm innovation, which depends on the reinvestment of profits.

C.7 Mass data collection and analysis by the private sector

Data generated by Internet users is now a valuable asset that fuels the global information economy (OECD 2015a, p. 452). The business models of many Internet companies depend on collecting, analysing and selling data, often in exchange for a service like email or a social media platform for which users do not pay a monetary price. However, the harvested data may be used for purposes that may not always be clear to users and they might not be asked for their consent. Consequently, a kind of mass harvesting is being carried out for the purpose of capitalising on "big data" analytics.[6]

Mass data collection and analysis by the private sector can have both positive and negative effects on openness. There can be a loss of privacy. When every website visited, every bit of content shared, is monitored, gleaned, analysed, and used to help advertisers target their wares, privacy may suffer. But users also receive benefits in exchange for their loss of privacy: free web searches, free email, free social media platforms, etc. Those are all things that enhance communication between people, make research easier, and improve people's economic and social lives.

However, users do not always receive benefits in exchange for the e-harvesting of their personal data. For example, banks may sell databases of customer profiles and data transactions, but they do not necessarily offer free or improved banking services in exchange. Then again, real social benefits can result from the private sector's mass data collection and analysis. For instance, Google's collection of search and email information related to influenza enabled it to provide useful reports on where influenza seemed to be most prevalent.[7]

Many other actions and conditions affect openness and could be the subject of future work at the OECD. These include infrastructure investments, broader use of internationalised domain names, traffic exchange agreements, walled gardens, the adoption of domain name system security extensions (DNSSEC), and hacking/data breaches by private individuals or groups. The anticipated effects on openness from these factors, though tentative at this point, are included in Table C.1.

C.8 Summary – the impact on Internet openness

Table C.1. is a prototype of a summary table that could be produced based on Section 2.3.2. of the paper, the preceding discussion in this Annex, and future work. It must be emphasised that the table's main purpose at this point is to illustrate an approach to analysing openness that could be undertaken and would need to be further developed in the future. At present, it contains tentative, not definitive, indications of where and how various actions and inactions might affect Internet openness. Note that the up and down arrows indicate what happens to overall openness (including its technical, economic, social, and other aspects), rather than what happens to various layers of the Internet (listed at the top of each column). So, for example, a downward arrow in the DNS column does not mean that there will be fewer domain names; it means that the action/inaction in the corresponding row affects the DNS in a way that reduces overall Internet openness.

Table C.1. Where and how actions and conditions affect openness

Internet Layer / Action or Condition	Network infrastructure	Transport protocols	DNS/IP addresses	Applications
Data localisation laws	↓		↓	↓
International law enforcement co-operation	↕		↕	↕
Filtering, blocking, takedowns and seizures	↕		↕	↕
Targeted data interception by governments	↓		↓	↓
Mass surveillance by governments	↓		↓	↓
Infrastructure investments	↑			
IPv4 (→ IPv6)			↓(↑)	
IDNS			↕	↕
Procedural (un)interoperability	(↓)↑		(↓)↑	(↓)↑
(Lack of) competition	(↓)↑		(↓)↑	(↓)↑
Traffic management				↕
Walled gardens				↕
Fragmentation of technical standards	↓	↓	↓	
Mass data collection by companies			↕	↕
Traffic exchange	↑			
DNSSEC			↑	↑

In the future, it might be useful to construct separate tables for each type of openness (i.e. technical, economic, social) rather than, or in addition to, this aggregated table for overall openness.

ANNEX D: GLOBAL DATA FLOWS – A MEASUREMENT CHALLENGE FOR STUDIES OF INTERNET OPENNESS

Internet openness is a broad concept, encompassing technical, economic, political and social aspects. This is not an easy starting point for measurement or establishing quantitative links to trade, innovation and entrepreneurship and other economic indicators.[8] In an ideal world we would be able to determine the strength and direction of the relationship between Internet openness and various economic indicators, and how Internet openness itself is affected by policy and private sector actions. But this quickly meets a stumbling block – how do we measure Internet openness?

Studies of the Internet's macroeconomic impact have typically used various proxies of Internet *presence*, including adoption indicators (such as broadband penetration rates), economic indicators (such as network investment) and technical indicators (such as IP addresses per capita). Each of these proxies has limitations, one being a lack of insight into how people, firms, industries or regions actually make use of the Internet (OECD, 2012a). Unfortunately, these proxies are also imperfect as measures of Internet openness, as they essentially focus only on access and availability.

Quantitative studies of the Internet from a digital trade angle have typically used proxies of data flows for their analysis. On the face of it, using data flow information as a measure of Internet openness has merit. If a major practical consequence of the Internet is to facilitate movement of data/information/knowledge, for whatever purpose, then measuring flows of data could shed light on current levels of openness, even if we do not necessarily know the economic value of the data flows. Changes in flows could then be related to changes in trade and other variables on the one hand, and changes in policy or other factors on the other hand (assuming we could construct robust policy indicators). In addition, as many of the factors that challenge Internet openness are occurring at the level of data flows, measuring this aspect would be highly relevant.

However, proxies of data flows used to date also have drawbacks:

- As Hofheinz and Mandel (2015) point out, using official statistics (such as trade data related to digital activity) essentially underestimates the size of cross-border data flows, because not all flows are monetised.

- While looking at the bits and bytes themselves is another option, information on the capacity of the infrastructure (e.g. Telegeography statistics, as used in MGI 2014) does not inform us of actual data flows.

- Adding capacity usage estimates or traffic estimates can bring us closer to actual data flows, but such estimates (e.g. Cisco global IP traffic forecasts, as used in Hofheinz and Mandel 2015 & 2014[9]) do not differentiate where the traffic is coming from or going to, e.g. whether start and end points are local or cross-border, or the type of flows.

In one of the few studies that have approached Internet openness more directly, Dalberg (2014) chose to use Freedom House's Freedom on the Net index to look at the "economic benefits of Internet openness". This index is based on qualitative assessments and surveys, and measures the level of Internet and digital media freedom in three areas: 1) obstacles to access (e.g. regulatory obstacles for ISPs); 2) limits on content (e.g. instances of filtering); and 3) violations of user rights (e.g. state surveillance). However,

Dalberg considered that the limited time series and country coverage did not allow statistically significant causal relationships to be established; as such, one of their key conclusions was to urge stakeholders "to establish standard and universally measurable indicators of Internet openness" (ibid.: 50).

Along the lines of Freedom House's index, some other efforts are emerging that group together various indicators of Internet activity, including aspects that touch on Internet openness. For instance, BCG's e-Friction index agglomerates 55 indicators to indicate the ease with which people can participate in the Internet economy (one of which is the Freedom House Freedom on the Net index) (BCG, 2014). The e-Friction index could perhaps be interpreted as an openness index, although some of the indicators (e.g. company-level technology absorption; financing through local equity market, etc.) are relatively upstream from practical Internet openness; furthermore, there are significant data gaps. Another effort to draw together a variety of indicators on Internet trends comes from the Berkman Center for Internet & Society, whose Internet Monitor research project aims to shed light on Internet content controls and Internet activity worldwide.[10] As well as an index related to Internet access and infrastructure, a "dashboard" was recently launched that incorporates data on traffic, cyberattacks and website availability, amongst other indicators.

However, there is no easy off-the-shelf solution to measuring Internet openness. One goal of this work was to begin pushing the data boundaries by collaborating with global companies to provide a new perspective on global data flows across the Internet. This should facilitate analysis of Internet openness's effects at a more general level than that found in case studies of individual firms or situations, and thus help reinforce the evidence base available to policy makers.

At the time of writing, the OECD had analysed information related to Google searches and YouTube uploads and downloads, and had just received a sample of cross-border financial flow data from PayPal (described in D.1 below). These data provide an interesting glance into patterns of data flows, but currently may lack the geographic precision and representativeness desirable for use in more formal analysis of trade, innovation and other economic indicators. Nevertheless, the exercise was a valuable initial step and has paved the way for further work to provide a comprehensive picture of Internet openness and its links to economic performance.

D.1 The interlinked world – building a new snapshot of data flows

By any measure, global data flows are large and growing. Weller and Woodcock (2013) remarked that in 2013, 20 households with average broadband usage generated as much traffic as the entire Internet carried in 1995. Cisco (2015a) forecasts that annual global IP traffic will exceed a zettabyte by the end of 2016, and 2 zettabytes by 2019. It is hard to grasp how large this is – helpfully, Cisco provides some tangible comparisons, one being that global IP traffic in 2019 will be the equivalent of 58 million DVDs per hour. According to Cisco, video content is driving this traffic increase, with improvements in broadband speeds underlying the trend; Weller and Woodcock (2013: 10) also point to the transition of applications from the desktop to the cloud as contributing to the growth in traffic. Looking even further ahead, to 2025, MGI (2014: 113) predicted ongoing growth in global IP traffic volumes, ranging from traffic of 240 000 petabytes/month, equal to a 6-fold increase over 2012 (a linear growth trajectory), to traffic of 625 000 petabytes/month, equal to a 14-fold increase over 2012 (an exponential growth path scenario).

These measures are highly aggregated and not easy to mesh into analysis of economic benefits of Internet openness.[11] It was to explore underneath these aggregate data flow statistics that the OECD sought to obtain information from global companies. A more accurate measure of actual data flows on a country-to-country basis over time could allow comparisons with other bilateral indicators, such as those on trade and innovation, and could provide insights into the flows of knowledge over the Internet and their relation to economic and social outcomes. Data from individual companies can obviously only tell part of this story. However, given that Google constitutes an important portion of all Internet traffic, it seems

reasonable to assume that the patterns seen in information on searches and YouTube are meaningful and worthy of analysis.[12] Paypal too has weight, with 179 million active customer accounts, a presence in more than 200 markets and 4.9 billion payments processed in 2015.[13]

The OECD analysed four tables of information related to Google searches and YouTube watch time. Specifications are provided in Box D.1, but as a general description, the information was intended to provide insights into the website domains that users in a country visit via Internet search, and where YouTube content is watched. While not giving a sense of volumes (as the information was expressed in percentages), some 240 countries are covered in the tables analysed, enabling the exploration of interlinkages.

Box D.1. Information on Google searches and YouTube watch time

The OECD analysed four tables of information, related to Google searches and YouTube watch time, as follows:

Source 1: Google search – focus on user country

A table of 240 countries[1] (including 1 "zz" category where the country of the user could not be determined) by 101 top level domains (TLDs – comprising 87 country domains, 13 generic domains and 1 "other" category), showing the percentage of clicks on search results by users of a particular country searching on Google (all domains) that landed on websites of each TLD.[2] This allows us to see, for instance, that in 2014, just five TLDs (.com, .au, .org, .net and .uk) accounted for 96.11% of Australian users' Google search result clicks, with the remaining 3.89% of clicks going to a variety of landing page TLDs. User location was based on IP addresses.

Timespan: 2007-2014 (8 years) for most countries in the table.

Source 2: Google search – focus on landing page TLD

A table of 240 countries (including 1 "zz" category where the country of the user could not be determined) by 101 TLDs (again, 87 country domains, 13 generic domains and 1 "other" category), showing the percentage of clicks on search results related to each landing page TLD that come from users of a particular country who are searching on Google (all domains).[3] This allows us to see, for instance, that in 2014, 25.35% of clicks received by .com landing page domains via Google search results came from United States users. User location was based on IP addresses.

Timespan: 2007-2014 (8 years) for most countries in the table.

Source 3: YouTube – focus on country of uploader

A table of 240 uploading countries by 240 watching countries, allocating the percentage share of watch hours of an uploading country's YouTube videos across each watching country. There is additionally a "zz" category where the countries of uploading user and watcher could not be determined.[4] This allows us to see, for instance, that in 2014, 18.23% of the watch hours for videos uploaded by users from Spain were by users located in Mexico – the second highest watch hour share after Spanish viewers (at 23.44%). The location of uploading users was user-specified, while that of watching users was based on IP address.

Timespan: 2010-2014 (5 years) for most countries in the table.

Source 4: YouTube – focus on watching country

A table of 241 watching countries by 250 uploading countries (each including a "zz" category where the countries of uploading user and watcher could not be determined), allocating the percentage share of a country's YouTube watch hours across different YouTube video uploading countries.[5] This allows us to see, for instance, that in 2014, Slovenian users spent 1.61% of their YouTube watch hours on videos uploaded by users in Italy. The location of uploading users was user-specified, while that of watching users was based on IP address.

Timespan: 2010-2014 (5 years) for most countries in the table.

Box D.1. Information on Google searches and YouTube watch time (cont.)

Notes:

1. References to "country" should be read to include all geographic areas with 2-digit country code top-level domains identified in the tables. These include not only the 193 Member States of the United Nations but also other territories.

2. As the information is in percentages, it is not possible to say how large the "zz" user category is compared to other user countries. However, the share of user clicks going to the "other" category are typically small – for instance, for all OECD, Key Partner and Accession countries except for Luxembourg, the share of user clicks going to the "other" category are less than 1%. (In Luxembourg's case, 13-17% of clicks went to "other" over the 2007-2014 sample period.)

3. In this table, it is not possible to say how large the "other" category is compared to the other TLD, but we can see that the "zz" user category makes up less than 1% of clicks on TLDs in the majority (84%) of cases. Over the 8 year period, .co (Colombia), .id (Indonesia), .in (India), .ir (Iran), .pk (Pakistan), .sa (Saudi Arabia) and "other" saw the most frequent incidences of a high "zz" user share.

4. In this table, it is not possible to say how large the "zz" category is as an uploading country, but we can see that "zz" as a watcher accounts for less than 1% of watch hours for any country's YouTube videos in the majority (94%) of cases, with this share typically decreasing over the sample period. The most frequent incidences of a high "zz" watcher share were for .al (Albania), .ir (Iran), .mc (Monaco) and .mk (Former Yugoslav Republic of Macedonia).

5. In this table, it is not possible to say how large the "zz" category is as a watcher country, but we can see that "zz" as an uploader has accounted for a steadily decreasing share of each country's watch hours over the sample period. In 2010, the share of watch hours going to "zz" YouTube videos reached 15% in some cases (Iran and Japan), but by 2014, the share was below or close to 1% in all cases.

Key findings and lessons from the information analysed are highlighted below in D.1.1 and D.1.2. Their interpretation is shaped by some important factors, namely that:

- A country-code top level domain (ccTLD) for a website does not necessarily imply that the content is hosted within that country. For instance, you do not need to be based in New Zealand to register a .nz domain name and the domain name is not required to be hosted in New Zealand.[14]
  - Indeed, some ccTLDs have no substantive linkage to the country at all and instead are used much like a generic TLD. Examples include Belize (.bz), the Cocos Islands (.cc), the Federated States of Micronesia (.fm), Lao PDR (.la), Montenegro (.me), Niue (.nu), Samoa (.ws), Sint Maarten (.sx), Tokelau (.tk), Tonga (.to) and Tuvalu (.tv).
- A generic top level domain (gTLD) for a website cannot be matched to a particular country, either in terms of "owner" of the site or where the content is hosted, as these domains are available for registration by Internet users worldwide (albeit with some restrictions for some domains[15]).
- The network architecture of the Internet, the extensive use of data centres ("the cloud") and the growing presence of content distribution networks (CDNs) mean that the physical route taken by data may bear little resemblance to a straightforward bilateral flow between two countries.

Unless otherwise stated, the analysis focuses on OECD countries plus Key Partners and Accession countries (Brazil, China, Colombia, Costa Rica, India, Indonesia, Latvia, Lithuania, Russia and South Africa). Future work could delve further into additional country detail from the information provided.

In addition to this, the OECD analysed a dataset related to cross-border financial flows over the Paypal system during 2013. Specifications are provided in Box D.2, but as a general description, the data were intended to give an insight into the volume and global dimensions of Internet-based financial

transfers. Almost 82% of the transfers originated in OECD countries, and receipts were also dominated by OECD countries (accounting for just under 75%). In fact, the six OECD countries in which English is the primary spoken language (Australia, Canada, Ireland, New Zealand, the United Kingdom, and the United States) accounted for almost half of PayPal's international financial flows in 2013, sending USD 21.7 billion (49.6%), and receiving USD 20.5 billion (46.8%). These patterns likely reflect relatively high rates of both Internet usage and trade in OECD countries, as well as the origins of PayPal in the United States. At the same time, over 200 countries and territories are represented in the financial flows, illustrating the international reach of Internet-based flows. A snapshot of the data was presented in Chapter 2 and the OECD will continue exploring avenues for further analysis.

Box D.2. Data specifications - PayPal

PayPal provided the OECD with a dataset of all international transactions made over its payments system in 2013. The payments are an aggregate of B2B, B2C and remittance (C2C) flows. Transactions were sent from a total of 219 countries and territories, and received by 173. The dataset did not include within-country transactions (i.e. it shows transactions between PayPal account holders in country X and country Y, but not transactions between PayPal account holders within country X).

The dataset consists of 800 982 483 transactions with a total value of USD 43.8 billion, which averages to USD 54.68 per transaction.

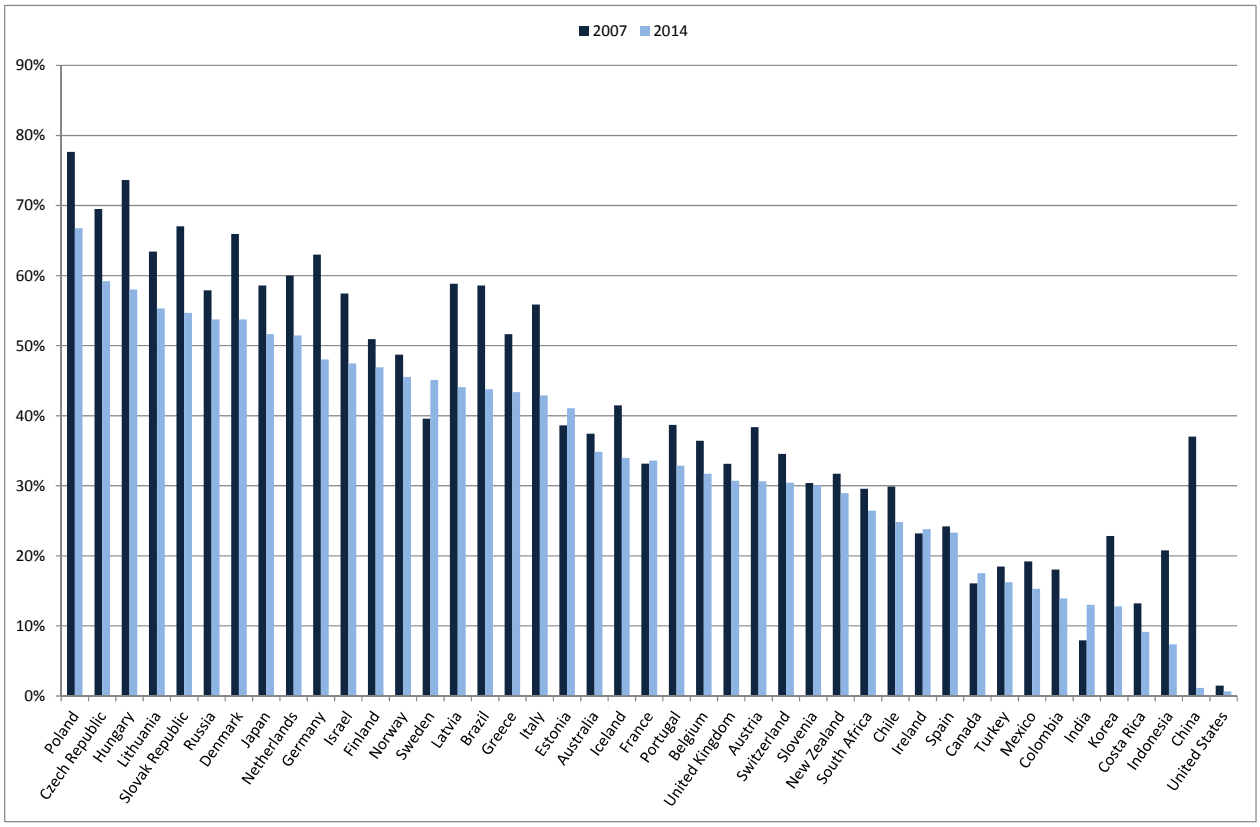
D.2 Insights from information on Google searches

The Google search information from source 1 shows that Internet users differ widely in the extent to which they select results in their own country's domain. For instance, in 2014, 67% of Google search clicks by users in Poland led to .pl domains, whereas only 13% of search clicks by users in Korea led to .kr domains (Figure D.1). The United States is an exceptional case; for historical reasons gTLDs such as .com were preferred to the .us domain, which was commercially marketed at a later stage, and just 0.66% of US users' Google search clicks went to .us websites in 2014.

Accompanying this diversity is an almost uniform trend of users increasingly accessing content outside their countries (also see Figure D.1). With the exception of Canada, Estonia, France, India, Ireland and Sweden, all countries experienced a decline in the share of Google search clicks going to their own ccTLD between 2007 and 2014. This could be interpreted as signalling a geographically wider variety of content being accessed, increased cross-country information and knowledge exchange, and potentially an increase in actual cross-border data flows, subject to the caveats mentioned earlier.

Figure D.1 Share of Google search result clicks leading to sites with own country TLD

2007 and 2014



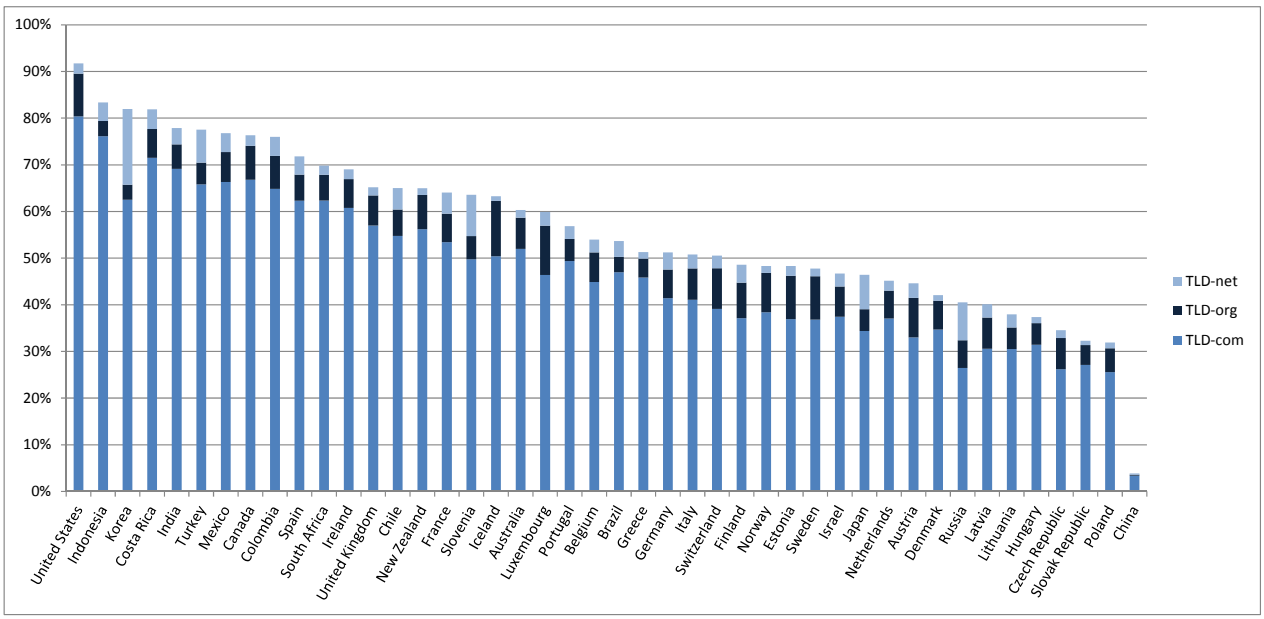
Note: Information on Luxembourg (.lu) as a search domain was not available in the table.

Source: OECD calculations, based on information from source 1.

The extent to which these patterns are accompanied by (changes to) Google's search algorithms is an interesting question. Google's algorithms rely on over 200 "signals" to help guess what the user might be looking for in their search, including terms on websites, content freshness, the user's region and PageRank (a measure of how authoritative a webpage is).[16] An increased internationalisation of the content accessed by Google users could reflect many factors and developments. It is possible that the queries issued by users over time relate to more international topics (i.e. a change in the "query mix"), thereby leading to more international results being surfaced. Even for an unchanged query mix, it is possible that users over time become more interested in international sources, seeking them out in search results; this could potentially be accompanied by Google's algorithms taking account of this preference in the composition of search results. In addition, the shape of the underlying Internet is ever changing, and to the extent that the growing number of webpages "internationalise" this base, one would expect this to be reflected in Google's index as well. Irrespective of the precise explanation, the fact remains that many users are increasingly looking beyond their own country content.

The information on generic TLDs show that a significant share of users' search clicks go to sites with a .com domain. In fact, in every country .com domains were the first or second most common result click along with the country's ccTLD (with the exception of China, Korea, Luxembourg and the United States, where the .com domain was accompanied by .hk, .net, "other", and .org, respectively, in the top two). 13 gTLDs were included in the Google search information (.com, .org, .net, .edu, .info, .gov, .biz, .cat, .mobi, .xxx, .mil, .name, .int), with .com, .net and .org uniformly the top three gTLD clicks and cumulatively accounting for over 50% of search result clicks in 27 of the countries in 2014 (Figure D.2).

Figure D.2 Share of .com, .org and .net in search result clicks, by country, 2014



Source: OECD calculations, based on information from source 1.

The importance of language/culture and geographic proximity can be observed in the search information. Proximate countries and those with a common language are typically amongst the top ten ccTLDs in a country's search result clicks. For example, Chilean users click on results in the Spanish, Argentinian, Mexican, Colombian, Peruvian, and American ccTLD spaces, while Swiss users click on results in the German, French, Italian, United Kingdom and Austrian ccTLD spaces. This behaviour is consistent with international trade models for goods and services that show "gravity" as measured by proximity, common language and so on, is an important factor driving trade links, although there may also be an algorithm effect in operation.

At the same time, the usage of the "generic ccTLDs" is also notable. While Tonga and Tuvalu might seem logical search result clicks for users in Australia and New Zealand – Pacific neighbours and home to immigrant communities – they are less obvious choices for users in Estonia and Israel, and the widespread appearance of these ccTLDs in top 10 search result click lists underscores the lack of a 1-to-1 relationship between ccTLDs and their "home country". For instance, Tuvalu's ccTLD is often used by media companies (the .tv domain name having clear marketing value). Nevertheless, the share of total search result clicks received by such TLDs is typically small since, as clearly illustrated in Figure D.2, gTLDs account for a significant share of total user clicks.

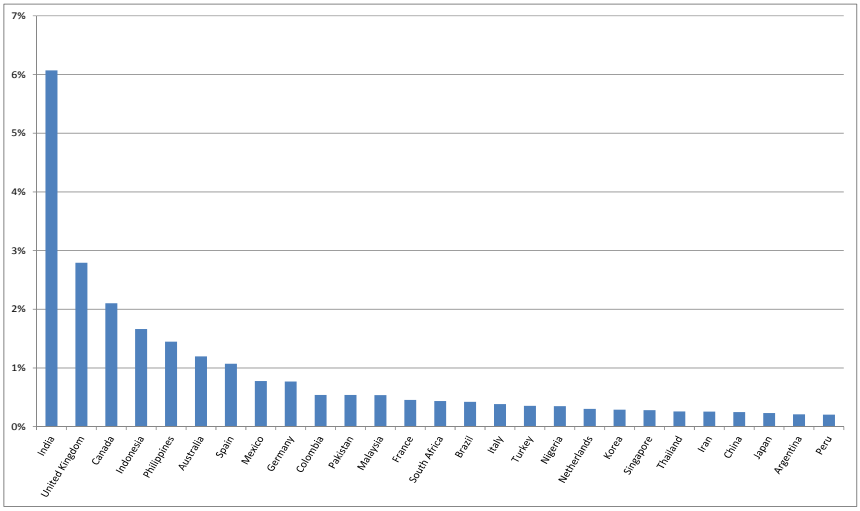
The Google search information from source 2 suggests that most website ccTLDs have a highly concentrated user base, accompanied by a long tail of user countries with tiny shares of total search result clicks. Taking the full sample of ccTLDs included in the table (excluding those that are clearly used in practice as gTLD), 41 of 75 ccTLD received 95% of search result clicks from 4 or fewer user countries in 2014. These were typically the country of the ccTLD plus proximate countries (either geographically or via cultural/language similarities) – for instance, users from Israel and the United States accounted for over 95% of search result clicks to websites with Israel's ccTLD (.il), while users from South Africa, the United States and the Netherlands accounted for over 95% of search result clicks to websites with South Africa's ccTLD (.za). Most OECD countries received 95% of search result clicks from 6 or fewer user countries.

However, some ccTLDs have lower levels of concentration, although still with the long tail. OECD countries that stand out in this respect include Spain (12 user countries accounted for 95% of search result clicks in 2014), as well as Sweden, the United Kingdom, the United States and Iceland (20, 21, 27 and 50 user countries, respectively). Mexico and Colombia accounted for a significant share of Google search result clicks to websites with Spain's ccTLD (.es), followed by a number of other South American countries plus the United States, Germany and India. The wide range of user countries behind search result clicks to websites with the United Kingdom ccTLD (.uk) is reflective of the United Kingdom's historic Commonwealth links as well as its status as a global hub.

The user base of gTLDs is unsurprisingly less concentrated than that of ccTLDs, matching their greater global availability. One interesting observation is the variety of user countries for the gTLD .edu, which is available only to United States post-secondary institutions that are accredited by an agency on the United States Department of Education list of Nationally Recognised Accrediting Agencies.[17] The Google search result clicks could be interpreted as mirroring the international attractiveness of the United States as an education destination. Users from the United States accounted for almost 71% of search result clicks to .edu domains in 2014 – users from 27 other countries (shown in Figure D.3 below) then accounted for a further 24% of the clicks.

Figure D.3 Top users of .edu TLD, measured by share of search result clicks, 2014

(excluding the United States)



Note: Users from the United States plus the 27 countries in the chart accounted for 95% of Google search result clicks to websites with a .edu TLD in 2014.

Source: OECD calculations, based on information from source 2.

D.3 Insights from information on YouTube watch hours

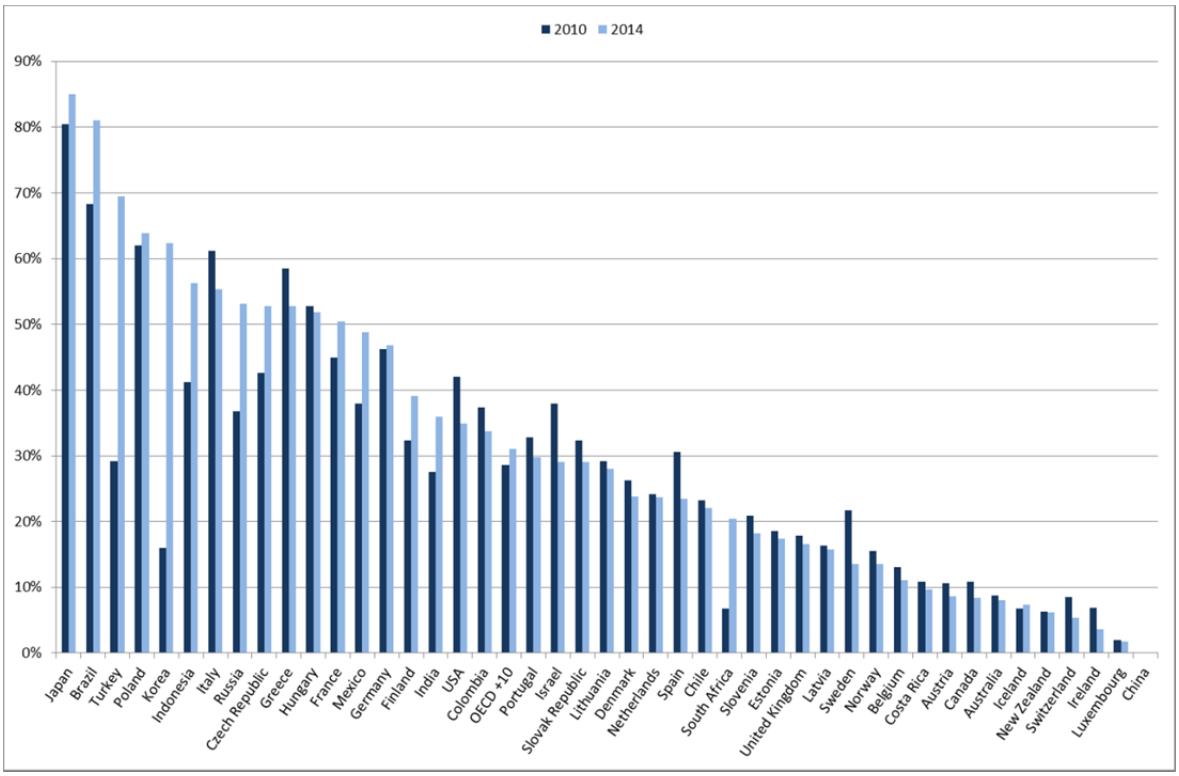
YouTube is a platform for user-generated video content, from music to do-it-yourself bicycle repairs, from professional to amateur. It has been credited as a source of ideas and cross-fertilisation.[18] The YouTube information in sources 3 and 4 provide an aggregated picture of the viewing patterns of YouTube users – they do not distinguish between types of content.

Figure D.4 (drawing on source 3) shows that there is a wide variation in the extent to which content is viewed outside the country in which it is uploaded. In 2014 for instance, 85% of the watch hours for videos uploaded by users in Japan were from users located in Japan. Towards the other end of the scale, just 8%

of the watch hours for videos uploaded by users in Australia and Canada were from users located in those countries. For both Australia and Canada, users in the United States accounted for the largest share of watch hours for Australian and Canadian-uploaded content (27% and 37%, respectively). United States users were the second-largest viewers of Japanese YouTube content, with a share of almost 3% of watch hours.

Figure D.4. Views of YouTube content uploaded by users in own country

As percentage of total watch hours for country's uploaded content



Source: OECD calculations, based on information from source 3.

Figure D.4 also shows how for more than half of the examined countries, dispersion of content is becoming increasingly international. In the United States for instance, the share of watch hours for United States-uploaded content accounted for by United States users fell from 42% to 35% over the period 2010-14. After United States users, the top watchers of United States-uploaded YouTube content in 2014 were the United Kingdom, Viet Nam, Mexico, Canada, Russia, Japan, Australia, Brazil, Germany and Turkey, in that order. In contrast, Japan, Brazil, Turkey and others saw an increase in the share of local watchers in watch-time for their content between 2010 and 2014. In some instances, this may be because the amount of local content being produced is increasing and attracting new local users; this in turn may be related to the penetration of smart phones, which offer another way to capture and view content.

The range of countries amongst watchers of a country's content sometimes points to the importance of a common language. For instance, YouTube content uploaded by Spanish users in 2014 obtained its highest share of watch hours from local viewers (23.4%), followed by Mexico (18.2%), Argentina (9.1%), the United States (6.1%), Chile (5.6%), Colombia (5.3%), Peru (3.6%), Venezuela (2.5%) and Ecuador (2.4%). Proximity and historical links can also be observed – in France for instance, the highest share of watch hours of content uploaded by French users in 2014 came from France (50.5%), followed by the United States (5.1%), Belgium (4.3%), Canada (3%), Morocco (2.6%) and Algeria (2%).

Focusing now on what people watch, source 4 shows that, for the most part, the share of any country's watch hours spent on another country's YouTube content is numerically small (i.e. less than 1%), implying that in aggregate, people are taking a smorgasbord approach – "a little bit of lots of things". However, there are three instances where this is not the case:

- All watching countries spent 10% or more of their watch hours on United States-uploaded content, with 20 countries spending more than 50% of their watch hours on United States-uploaded content (aside from the United States itself, these were Caribbean island nations plus Antarctica, Bermuda, the Marshall Islands and several United States island territories).

- Some countries' consumption of local content accounts for very high shares (over 50%) of total watch hours. Brazil stands out as a large consumer of its own content – 72% of its watch hours are on Brazil-uploaded content. Indian users also spend more than half their watch hours on local content (almost 58%). Other countries in this category are Japan (65%), Korea (62%), Poland (55%) and Thailand (66%).

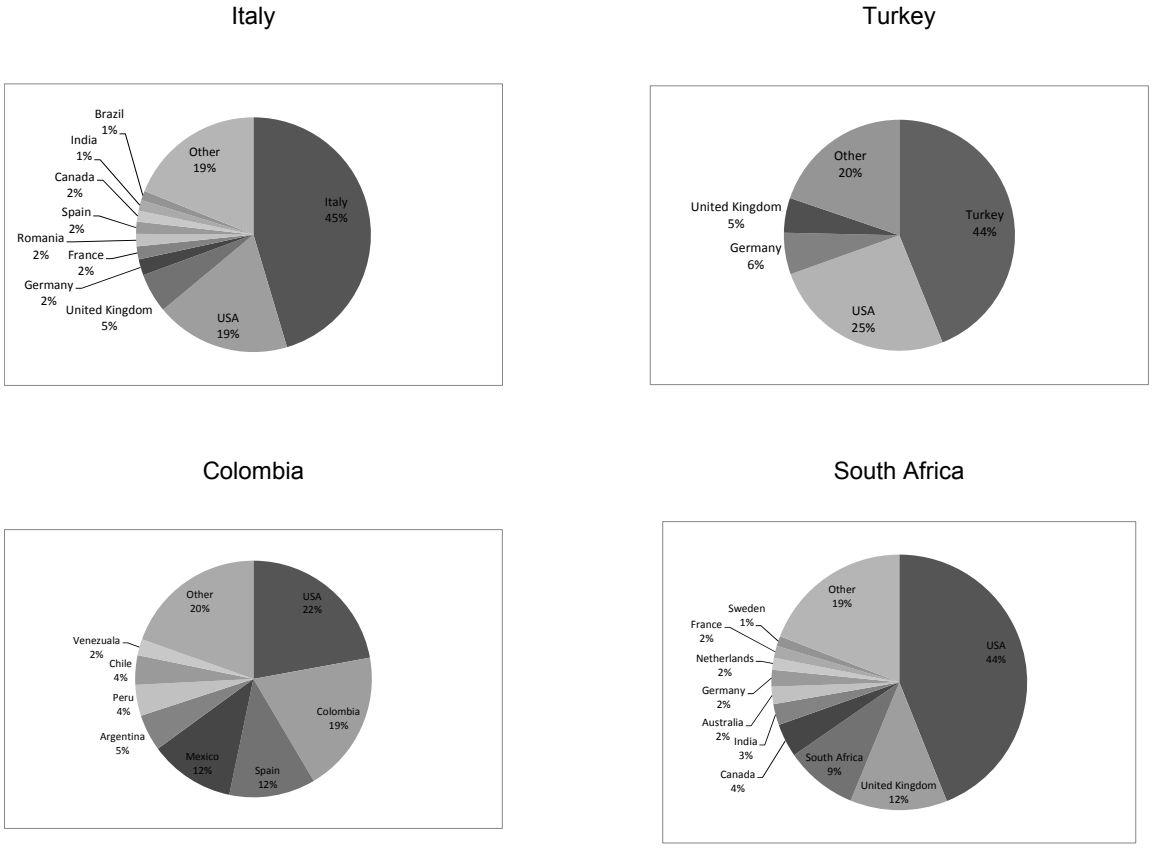
- Certain countries' content more regularly accounts for a high share of watch hours in other countries. Spain, France and the United Kingdom stand out with their content accounting for 10%-50% of a relatively large number of watching countries' total watch hours (20, 38 and 45 countries, respectively). There are clear language and historical links – for instance, the countries for which French content accounts for 10%-50% of watch hours are Algeria, Belgium, Burkina Faso, Burundi, Benin, Cameroon, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, French Guyana, French Polynesia, Gabon, Guadeloupe, Guinea, Haiti, Luxembourg, Madagascar, Mali, Martinique, Mauritania, Mauritius, Mayotte, Monaco, Morocco, New Caledonia, Niger, Reunion, Saint-Pierre and Miquelon, Senegal, Switzerland, Togo, Tunisia, and Wallace and Futuna (as well as France itself).

Aside from these patterns, there are also some individual cases that stand out. For instance, Indian content accounts for more than 10% of watch hours in several Middle-Eastern countries (e.g. 24% of watch hours for the United Arab Emirates, 15% for Bahrain, 12% for Kuwait, 15% for Oman and 22% for Qatar). Fijian users also spend a significant share of watch hours on Indian content (26%). This is likely due to past and recent immigration patterns that have created significant Indian communities in these countries and/or to the creation of content in India that particularly appeals to Middle-Eastern users.

Given the factors above, a country's watch hours typically display a long-tailed pattern, much like in the earlier information on Google searches, where most watch hours are dedicated to content from a small group of countries and the remainder of watch hours are accounted for by small amounts of many countries' content. Four country examples are presented in Figure D.5 below. In each case, the pie chart specifies the uploading countries (in descending order of importance) that together account for 80% of watch hours, with the remainder of sources aggregated as "other". It shows that for Italy, 10 countries accounted for around 80% of Italian YouTube watch hours in 2014, although within that, a large chunk was local Italian and US content. Ten countries, led by the United States, the United Kingdom and then local content, also accounted for around 80% of South Africa's watch hours. Eight countries accounted for 80% of Colombians' watch hours in 2014 – this was more evenly spread between United States, Spanish, local and Mexican content. Turkey stands out in the Figure with just 4 countries accounting for 80% of watch hours, namely Turkey, the United States, Germany and the United Kingdom.

Figure D.5. Whose YouTube content are they watching?

2014 watch patterns



Source: OECD calculations, based on information from source 4.

The information from source 4 also provides the possibility to observe how watch patterns have changed over the period 2010-14 for individual countries. As an example of this type of analysis, Box D.3 looks at seven African countries – Cameroon, Ghana, Kenya, Malawi, Nigeria, Rwanda and Tanzania. Africa has been the last continent to achieve Internet connection and is still in the relatively early stages of expanding access and coverage to its population. It is interesting to see that all countries in this sample have experienced an increase in the share of watch hours attributed to local- and proximately-uploaded YouTube content, although the absolute shares differ widely, reflecting their different stages of digital development.

Box D.3. YouTube in Africa - a peek at watch patterns

Source 4 allows an analysis of YouTube watch patterns across a wide range of countries – too wide for this report to give attention to all interesting cases. However, given Africa's status as a catch-up continent on Internet connection and usage, the table below presents some simple statistics on the change in YouTube patterns in the period 2010-14 and current watch patterns for seven countries.

There are large differences between the countries in the share of local content watched in 2014, but all showed growth in this share from 2010 to 2014. Nigeria has the strongest local following, perhaps due to its film industry and milieu generating a wealth of content for viewers. The United States and United Kingdom figure prominently in watch hours, and Nigerian content is also popular in Cameroon and Ghana (in fact, it features in the top eight of all countries in the sample). The share of watch hours spent on United States content is similar to that found in OECD countries – for instance, Cameroon is comparable to Mexico and Portugal, while the others are comparable to Denmark, Estonia, Norway, Sweden and the United Kingdom, whose shares of watch hours spent on United States content are in the area of 34%-39%.

	Share of watch hours spent on local content, 2014	Increase in share of watch hours spent on local content, percentage points, 2010-14	Top 3 content countries, by watch hour share	Share of watch hours spent on United States content, 2014	Concentration of watch hours - # of countries accounting for 80% of watch hours
Cameroon	3.14%	1.46	United States, France, Nigeria	25.23%	14
Ghana	9.92%	4.56	United States, Nigeria, United Kingdom	35.87%	10
Kenya	13.59%	6.88	United States, Kenya, United Kingdom	36.69%	12
Malawi	2.01%	1.24	United States, United Kingdom, India	38.15%	14
Nigeria	25.05%	19.88	United States, Nigeria, United Kingdom	32.69%	7
Rwanda	9.35%	5.53	United States, Rwanda, France	34.10%	14
Tanzania	13.64%	9.76	United States, Tanzania, United Kingdom	32.37%	12

While the absolute number of watch hours is unknown, the period of 2010-2014 is likely to have been one of strong growth, due to greater infrastructure provision. For instance, in 2009 there were no undersea cables connecting East Africa to the Internet, and only one cable serving the West and Southern coasts. By 2013, numerous cables had been laid, and some coastal countries are now served by multiple cables.[1] In-country infrastructure has also improved. There are now 37 Internet Exchange Points (IXPs) on the African continent (PCH, 2015) and at least two projects aim to advance regional and cross-border interconnection (AXIS and African Peering and Interconnection Forum)[2]. Foreign companies are contributing – for example, in 2011 Google Global Cache[3] was made available via the Kenyan IXP. Reductions in costs and latency significantly improved the user experience for video streaming (including YouTube) and Kenyans were able to more easily consume more local content, such as Kenyan news channels and TV programs. Local provider, KENET reported a ten-fold increase in Google usage after the cache occurred.

1. See maps developed by Steve Song at https://i1.wp.com/manypossibilities.net/wp-content/uploads/2014/04/AUC_history.gif
2. http://pages.au.int/axis/about and http://www.internetsociety.org/events/afpif
3. Google Global Cache is part of Google's content delivery system, whereby Google servers are placed inside the network of network providers and ISPs to serve popular Google content, including YouTube.

Source: OECD calculations, based on information from source 4; Emily Taylor.

The international sharing of YouTube content is clearly a facet of global knowledge and information flows, but its value is likely to depend greatly on the content in question, as well as how economic and social value is measured. Subject to data availability, future work could usefully explore different categories of content, distinguishing, say, education content from other content.

D.4 From description to measurement?

The current dataset from PayPal represents financial flows over just one Internet-based platform, so a question arises regarding whether it is sufficiently representative to be a good proxy for global data flows. However, given that it covers a full year of data, it may be possible to link it to data on trade and other relevant economic indicators. The OECD will continue to explore options with PayPal to work with the data and to identify further potential datasets to progress this analysis.

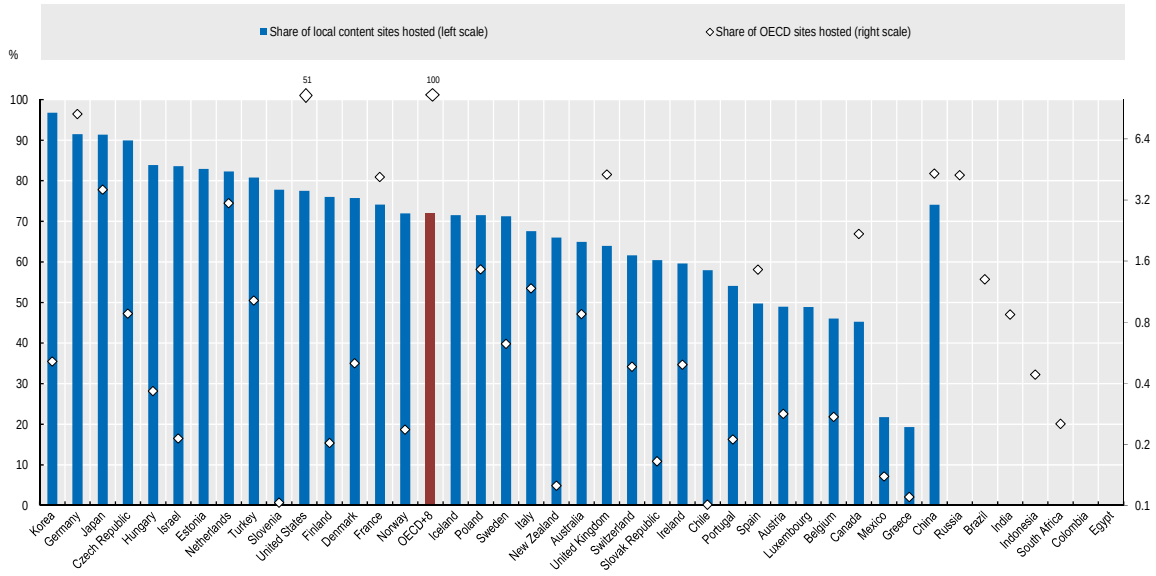
Regarding the information on Google searches and YouTube watch hours, the lack of geographic precision means that using this as a stand-alone proxy of global data flows and linking it to data on trade, innovation and other economic indicators would be misleading. In particular, the fact that gTLDs cannot be given a geographic tag makes the use of information on searches to proxy data flows on a country-by-country basis inaccurate. With .com domains representing over 40% of search result clicks in 2014 in 20 OECD countries (over 80% in the United States), for example, this loss of geographic information is significant. Added to this is the lack of 1-to-1 relationships between ccTLDs and the location of content. While for the YouTube information reviewed, the start- and end-points of data flows are clearer, both it and the search information have the common problem that the actual route of data flows (and thus the interdependence of global connections) is hidden behind the bilateral data points in the tables reviewed here.

However, comparing the patterns in the tables with information related to infrastructure can provide additional insights into data flows and gives some pointers for the direction of work. In short, Internet infrastructure has both influenced and evolved around data flows, and continues to do so in response to market and regulatory imperatives. For instance, the growth of heavy content and consumer demands for speed and quality mean that for some types of data flows there is a clear economic case for data to stay as local as possible. One example of this might be software updates, where the same content is being downloaded multiple times and where the balance of transit costs, speed/quality outcomes and storage costs makes it sensible to shift the content close to the consumer. At the same time, there remain data flows that do not lend themselves easily to localisation near the customer – they may be more unique in terms of content and need to traverse regional if not global networks on a constant basis. One example might be financial and logistical information flows associated with international trade. This suggests that measures and interpretations of data flows need to be nuanced to account for different contexts. The following discussion walks through the logic of this and proposes some next steps.

D.4.1 Location, location, location

The determining factor in identifying Google search destinations (and thus data flows) is where the site is hosted, and for some ccTLDs, this is predominantly offshore. Figure D.6 shows to what extent countries hosted the content of their ccTLD domain in 2013. It reveals that most OECD countries host at least half the content associated with their ccTLD, but there is nevertheless a wide range of outcomes, from Korea hosting almost 97% of .kr sites to Greece hosting just 19% of .gr sites. This underscores the strong global nature of the digital economy and its associated data flows. For example, 54% of .pt sites were hosted in Portugal in 2013. This implies that perhaps half the time, a “local” search click to a .pt website actually entailed cross-border data flows. At the same time, Portugal hosts foreign content (in fact, in absolute terms, Portugal hosts more foreign sites than local .pt sites), thus a share of “foreign” search clicks will stay local.[19]

Figure D.6. Local content sites hosted in country, 2013

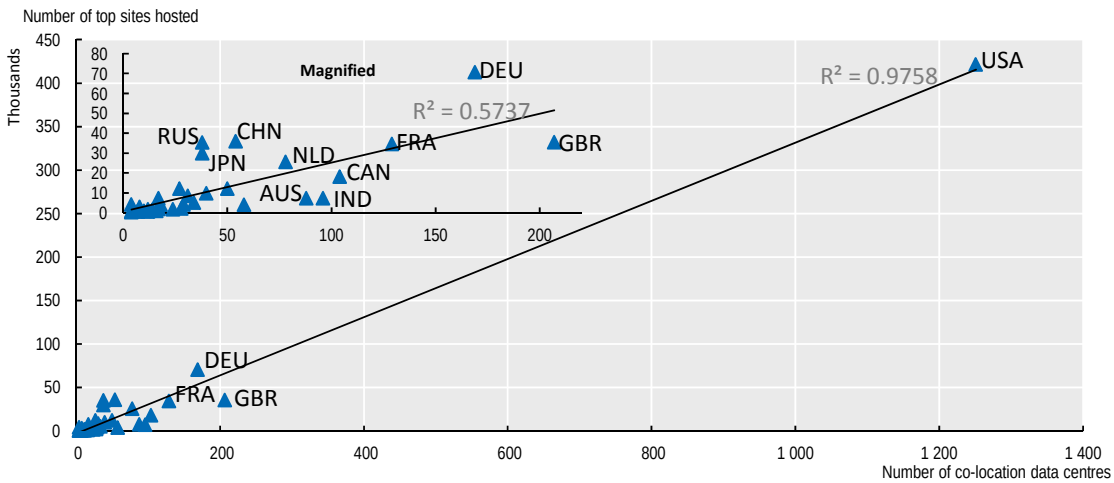


Note: Based on the analysis of 429 000 ccTLDs of the top one million sites. The remaining sites including the generic top-level domains were omitted from the list, as there is no reliable public data as to where the domains are registered. Data on the share of local content sites hosted were not available for Brazil, Colombia, Egypt, India, Indonesia, Russia and South Africa.

Source: OECD (2015a), based on Pingdom, Alexa, and *datacentermap.com*.

The location of hosting appears to go hand-in-hand with access to efficient infrastructure. Figure D.6 shows that the United States accounts for a large share of the off-shore market for hosting – it hosts 51% of all top sites in the OECD plus Brazil, China, Colombia, Egypt, India, Indonesia, Russia and South Africa. Figure D.7 then shows the clear correlation between the number of co-location data centres[20] and the number of top sites hosted in a country, suggesting that the favourable environment in the United States for setting up data centres (backhaul infrastructure, cost of energy/electricity, cost of land, regulatory environment) is an important factor in its pre-eminence. Germany is another popular location for hosting, along with France and the United Kingdom.

Figure D.7. Co-location data centres and top sites hosted



Note: Number of top sites hosted based on the analysis of 429 000 ccTLDs of the top one million sites collected in 2013. The remaining sites including the generic top-level domains were omitted from the list, as there is no reliable public data as to where the domains are registered.

Source: OECD (2015a), based on Pingdom, Alexa, and *datacentermap.com* (accessed 27 May 2014).

Logically, top hosting countries will be key conduits for data flows. For some businesses, there is a clear cost and efficiency advantage in routing data and content to data centres in these locations. Aggregating data processing, for example, can enable better control over data practices, maximise the utilisation of skilled staff, and improve operational efficiency. Placing this activity in the most cost-efficient location is the best business choice.

Nevertheless, for some businesses there are advantages to keeping data and content close to consumers, not all of whom are in the top hosting locations. Growth in use of content delivery networks (CDNs) and caching of content close to customers are contributing to what is, in effect, economically-driven localisation of some data flows. Weller and Woodcock (2013) note that CDN services, such as those provided by Akamai, have supported the demand for activities such as video streaming and download, while some large service providers, including Google, are building their own alternatives to transit (i.e. data centres). They note that where one end of a traffic flow is a server, the data can be replicated in many locations so as to be closer to users.

This kind of structural change in the market makes routing more direct (thus reducing costs), improves quality and increases speed of delivery. It also makes the analysis of cross-border data flows more complex, since what may once have been multiple cross-border flows of content (e.g. a music video) can become one initial cross-border flow followed by multiple local downloads from a local cache. Internet openness remains important for the content to be shared but the magnitude of content consumption enabled by that openness becomes less well-represented by cross-border data flow data.

A key piece of shared infrastructure that enables data flows to stay local when it is economically logical to do so is Internet exchange points (IXPs). IXPs enable the exchange of traffic via peering between connected networks and their global distribution plays an important role in data flow routing. Crucially, the denser their presence, the more likely it is that data can flow across shorter and faster paths between source and destination. An analogy is with transport networks – must travellers transit through a distant hub or can they get to their destination more directly? The shorter the distance between customers and their IXP, the lower the costs and higher the quality of data flows.

IXPs are densest (most numerous) in the United States, Brazil and Russia, with high density also in Argentina, Australia, France, Germany, Japan and Poland, each of which has 10 or more IXPs.[21] Countries with low density of IXPs are more likely to have cross-border data flows associated with their Internet activity, partly because IXPs and data centres are often co-located[22], and partly because even if it involves a locally hosted site, data may have no choice but to transit through an IXP in another country to gain access to the destination network. Linking this back to the information on Google searches and again using the Portuguese example, Portugal has a relatively low density of IXPs (in fact, just one), increasing the possibility of data taking a multi-country path between its host location and the user in Portugal.

Over time, the number of IXPs has been growing, particularly in emerging economies. In April 2011, Weller and Woodcock (2013: 54) counted 357 IXPs worldwide, with 25% of these in North America and 38% in Europe. Over the five previous years, all regions had built new IXPs, with growth especially high in Latin America, which went from 20 to 34 IXPs. This growth was welcomed by the authors as it reduces the need to "trombone" traffic out of the country or region, allows for more direct routing of traffic and thus improves service quality, and frees up long-haul capacity to focus on actual out-of-region traffic (Weller and Woodcock 2013: 9).

As of October 2015, the global number of IXPs had grown to 452, with 60 in Latin America and 37 in Africa.[23] The impetus to build an IXP essentially comes down to cost – Internet service providers (ISPs) prefer to have an IXP in close proximity so that the cost of outbound traffic is reduced.[24] The break-even point depends on traffic volume and the ratio of local to international traffic – but at a cost of USD 3.50 per Mbps for IP transit, an ISP could be better off joining an IXP with a traffic volume of just 2 000 Mbps.[25]

D.4.2 Where to from here?

The clear takeaway from these infrastructural insights is that the flow of data across the Internet is complicated – data flows come in different forms and they do not follow political or geographic borders but rather economic parameters that are set by changing market conditions and the regulatory / competitive environment. How then, can we most usefully measure Internet openness so as to link it to indicators of our ultimate economic policy goals – trade, innovation and macroeconomic performance?

Looking ahead, two complementary approaches could be proposed as future research paths:

- **Approach 1:** Constructing a global data flow dataset that more accurately tracks geographical start and endpoints as well as important waypoints en route, ideally with information on the types of flows, so as to better understand the nature and volume of data flows. This approach would essentially seek to build a data flow dataset that could more easily be married with economic datasets, which are typically organised by country. Possible additional data and information sources to assist with this include:

  – Actual traffic data, both aggregate and in certain sub-categories;

  – Further flow data from firms;

  – Information on the location of .com sites;

  – Information on the location of key data centre sites and their through-put; and

  – Information on barriers to data flows, to be used in constructing proxies for modelling purposes.

This approach raises the question of whether governments should seek to establish voluntary national statistical collections of traffic data. Australia, for instance, conducts a twice-yearly survey of ISPs with more than 1 000 subscribers, collecting data on *inter alia* the number of ISPs, subscriber sectors and the volume of data downloaded.[26] It is perhaps time to explore whether such surveys should be expanded and include information on cross-border data flows. At the least, establishing a consistent cross-country methodology for collecting ISP data could enable analysis using domestic network traffic as a proxy for Internet openness, with coverage eventually expanding to cross-border data flows.

- **Approach 2:** Identifying hot-spots of data flow intensity (and, where possible, identifying hot-spots of data-flow value) and overlaying these with data showing the intensity and value of various economic performance variables (related to trade, innovation, entrepreneurship, productivity, etc.). In some ways, this approach would cast data flows as global data chains – taking inspiration from global value chains in the trade space – with intensity (and value) varying across different parts of the chain. Possible additional data and information sources to assist with this include:

  – Density of data infrastructure[27]: density and composition of players at IXPs; density of interconnection agreements at IXPs; bandwidth at IXPs; IPv6 deployment by region;

  – Analysis of value added of certain Internet-related activities, similar to Trade in Value Added (TiVA) analysis.

Both of these approaches would need to ensure that indicators are robust to changes in Internet technology, or at least cognisant of it. For instance, data flows over submarine cables could be substituted by data flows over satellite technology or other, new, technological innovations. And access may increasingly occur via mobile technologies used by apps rather than relying on Internet browsers. Measures of openness need to take account of changes in the way it may be manifested.

Despite the evident need for further work, there are nevertheless two important conclusions regarding Internet openness that emerge from this initial analysis. First, in line with its original design, the Internet remains a highly interdependent system. Data flows frequently have international dimensions and are not necessarily predictable. Reducing openness in any part of the system could have knock-on effects across the whole system and thus, all countries have an interest in ensuring that policy decisions regarding the Internet take into account the costs and benefits of openness. Given the important role of the United States in many aspects of the digital economy, its policy decisions clearly matter, but so too do those of other countries. For instance, Figure D.6 showed Germany hosted almost 8.5% of OECD top websites in 2013, which suggests that its policy decisions on data flows and Internet openness would likely have significant consequences across the system.

Second, Internet openness, in terms of enabling data-information-knowledge to flow across the globe, is incontrovertibly tied to open markets and competitive conditions. Firms must be able to invest in or establish access to infrastructure that allows them to efficiently and effectively provide their services, be it on a local or cross-border basis – if they cannot, then customer access, choice and service quality suffers. Weller and Woodcock (2013: 45) noted a frequent observation that "improvement of the Internet depends upon a circular path of improvement of each component of the Internet's infrastructure: IXPs, international connectivity, content, backbone networks, and access networks. One circumnavigates this circle endlessly, upgrading each in turn…" This has distinct parallels with Internet openness and suggests that measures of Internet openness need to incorporate infrastructural factors.

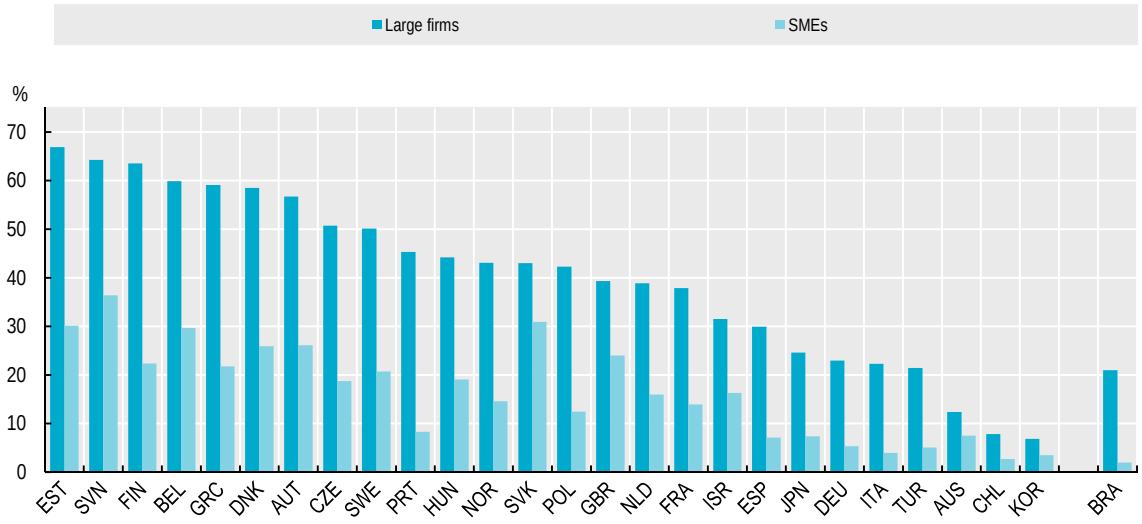
ANNEX E: THE INTERNET, INNOVATION AND ENTREPRENEURSHIP

E.1. Enabling knowledge flows

In looking at the role of the Internet in enabling knowledge flows for innovation and entrepreneurship, the first point to note is the significant body of evidence showing the importance of collaboration to innovation today. Figure E.1, for instance, shows that a notable share of firms involved in product and/or process innovation engage in international collaboration. While large firms are more likely to exhibit such behaviour, still more than 25% of small, innovative firms in Austria, Belgium, Denmark, Estonia, the Slovak Republic and Slovenia also engage in international collaboration. This collaboration can reap rewards for participating firms. For example, Fitjar and Rodríguez-Pose (2011) showed the most innovative firms in urban Norway were those with a greater diversity of international partners.[28]

Figure E.1. Firms engaged in international collaboration, by firm size, 2010-12

As a percentage of product and/or process-innovating firms in each size category



Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey. Please see www.oecd.org/sti/inno-stats.htm and chart notes for more details.

Source: OECD, based on Eurostat Community Innovation Survey (CIS-2012) and national data sources, June 2015. In OECD (2015b) http://dx.doi.org/10.1787/888933274095.

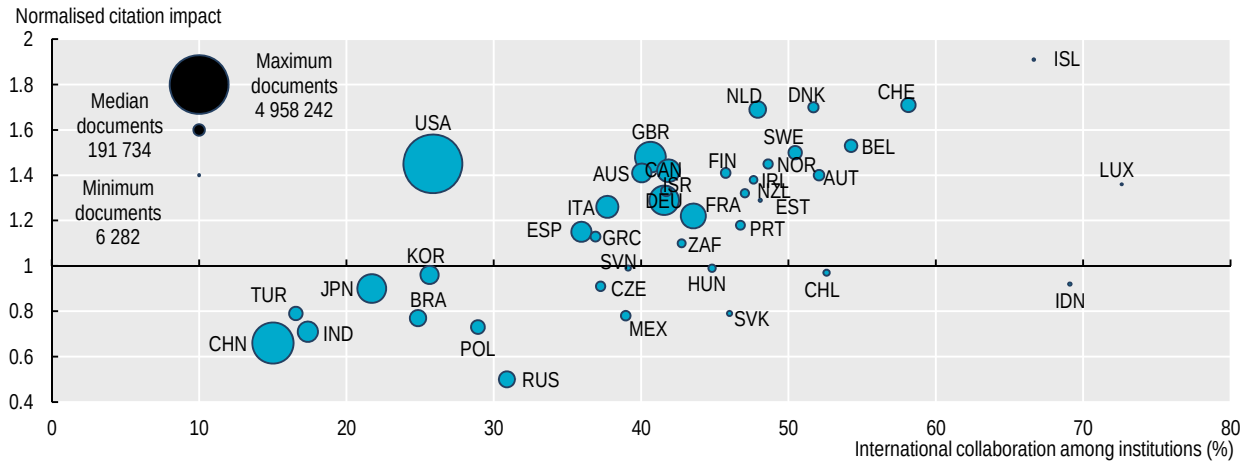
At the research level, scientific publication has exhibited increasing domestic and international collaboration over recent years. From 2003 to 2012, almost all OECD countries saw an increase in the share of scientific papers prepared by author groups that included contributors affiliated to foreign institutions (OECD, 2015b[29]). That same trend was occurring globally, with the share of single author and single-institution-authored papers in total publications falling from 1996 to 2013, and the share of multi-author collaborative efforts increasing (OECD, 2015b[30]). Purely international collaborations accounted for

7.4% of publications by 2013, up from 5.8% in 1996, while publications generated by domestic and international collaboration rose from 6.5% to 11.3% of the total in the same period.

There is evidence that international collaboration boosts the quality of scientific outputs. Figure E.2 shows the positive correlation between international collaboration and the impact of scientific publications; papers prepared by wider cross-country groups of authors typically receive more citations, indicating higher quality. More informally, the interest that academics show in building international bridges to share research data indicates that collaboration is of value to their work. The creation in 2013 of the Research Data Alliance (https://rd-alliance.org/), for example, which now boasts over 3 300 members (the majority from academic institutions), shows the active interest of researchers in working co-operatively to establish "rules of the road". Such rules allow data to be shared now and in the future for the benefit of their research work.

Figure E.2. The citation impact of scientific production and extent of international collaboration

2003-2012



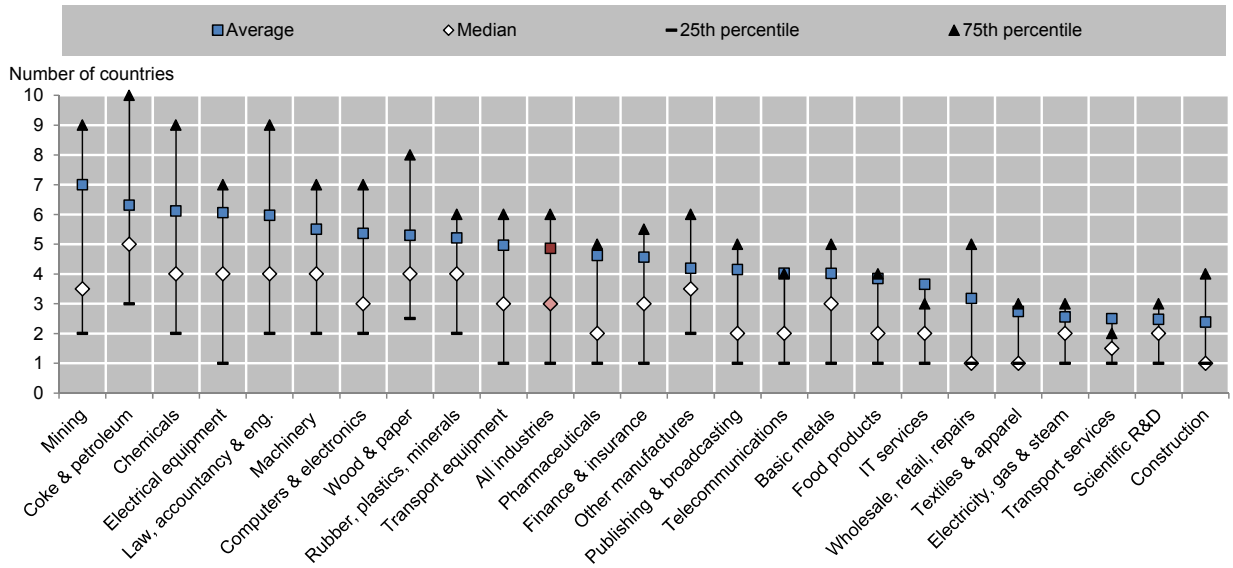
Source: OECD and SCImago Research Group (CSIC) (2015), Compendium of Bibliometric Science Indicators 2014, http://oe.cd/scientometrics. In OECD (2015b) http://dx.doi.org/10.1787/888933273878.

Turning to patents, Figure E.3 illustrates the importance of cross-country knowledge flows for innovation in a wide range of industries, as illustrated by the patent portfolios of firms.[31] The data relate to industries that have at least 10 firms in the top 2 000 corporate R&D investors and show that, on average, inventors from five countries are involved in developing patents owned by firms in this sample. In all industries, the median number of inventor countries is lower than the average number, suggesting there are some firms pulling up the average with a very wide geographic spread of inventors contributing to their patent portfolio. The values differ quite widely across industries, but it is notable that the average is always above two, i.e. innovation relies on a geographically dispersed set of expertise.

At the level of individual patents, there is also evidence of the importance of cross-country knowledge flows, with the share of patents developed via international co-invention increasing on average in OECD countries. Over the period 2000-03 to 2010-13, patents emerging from international co-invention rose from 6.1% to 7.4% of total patents (OECD, 2015b[32]). Underlying this average is a wide range of country experiences; Belgium, the Czech Republic, Ireland and Switzerland saw 25% or more of their patents developed by a mix of domestic and international inventors, while for Japan and Korea, this figure was less than 2%. In non-OECD countries, India, Malaysia, Russia and Singapore saw the highest rates of international co-invention in 2010-13, above 25% of total patents in each case.

Figure E.3. Diversification of inventors' location by industry

Number of inventors' countries in companies' patent portfolios (EPO and USPTO)



Note: The data are based on all the inventors' countries listed in each company's patent portfolios. Data relate to industries with at least ten companies in the top 2000 corporate R&D investors sample.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014. In Dernis *et al.* (2015: 47).

What is the role of the Internet in all this? In short, the Internet has been shown to aid the process of collaboration and knowledge sharing. For instance, a recent study of more than a thousand entrepreneurs pointed to the key role of digital technologies in supporting large-scale open innovation amongst geographically-dispersed collaborators and in providing the tools to globally disseminate information to help business decision-making (Accenture & G20 YEA, 2014). The study's survey found nine in ten entrepreneurs collaborated with customers to co-create, while half to two-thirds collaborated with organisations such as public institutions, universities, or incubators. Digital technologies were considered to underpin innovation and globalisation efforts, and the corresponding ability of entrepreneurs to expand their businesses and create jobs. In a more specific example, a study of the online Minecraft game illustrated how 'consumption' of the video game comprises an important step in the value chain, as the community of game users actively influences the game's ongoing development (Swedish National Board of Trade, 2013). The current developer follows game forums to stay abreast of user discussions, invites community members to actively help develop Minecraft and has occasionally employed talent from the community. This live development at the consumption end of the chain feeds directly back to the innovation and R&D stages, in the form of knowledge flows and collaboration.

It is also difficult to imagine scientific and inventive collaboration occurring in the absence of technology that allows knowledge to flow at a distance. Indeed, the increase in collaboration in scientific publications and international co-invention and the massification of the Internet from the late 1990s may not be coincidental. The ability to tap distant expertise and data, and work with colleagues regardless of their location, is clearly boosted by the Internet. This is not to say that collaboration always involves communication over the Internet – scientific authors, for instance, also show important levels of physical mobility – but the scale of collaboration can undoubtedly make a step change with the benefit of Internet technology, especially if it supports free flows of data. This can have important economic development impacts – research shows that the adoption of advanced Internet technologies mitigates the tendency of

innovation (as measured by patent applications) to be geographically concentrated, meaning that regions are not doomed by history to remain low-level innovators (Forman *et al.*, 2014).

Knowledge flows supported by the Internet are not just a boon for collaborative efforts amongst businesses and the scientific and research community – they also allow individual firms to boost their performance. Castro and McQuinn (2015) highlighted the benefits of cross-border data flows for "traditional" industries, with their case studies of firms in mining, manufacturing, oil and gas, retail, banking, and healthcare - uncovering numerous innovation benefits, including:

- Data analytics to improve mine efficiency, leading to more environmentally friendly and safer mining;
- New personalised services for consumers, based on analysis of enterprise data at an aggregated level;
- Cloud-based data exchange to underpin convenient global access to financial services;
- Real-time flows of airplane performance data to support maintenance and safety; and
- Data-sharing to establish larger datasets for clinical studies and development of better treatments.

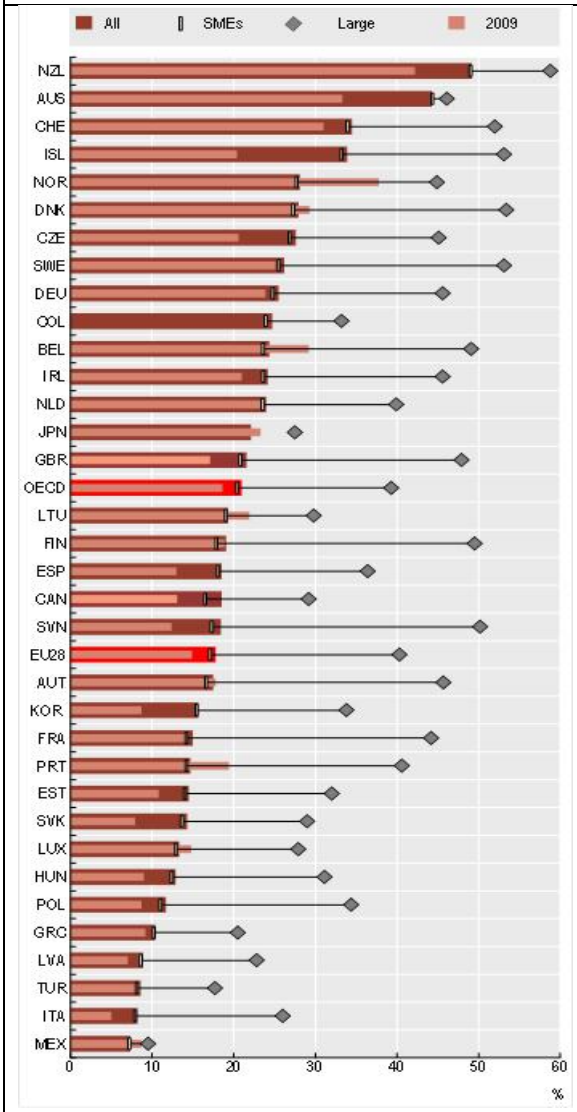
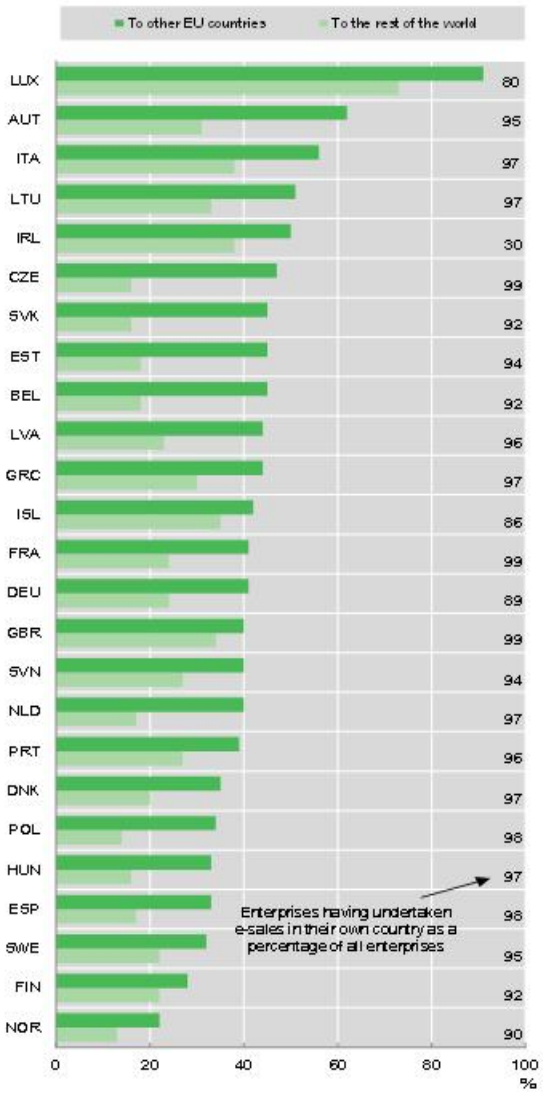
The Internet has also enabled access to data, information and knowledge that may once have been considered too difficult or too costly to share at all. One example of this is governments' growing use of the Internet to implement open access policies on public data as well as underpin their e-government strategies (see Chapter 10, OECD 2015a).

Finally, as well as access, the Internet may also help the absorption of knowledge at a distance by helping to break down the difficulties associated with exchange of tacit knowledge. Until now, tacit knowledge has been typically associated with face-to-face physical interactions, where people can learn and absorb knowledge from others. As noted by Fitjar and Rodríguez-Pose (2011), this provided support for cluster policies, enabling cities and regions to reap benefits from agglomeration economies. But repeated local interaction is only useful for innovation if it provides varied and regularly rejuvenated knowledge. By easing international communications, not least by providing a low-cost visual aspect to remote communications (e.g. through Skype), it seems highly likely that the Internet can help tacit knowledge to flow at a distance and widen possibilities for innovation.

E.2 Providing a platform

The growing use of e-commerce is one indicator of the Internet's importance as a platform for innovation and entrepreneurship. In the OECD, 21% of firms with 10 or more employees engaged in e-sales in 2013, up from 18.6% in 2009; this figure rises to 39.3% if large firms of 250+ employees are the focus (Figure E.4, Panel A). At the same time, nearly 50% of the adult OECD population made online purchases in 2013, up from about 31% in 2007 (OECD, 2014c: 43). The rise in e-commerce has not been uniform across countries, with Austria, Belgium, Denmark, Japan, Luxembourg, Mexico, Norway and Portugal recording a drop in the share of enterprises engaged in sales via e-commerce between 2009 and 2013. Nevertheless, e-commerce's future is considered bright – a PayPal study of cross-border online shopping in the United States, United Kingdom, Germany, Brazil, China and Australia suggested that between 2013 and 2018, the number of cross-border shoppers in these countries would grow from 94 million to 130 million, with average per-person spending rising from around USD 1 117 to USD 2 360 (PayPal, 2013).

Figure E.4. Enterprises engaged in e-commerce

Panel A: Enterprises engaged in sales via e-commerce, by size, 2013 As a percentage of enterprises in each employment size class	**Panel B: Enterprises having undertaken cross-border e-commerce sales, 2012** As a percentage of all enterprises having undertaken sales via e-commerce
	
Note: Unless otherwise stated, only enterprises with ten or more persons employed are considered. Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249), SMEs (10 to 249) and large (250 and more). See chart notes for more details.	Note: For Germany, data refer to 2010.
Source: OECD, ICT Database; Eurostat, Information Society Statistics Database and national sources, July 2015. In OECD (2015b), http://dx.doi.org/10.1787/888933274434	*Source*: OECD, based on Eurostat, Information Society Statistics Database, June 2015. In OECD (2015b), http://dx.doi.org/10.1787/888933274849

Although e-commerce is growing, national sales are still more common than cross-border sales for many countries, and geographic proximity still matters. With the exception of Luxembourg and Austria,

fewer than 60% of e-sellers have sold to other EU countries, and (again with the exception of Luxembourg) fewer than 40% have sold to countries outside the European Union (Figure E.4, Panel B). The PayPal study found geographical proximity to be important for cross-border sales – German shoppers purchased significant amounts from Austria and the Netherlands, for instance (PayPal, 2013).

Delivery costs may be part of the reason for ongoing proximity effects, since it remains the case that many online sales result in an item being physically shipped to customers: a USITC survey found two-thirds of online sales were of products and services delivered physically or in person (USITC 2014, p 39), while the PayPal study showed clothes, shoes and accessories, followed by health and beauty products, to be the largest cross-border purchase categories. There may also be a cultural similarity element – Blum and Goldfarb (2006) found Americans were more likely to visit websites from nearby countries when looking at products such as music and games (deemed taste-dependent), while visits to websites for non-taste-dependent products such as software were not affected by distance.[33] Still, proximity appears less of an issue for online transactions than offline – Lendle *et al.* (2012) compared cross-border transactions on eBay and comparable offline transactions and found that the importance of distance between trading partners was 65% smaller on eBay. They suggested technology can reduce frictions related to trust and information issues and found significant real income gains could be achieved if search costs could be reduced to the level of online trading.

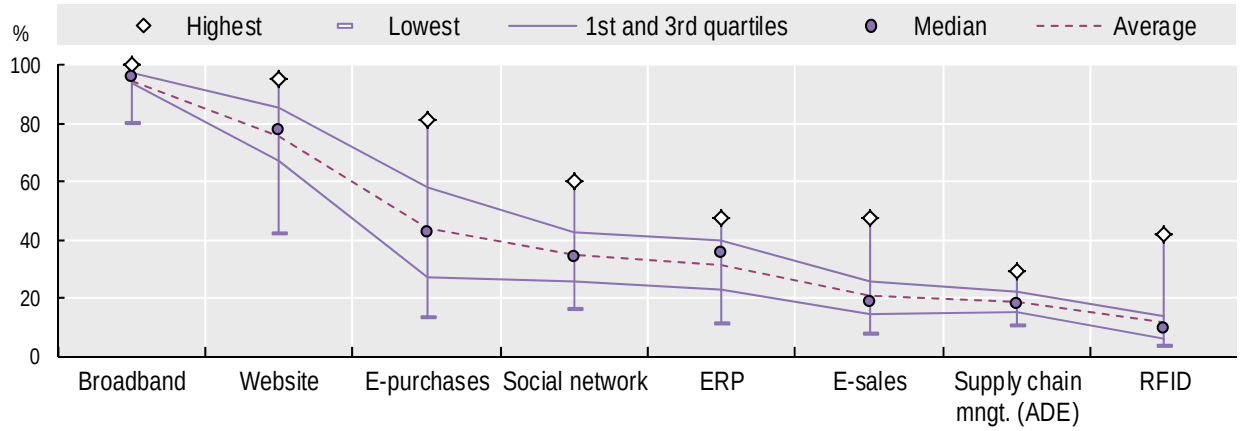
The "app economy" is another illustration of the Internet's role in innovation and entrepreneurship. The Internet's utility has been extended to smartphones and tablets through the development of new apps – dedicated software applications for mobile devices. The average smartphone user in the OECD has 28 apps installed, although uses fewer than 11 (OECD 2015b: 218). Not only do these allow users to benefit from a myriad of services, but the creation of the apps themselves is a growing sector of activity. In its 2015 retrospective, the analytics company App Annie reported that Google Play had experienced strong growth in worldwide downloads of apps, driven mainly by emerging markets where expanding mobile penetration suggests there is still significant room for growth (App Annie, 2016). App revenue for both Google Play and the iOS App Store doubled between 2013 and 2015, and App Annie pointed to the opportunities for app developers in watches, other wearables, virtual reality and other device categories yet to be invented. The expansion of ride-sharing and taxi apps was a notable feature of 2015, and this is not limited to developed countries – users in India have an app to order rickshaws.

E.3 Supplying essential inputs

Firms are clearly making use of Internet-based tools to run their businesses – notably websites but also social networks, which help connect them to customers, and e-purchases (Figure E.5). They are using cloud computing to access software and infrastructure, although as noted earlier in the text, uptake varies notably between large and small firms (as is also the case with e-commerce) and across countries. Of those European firms using the cloud, Figure E.6 shows that in many cases they are purchasing high-level cloud services such as accounting software, customer relationship management software, and computing power. (Unfortunately, the data do not identify where the cloud is located.)

Figure E.5. Diffusion of selected ICT tools and activities in enterprises, 2014

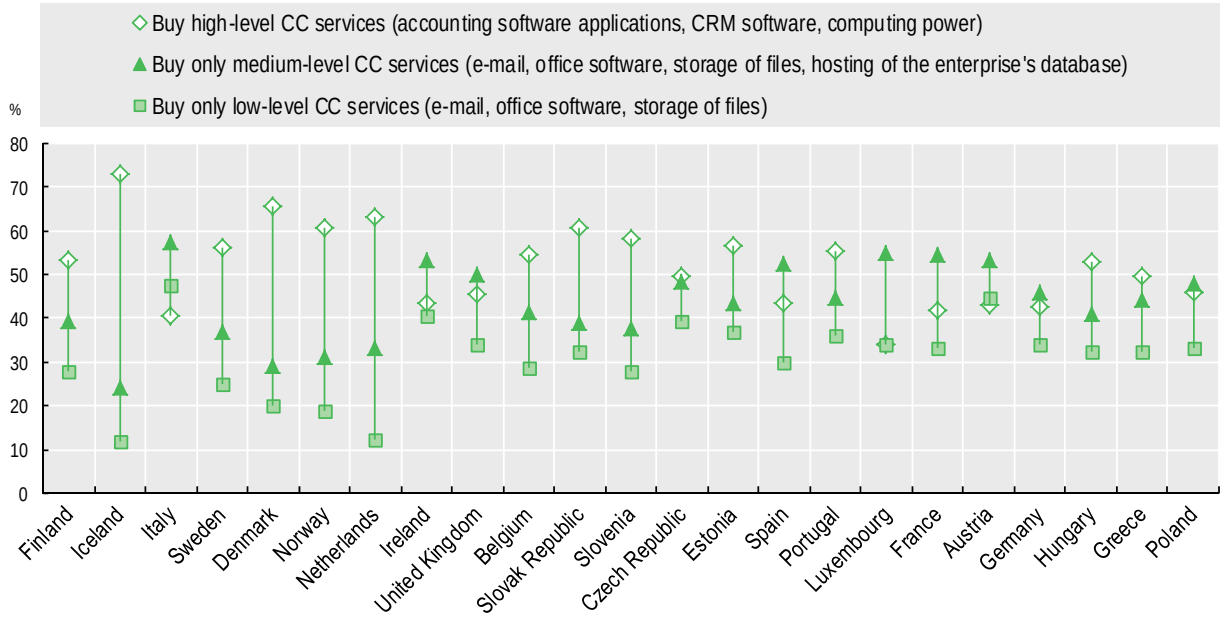
Percentage of enterprises with ten or more persons employed



Note: Supply chain management refers to the use of automated data exchange (ADE) applications. For countries in the European Statistical System, e-commerce variables (online purchases and online sales) refer to 2013. For Australia, Canada, Japan and Korea, data refer to 2013. For Mexico and New Zealand, data refer to 2012. For Switzerland, data refer to 2011.

Source: OECD (2015c), from OECD, ICT Database; Eurostat, Information Society Statistics and national sources, March 2015.

Figure E.6. Enterprises using cloud computing services, by type of services, 2014



Source: OECD (2015c), from Eurostat, Information Society Statistics, January 2015.

A survey of almost 10 000 US firms in digitally-intensive sectors (USITC 2014, Chapter 2) found that 98% of large firms use the Internet for internal communications (such as email, instant messaging, and videoconferencing), with 90% using it to communicate with other firms and 70% for customer communication. Interestingly, more SMEs used the Internet for customer communication (71%), even though their use of the Internet for internal and firm-to-firm communications was lower than that of large firms. SMEs were also bigger users of online advertising than large firms (64% versus 50%). Half of all firms used at least one social network to connect with customers and around 20% of firms had an app or mobile website.

Access to such Internet-based services can boost the performance of existing firms across a swathe of industries. In a report prepared for Google Australia, Deloitte (2015b) observed that internal business transformational change is taking place in Australia through use of cloud, data analytics and machine-to-machine technologies. Discussions with Xero, a provider of cloud-based financial platforms, pointed to the importance of these technologies for SMEs, which can not only gain time and reduce costs through cloud-based software, but increase their ability to monitor and manage their businesses. Importantly, the benefits are accruing to firms in all industries. Deloitte's interviews with a small sample of firms suggested that the use of technologies such as the cloud is not just happening in "digital" firms, but across the board – retail, manufacturing, finance, and business services (2015).

Internet-based services can also provide a launching pad for entrepreneurial activities by lowering barriers to participation. For instance, a study conducted for Facebook (Deloitte, 2015a) suggested that its biggest economic impact comes through marketing effects, as firms use Facebook tools to reach a huge ready-made audience. In particular, the ability to target and then fine-tune advertising through Facebook's insights into user characteristics offers firms a more cost-effective marketing option; the study also suggested the self-service, auction-based ad tool lowers the barriers to advertising for firms that may not have had the resources to engage in conventional advertising channels. Deloitte (2015a: 4) noted that as of June 2014, more than 30 million small- and medium-sized firms had established Facebook pages and more than 1.5 million firms were actively using Facebook's targeted advertising system.

The line is blurry between cost-effective inputs and explicit drivers of innovation, and some Internet-based service inputs clearly directly feed innovative activity. In fact, some believe innovation will be accelerated by technologies such as cloud computing, since it can be done "on the cheap and very fast" (Euchner, 2012). Financial resources are not needed to build infrastructure, there is access to sophisticated inputs (e.g. scientific instrumentation), and prototypes can be built more efficiently and tested in the market. John Seely Brown, former director of the Palo Alto Research Center (PARC), believed that this enabled the innovative edge to actually build a business, not simply feed innovation back to the core to exploit – in other words, enabling the formation of new business units (Euchner, 2012). (In this case, the edge can be interpreted as the nimbler fringes of the enterprise community, not the edge of the technical Internet network.)

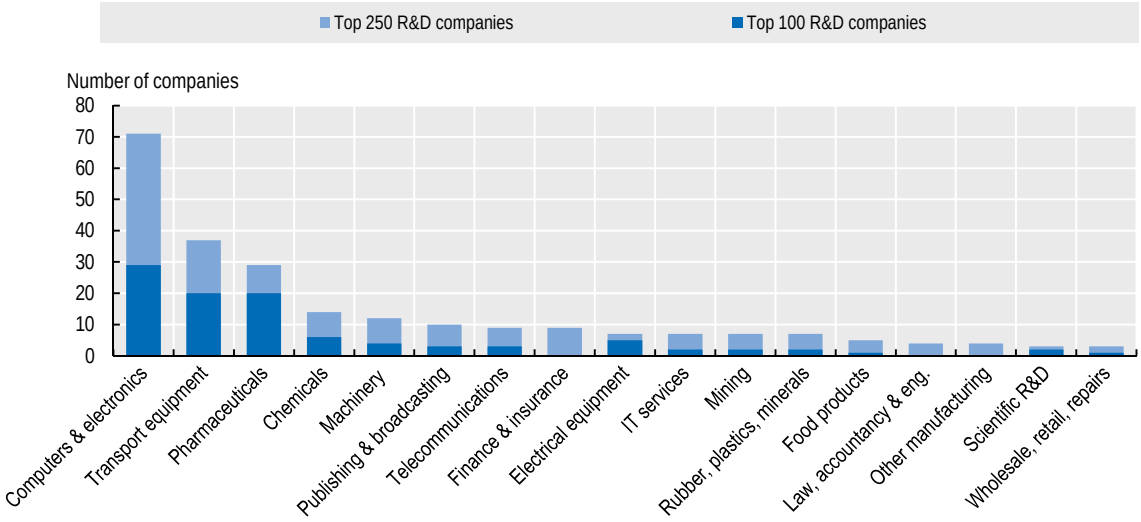
Further evidence comes from a survey of young entrepreneurs by Accenture (2013). It uncovered a strong bias towards the use of new technologies, especially those based on the Internet, for innovation. Of the respondents, 78% said innovation was one of the top strategic priorities for their company and 85% said new technologies were critical or important to support and enable innovation in business processes. After cost efficiency, the creation of new products or services plus quality improvement and management were the main benefits of technology-driven innovation. The survey, targeting 1 000 entrepreneurs aged 40 or younger, based in G20 countries, who were founders, owners or co-owners of a private business, clearly showed the importance of digital technologies, generating the observation that "every entrepreneur is a digital entrepreneur" (Accenture, 2013: 10). Social technologies were the most common technology currently being leveraged by entrepreneurs, followed by mobile technology, data analytics, the Internet of Things and cloud computing.

E.4 The ICT sector as an innovator

The ICT sector itself contributes to innovation. In terms of innovation inputs, data show that "ICT equipment" and "Information and communication services" are key R&D-performing sectors in many OECD countries. Except for Austria, Denmark, France, the Netherlands, the Slovak Republic and Slovenia, one or both of these industries feature(s) in the top three R&D performing industries of all OECD countries, as measured by industry R&D expenditure (OECD 2015b[34]). In Europe at least, the ICT manufacturing and IT services sectors also almost universally have a higher share of innovative enterprises than the manufacturing and innovation core service activities sectors as a whole (OECD 2015b[35]). This is

suggested also by Figure E.7, which shows that the computers and electronics sector outstrips by a large margin other industries in terms of its share of the top corporate R&D players in the world. In terms of outputs, the growth rate of patents in new generation ICTs is outstripping that of the patent field in total (Figure E.8), indicating that this sector's investment is generating innovation.

Figure E.7. Top 100 and 250 corporate R&D players by industry, 2012

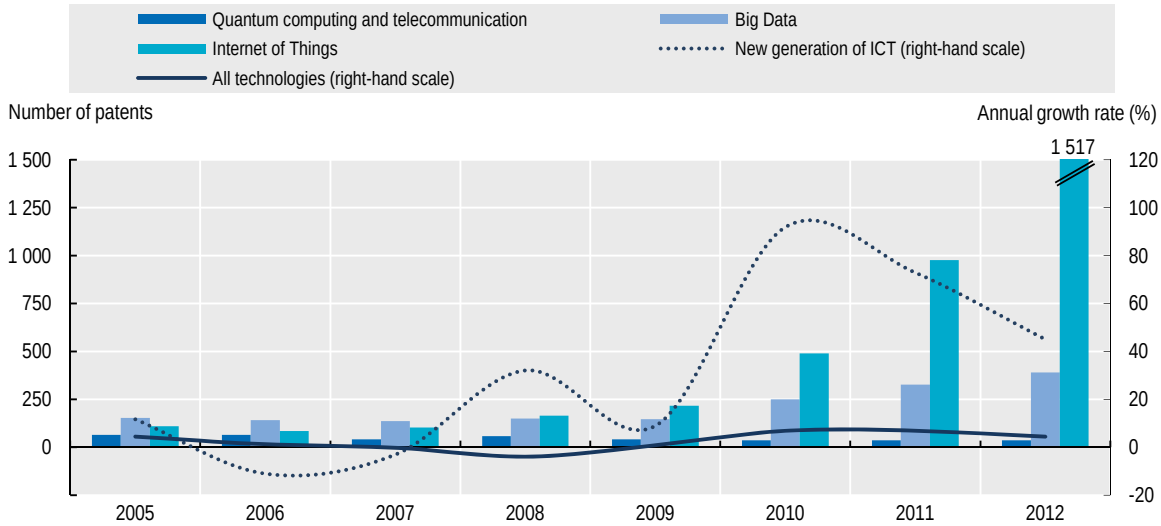


Note: Data relate to companies in the top 2 000 corporate R&D sample, ranked by R&D expenditures. Industries are defined according to ISIC Rev.4.

Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, June 2015. In OECD (2015b) http://dx.doi.org/10.1787/888933273426.

Figure E.8. Patents in the new generation of ICT-related technologies, 2005-12

Number of IP5 patent families and annual growth rates



Note: Patent data refer to IP5 patent families by first filing date. The Intellectual Property Office (IPO) of the United Kingdom has allocated patent documents to technology fields. For further details on IPO's patent landscape reports on Eight Great Technologies (October 2014), see www.gov.uk/government/publications/eight-great-technologies-the-patent-landscapes.

Source: OECD calculations based on IPO (2014), Eight Great Technologies: the Patent Landscapes, United Kingdom and STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, June 2015. In OECD (2015b) http://dx.doi.org/10.1787/888933273482.

ANNEX F: ICTS, THE INTERNET AND MACROECONOMIC PERFORMANCE

In the 1980s and 1990s, people were puzzled about why the widespread use of computers was not being reflected in productivity statistics.[36] OECD work in the early 2000s suggested that while a few OECD countries were experiencing a surge in MFP growth, notably in their ICT-producing industries and in some ICT-using services such as wholesale and retail trade, many countries were not seeing such improvements (OECD 2001: 23-24). At that time, three factors were put forward to explain the puzzle: quality improvements not being picked up in productivity statistics; diffusion and adoption of technology taking time and requiring complementary investment (e.g. in skills); and, assuming ICT lifts MFP in part via the networks it provides, taking time to build networks large enough to have an effect on the economy.

Now, data show that on average, information industries[37] have labour productivity that is 60% higher than that of the total economy in OECD countries (OECD 2015b: 37). There is also evidence that business sector services with the highest labour productivity tend to be more exposed to international competition and use modern ICTs (OECD 2015g). Financial and insurance activities are a notable example of this. However, it remains technically difficult to measure the extent to which diffusion of ICTs boosts productivity in ICT-using sectors (see OECD 2012a: Annex A for a discussion of methodological considerations in measuring the Internet economy). The challenge of adoption also remains, spurring work on stimulating digital innovation amongst users, particularly SMEs (OECD 2016c forthcoming). This all suggests that the impact of ICTs on productivity may be both underestimated and yet to come, putting a premium on policies that place as few barriers as possible to widespread ICT adoption and use. Indeed, Blix (2015: 107) noted the speed of improvement in productivity growth depends on a variety of regulatory and institutional barriers.

Of course, "ICTs" do not equal "the Internet", and to find evidence of the link between the Internet and productivity, we typically need to turn to firm-level data and case studies. At the aggregate level there are many other factors that may mask the link – indeed, it is likely that poor economic performance, low levels of infrastructure and low levels of Internet provision and adoption go hand-in-hand. One example of more disaggregated evidence is an analysis of ADSL broadband rollout in the United Kingdom over the period 1999-2004, which suggested that there is a positive causal relationship from ADSL enablement to ICT intensity and from ICT intensity to labour productivity in a firm (Mölleryd, 2015). The results further suggested that ADSL induces firms to invest in a certain type or combination of ICT that leads to substantially higher productivity gains than would be seen from basic computer use.

Other studies have also focused on the impact of broadband – a review of evaluations of the local economic impact of broadband found that it can positively impact firm productivity but the effects are not always positive, are not necessarily large and may depend on complementary investment (What Works Centre 2015: 24). The review suggested productivity effects can vary across different types of workers, with skilled workers possibly benefiting more than unskilled. Importantly, though, the review only included two studies that directly compared broadband adoption with provision, and noted that the effects may differ (i.e. in a similar argument to that above, where ICT adoption is key to seeing productivity effects more widely). The review clearly highlighted the need for further work, since of more than 1 000 policy evaluations and evidence reviews from the United Kingdom and other OECD countries, it found only 16 impact evaluations that met the minimum quality standards for inclusion in the study (ibid. 4).

Case study evidence produced by the Swedish Agency for Growth Policy Analysis, conducted on four ICT-using firms, showed that digitalisation is becoming a part of core business and is offering significant opportunities for cost savings (Ek, 2014). The Agency looked at Boliden (a connected mine), HL Display (a digital value chain), Skistar (digital skiing) and Scania (connected vehicles) and found several similarities in their experiences – first, that while ICT investments have already reduced costs, future costs savings are expected to be much larger; second, that the implementation of new technology has been accompanied by changes in day-to-day operations and new business offerings; and third, that while big data analytics is underway, there is still some distance to travel to put these capabilities to profitable use.

ANNEX G: SOME ADDITIONAL SOCIAL BENEFITS OF OPENNESS

G.1 Better transportation services

Openness makes it more feasible to collect large pools of data for "big data" analytics, a set of tools and practices that have been producing considerable social benefits in many areas, including transportation (OECD, 2015a). For instance, Dublin, Ireland combines real-time data streaming with traffic information to map city bus locations and reduce traffic jams. (Center for Data Innovation, 2013) (citing Bertolucci, 2013.) Waze is a traffic and navigation app that pools data from drivers' mobile devices, analyses it, and yields real-time traffic and route information, thereby shortening commute times and saving fuel costs. Other apps help commuters by telling them when the train is coming. These services work because of technical, end-to-end openness. Data can flow seamlessly across the Internet from the bus or train to any user's device that can connect to the Internet and use the app.

Transportation would likely be a good area for further research on the social benefits of openness. Cars that have a limited ability to drive themselves, for example, have begun to appear on the market and their functionality and popularity are expected to increase. These cars connect with and depend on data that flows over the Internet. The need for at least a certain amount of openness is obvious because as the cars themselves cross borders, their need for data will cross with them. One might expect the benefits of these cars to include reducing the frequency of accidents and freeing people who would otherwise have to focus on driving to spend their time on other things. Transportation-related peer platforms (e.g. Uber, BlaBlaCar) depend on Internet openness, too, and generate both economic and social benefits that merit further study. Indeed, exploring the peer platform economy is the topic of Panel 3.1.

G.2 Helping asylum seekers

Due to the ongoing conflict in Syria, more than 4 million Syrian citizens have fled their country in recent years (United Nations High Commissioner for Refugees, 2015). Many of them have been making the journey to Europe to seek asylum. Crossing the Mediterranean Sea and getting into Europe is costly, dangerous, and difficult, and some of these journeys have ended tragically. Boats capsize, human traffickers take money but do not always deliver on their promises, and in some places refugees have been beaten or teargassed by police. During the first nine months of 2015, nearly 4 000 migrants died around the world and more of them died in the Mediterranean region than in any other area. European governments have been changing their policies in response to the influx, leading some to put up barriers (Esri, 2015).

The openness of the mobile Internet is helping refugees, including asylum seekers. Smartphones, with access to maps, global positioning apps, social media, WhatsApp and Skype, have become essential tools that refugees use to post real-time updates about safe routes, arrests, border guard movements and transportation options, as well as places to stay and prices. Once in Europe, apps are helping them to find work, obtain residency permits and open bank accounts. Furthermore, the mobile Internet is making it less costly to make the journey out of the Syrian war zone, putting asylum within reach for more people. As one relief worker observed, "Right now, the traffickers are losing business because people are going alone, thanks to Facebook. [T]he prices charged by traffickers have gone down by about half since the beginning of the conflict." In fact, the mobile Internet has been so helpful that the United Nations has distributed tens of thousands of SIM cards to Syrian refugees (The Times of India, 2015).

All of these results depend on the end-to-end principle, among other elements of openness. The smartphones and apps have to work, and work consistently, wherever the migrants find themselves and whatever devices they are using. Simply put, the free flow of data across borders is helping *people* to cross borders. For them, the social benefits of openness are real and significant indeed.

G.3 Facilitating political speech and freedom of assembly

From the Arab Spring to the Occupy movement and the more recent protests in Hong Kong, Internet openness has helped people around the globe to express their political views to each other, to their governments, and to the world. Similarly, it has helped them to organise, mobilise, demonstrate, and in some cases, even to depose dictators. In Egypt's 2011 uprising, for example, citizens used Facebook, Twitter, Flickr, blogs and other online tools to report on strikes, alert their networks about police activity, organise legal protection and draw attention to their efforts (Alghoul, 2015; see also Gustin, 2011). Then, in an interesting turn of events, Occupy Wall Street protesters in established democracies learned from the Arab Spring demonstrators and used similar online tactics to advance their cause (Saba, 2011).

The fact that repressive regimes have used a variety of methods to restrict Internet openness, including censorship, mass surveillance, and cutting off Internet access altogether, suggests that openness is effective in helping people to make political statements, to assemble and to demonstrate. The Egyptian government's Internet shutdown in response to the anti-Mubarek demonstrations in 2011 was mentioned earlier. In April 2013, Aleppo — Syria's largest city, which was held by rebels at the time — was suddenly and completely cut off from the Internet. The Washington Post observed that "Internet outages in Syria have a curious history of happening at times convenient for the Assad regime" (Peterson, 2013).[38] DPRK, Iran, China and Viet Nam have fully or partially blocked Facebook, Twitter, and/or YouTube (Berners-Lee, 2014).

Future work on the social benefits of Internet openness could encompass a great many other factors, as mentioned at the start of Section 3.5. Improved government transparency and accountability, for example, facilitate citizens' access to information such as tax forms, how and where to renew licenses, how tax dollars are being spent, how lawmakers are voting on proposed legislation, and what the sources and amounts of campaign contributions are. More affordable international remittances help fight poverty. More convenient charitable giving has obvious social benefits, as does faster, more efficient disaster recovery. A host of other social benefits are discussed in Atkinson & Castro (2008).

ANNEX NOTES

1 Note that "interoperability" as the term is used here refers to interoperability with the network. It does not imply that devices sitting outside the network must be interoperable with each other, but only that the protocols used by the network should be available to device makers so that they can make their products compatible with the network. Thus, for example, iPhones and Android phones can both connect to the Internet, but they run on different operating systems.

2 Address allocation and registration has been an evolutionary process. The original address administration and registry function was managed through United States research agencies. The evolution of that model led to the creation of five "Regional Internet Registries," each of which serves the address allocation and registry function needs of regional communities. The practices relating to access to address space through allocation and assignment are based on policies developed by the respective address communities in each region. The general theme of these policies is one of "demonstrated need", where addresses are available to applicants who can demonstrate their need for these addresses within their intended service infrastructure.

3 Currently, all destinations on the Internet do not have a unique IP address because there is a scarcity of IP addresses to allocate under the IPv4 standard. This problem, along with a solution, is discussed in Part C.1. of Annex C, "The slow transition from IPv4 to IPv6".

4 The full citations are OECD (2013), *The OECD Privacy Framework*, OECD Publishing, Paris, available at: www.oecd.org/sti/ieconomy/oecd_privacy_framework.pdf, and OECD (2015), *Digital Security Risk Management for Economic and Social Prosperity: OECD Recommendation and Companion Document*, OECD Publishing, Paris, available at: http://dx.doi.org/10.1787/9789264245471-en

5 Requests related to copyright infringement use standard notification formats and work much better than all other types of requests (related to everything from cybercrime to online defamation). Rights holder organisations are running high volume notice and takedown programs enabling the removal of infringing content, reducing internet traffic, and therefore revenues, for blatantly infringing sites. Furthermore, some governments have tried to make the reporting and removal process more efficient. For example, French authorities have mobilised the 'PHAROS' platform for reporting and removing content that endangers the public order (terrorism, incitement to hatred, racism, pedophilia, scams, etc.). This platform works in close interaction with Internet providers.

6 "Data analytics refers to the set of techniques and tools used to extract information from data by revealing the context in which the data are embedded, their organisation and their structure . . . Data analytics reveals the signal from the noise and with that the data's manifold hidden relations (patterns) including correlations, and interactions between facts, entities, and concepts" (OECD 2015a, p. 452).

7 See https://www.google.org/flutrends/about/.

8 As discussed earlier, we are not seeking to make quantitative links between Internet openness and societal benefits in this report.

9 Hofheinz and Mandel's concept of "digital density" (the amount of data used per capita in an economy) as a proxy of data usage is based on Cisco IP traffic forecasts for major countries, which are built on a series of estimates of user numbers, adoption rates, minutes of usage and bitrates to obtain a per month traffic estimate (see Cisco 2015a,b). Hofheinz and Mandel (2015) acknowledge that using this as a proxy for consumption of cross-border data flows is a leap, but propose this measure gets closer to data usage than other measures of cross-border data flows.

10 See https://thenetmonitor.org/ for further details on the Berkman Center's initiative.

11 Equally, one could seek to explore the costs of fragmentation / reductions in Internet openness. However, recognising that not all fragmentation is "bad" (e.g. restrictions on child pornography online), this work seeks to look at the benefits side of the coin. In practice, evidence from both angles is incorporated where relevant.

12 There is no definitive statistic on the share of Internet traffic accounted for by Google, but various reports have suggested it is important. For instance, in mid-2013, Google was estimated to account for 25% of all consumer Internet traffic through North American ISPs (McMillan, 2013). Also in 2013, a 5-minute outage of Google services was associated with a drop in global Internet traffic of 40% (Blodget, 2013). And Weller and Woodcock (2013: 10) noted that Google ranked third among networks in global traffic carried, behind Level 3 and Global Crossing. Nevertheless, Google searches are not the only point of entry to the Internet. Amazon, for instance, receives about 65% of its traffic directly and through referrals, with search only accounting for around a quarter of its traffic (according to data from Similarweb – see www.similarweb.com/website/amazon.com [accessed 23 November 2015]). And social media and apps are increasingly utilised as entry points – for instance, Facebook accounts for more traffic to news sites than does Google (Ingram, 2015).

13 Information from Paypal's Media Resources – Q4 and 2015 Earnings Release (accessed 2 February 2016): https://www.paypalobjects.com/digitalassets/c/website/marketing/global/pages/stories/docs/paypal-q4-and-2015-earnings-release.pdf

14 See information at the .nz Domain Name Commission, https://dnc.org.nz/the-commission/faq.

15 See ICANN's list of TLDs and registrars: https://www.icann.org/registrar-reports/accredited-list.html

16 See https://www.google.com/insidesearch/howsearchworks/algorithms.html.

17 The .edu domain's sole registrar is Educause, an association for information technology in higher education. Eligibility for the .edu domain name is restricted – see http://net.educause.edu/edudomain/eligibility.asp.

18 See, for example, www.nytimes.com/2013/11/14/health/new-tool-to-ease-difficult-births-a-plastic-bag.html?_r=0

19 It is possible that the data underestimate locally hosted sites, e.g. in cases where content may be presented in a national and international version (a newspaper may, for instance, have a site hosted in the country for local users, and another abroad in a location close to its international readership) or in cases where content delivery networks (CDNs) are used to distribute data. In each case, these would have shown up as hosted outside the country in the dataset (OECD, 2014b).

20 OECD (2014b) identifies three types of data centres: 1) in-house data centres, located with their organisation; 2) third-party data centres (or co-location facilities) that offer space to clients and compete on location (sites are often around large cities, capitals and financial centres), interconnection and energy efficiency; and 3) Internet industry data centres, e.g. for Amazon or Facebook, for which energy and land costs are crucial.

21 Data obtained from Packet Clearing House https://prefix.pch.net/applications/ixpdir/menu_download.php (download 20 October 2015).

22 OECD (2014b) notes that carrier-neutral data centres endeavour to get IXPs into their facilities as this means interconnection with many networks is possible.

23 Data from PCH as noted above.

24 Weller and Woodcock (2013, Annex 4) describe how peering agreements, which comprise over 99% of all traffic exchange agreements, are constructed on the basis of equitable cost-revenue sharing between partners. This in turn relies on a distribution of IXPs that allows ISPs to have a similar balance of short- and long-haul paths to their traffic partners, so neither is bearing disproportionately high costs.

25 The Internet Society (2014b: 23) shows an example where traffic is destined for local termination and is either "local", "near" or "far" from the IXP. Colocation costs are estimated at USD 1 000 per month, peering fees at USD 2 000 per month, equipment costs at USD 2 000 per month, and transport into the IXP ranging from USD 2 000 to USD 6 000 per month depending on the distance. With an IP transit cost of USD 3.50 per MBPS (estimated from information from ISPs), the breakeven point to join the IXP ranges from 2 000 to around 3 140 Mbps.

26 See the Australian Bureau of Statistics Internet Activity Survey (catalogue 8153.0).

27 Presentation of this kind of data could take inspiration from the Internet connectivity maps produced by Larry Landweber in the 1990s (http://internethalloffame.org/news/in-their-own-words/larry-landweber-play-lab-world).

28 Fitjar and Rodríguez-Pose based their findings on a survey of 1 604 firms of more than 10 employees in Oslo, Bergen, Stavanger, Trondheim and Kristiansand.

29 For data see http://dx.doi.org/10.1787/888933273861.

30 For data see http://dx.doi.org/10.1787/888933273347.

31 Patents are by no means a perfect indicator of innovation; however, the wealth of data available on patents means they are a well-accepted measure that helps shed light on innovation patterns.

32 For data see http://dx.doi.org/10.1787/888933273980.

33 In this study also, website country of origin was identified by country suffixes and therefore may not represent the actual "nationality" of the website. However, if taste-dependent and non-taste-dependent websites are equally likely to adopt different nationalities then the results should still hold.

34 For data see http://dx.doi.org/10.1787/888933274128. Data do not include Chile, Ireland, Luxembourg or New Zealand.

35 For data see http://dx.doi.org/10.1787/888933274183.

36 This was referred to as the "Solow paradox", attributed to economist Robert Solow.

37 Namely ISIC Divisions 26 (Manufacture of computer, electronic and optical products), 58-60 (Publishing and broadcast industries), 61 (Telecommunications), and 62-62 (Computer programming and information services).

38 The Post added that 92 % of Syrian Internet traffic went offline in November 2012, when rumours were spreading that the regime was mixing chemical weapons, and that 78 % went offline in January 2013 when President al-Assad gave a rare televised address (Peterson, 2013; Quinn, 2012).