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# The Impact of Internet in OECD Countries

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## Working Party on the Information Economy

# THE IMPACT OF INTERNET IN OECD COUNTRIES

**English - Or. English**

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## FOREWORD

This report was presented to the Working Party on the Information Economy (WPIE) in December 2011. It was declassified by the Committee for Information, Computer and Communications Policy (ICCP) in March 2012. The report was prepared by Mr. Piotr Stryszowski. It is published under the responsibility of the Secretary-General of the OECD.

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# THE IMPACT OF THE INTERNET IN OECD COUNTRIES

## Main Findings

The Internet significantly affects OECD economies at different levels and in numerous different impact areas. In particular the Internet impacts firms in various sectors, individuals and governments. It also has some observable general macro-economic effects.

At the firm level, the restructuring of business models in association with use of the Internet has led to improved efficiencies.[1] The impact of the Internet can also be seen in the rapid growth of new firms founding their businesses on the Internet. The Internet's enhanced communication capabilities are affecting nearly all sectors of the economy in ways that may be as subtle as making previously hard-to-find data available online or as profound as transforming an entire market such as is occurring with music, video, software, books and news.

The Internet is reshaping the way individuals live. It brings benefits of higher consumer welfare (through a larger variety of digital goods and services, lower prices, improved information gathering, more distribution channels and so forth). In addition, individuals benefit from a more efficient labour market[2] and, on a broader level, from positive impacts on the environment[3] and in education.

For governments, Internet development enables better communication with citizens, industry and other organisations. The Internet has also helped governments run more efficiently via improved information sharing, increased transparency and the automation of various resource-intensive services.

The impacts of the Internet on the individual, firm and government level can be also observed at the aggregated, macroeconomic scale. Existing empirical studies, including ongoing OECD work, suggest a positive link between increasing Internet adoption and use and economic growth. Even though the aggregated effects are still preliminary, the relationship between Internet development and economic growth, as well as microeconomic evidence, suggest that governments should continue to pursue policies that help promote Internet connectivity and encourage the take-up of services. Many of these recommendations can be found in the OECD Recommendation on Broadband Development (OECD, 2004) and in Broadband Growth and Policies in OECD Countries (OECD, 2008b).

## Introduction

Today the question about the nature and magnitude of the relationship between the development of the Internet and economic performance is particularly relevant. Policymakers are designing new legal rules involving Internet intermediaries, debating new regulations in this area, and considering new investments in network development (*e.g.* government investments in networks in countries such as Australia, the United States and New Zealand.) To develop rules, regulations and policy, policymakers need to understand the role of the Internet in the economic processes at both micro- and macro-economic levels. To understand better the areas and magnitude of the economic impact of the Internet, the OECD has developed a research program that examines these issues.

There is a widespread sense that the impact of the Internet has a far wider reach than just the IT sector itself (see OECD 2007).[4] The Internet began as an important tool for improving communication but has transformed into a ubiquitous technology supporting all sectors across the economy. In fact, the Internet is now widely considered a fundamental infrastructure in OECD countries, in much of the same way as electricity, water and transportation networks. It can now be considered as having the characteristics of a general purpose technology.

Because of the universal, transformational character of the Internet, its economic impact can be observed in numerous different areas, at various levels. Today the Internet affects the everyday activities of individuals, firms, and governments in many ways. In addition, the Internet also tends to produce broader, economy-wide effects.

This paper informs policymakers about ways in which the Internet impacts economies, and about the levels and areas of impact. It is designed to structure and to assess the economic impact areas of the Internet at the individual-, firm-, and government-levels, as well as at the aggregate, macroeconomic level.

It begins with a short discussion of possible methods of quantitative assessment of both: the Internet and its economic impact. Indeed, in order to assess its economic impacts, one should first discuss the ways of measuring the Internet, which is challenging because the Internet itself is rapidly changing.

The paper then systematises the impacts that the Internet has at the individual, firm - and government-levels. For individuals, the Internet improves access to information, enables new communication channels and permits for more active participation in numerous market and social processes. Firms have been using the Internet as a way to reduce operational costs, improve access to information and facilitate communication over the last two decades. For governments, it improves the communication between citizens and the government and enables more efficient operations.

Finally, the paper discusses the general, macroeconomic effects of the Internet. Indeed at the general level, the Internet affects the structure of modern economies by enabling new methods of delivery, accelerating globalisation processes and promoting the emergence of new industry branches. This in turn translates into some observable effects that the Internet seems to have on economic growth.

The paper is structured in a way that combines existing academic literature with illustrative cases.

**Measurement issues**

Before the quantitative assessment of the Internet's macroeconomic impact can be undertaken it is important to discuss possible ways to measure and proxy the development of the Internet. Indeed, a reliable, aggregated proxy of the development of the Internet is an essential input for a thorough, robust and quantitative analysis of its impact (Lehr, 2012).

To date, the focus has been on measuring the availability and adoption of Internet access: initially offered through dial-up and currently through broadband connections. However, as noted by Lehr (2012), as the Internet evolves to become basic infrastructure and adoption saturates, the Internet economy will become increasingly indistinguishable from the overall economy. What will matter is how different firms, workers, or consumers utilise the Internet and then measurement becomes inherently more difficult.

The growth of the self-service economy and the changing role of consumers as producers of media content, participants in product design, promotion, and transaction processing illustrate this phenomenon. Separating consumption from production when the boundary between firm and customer blurs requires ever-more detailed information about the specific activities being undertaken. Increasingly detailed business and labour surveys will be needed to track how the Internet is being used to accomplish the varied tasks that go into business production. Initially, we may focus on the time spent using the Internet in different business functions (*e.g.,* research and development, supply chain management, retailing, or general and administrative tasks) or worker activities (*e.g.* web browsing, word processing, or communications).

The need for precise quantification is particularly visible at the macroeconomic level because is it vital for a robust quantitative analysis. For single cases, at the individual, firm- or government-levels, qualitative analyses are often sufficient. Indeed the illustrative examples of the impact of the Internet at these levels could be sufficient to demonstrate its narrow impact in a given firm or given case. An aggregation of individual cases should be supported with some quantitative analysis that in turn should use a single, quantitative proxy for the Internet use.

There are two main challenges related to the measurement exercise:

- First, the Internet is a young and rapidly changing phenomenon. Most available measures illustrate the past, not the current picture of the situation.
- Second, it is virtually impossible to pin down a single proxy that could consistently illustrate the development and intensity of use of the Internet. The heterogeneity in adoption behaviours across firms, households, and industries and the regional differences between Internet development strategies mean that creation of a single proxy becomes unattainable.

Consequently, all available proxies that refer to the Internet are to some extent biased, and omit some aspects of the economic development of the Internet or ways of its application.

Concerning the first point, any examination of the impact of the Internet is constrained by the fact that Internet technologies, services and use have been changing extremely rapidly. The shift from the early days of dial-up access, to DSL and ADSL2 and now fibre and high speed wireless, has considerably changed the utility of the Internet and the applications and services which can be provided on the Internet. The development of Internet technologies is difficult to measure because it is a general purpose technology that shows continuous improvement and stimulates innovation in products and processes, as well as reduces costs.

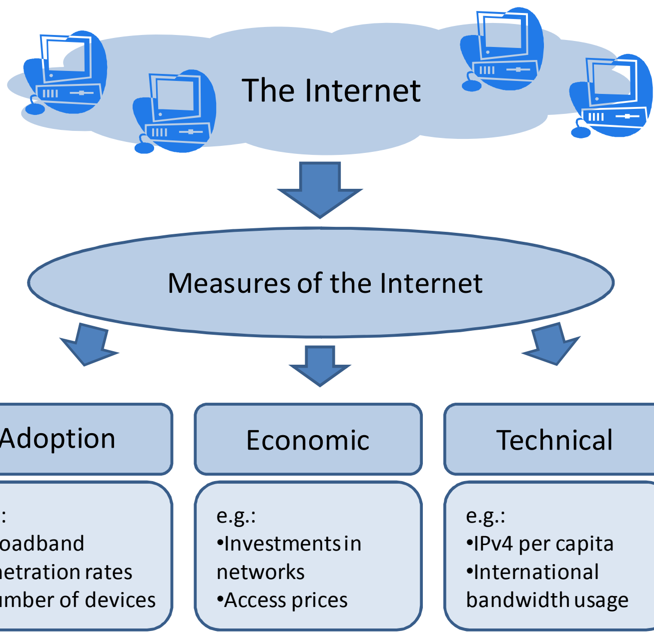
An insightful lesson can be learned from efforts to estimate the economic impacts of computers, broadband, and other information and communications technology (ICT) components. Although a number of firm-level studies were able to demonstrate the positive productivity contributions of computers in the 1990s (Brynjolfsson and Hitt, 1998; Lehr and Lichtenberg, 1999) it was not until after 2000 that the large contribution of ICTs to economic growth was demonstrable in macroeconomic data (Jorgenson, 2001).

As Lehr (2012) notes, this experience with the assessment of the economic impact of ICT offers several important lessons that are worth remembering as we turn our focus toward measuring the Internet. First, we will likely only be able to reliably estimate the economic impacts *after* the fact. Businesses and government policymakers needed to invest in ICTs *before* economists were able to demonstrate that economic impacts were, in fact, positive. Second, the first and best evidence of economic impacts is likely to come from micro-data (firm or smaller) before being visible consistently in macro-data (industry or national). It is also important to stress that benefits will best be captured when there is sufficient usage and organisational change to accommodate the new technology.

There is not just one way to measure "the development of the Internet" as it is becoming a ubiquitous and multidimensional technology. Moreover, available datasets are limited in terms of the number of years covered and this poses an additional constraint to performing a complete causality analysis.

The development of the Internet can be measured at a number of levels using various proxies (OECD, 2009f). These partial measures can be grouped in three broad categories: *i*) measures of adoption, *ii*) economic measures, and *iii*) technical measures (see Figure 1.)

**Figure 1: Proxies of the Internet**




Most of the existing literature relies on ***adoption measures,*** such as broadband penetration rates, as the proxy for the development of the Internet. The most common data set used by researchers is the *broadband penetration rate* (broadband subscriptions per 100 inhabitants) that is produced by the OECD.[5] Data on broadband penetration rates are collected on a quarterly basis directly from regulators and operators so they are highly consistent and reliable. Moreover, the available datasets are relatively large and the measures themselves are intuitive – higher penetration rates correspond to a greater "quantity of broadband services" that are "consumed in the market."

Unfortunately these proxies also have some drawbacks that limit their use as general measures of the development of the Internet.

- First, by their construction, data on adoption are size-limited by the saturation level of an economy. To put it differently, adoption measures cannot report balanced, long run growth rates since their growth ultimately stops once all interested parties have an Internet connection. Econometrically this issue can be addressed by applying a control variable; nevertheless this is a possible limitation that should be recognised throughout these types of analysis.

- Second, adoption measures only capture that a device is used, rather than the actual intensity and purpose of use of the Internet.

- Third, construction of some adoption measures might lead to underestimation of the true adoption rate. For example broadband subscription numbers may undercount the total number of users if connections are commonly shared within a household or business.

- Last, some of these measures[6] do not capture some alternative types of Internet connectivity, such as via dial-up or mobile broadband access using mobile devices such as smartphones.

The ***economic measures*** refer to the economic dimension of the Internet, and in most cases are expressed in monetary terms. Examples of economic measures include average monthly subscription rates, investments in broadband infrastructure or full port prices for backhaul capacity.

Given that the economic measures are expressed in monetary terms, they can be useful tools for cross-country comparisons and time-series construction. In addition these measures are very intuitive and can be easily standardised (*e.g.* by application of a PPP deflator or by expressing them in terms of GDP share). They can provide a good picture of the quickly evolving Internet environment.

The economic measures have certain drawbacks that limit their usefulness in an econometric analysis. First, prices are the final result of the mechanisms in the market for the Internet, and therefore cannot be considered a credible indicator of the actual state of the Internet. Technically speaking, these measures largely suffer from "endogeneity" because prices are influenced by the state of the Internet market. Second, they represent only the monetary dimension of the Internet on a given market, which does not necessarily correspond to the actual level of development of the Internet in that market.

The last category is ***technical measures*** of the Internet. Even though the Internet is heavily influenced by economic and social factors, its infrastructure is technical and can be measured in a number of ways. Although, these proxies are not as intuitive as the economic or adoption proxies*,* they partially illustrate the intensity of use of the Internet in a given economy.

Examples of technical measures include the number of IPv4 addresses per capita[7] and the number of autonomous systems[8] per capita.

Apart from the technical meaning, these proxies have certain economic features that make them potentially useful proxies of the Internet's development and use. For example, data on IP addresses to some extent illustrates the number of connections to the Internet with their own unique IP address. Hence, they can be considered as a proxy of the use of the Internet by individuals and the industry. Moreover, some of these technical proxies cover all the different ways of accessing the Internet; (*i.e.* via broadband, dial-up and business leased lines).

There are several potential problems related to the use of technical measures as a proxy of the Internet. Since these proxies are by construction technical, there are certain imperfections in the way they illustrate the usage of the Internet. In this context, two measures, *the number of IPv4 addresses per capita* and *the number of autonomous systems per capita* can provide illustrative examples.

In the case of IPv4 addresses, multiple devices often share one IP address. This is possible due to a technical process called network address translation (NAT) that can be used in routers to share one IP address among a number of devices/computers. NAT is commonly used in households (*e.g.* home routers) as a way to share one broadband connection among multiple devices but it is much less commonly deployed by fixed ISPs to individual homes given many ISPs in OECD countries have sufficient IP addresses to accommodate their existing subscriber needs. This implies that the number of IP addresses per capita could underestimate the actual level of the Internet's use and development.

Moreover, in case of allocated IP addresses, an allocation of the IP addresses does not imply they are in use, as many of the IP addresses are not used at all. This in turn could lead to a bias in cases when *allocated* IP addresses are used as a proxy. For allocated IP addresses to be "visible on the public Internet, organisations must publish the addresses in the Internet routing tables, which list the "routes" to network destinations. It is important to note that even if addresses are routed on the public Internet, they are still not necessarily used (OECD, 2011b). Concerning individual networks on the Internet, or "autonomous systems", it is important to keep in mind that network operators have various strategies for configuring their networks. For example, an international operator may choose to use different AS numbers for different countries where it operates or simply use one AS across multiple countries. It must be noted that in some cases, a country could have widespread broadband infrastructure but a relatively small number of AS numbers. Australia is an example of this case. These limitations need to be considered when the AS proxy is employed.

Table 1 summarises the measures discussed above.

Table 1. **Measures of the development of the Internet**

| Type | Example of indicators | Benefits | Drawbacks |
|---|---|---|---|
| ***Adoption measures*** | **- Broadband penetration rates** (Number of broadband subscriptions per 100 inhabitants in the economy.)<br>- **Number of devices** connected to the Internet per capita | - Simple intuition behind the data; refers to the basic economic concept of quantity traded on the market<br>- Dataset consistent across the countries | - Upper limit of growth set by the saturation level of an economy<br>- Difficult to illustrate actual use of the Internet.<br>- Some measures do not capture alternative Internet connectivity.<br>- Broadband subscriptions can be shared by more than one user |
| ***Economic measures*** | **- Minimum/average monthly subscription prices**<br>**- Full port prices** (international Internet traffic)<br>**- Investment intensity in network development** | - Intuitive<br>- Provide good intuition about the changing environment (consistent over time)<br>- Good tool for international comparisons | - Limited use for econometric analysis due to the endogeneity problem<br>- Presents the outcome of the market mechanisms, not the state of play |
| ***Technical measures*** | **- IPv4 addresses per capita**<br>**- Autonomous systems per capita**<br>**- International bandwidth usage by country** (Mbps) | - Proxy the actual intensity of use of the Internet in a given economy<br>- Illustrate all ways of connecting to the Internet (broadband, mobile…) | - Not intuitive<br>- Number of devices may be under-reported because multiple devices can share one IP address<br>- Number of connections may be over-reported if a given IP address is allocated but not routed. Even routed addresses are not necessarily used.<br>- IPv4 addresses are mostly useful as a historical indicator because the various Internet registries started to run out of previously unallocated IPv4 addresses in 2011 and have made their allocation policies much stricter.<br>- The number of autonomous systems can under-represent the level of Internet development in cases where network operators use one AS to cover a large portion of their network footprint (*e.g.* Australia) and is also a reflection of allocation policies put in place by regional Internet registries (RIRs). |

**Existing evidence at the individual, firm and government level**

The economic influence of the Internet can be seen in various areas of the economy, from consumer welfare and firm-level productivity to the environment and education. This influence affects individuals, governments and firms. This section will provide examples of Internet impacts across various sectors in the economy. It cannot even begin to capture the benefits in a given sector but is rather a set of examples showing areas where the Internet is having a significant impact.

Table 2 summarises principal economic impact areas of the Internet on individuals, governments and firms.

Table 2. **Examples of main impact areas and principals effects of the Internet**

| Impact area | Principal effects | Main affected parties |
|---|---|---|
| Consumer welfare | - Positive impact on consumer welfare and on social capital formation (*larger variety of primarily digital goods and services, improved information gathering, more distribution channels, lower prices of some goods*)<br>- Privacy and security concerns. | Individuals |
| Employment | - Several positive effects on employment (*smoother search and matching processes in the labour market; enabled teleworking*)<br>- Potentially reduced demand for lower skilled tasks. | Individuals, firms |
| Business environment | - New business models (*e-commerce, digital delivery, e-banking*); enabled emergence of the "digital economy"<br>- Higher business uncertainty and volatility, particularly in sectors under transformation. | Firms |
| Firm performance | - Cost savings and efficiency enhancement.<br>- Rapidly changing technological environment that requires certain skills. | Firms |
| Environment | - Internet-enabled environmental solutions (*smart grids, telework, cloud computing*).<br>- Potentially significant Internet environmental footprint | Individuals, firms, governments |
| Education and research | - New possibilities for improving educational processes (*e-education*), new possibilities for scientific research. | Individuals, governments |
| Healthcare | - Complex, Internet-enabled solutions offering ways to improve healthcare efficiency (*e-health, monitoring, research*) | Individuals, firms, governments |
| Government activities | - Improved efficiency of activities and improved communication with citizens, industry, and other organisations (*e-government*) | Governments, individuals, firms |

Source?

### *Consumer welfare*

One of the main ways the Internet affects individuals is through improvements in **consumer welfare**. These effects are manifested in a variety of ways. For example, the Internet affects consumer welfare through new distribution channels for existing products (*e.g.* e-commerce, digital delivery of music, video or software). In addition, more efficient search mechanisms for locating information and better availability of assessment of a given product can lead to lower prices of some consumer goods.[9] Consumers also benefit from new ways of addressing consumers needs on line, often at very minimal cost (*e.g.* e-mail) or completely new products or services (*e.g.* community portals). Another area where consumer surplus is affected is through better access to knowledge and education (*e.g.* Google e-books). Together, these impacts translate into a significant improvement in individual utility, and on aggregate, into a global improvement in consumer welfare.

Only a part of these impacts has been quantified. Certain effects, although significant and observed, cannot be economically measured and expressed in economic value terms. This, for instance, refers to the satisfaction individuals derive from various services offered through the Internet such as with participation in social networks (see Box 1) Several studies indicate that on-line social networking websites such as Facebook or MySpace tend to contribute to the social capital formation that, in turn, can raise individual perception of well being (Shah *et al.,* 2001; Gibson *et al.,* 2009.) These benefits are, however, a challenge to capture quantitatively.

Several studies provide empirical evidence about the positive and measurable impact of the Internet on consumer welfare (Morton, 2006; Dutz *et al.,* 2009; Greenstein and McDevitt, 2011 and 2012). These studies focus mostly on the consumer's economic benefits that arise from affordable access to the Internet so their findings are limited to only one (although noticeable) component of consumers' welfare.

The development of the Internet is also related to certain threats security and privacy threats for consumers that could in turn potentially reduce consumer welfare. For example, data is increasingly under threat from criminals who are able to make fraudulent use of identity information gained through phishing or malicious spam, and more generally, techniques called malware (short for malicious software). Malware has become a critical threat to the security of all who use the Internet (OECD, 2010b).

**Box 1. Online social networks and well-being**

On line social networks (*e.g.* Facebook or MySpace) are often cited as prominent examples of services that mostly rely on advertisement-based business models, and that are enabled by the rapid development of the Internet. Whereas certain social networks can primarily serve business and professional networking purposes (*e.g.* LinkedIn), most of them are designed solely for social networking.

According to recent studies, online social networks are an important medium of formation and maintenance of social capital. Some research has shown, for example that these networks are particularly useful for people who otherwise have difficulties generating and maintaining interpersonal relationships. On-line social networks can lower barriers to interaction, encourage people to interact socially and increase psychological well-being.

Even though these impacts can to some degree observed and quantified at the individual level, it would not be possible for individual benefits of the Internet or the "benefits of happiness" to be taken into account and aggregated into broader economic measures (*e.g.* as a component of GDP).

*Source* : Bargh, McKenna, and Fitzsimons (2002), Bargh and McKenna (2004), Ellison, Steinfield and Lampe (2007).

### *Employment*

Individuals are affected by the Internet through its impact on **employment** through several channels. First, the development of the Internet and related communication technologies results in a significant improvement in information access, which in turn smoothes search and matching processes on the labour market (see Box 2). Second, the Internet generates a large volume of employment in the IT sectors of the economy due to Internet-generated economic activity. Third, the Internet introduces additional flexibility in the labour market that can make it more productive via Internet-enabled solutions such as telework or remote access to computing resources. Telework, in particular, could bring people into the workforce who may otherwise not have employment opportunities in their geographic area.

The rapid development of the Internet could also have some negative effects on total employment, through changes in demand for various types of labour (Bresnahan *et al.,* 2002) and its labour-saving effects. This could be observable in the case of low-skilled workers who cannot effectively use new technologies and information-intensive jobs that can be replaced by the introduction of some Internet technologies (Spiezia and Vivarelli, 2002).

Added together, these microeconomic mechanisms should have an observable impact at the broader level. Indeed, several macroeconomic studies tend to provide empirical support for this claim, suggesting that the measured positive effects from Internet access outweigh the negative. For example, Crandall, Lehr and Litan (2007) find a positive relationship between the use of the Internet (measured by broadband penetration rates) and employment in a given industry.[10] Similar findings that suggest a positive impact of the Internet on employment were presented in a paper by Lehr *et al.,* (2006), who used a panel data set at the zip-code level for the United States.

**Box 2. Internet helping to drive recruiting and job-search**

A growing number of companies actively use social media for recruitment purposes, particularly when searching for specific skills. These include the most popular social networks like LinkedIn or Facebook, but also other social media services like Twitter. This is paralleled by a reduced intensity of use of traditional methods for employee searches such as job boards or the use of external recruitment companies. Searching via social media has proven to be efficient for many companies who have successfully hired employees using the services.

The growing impact of the Internet on labour market processes from the job-seekers perspective is also confirmed by the Institute for Employment Research of the University of Warwick. The findings point at the rapidly increasing trend of using the Internet to look for work over the past years. At the same time, the study highlights a dynamic and complex "digital divide" in the use of the Internet for job-search reasons.

*Sources:* Jobvite (2010),
Labour Force Survey (LFS), available at: http://research.dwp.gov.uk/asd/asd5/,
Boston Herald, “Recruiters find job seekers in most unlikely places”, 14 March 2011 at:
*http://www.bostonherald.com/business/general/view/2011_0314recruiters_find_job_seekers_in_most_unlikely_places/*

### *Business environment*

For firms, the emergence of the Internet implied a significant re-shuffle of the existing **business environment**. For many firms, especially small and medium-sized companies, the Internet extends the geographic reach of their market significantly and allows for extended inter-firm communication opportunities. This lowers the costs of accessing suppliers or wholesale markets and, in many cases, eliminates the need for intermediaries. For a number of companies and industries, the Internet opens new ways of delivering products and services, introduces new advertisement possibilities or even enables entirely new business models. This is reflected in the recently observed growth of e-commerce and e-payments (see Box 3) or in the changes of the modes of operation of creative industries. The rapid evolution of the Internet is also increasing uncertainty in certain sectors due to the lack of new business models, the uncertain returns from switching to new technologies (and the organisational changes that this requires) and competing technologies in fast-changing technological environment (Katz and Shapiro, 1986; Eisenach and Lenard, 1998).

The business models of creative industries have been under strong pressure to evolve and to take advantage of Internet technologies. The Internet offers creative industries new ways of delivering content online (*e.g.* online music stores, like iTunes and Amazon or streaming sites such as Spotify, Deezer or Pandora) and introduces new revenue sources (*e.g.* paid streaming services of old TV programmes). The Internet has also introduced a piracy threat to firms (see OECD 2009a). For numerous other industries, the Internet opens an additional way of advertising, gathering information or delivering products. Examples include the delivery of news (see OECD, 2009b) and other media sectors.[11]

The Internet also enabled the creation of numerous new industries and services that rely solely on this technology. This includes the emergence of the Internet-based software industry, cloud computing, as well as the introduction of completely new products such as social networks or search engines relying on new, Internet-enabled business models (online advertising or pay-per-click advertising).

Even though there is no clear definition of an Internet firm, there are a number of obvious examples of firms earning their revenue from Internet-based activities without being members of any of the other ICT firm categories. Some of these firms have enjoyed spectacular growth and are moving up the rankings. The largest Internet firm by revenues in 2010 is Amazon.com (USD 34.2 billion revenue) followed by Google (USD 29.3 billion revenue).

**Box 3. E-payment smoothing business transactions**

The share of e-payments in total retail payments has been growing steadily. This growth is, in turn, reflected in certain developments in the field of micropayments, where there seem to be substantial growth opportunities in new platforms, touting the continuing convergence of the classical retail and the online sectors.

Increasingly, mobile phones can be used to make payments for certain goods (*e.g.* car parking, public transport). This can help reduce the time it takes to carry out a transaction while also decreasing the need for cash payments. One example of this evolution is the Square iPhone payment system that permits smartphones to be used to accept credit card payments. New systems such as Square could make it much easier for consumers and small businesses to accept credit card payments.

Clearly these developments increase markets efficiency, facilitate exchange and greatly reduce transaction costs. In fact they are also a milestone towards the convergence of the online and offline worlds.

*Sources :*
*http://www.ecommerce-guide.com/article.php/3924491*
*http://asia.cnet.com/smartphones-the-wallet-of-the-future-62202445.htm*
*http://www.tuaw.com/2010/01/19/kevin-rose-demos-square-payment-system-for-iphone/*

### *Firm performance*

Apart from the broad effects on the business environment, the Internet also affects **firm performance.** The effects are well described in the existing literature. Much of the academic research on the impact of the Internet and broadband, in particular, has focused on the micro-economic level because of a lack of data with a sufficient time series for an empirical analysis across economies and given that available micro data could lead to reliable estimates.[12] At the micro level, firms tend to be more efficient when they use broadband because the connectivity allows for more interaction among all market players. It also leads to more intense information flows, creates better and faster matching processes and consequently results in a higher rate of aggregated technology growth (Brynjolfsson, 2003; OECD, 2008 and 2010a; Grimes and Ren, 2009; Majumdar *et al.,* 2009; Forman and van Zeebroeck, 2010; Bertschek *et al.,* 2011)

Examples of these impacts at the firm level can be seen by examining the benefits resulting from Internet connectivity in individual sectors. For example the OECD's work on Virtual Worlds (OECD, 2011a) highlights how Starwood Hotels first launched a virtual version of its new hotel line, the aLoft, within the virtual world Second Life to test the concept and layout before using the feedback to change the plans of the real hotel when it was built. The Starwood hotel example is just one of many of how firms have used the Internet to improve efficiency and these effects should be visible in macroeconomic studies. In particular, Internet connectivity is affecting four of the largest sectors of the economy, which comprise nearly 25% of GDP in OECD countries. These are health, education, transportation and electricity. Efficiency gains from broadband in these four sectors could have a measurable impact on growth simply because of the size of the sectors.

***Environment***

The Internet also enables solutions that could have a significant positive impact on the **environment** (OECD, 2009c; Prasad, 2010). This broad impact is captured by the term *Green ICT* that in turn encompasses various solutions such as *smart grids*, *smart buildings* and *smart cities* etc. The electricity sector provides a good example of where Internet connectivity will have an impact on environment and firm efficiency. The Internet can serve as the communication foundation of *smart* electrical *grids* (advanced metering infrastructure) by addressing a historical information gap between end-users and distributors. Smart grids use a communication network to inform consumers of their electricity consumption in real time as well as the overall supply and demand situation on the network, allowing them to adjust consumption based on price signals. On the supply side, the electricity provider benefits from the smart grid because they can smooth out demand by monitoring and influencing consumption in real time either through technical intervention or variable demand-based pricing (see Box 4). Smart grids will be a vital platform in the shift to electric vehicles.

**Box 4. Smart grid leads to real savings**

Opower, a smart grid provider, has found that simply providing feedback to consumers about their own consumption consistently leads to energy savings of 1.5 – 3.5% across the entire targeted population. These impacts can be potentially very large given electricity consumption accounts for 4% of GDP, on average, across the OECD countries.

The investments in smart grids are simply needed to meet expected growth in demand. However, the World Energy Council notes that the production and use of electricity accounts for around 40% of greenhouse gases, making the industry the single largest polluter. This has led to a focus on developing smart grids that make use of the Internet to manage energy demand.

*Sources:* (OECD, 2009d)

It must be highlighted that even though the Internet has traditionally been viewed as a low-carbon impact alternative to traditional activities, some studies point at the potently high carbon footprint of the Internet itself, caused by the growing greenhouse gas emissions per hour of electricity use. Even though some sources tend to attribute the relatively high carbon footprint to the Internet, this issue still lacks a coherent, general analysis that took into account all possible aspects of its environmental impact.

***Education and research***

The Internet is also increasingly used in the field of **education** (Lenhart *et al.* 2001; OECD, 2008c; Spiezia, 2010). Remote education over radio and television has been used for many years in rural and remote areas but the Internet permits for a more general and dynamic development of education services. There are two key ways in which Internet access can help make education more efficient. First, the Internet improves education by enhancing remote communication and delivering teaching or training materials. Second, the Internet greatly facilitates gathering of information using a myriad of services and applications such as online classes and seminars, dedicated web pages and online forums for expertise exchange. As an example, Stanford University in the United States makes some of its classes available online to the general public for free. Videos of the classes and copies the slides shown are posted at a dedicated webpage a few days after each class meeting.[13] This initiative was developed by Stanford University in co-operation with Apple. In terms of economic benefits for individuals, the content provides a great opportunity to acquire state-of-the-art knowledge; for Stanford it is a novel way of demonstrating its teaching quality and the richness of its curriculum.

Apart from general education the Internet has also certain impact on scientific research. The primary impact focuses on the areas where Internet technologies have improved access to information and facilitated communication between researchers and research centres. Notable examples include instant access to digitised scientific articles and databases offered by various providers over the Internet, (*e.g.* JStore and ScienceDirect). The development of the Internet has also enabled new forms of co-operation in research that rely on public-domain and open-access models of information creation *(e.g.* science commons)

**Box 5. Internet impact: Scholarly research in the humanities**

The humanities and social sciences are the emerging areas for the application of advanced Internet-based solutions. Currently, several IT-based projects are successfully used to digitise and store materials on an unprecedented scale. An example of this process is Google's general project of digitisation of books. Google scanned 5.2 million books in several languages with publication dates between 1500 to 2008.

The projects of digitisation of materials used in humanities offer huge potential benefits not only to scholars and researchers but also to regular consumers. Scholars can save a great amount of their time and effort usually devoted to a classical library search. Researchers obtain free access to the current stock of knowledge, which is not only a clear reduction of research costs but also a valuable potential source of inspiration. Lastly, individual users also obtain access to the stock of books, which for them implies improvement of skills, but also pure consumer utility and satisfaction. Apart from these great opportunities there are still some remaining issues to be resolved. For example several authors and publishers point to possible copyright infringements related to digitisation of copyright-protected material.

*Source: http://chronicle.com/article/Scholars-Elicit-a-Cultural/125731/*

### *Healthcare*

**Healthcare** is a sector where the Internet and other communication technologies are increasingly employed to address escalating healthcare costs. As an example, Internet technologies could help reduce the number of physical doctor visits needed by elderly patients who still choose to live at home. The Internet and evolving sensor technologies make remote check-ins economical. Currently the share of GDP spent on healthcare is rising across OECD economies. Moreover these costs have been rising over the past decades. According to recent figures in the OECD, countries health expenditures amount to 8.8% of GDP.[14] This is due to the aging processes, high costs of related education and technological progress and the economic complexity of the healthcare issues.

E-health is an effective solution that could be applied to at least partially address this problem. The term e-health refers to a range of Internet-enabled solution and services solutions that enhance healthcare efficiency (*e.g.* telemedicine), enhance access to information and health records and offer other ways of healthcare improvement, *e.g.* through better access to medical journals, epidemiological tracking or sharing of patient-specific information. E-health could lead to a significant reduction of costs in the healthcare system. It is expected that these services will be rapidly developed and the share of e-health among other services offered through the Internet will continue to grow.

**Box 6. The Internet: Finding solutions by sharing health experiences**

The platform *PatientsLikeMe* is an example of a successful Internet application/platform to enhance research in the healthcare area. The platform is an Internet-based community of patients diagnosed with life-changing diseases, doctors, and organisations. It enables users to share information that can be used for research on a particular disease and that improve patients' lives. In particular, the Internet platform permits the collection and sharing of real world, outcome-based patient data. Relevant data are transmitted to doctors, pharmaceutical and medical device companies, research units, etc. who have established data-sharing partnerships with *PatientsLikeMe*. Since most of the research in modern medicine relies on large amounts of data, this platform becomes an extremely efficient tool for healthcare professionals and industry organisations that are trying to treat the disease and, at the end of the day, for patients themselves.

*Source* : *www.patientslikeme.com/*

### *Government activities*

In addition to issues related to the environment and healthcare, there are other significant areas where the Internet affects **governments**, with e-government services being an illustrative example.[15] This term refers to the digital, mostly Internet-enabled interaction between the government and citizens, firms and other public agencies. The Internet acts here as a channel to enhance the efficiency and effectiveness of the public sector. The benefits of e-government are clear; Internet-based solutions improve the accessibility, efficiency, and convenience of public services by permitting for instantaneous communication and removing the requirements of a physical presence at the government agency. Increased interaction with the government and easy access to documentation can also raise transparency, promote democratisation and reduce the levels of corruption (Andersen *et al.,* 2011).

Another channel through which the Internet might have an impact on government activities is through intensified social capital. Higher social capital in a society translates in turn into intensified political participation of individuals (Shah *et al.,* 2001; Gibson *et al.,* 2009.) An illustrative example for this mechanism is the so called "Arab spring", where the Internet was used as an efficient tool to enhance and co-ordinate democratisation processes in countries such as Tunisia or Egypt.

**Box 7. E-government: Examples from Spain**

Spain has dedicated significant efforts and resources to the advancement of its information society. It is one of the few countries with a consistent legal act solely and entirely dedicated to e-government (Law on Citizens' Electronic Access to Public Services). Three prominent, Internet-enabled achievements of Spain's e-government plan are the introduction of e-ID documents, the centralisation of public procurement services, achieving a paperless administration in the tax agency, and the high availability of online public services.

The introduction of an *electronic ID* document for every Spanish citizen enables personalised, secure online access to numerous public web services. This service significantly reduces all individual costs of interaction with public authorities in terms of time, effort and money. By doing so, it also facilitates economic activity and indirectly enhances economic exchange. Spain also relies on the Internet to centralise *public procurement* services. A unified structure permits to enhance the efficiency and reduce costs of the various public procurement processes.

*Source*: OECD (2009e)

Clearly, governments also benefit indirectly from the development of the Internet. Internet connectivity should help raise internal productivity in governments the same way as it improves processes in the private sector.

**Macroeconomic impact**

As summarised in the previous section, there is evidence about the positive effect that the Internet has at the individual- firm- and government levels in the economy. The beneficial and transformational effects of the Internet at these levels mean that analogous effects of broadband should be observed at the aggregated, macroeconomic level. A number of studies consider these general economic effects of the Internet, and discuss the role of the Internet in the macroeconomic context.

Generally, there are two approaches towards assessment of the broad, macroeconomic effects of the Internet:

- The *growth accounting approach* focuses solely on the investment in Internet-related ICTs and the direct revenues from Internet services (see Box 8).

- The *econometric approach* goes one step further than the growth accounting approach and takes into account all the aggregated macroeconomic effects of the Internet on industries, consumers and governments and the additional long term socio-economic effects.

**Box 8. Using growth accounting to estimate impacts on productivity and growth**

Concerning the studies on the impact of the Internet as a sector, most macroeconomic and industry studies are based on the growth accounting framework in which each input factor (*e.g*. labour, capital, or ICT capital) contributes proportionally to its share in total input costs. Oliner and Sichel (2000) conclude that the contribution of ICT capital between 1996 and 1999 increased significantly using this framework. Similar conclusions about the importance of the ICT sector using the growth accounting framework have been found by Oulton (2010) in a study that focuses on the UK economy and Crepon and Heckel (2002) in a French–based paper and by Van Ark *et al.* (2002), who look at ICT-related patterns of productivity differences between the United States and Europe.

There are several reasons why measuring the contribution of ICT investment to growth and productivity is difficult. Firms do a number of other things while investing in ICT: they change their organisational structure, invest in complementary inputs and shift the production mix between labour and capital. Firms also adjust to external shocks, such as economic recessions and booms or changes in terms of trade. Disentangling the effects of these simultaneous changes in the statistical data has proven to be a difficult task.

One approach to address these issues is to assume that the contribution of ICT investments to growth is proportional to their share in the value of output. Much of the evidence on the impact of ICT comes from the growth accounting method and is based on this assumption.

Although the growth accounting framework follows from economic theory, it relies on a set of strong assumptions that significantly limit its explanatory power. In particular, it assumes that all markets are competitive, there are no spillovers and that firms can predict the returns from investing in Internet technologies. These conditions appear problematic because the Internet itself reshapes competition in markets, the network nature of Internet generates spillovers and the return from investments in Internet technologies is unlikely to be known with certainty due to the continuous flow of new software and hardware developments.

There are several survey-based empirical studies that verify the claim about the possible positive impact that the Internet might have on economic growth.

One of the earliest studies that went beyond the micro-scale is by Varian *et al*. (2002) who analysed the impact of Internet technologies on economic activity based on a survey of companies from various industries in the United States, the United Kingdom, France and Germany. The purpose of the study was to measure the effects that Internet technologies have had to date and to project their future impact. The Internet technologies were defined as *any initiative that combines the Internet with networking, software and computing hardware technologies to enhance or improve existing business processes or create new business opportunities*. Based on collected responses, the study found that already at the early stage of broadband development, companies actively looked for solutions using the Internet, which helped them to cut their costs and increase revenues. Specifically firms in the four analysed countries reported realising a cumulative cost savings of USD 163.5 billion with the majority of the savings occurring since 1998.

Another early study that attempted to deal with the economic effects of the Internet in a broader context was done by Lehr *et al*. (2006). The authors used a panel data set at the zip-code level for the United States and concluded that broadband positively affects economic activity.

An extensive study by Franklin *et al.,* (2009) used a large dataset on broadband from several European countries. This statistical analysis found that the use of broadband is correlated with higher firm-level productivity. Moreover the firm-level analysis in Sweden and the Netherlands indicates that it is due to ICT being a facilitator of wider innovation.

Concerning the aggregated, macroeconomic approaches, Qiang *et al.,* (2009) also found the positive relationship between the adoption of broadband and the rate of economic growth. Apart from a substantial literature overview, the study introduced a cross-country empirical model to analyse this relationship. The authors used data from 120 developing and developed countries in an endogenous growth model based on Barro (1991). This approach allowed them to test the quantitative relationship between broadband penetration rates and the average growth rate of per capita GDP between 1980 and 2006 while controlling for other factors that may have impacted growth rate. Qiang *et al.,* (2009) find that that a broadband penetration rate that is 10 percentage points higher is paralleled with an annual per-capita economic growth rate that is 1.21 percentage points higher.

Clearly correlation does not imply causation since this basic association between the stage of the Internet development and economic growth may be driven by reverse causality and other variables. If fact, several studies concluded that economic growth was one of the main determinants of the development of the Internet (Kiiski and Pohjola, 2002; Chinn and Fairlie, 2007.) These conclusions highlight the mutual dependency between the development of the Internet and economic growth. On the one hand, more developed countries invest more in the development of the Internet. On the other hand, a more highly-developed Internet might contribute to the rate of economic growth.

Several studies have addressed the question of whether Internet development drives economic growth by applying econometric techniques (*e.g.* Crandall *et al*., 2007; Czernich *et al*., 2011; Koutroumpis, 2009). The results suggest that Internet development might indeed have some causal effect on growth.

The study by Crandall, *et al*. Lehr and Litan (2007) looked at the effects of *broadband penetration* on both output and employment, in the aggregate and by sector, using state-level data. To check the macroeconomic impact of the Internet, the authors employ an ordinary least squares regression analysis[16] using the number of broadband lines per capita as a proxy of the Internet and the ratio of employment or output in 2005 to its level in 2004 (or 2003) as dependent variables. They find that non-farm private employment and employment in several industries is positively correlated with the use of broadband. Specifically, for every 1% increase in broadband penetration in a US State, the corresponding level of employment is higher by 0.2% to 0.3% per year.

The study finds a significant causal positive link regarding the impact of broadband on output, especially when a critical mass of infrastructure is present. In particular, a 1% increase in the penetration rate increases economic growth by an average of 0.025%.

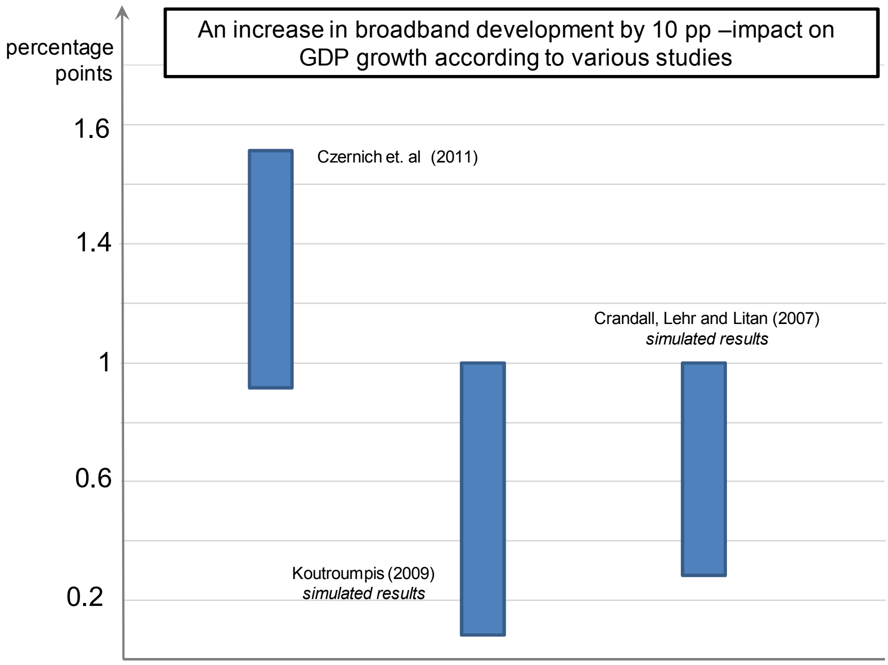
Another study by Czernich *et al.,* (2011) examined the effect of broadband infrastructure on economic growth in a panel of OECD countries (1996-2007) using *broadband penetration rates* as the proxy for the Internet development. To overcome the potential problem with endogeneity, the authors performed the analysis in two steps. In the first step, they constructed a predicted pattern of broadband evolution (free of shocks and policy interventions) using the data on cable TV and phone lines as instruments. This predicted estimator is used then in the second step to explain the rates of economic growth. The study finds that an increase in broadband penetration by 10 percentage-points raises annual per-capita growth by 0.9-1.5 percentage points.

A study by Koutroumpis (2009) also investigated how the Internet (measured by *broadband penetration rates*) affects economic growth. It was done using a macroeconomic production function based on a micro-model for broadband investments. Specifically, a structural econometric model (a framework that endogenised telecommunications investment) was inserted within the macroeconomic production function. The results suggested that there were increasing returns to broadband investments that corresponded to the persistence of network externalities.

The quantitative studies provide a strong indication but not precise evidence regarding the general economic impact of the Internet. The Internet is relatively new and grows relatively fast but data used in analyses measure the past, not the present. Following Holt and Jamison (2009) and Lehr (2012), one should highlight that the exact quantitative impact of the Internet cannot be measured with great precision. In fact, the existing studies find similar qualitative and quantitative results, and as presented in Figure 2, have similar ranges of magnitude even if a precise measure is not available.

**Figure 2. Quantitative impact of the Internet on economic growth: sample results from existing studies**

Effects on GDP growth resulting from a 10 percentage point increase in broadband development




Moreover, it must be stressed that measuring the macroeconomic impact of the Internet requires a large, consistent, underlying dataset to produce econometrically solid and robust results. Given that the Internet is a relatively new, and rapidly growing phenomenon this data requirement cannot be fully met (Lehr, 2012). Hence the results presented above cannot be interpreted as a robust confirmation of the causal effect that the Internet has on economic growth, but as a preliminary indication of such effect.

Several other studies have assessed the macroeconomic effects of broadband in the context of national development programmes and the resulting technological change (Katz *et al.*, 2010; Greenstein and McDevitt, 2011) or in the context of the economic recovery (Box 9).

**Box 9. The Internet and the economic recovery**

The multi-purpose economic role of the Internet and broadband in particular was taken into account by policymakers while setting the policies to counter the economic downturn. Particularly, the investments in broadband were perceived as a stepping stone towards the economic recovery and therefore were included in government investment programmes. The general role of the Internet in the process of economic recovery was highlighted by the OECD in 2009 (OECD, 2009g) Several other studies analysed the effects of broadband investment packages for various economies.

Atkinson *et al.,* (2009) provided a detailed analysis and estimates of the short-term job impact of investment in three critical digital networks in the United States: broadband networks, the smart grid and health IT. They found that investing in the new economy of digital infrastructures would provide significant opportunities, not just for short-term stimulus and job creation, but also longer-term economic and social benefits. They estimated that spurring an additional investment of USD 30 billion in America's IT network infrastructure in 2009 would create approximately 949,000 jobs. Similar results of broadband development on job creation in the United States were found in a study by Katz and Sutner (2009), who concluded that future investment for four years would generate about 27-84 jobs per USD 1.2 million invested. The authors used input-output analysis based on the American Recovery and Reinvestment Act.

Liebenau *et al.,* (2009) aimed to determine the specific impact of investments in ICT infrastructure in the United Kingdom (broadband) on direct, indirect, and induced employment by taking estimates of the economic employment and output multipliers. The study focused on the issue of future investments and concluded that about 38 jobs could be created per USD 1.2 million in broadband investment

A study by Katz *et al.,* (2010) focused on the German economy and assessed the macroeconomic impact of the German "National Broadband Strategy". Building on that strategy, the study defined two sequential investment scenarios (one in 2014 and one in 2020) and quantified the impact on broadband investments employment and output. The economic effect of investment in broadband technology over a ten year period in Germany was estimated to be equal to 968 000 additional jobs and USD 230 billion in incremental output.

A similar study for the United States economy was undertaken by Greenstein and McDevitt (2011). They assessed the factors that shaped the anticipated incremental costs and benefits from the national upgrade to broadband. In order to assess the overall benefits from shifting from dial-up to broadband, the study used a calibrated macroeconomic model. The conclusion was that broadband generated approximately USD 8.3 to 10.6 billion in additional revenue (above and beyond what dialup would had generated), and between USD 4.8 to 6.7 of consumer surplus. Broadband generated between 40% and 50% of measured GDP in new additional revenue. The study also found that the upgrade from dial-up to broadband had resulted in an unmeasured decline in all Internet-access prices of between 1.6% and 2.2% per year.

Lastly, with respect to the long–term effects of the Internet, these are mostly indicated by the current economic literature. Current academic literature highlights that improvements of disembodied knowledge (know-how, technology, ideas, etc.) remain the key engine of sustained long-term economic growth. Given the tremendous positive impact of the Internet on knowledge generation, one could conclude that, in the long run, the Internet should have some positive effect on the rate of economic growth.

Clearly, due to the long-term transmission of this type of impact, this type of effect remains mostly theoretical so far. However, even though there is no direct empirical support for the long-term beneficial effect of the Internet on growth, in a preliminary sense, this hypothesis seems to be true given the whole evidence provided by the current economic literature (for an overview see: Aghion and Howitt, 1998; Barro and Sala-I-Martin, 2003). One should expect that in the long term, the development of the Internet boosts knowledge creation and enhances per capita income growth across the economy. Given that limited data have been available and time series have been too short, there has been less empirical evidence, especially across economies.

**Concluding remarks**

Interestingly, most of the positive evidence was found for US data, and it is more difficult to find evidence in Europe. Therefore a better understanding of how spillovers work with Internet infrastructure might help bridge the gap, especially since many questions regarding possible externalities remain unanswered: do management ideas and knowledge about the Internet diffuse among firms? How can this knowledge best be transferred? How much of a time lag is needed for spillovers to materialise? Moreover, while the "general purpose technology" property of the Internet is widely discussed, it has not been tested explicitly for broadband, even though this seems to be the main target of policy agendas.

In terms of next steps, more work is needed to understand the causality of the relationship between Internet development and GDP. This will improve as the time series expands. Researchers may also be interested in the factors concerning how efficiently connections are used. Once causality is firmly established, for example, it may be possible to view differences across countries in how effectively positive effects of the Internet spread over the economy. Another key step forward may be focusing on changes within particular sectors of the economy such as health, energy or education.

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## ENDNOTES

1. Brynjolfsson (2003,) OECD (2008a and 2010a,) Grimes and Ren (2009,) Majumdar *et al.,* (2009,) Forman and van Zeebroeck (2010,) Bertschek *et al.,* (2011.)

2. The adoption of Internet-based IT solutions might raise demand mostly for highly skilled workers (Bresnahan *et al.,* 2002) which might also temporarily reduce demand for lower skilled tasks (Spiezia and Vivarelli, 2002.)

3. OECD (2009c and 2009d,) Prasad (2010.)

4. A strict definition could describe *the Internet* as a global network of interconnected computer networks using the standard Internet Protocol. In the context of this paper the terms *the Internet* and *Internet technologies* are used interchangeably and refer to a myriad of presented Internet-based technological solutions used for web development, information search, communication, e-commerce, e-health, etc.

5. The term *broadband* refers in most cases to lines offering Internet connectivity which are capable of download speeds over a certain value (*e.g.* at least 256 kbit/s). The data are provided by the OECD on its Broadband Portal *www.oecd.org/sti/ict/broadband*.

6. In some countries recent statistics take into account some alternative types of Internet connectivity.

7. An IPv4 address is a numeric identifier for a single device connected to the Internet. They are a proxy for the number of devices that are attached to the Internet. The indicator has a number of limitations but, in many ways, these are similar to limitations with other indicators such as broadband subscriptions per 100 inhabitants. The introduction and adoption of IPv6 by network operators, while at the early stages now, will decrease the usefulness of this indicator in the future.

8. An autonomous system is a collection of connected Internet Protocol (IP) routing prefixes under the control of one or more network operators. An autonomous system is controlled by a single entity, in most cases an Internet service provider (ISP) or a very large organisation (company) with independent connections to multiple networks.

9. For example for new cars, Zettelmeyer, Scott Morton and Silva-Risso (2001) found that consumers who bought their cars online pay on average 1.2% less than offline consumers do.

10. The empirical detection of causality can be relatively difficult so caution should be paid to the interpretation of causality mechanisms in these relationships.

11. See OECD work on digital content: *www.oecd.org/sti/digitalcontent.*

12. For example micro data provides a way to econometrically control for self-selection and endogeneity problems.

13. *http://itunes.stanford.edu.*

[14] *Source*: OECD Health Data 2010 homepage

[15] For OECD work on e-Government see *www.oecd.org/department/0,3355,en_2649_34129_1_1_1_1_1,00.html*

[16] Thus, the quantitative results present the correlation rather that causality.