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Skills and Jobs in the Internet Economy

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FOREWORD

This report from the Working Party on the Information Economy (WPIE) was prepared by Taylor Reynolds and Piotr Stryszowski of the Secretariat as part of a broader work-stream on ICT jobs to be further developed for the 2016 OECD Ministerial meeting on the digital economy. The Committee for Information, Computer and Communications Policy approved the report in December 2013.

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KEY FINDINGS

The Internet is transforming jobs across the economy

The combination of slow economic growth, lingering unemployment, some of it structural, and a dramatic demographic shift towards older populations on the horizon is increasing pressure on policy makers to find ways to boost productivity. The Internet is seen as a key platform that can help support needed productivity gains, open up new business opportunities, and lead to new and better jobs. But at the same time, the Internet is forcing a significant reorganisation of businesses, and this affects labour demand and ultimately employment. The combined effect of these drivers is not obvious, and may depend on specific conditions and policies in each country.

There is increasing demand for ICT skills

Workers increasingly need both generic and specialised ICT skills to accomplish their tasks at work as the Internet becomes more engrained in work processes. An analysis of the O*NET database in the United States shows that the information technology category of occupations has the highest percentage of occupations categorised as having a "bright outlook" through 2022. This suggests continued growth for ICT jobs and highlights the need to promote ICT skills among workers.

ICT-related occupations are spread throughout the economy but certain sectors have a higher concentration of ICT-categorised occupations than others. The health care/social assistance sector has the largest number of ICT-related occupations, accounting for nearly 20% of all ICT-related occupations in the United States. A combination of a rapidly ageing population and the potential cost savings possible from ICTs suggests that this sector will likely remain an important source of ICT-related jobs in the future. Educational services, manufacturing and public administration also have a high proportion of ICT-related occupations.

ICT skills are needed for jobs throughout the economy. The sectors of the economy that require the highest levels of ICT skills from workers include ICT, finance/insurance, professional services and real estate. Data from the OECD's Programme for the International Assessment of Adult Competencies (PIAAC) also show that managers, professionals, technicians and clerical support workers use more ICT skills at work than other occupational clusters in the economy. Workers in smaller firms are less likely to use ICTs than workers in much larger firms. Smaller firms typically lag behind larger firms at adopting ICTs but these firms will likely need to leverage ICTs more effectively in order to stay competitive.

But the current lack of ICT skills in the economy needs to be addressed

ICT skills are becoming an important requirement for employment across the economy, but a significant part of the population lacks the basic skills necessary to function in this new environment. **PIAAC data across economies reveal that between 7% and 27% of adults have no experience in using computers or lack the most elementary computer skills, such as the ability to use a mouse**.

In OECD countries only 6% of the population is categorised with the highest level of ICT skills meaning they can complete tasks involving multiple applications, a large number of steps, impasses, and the discovery and use of *ad hoc* commands in a novel environment.

The PIAAC data begin to paint a picture about ICT core competencies and experiences with computers. Young adults, those with tertiary levels of education, and those in skilled occupations are the most likely to have the ICT core competencies and experience with computers. By contrast, the demographic factors most commonly associated with a lack of core skills and no computer experience are people aged 55-65, people with less than an upper secondary level of education, and people in semi-skilled occupations.

This lack of ICT skills in the adult population is of particular concern for policy makers because **the groups with the least ICT skills tend to be among the demographic groups at the most risk of losing jobs** in the current technology transformation of the workforce. For example, ICT-enabled automation has hit semi-skilled workers particularly hard, yet PIAAC data indicate that these workers have the lowest level of computer experience and ICT skills demanded in the new economy.

On the other hand, while significant numbers of adults lack basic computer and Internet skills, young students are nearly universally familiar with computers and have extensive access to the Internet at home. Data from the OECD's Programme for International Student Assessment (PISA) show that by 2009, 92% of students had a home computer and 89% had Internet access at home.

The PISA study finds that the frequency of computer use at home, particularly for leisure, is positively associated with navigation skills and digital reading performance, while the frequency of computer use at school is not. This suggests that students are developing digital reading literacy mainly by using computers at home to pursue their interests, rather than at school; this may lead policy makers to reconsider how ICTs are used for learning at school as well as the role of ICT access outside the school environment.

As well as the mismatch between those with strong ICT skills and those who use them at work

Data highlight a potential skills mismatch among those with the strongest ICT skills (the youth) and those who actually use them at work (prime age and older adults). These results likely stem from a multitude of factors including cultural attitudes and the average age youth enter the workforce, but they suggest room to boost opportunities for youth to use their ICT skills in productive areas of the economy.

Governments need a comprehensive and coherent approach for building ICT skills for the new economy

The growth of the Internet will require updated and new skills from most workers in the economy. The Internet will continue to create labour market disruptions and people, as well as governments, who prepare and position themselves with the right skills, will be at an advantage in the global economy. Labour market disruptions will hit some workers harder than others, and often these people will be precisely the people with the lowest levels of ICT skills and those who are the least prepared to update their skills.

Governments could benefit from a comprehensive and coherent approach to expand ICT skills throughout their population. The OECD has already developed a comprehensive skills strategy, which is currently being adapted to the national level, and ICT skills need to become an integral part of this strategy. Potential policy issues that could be addressed include leveraging ICT use at home, integrating ICTs throughout the educational curriculum rather than as a separate subject, targeting those whose lack of skills make them the most vulnerable to employment shocks, and finding ways to pair ICT skills with other sector-specific skills.

INTRODUCTION: THE NEED FOR GROWTH AND JOB CREATION

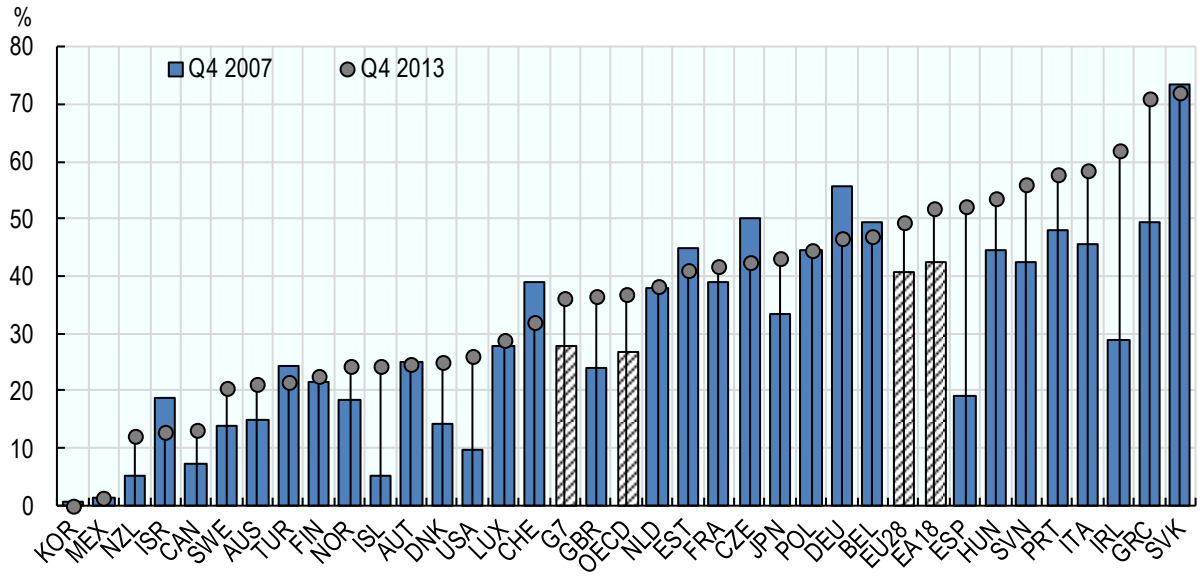
The combination of slow economic growth, lingering unemployment, some of it structural, and a dramatic demographic shift on the horizon is increasing pressure on policy makers to find ways to boost productivity. This economic crisis, in particular, has put a strong emphasis on "doing more with less" and the Internet is seen as a key platform that can help support these needed productivity gains.

Even if some semblance of an economic recovery may be in sight, it may take a long time, if ever, for countries to get back to pre-recession levels of employment and business activity. Public finances will remain under pressure for the near future, and policy makers are therefore keen to understand how limited resources can be used more efficiently across the entire economy to boost growth and improve standards of living.

Structural unemployment

Many OECD economies are returning to growth after the economic crisis but job growth has not kept pace. The OECD reports that the recovery in advanced economies is moderate, but growth throughout the world remains sluggish with significant risks. Despite the improvement in output, the unemployment rate is still higher than pre-crisis levels in 2008 (Figure 1) (OECD, 2013a and b, 2014a). This represents a significant concern to policy makers who fear the recession could lead to longer-term structural unemployment and slow the global recovery. Apart from economic consequences, there are substantive concerns about the potentially significant social impact of these high and persistent levels of unemployment.

Figure 1. Persistently high levels of unemployment



Source: OECD (2014a)

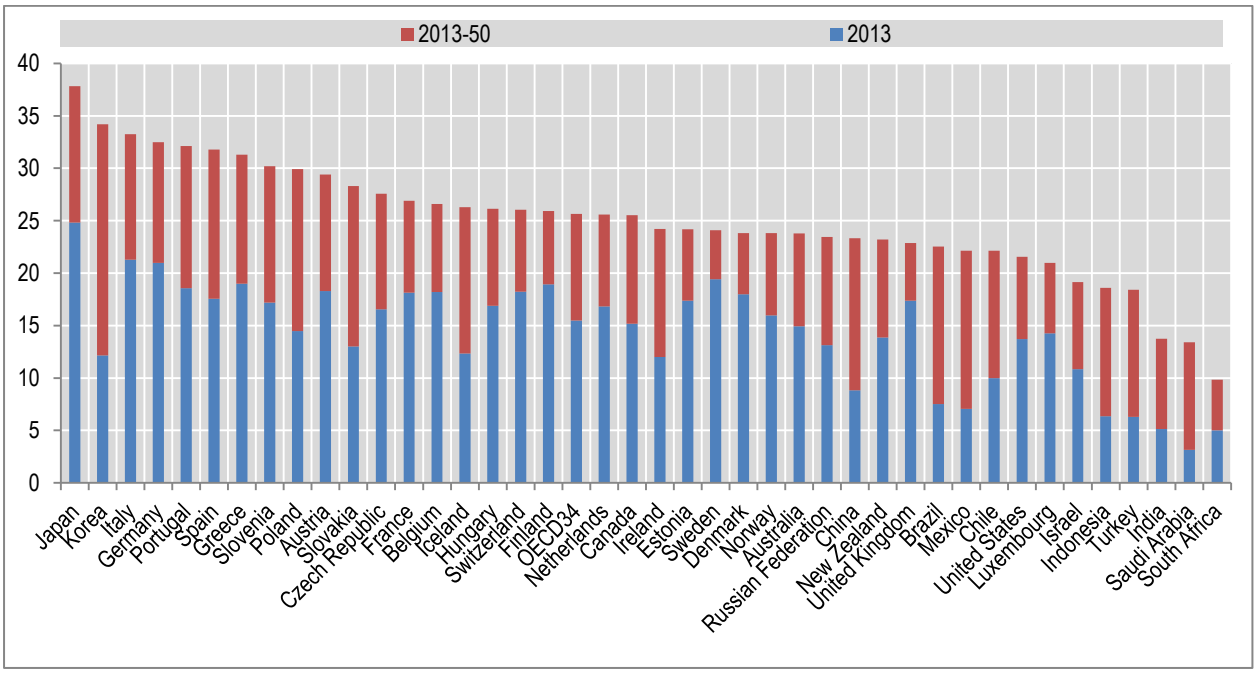
The long-term unemployed are also particularly disadvantaged in the current crisis. Long-term unemployment has probably peaked in most countries, but it remains a major source of concern. For the OECD area as a whole, 16.3 million persons – more than one in three of all unemployed – had been out of work for 12 months or more in the first quarter of 2014.

Changing demographics

A dramatic demographic shift is also underway that will require significant productivity growth just to maintain current standards of living. In Western Europe, the number of people aged over 64 has more than doubled in the last 50 years, while the number of those aged over 80 has quadrupled. The United Nations Department of Economic and Social Affairs projected that between 2005 and 2050, half of the increase in the world population will be accounted for by a rise in the number of people aged 60 years or over (Figure 2) (United Nations, 2006). This demographic shift will have profound impacts in all OECD countries and beyond.

Over the next few decades, the number of people over age 64 will boom while the number of active workers in the economy will stagnate or even fall. This means that economies will require significantly higher productivity just to maintain current standards of living if a larger percentage of the total population is outside the workforce. Without changes in employment, retirement and productivity patterns, the ratio of older, economically inactive persons per worker will increase from 1:3 in the OECD area in 2006 to just over 2:3 in 2050 (to almost 1:1 in Europe) (OECD, 2006).

Figure 2. Population aged 65+ as a percentage of the total population



Source: OECD (2011b)

The Internet supporting productivity gains

Promoting growth through technological progress and innovation has a new sense of urgency linked to the slow recovery from the economic crisis, high levels of unemployment – in particular among the youth, and impending demographic change. The result of these three effects is that economies will require significantly higher productivity just to maintain current standards of living in the future. There is a general perception that any systematic effort to raise productivity will need to include a strong focus on innovation, including the efficient use of information technologies, and particularly the Internet (OECD, 2012a). Policy makers increasingly look to the Internet for productivity gains because it directly supports two key engines of long-term economic growth – knowledge accumulation and technological advancement.

As the Internet economy gains momentum, the economic landscape changes. The Internet is now widely considered a fundamental infrastructure in OECD countries, in much the same way as electricity, water and transportation networks. In economics this is referred to as a general purpose technology (GPT) and corresponds to other key technologies such as electricity (Guerrieri and Padoan, 2007; Carlaw *et al.* 2007; Kretschmer, 2012; OECD, 2013c)

Researchers have produced a significant repertoire of studies linking ICT and Internet adoption to increased firm productivity (OECD, 2012a), providing the evidence base for policies that can extend the benefits of ICT to more businesses, e.g. in bringing them online and helping them flourish. Many policy makers see the Internet as a tool that can support businesses to grow, hire employees, and ultimately help pull countries out of the lingering effects of the recent economic crisis. At the same time, the Internet is leading to market transformations and labour disruption that if left unaddressed, could threaten future growth and global competitiveness.

THE INTERNET IS TRANSFORMING JOBS ACROSS THE ECONOMY

The Internet is often viewed as a source of new jobs, both in the ICT sector and as a catalyst for new business innovation across all other sectors of the economy (OECD, 2008). But at the same time, it is clear that the Internet is forcing a significant reorganisation of businesses, and this affects labour demand and ultimately employment. The net effects of the Internet on employment are therefore ambiguous and are still poorly measured and understood.

Job gains/losses from technology: not a new phenomenon

The Internet is leading to changes in labour markets but these disruptions have long been associated with the introduction of new technologies. Workers and users need new skills in order to capture the potential productivity gains of the Internet, or any other technology. As Nelson and Phelps noted in 1966, a technology-induced need for skills particularly concerns *innovative functions which demand keeping abreast of improving technology.* Ensuing economic literature supports the notion that technological advancements tend to be skill-biased, meaning they require specific skills to be effective (Nelson and Phelps, 1966; Galor and Tsiddon, 1997; Hassler and Rodriguez Mora, 2000; OECD, 2011a). The rollout of Internet connectivity throughout the economy has introduced the need for new Internet-related skills in order for people to do their jobs within this changing communication environment. For example, workers in most office settings should now be familiar with e-mail as a communication tool.

Existing data highlight the growing demand for skills that are related to ICTs and the Internet. This includes employment directly in the ICT sector, ICT-specialists in other sectors (e.g. health care), and also ICT-intensive users in all sectors who rely on ICT skills to perform their work (OECD, 2012b).This shift in demand for skills underscores a significant reshuffling of existing working patterns, which becomes a source of turbulence in labour markets.

The structure of the labour markets changes with new technologies, particularly for low-skilled occupations. Existing studies find that new technologies such as the Internet are leading to job growth in the low-skilled service sector but declines in occupations that require routine tasks that can increasingly be done by mechanisation. Autor and Dorn (2003) and Autor, Levy and Murnane (2003) called this “routinization” and find that within industries, occupations, and education groups, computerization is

associated with reduced labour input of routine manual and routine cognitive tasks and increased labour input of non-routine cognitive tasks. Service jobs that require cognitive and interpersonal skills are believed to be growing because it is more difficult for these jobs to be automated. The wages of these service-based jobs tend to rise relative to other low-skill occupations. This phenomenon is broadly important because it offers insight into the polarization of employment and earnings in the United States and, potentially, other industrialized countries. (Autor, Katz and Kearney, 2006, for the US; Goos and Manning, 2007, for the UK)

Specific role of the Internet

In the context of this paper, the Internet's impacts on jobs can be viewed in four broad categories:

- ***New jobs***. The Internet leads to the creation of new jobs. Some of these are directly tied to the technology (e.g. Internet engineers, networking specialists, hardware), while other jobs extend to the related eco-system (e.g. mobile app developers, data scientists, community specialists in social networks). Most importantly, however, the Internet can lead to job growth in traditional occupations by supporting the creation of new businesses (e.g. entrepreneurship) or the expansion of existing firms (e.g. growth from tapping into foreign/new markets or more effective marketing).

- ***Transformed jobs.*** Technology transforms the work practices in existing jobs. The introduction of new communication technologies means work processes can be adjusted but workers must learn new skills to take advantage of the new technological advances. This transformation is also partially driven by how the Internet facilitates the outsourcing of different parts of the production process.

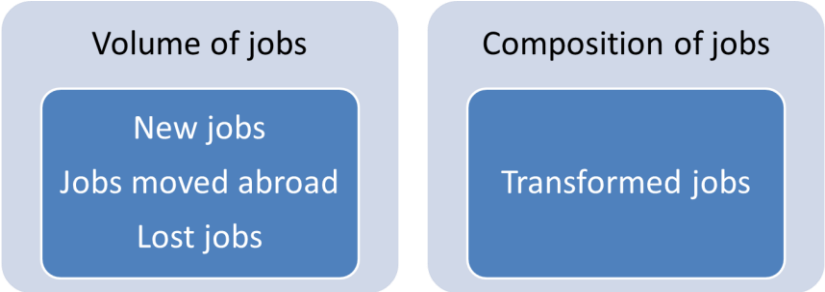
- ***Jobs moving internationally***. The Internet also supports the global outsourcing of tasks more-specialised locations or workers (e.g. offshoring), enabling firms to benefit from different cost and productivity conditions, or from the availability of specific skills or firms. This implies some direct job losses in one country but job gains in another.[1]

- ***Lost jobs.*** The Internet can also lead to the loss of certain jobs, either as technology replaces tasks previous undertaken by individuals (e.g. online travel booking vs. travel agents).

Other ways to consider the transformation of employment resulting from the Internet is in the context of the volume or composition of jobs (Figure 3). The creation of jobs, lost jobs and any jobs moved abroad will affect the overall volume of jobs in the economy. There is another transformation taking place though concerning the composition of these jobs (as captured by transformed jobs) regarding which tasks can now be outsourced and which tasks remain within the company.

[1] Jobs may also move within a country, in which case jobs are lost at one firm, and gained at another.

Figure 3. Internet's effects on employment broken down by volume and composition of jobs



Acemoglu and Autor (2011) investigate how the introduction of new technologies improves labour productivity and enables outsourcing and offshoring possibilities. They find that new technologies generally lead to a reduction of demand for work performed by moderately-skilled workers, as this type of labour is primarily offshored and replaced by technology.

New jobs

The Internet's most important job creating potential may be how it supports the creation of new firms or the expansion of existing ones. The Internet expands the addressable market for small- and medium-sized firms that can now grow their businesses more effectively by procuring inputs and selling globally via the Internet, often resulting in demand for more workers. One area of particular interest has been the Internet's potential for supporting and opening up markets for home-based businesses, which account for more than half of all businesses in the United States.[1] As MGI (2011) highlights, this is where the more significant job creation potential lies, as opposed to the purely technical jobs related to the functioning of the infrastructure.

The Internet sector has, however, been one of the few flourishing areas amid the recent economic crisis and demand for highly-skilled workers remains strong. Some of the new jobs related to the Internet are linked to the networks themselves. There is a strong need for workers who can install fibre optic networks that carry high-capacity data traffic on the Internet. The demand for installers will remain high during the network rollout stage but will likely decline once the initial coverage is completed as networks will remain in place for decades. There is also high demand for jobs related to network and IT specialists who can install, configure, and maintain networks as businesses move more processes onto the Internet.

Other new jobs relate to the broader Internet ecosystem where demand is especially high for workers in the fields of software programming, engineering, or business operations integration. Businesses have a strong need for data scientists who can extract insights from large data sets, or "big data" (OECD, 2013c). Another illustrative example is the mobile app industry, which emerged in 2008, and has been an area of spectacular growth. Apple's data show there were 192 000 active app publishers in 2012 with apps listed in the Apple App Store (OECD, 2013a).

Reaping the full benefits of data requires a sufficiently high-level of data analytic capacities in the economy and society. The growth of cloud computing and data analytic tools means improved data analytic (data scientist) skills are needed. Some technology firms and policy makers point to a shortage of highly-skilled labour to fill jobs in the Internet economy. [2] Policy makers are looking at ways to increase the number of available workers to fill jobs that support the growth of the Internet economy, either by transforming domestic educational institutions or by promoting the immigration of those with the necessary skills.[3]

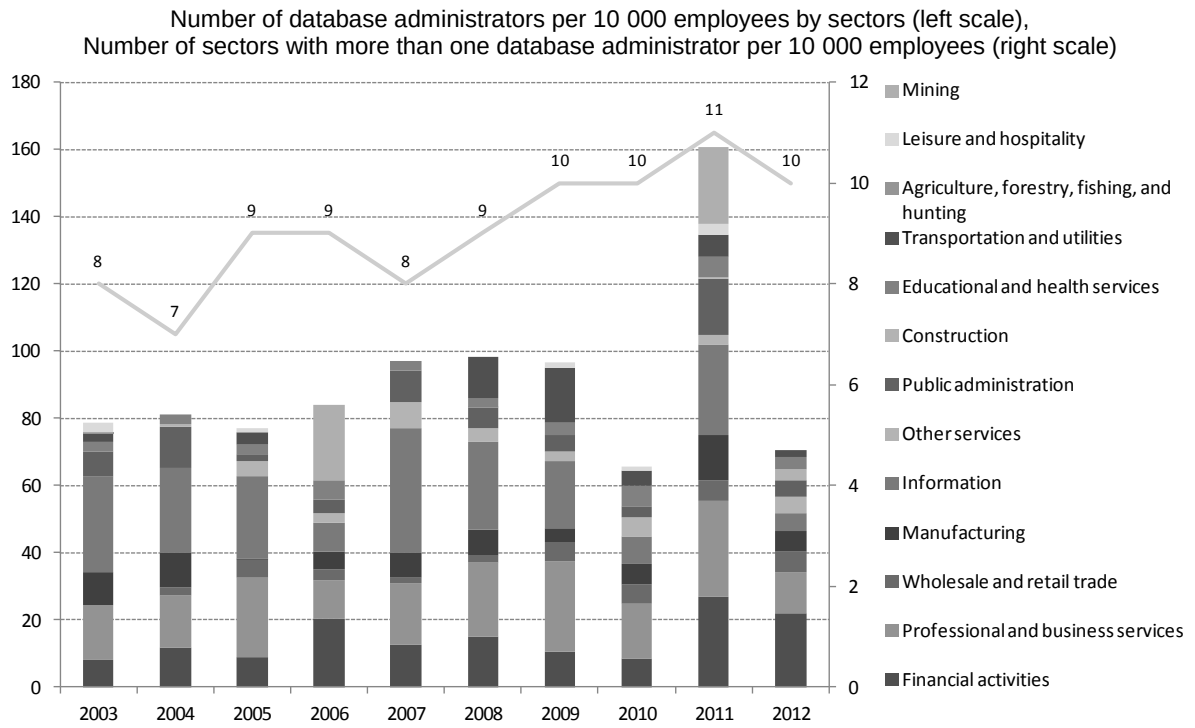
The Internet can also lead to job creation outside of the ICT sector because it enables firms to increase productivity, tap into new markets and reorganise their business processes. For example, a small retailer may hire workers with particular language skills as it branches out into foreign markets online. These jobs would not classified in the ICT sector, but rather supported by the introduction of ICTs in the workplace.

Current jobs (transformed)

The Internet influences work processes throughout the economy, leading to a transformation of existing jobs. The transformation is widespread as Kretschmer (2012) highlights that nearly all existing industries tailor their activities to take advantage of the Internet. This transformation requires that users upgrade their skills in order to adapt to the new technology and use it efficiently.

An example of the breadth of this transformation can be seen in the growth of database administrators across industry sectors. Figure 4 shows that nearly all the industry sectors are data intense in terms of the number of employed database administrators, as well as in terms of number of sectors with more than one administrator per 10 000 employees (OECD, 2013d).

Figure 4. Data intensity of the United States economy, 2003-12



Source: OECD based on the Current Population Survey (March supplement), United States, 2012.

Jobs moving across borders

The Internet opens opportunities and lowers the costs of coordinating with suppliers and contractors abroad, supporting the outsourcing or offshoring of various business processes. Grossman and Rossi-Hansberg (2006) argue that trade in goods has been replaced by trade in tasks thanks to the advances in ICTs and globalization. An example is how firms offshore tasks relying more on routine or unskilled jobs. Both outsourcing and offshoring have implications for local and foreign labour markets.

The Internet helps firms sub-contract work to other companies, or even hire freelance workers from around the world to reduce labour costs or take advantage of local specialisation. As Freeman (2009) states, "offshoring and digitalisation go together." Online outsourcing becomes a practical option for small and medium enterprises that can now seek internationally for affordable outsourcing solutions. Large companies also rely on international, Internet-enabled outsourcing especially in service operations that rely heavily on communication such as call centres or accounting services.

Economies that manage to attract service contracts via the Internet tend to develop specialisations and train workers in these areas. This leads to scale effects that reinforce these trends and cement these new international specialisation patterns. For example, the Philippines has attracted companies to locate call centres in the country due to linguistic commonalities and the low cost of routing calls to other English-speaking countries. In 2012, the call centre industry was estimated to generate USD 8.4 billion in revenues and to employ nearly half million people in the Philippines.[4] This business model would not have been economically possible before the Internet.

Jobs shifting across borders (or offshoring) improves productivity and leads to shifts in demand for labour, to the benefit of some workers and to the detriment of others. Offshoring as part of global value chains most likely leads initially to short-term employment losses. But these costs have to be balanced against the expected gains, often in the longer term and in other parts of the economy. The literature shows fairly consistently that economic openness is associated with higher GDP and economic growth (OECD, 2013f),

Lost jobs

The Internet can also lead to the loss of jobs, either as technology replaces tasks previously performed by workers or as the Internet facilitates the outsourcing of particular business functions to other locations. This reshuffling of labour demand is not specific to the Internet but is the a result of on-going technological progress that results in a continuing reallocation of factors of production from old and declining economic methods and processes to the new, expanding ones. Although historical data on innovation and employment indicate that on the macroeconomic level such concerns should not be overemphasized, this on-going transformation will lead to inevitable job losses in certain industry sectors and of certain tasks (OECD, 2012c; Caballero and Hammour, 1996).

Internet-powered automation could lead to the reduction of certain jobs that previously required human labour. As Brynjolfsson and McAfee (2011) note, computers are rapidly entering into economic domains that were previously occupied by workers. One example where this can clearly be seen is the shift from standard letter-post items to electronic communications. Universal Postal Union data show that the number of letter-post items handled by postal services across 13 OECD countries fell by an average of 4% per year between 2007 and 2011. This drop in handled items contributed to significant reductions in employment in this specific sector. For example, the United States Postal Service reported a 25% reduction in employment over the past 15 years, and most of the jobs lost were lower skilled.[5]

This impact could increase in the future as Internet-based technology improves to the point it can replace other workers in the economy. One potential shift that could revolutionise a sector is the development of autonomous cars that are being developed and tested by various car manufacturers (e.g. Daimler Benz, BMW, Volvo) and technology companies (e.g. Google). As the technology improves, there may ultimately be less demand for operators of commercial vehicles such as taxis and trucks. Brynjolfsson and McAffee also extend the potential impacts of the Internet to customer relations and sales as firms develop the ability to mine vast amounts of data and change jobs of a transactional nature.

In some cases, an entire industry is transformed by digital technologies in a way that brings down the largest industry players and leaves room for much smaller, nimble firms to capture market share. The number of employees working at Kodak reached 145 300 in 1988 at its peak but fell to 13 100 in 2012 as other firms captured the new market for digital photography. [6] It is worth noting that one of the most influential companies in the digital photo space in 2012, Instagram, was sold for USD 1 billion to Facebook when it had a total of 13 employees.[7]

Overall, the net impact of the Internet on jobs is unclear and more work is needed to understand the phenomenon. What is known is that the Internet and its ecosystem tend to create demand for specialised, highly-skilled workers. The Internet also transforms existing jobs in a way that makes them more efficient but requires employees to learn new skills. Finally, as with other technologies, the Internet will also lead to job losses in certain sectors as technology takes over tasks from workers or as jobs are outsourced to more competitive regions or countries. Even for those losing jobs as part of this transformation, the Internet is also a powerful platform for matching employers with potential employees and aiding in the retraining and reskilling workers.

DEMAND FOR INTERNET SKILLS IS INCREASING

There are increasing demands for ICT skills as firms implement ICT solutions to reduce costs and improve efficiency. The economic influence of these ICTs, and the Internet in particular, can be seen in various areas of firm activity. For firms, the emergence of the Internet implies a significant re-shuffling of the existing business environment and working methods, which lowers the cost of accessing suppliers or wholesale markets and, in many cases, eliminates the need for intermediaries. At the industry level, firms tend to be more efficient when they use ICTs and the Internet because the improved access to information and better connectivity allow for more interaction among all market players. The Internet leads to more intense data and 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)

The general impact that ICTs and the Internet have on firms is reflected in the changes of skills firms need from workers. Several studies examine the impact that the IT technical change has on skills demanded on the labour market. In the mid-nineties, Colecchia and Papaconstantinou (1996) explored the role of technology in the changing skill mix in various industries, and showed that the upskilling trend is more apparent in manufacturing than in services, while overall the shift to higher skilled jobs occurs primarily within industries, rather than between them. Later studies further explore these issues. Bresnahan *et al.* (2002) finds evidence of complementarities between the IT revolution and organisational capital in factor demand and productivity regressions. Other studies using firm level and industry data on employment by skill level also find a positive relationship between skill upgrading and IT adoption (Hollander and ter Weel, 2002; Toner, 2011; Handel, 2012)

The OECD has long collected and reported data on ICT employment. Early data collections focused on the number of people employed in the ICT producing sector, using a definition developed in 1998 by the Working Party on Indicators for the Information Society. The data helped policy makers understand the employment effects of the ICT-producing sector but lacked information on ICT-related employment in other sectors.

In 2001, Pilat and Lee (2001) introduced a new classification of ICT use by industry based on capital flow matrices and capital stock estimates. They find that while the industrial classifications are not entirely compatible, certain manufacturing industries (printing and publishing, electronic equipment, machinery and equipment), as well as communications, wholesale and retail trade, finance, insurance and business services turn out to be the largest relative investors in ICT equipment. This categorisation helped pave the way for more refined statistics.

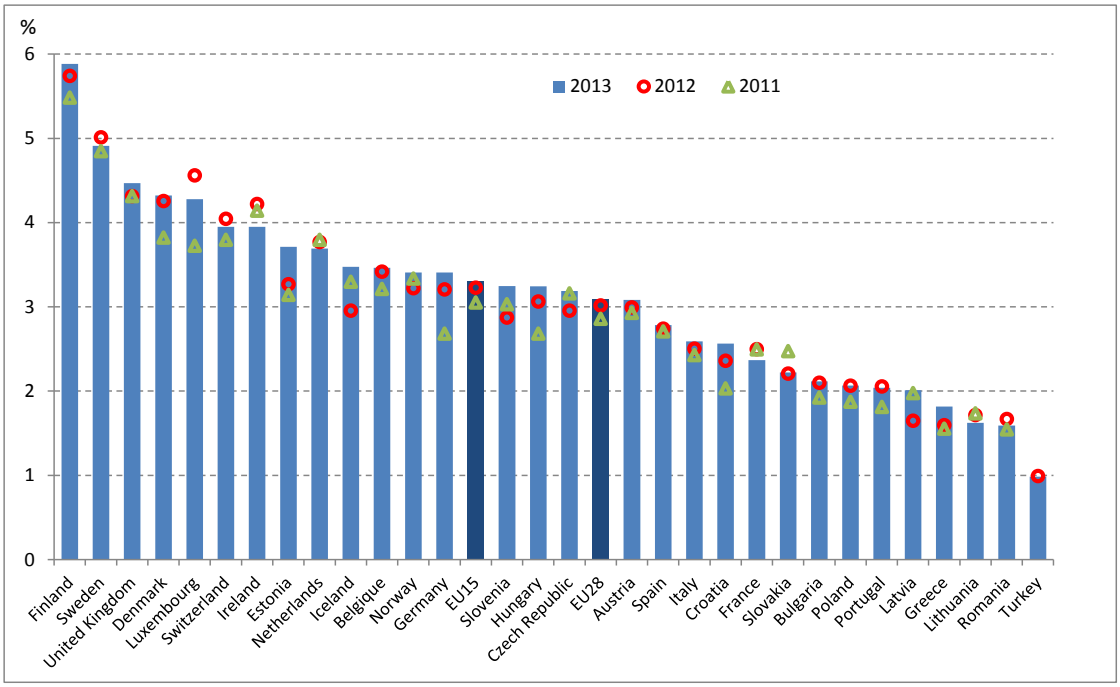
In 2004, the OECD defined several categories of ICT occupations within existing occupational data sets in order to compare differences across countries and understand the impacts over time. The research identified two main categories of ICT-related occupations (ICT specialists and ICT advanced users). The narrowest category of ICT specialists included programmers, software developers but also cable layers. A broader measure included occupations where people used ICTs intensively in order to do their work (both basic and more advanced users). These categories allow researchers to use occupational data to follow ICT employment trends (OECD, 2005).

The 2004 definitions have been widely used to track ICT employment but are quickly becoming less relevant as ICT and Internet use permeate into most occupations in the economy. Many occupations that were deemed to have no ICT-relationship in 2004 now rely on ICTs, highlighting that the 2004 definitions need to be revised. There are questions however, as to whether it is even possible to separate occupations into ICT-using and non-ICT using categories given the Internet's pervasive role as a general purpose technology – or if these categories would be meaningful for policy.

ICT specialists

One category that can still be defined relatively easily is "ICT specialists", and data show that employment of these specialists is growing over time. This paper includes an updated the cluster of ICT specialist occupations and finds employment growth over the previous three years (Figure 5). Eurostat data show that in most European countries ICT specialists account for approximately 3% of total employment. Countries within the sample with the highest percentages of ICT specialist out of the entire population are Finland, Sweden, the United Kingdom, Denmark and Luxembourg, all at more than 4%. More importantly, the share of ICT specialist employment in total employment has been recently growing at an average annual growth rate of 4%, reflecting an expansion relative to other occupations in the economy (Figure 6).

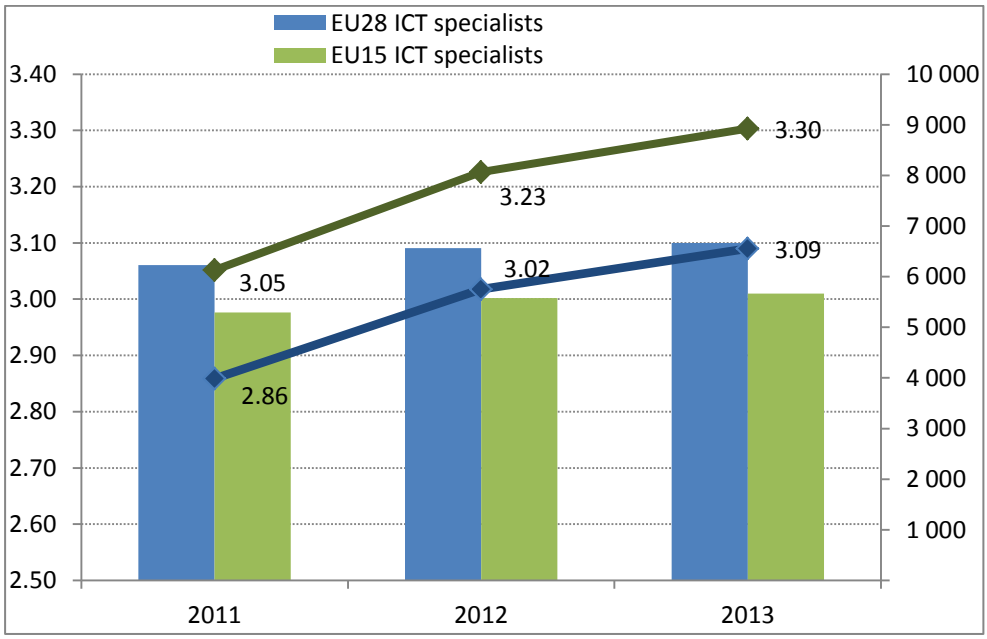
Figure 5. ICT specialists in total economy



Source: EU Labour Force Survey, October 2013.

Note: ICT specialists are defined here as the sum of the following ISCO 2008 codes: 215 Electrotechnology engineers, 251 & 252 ICT professionals, 351 & 352 Information and Communication technicians, 742 Electronics and Telecommunications installers and repairers

Figure 6. Eurostat: Short-term growth of ICT specialists in total economy



Source: EU Labour Force Survey data, October 2013

Note: ICT specialists are defined here as the sum of the following ISCO 2008 codes: 215 Electrotechnology engineers, 251 & 252 ICT professionals, 351 & 352 Information and Communication technicians, 742 Electronics and Telecommunications installers and repairers

Internet use in the broader workplace

Policy makers, educators, workers and students need data on career trends to help ensure that people are well positioned to take advantage of future economic opportunities. Some skills take a significant amount of time to acquire, so policy makers are keen to understand evolving employment trends now so they can adjust policies to best prepare the population for future jobs.

Predicting the skills that will be in demand in the future is challenging and imprecise, but various detailed data sets are helping us observe evolving trends. One example is the O*NET program in the United States from the US Department of Labor/Employment and Training Administration that collects information on 974 occupations.[8] O*NET is a comprehensive database of worker attributes and job characteristics. Survey data collected from job incumbents or occupational experts form a taxonomy of different occupations in the United States.

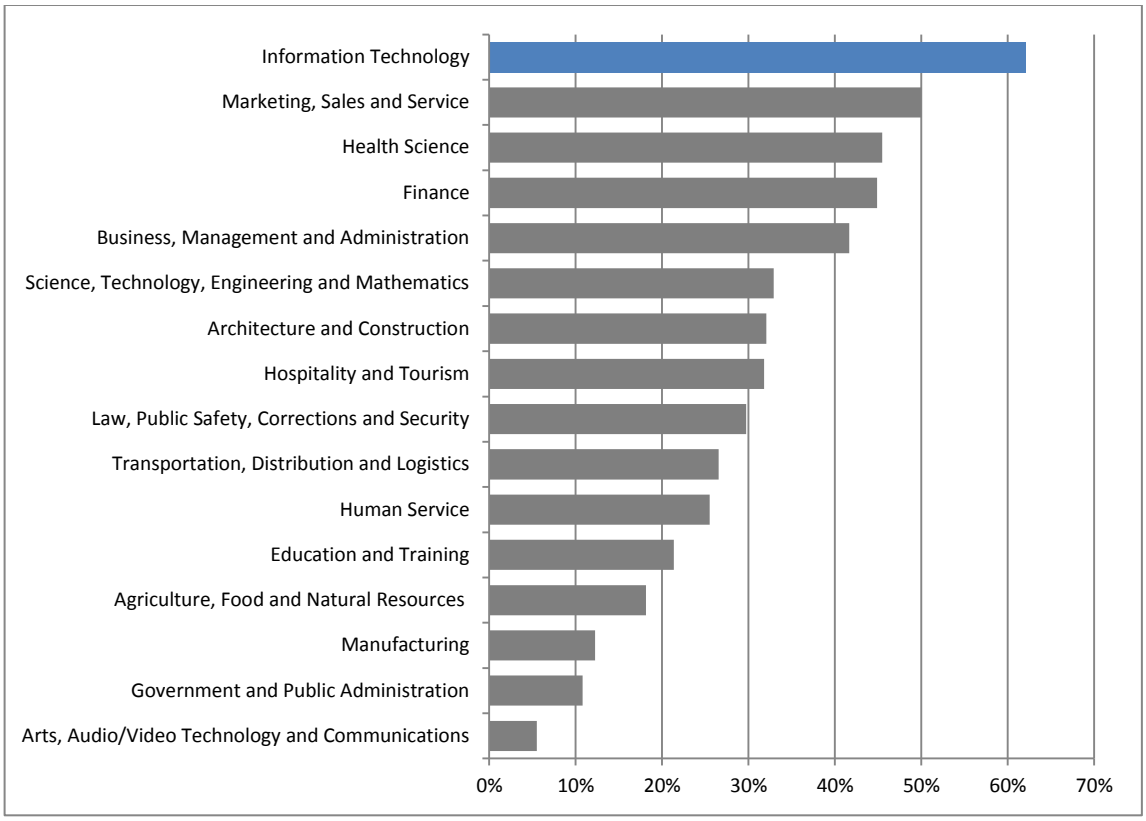
One key feature of the O*NET project is that it uses the collected survey data to compile a list of "bright outlook" occupations where new jobs opportunities are likely in the future. This list of bright outlook occupations helps policy makers, educators and students plan for careers in rapidly growing fields. In order to be categorised as having a bright outlook, the occupation need to fulfil at least one of three criteria:

- Projected to grow much faster than average (employment increase of 29% or more) over the period 2010-2020
- Projected to have 100,000 or more job openings over the period 2010-2020
- New & emerging occupations in a high growth industry

One way to gauge the relative importance of ICT occupations is to look at the relative percentage of occupations that are considered to have a bright outlook by O*NET across different occupational categories. A higher percentage of jobs with a bright outlook signals an area of future occupational growth. The O*NET data show that the information technology career cluster has the highest percentage of occupations (62%) considered to have a bright outlook (Figure 7).[9] The career cluster of marketing, sales and service was the second highest with half of its occupations categorised as having a "bright outlook". This highlights the growing importance of ICT occupations relative to other careers such as manufacturing or public administration. It is important to note that the O*NET data is specific to the United States, but it aligns with trends seen in similar databases in the UK, Canada and Germany.

Figure 7. US: Bright outlook occupations

Percentage of occupations in the category that are considered to have a bright outlook



Source: OECD based on O*net online (http://www.onetonline.org/)

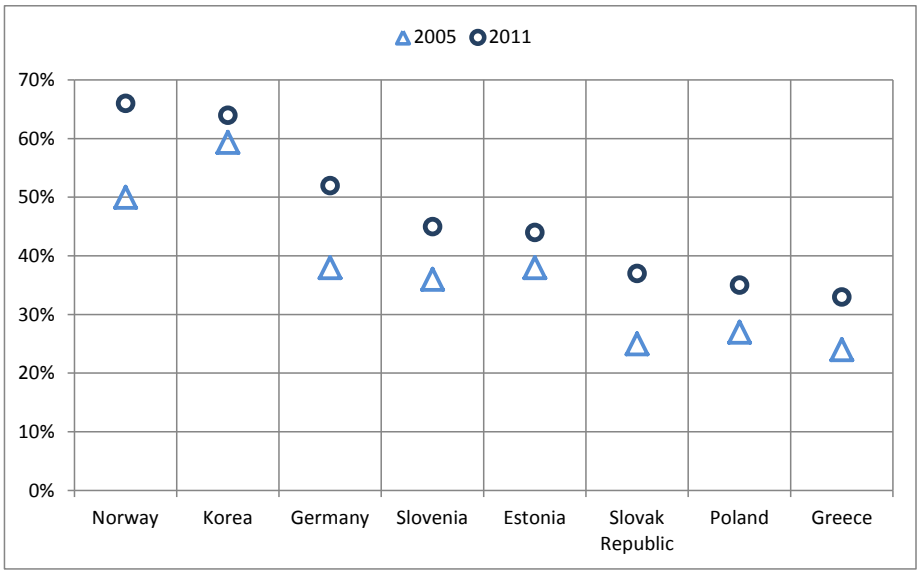
Surveys of Internet use at work

An increasing number of people use the Internet at work as part of their jobs. The demand for ICT skills at work can be proxied by the percentage of employed people who use a computer with access to the Internet for their job. The challenge is that data on Internet use at work are not systematically collected in all OECD countries. Eurostat and Korean data show increases in the percentage of employees in the economy who work at a computer with access to the Internet (or World Wide Web depending on the survey) (Figure 8). The trend holds true across all OECD countries for which data are available.

In the United States, the most recent data from the Pew Internet and American Life Project on Internet use at work is from 2008 and shows 62% of Americans already reported using the Internet or e-mail at work (Pew, 2008). In Europe, Eurostat data show that 30% of individuals in the EU28 reported using the Internet at work in 2011. Norway, Iceland and Sweden all had higher levels, with more than 50%.

Figure 8. Persons employed using computers with access to the Internet

Selected countries, 2005 and 2011



Source: OECD, ICT Database

Most common occupations needing ICT skills

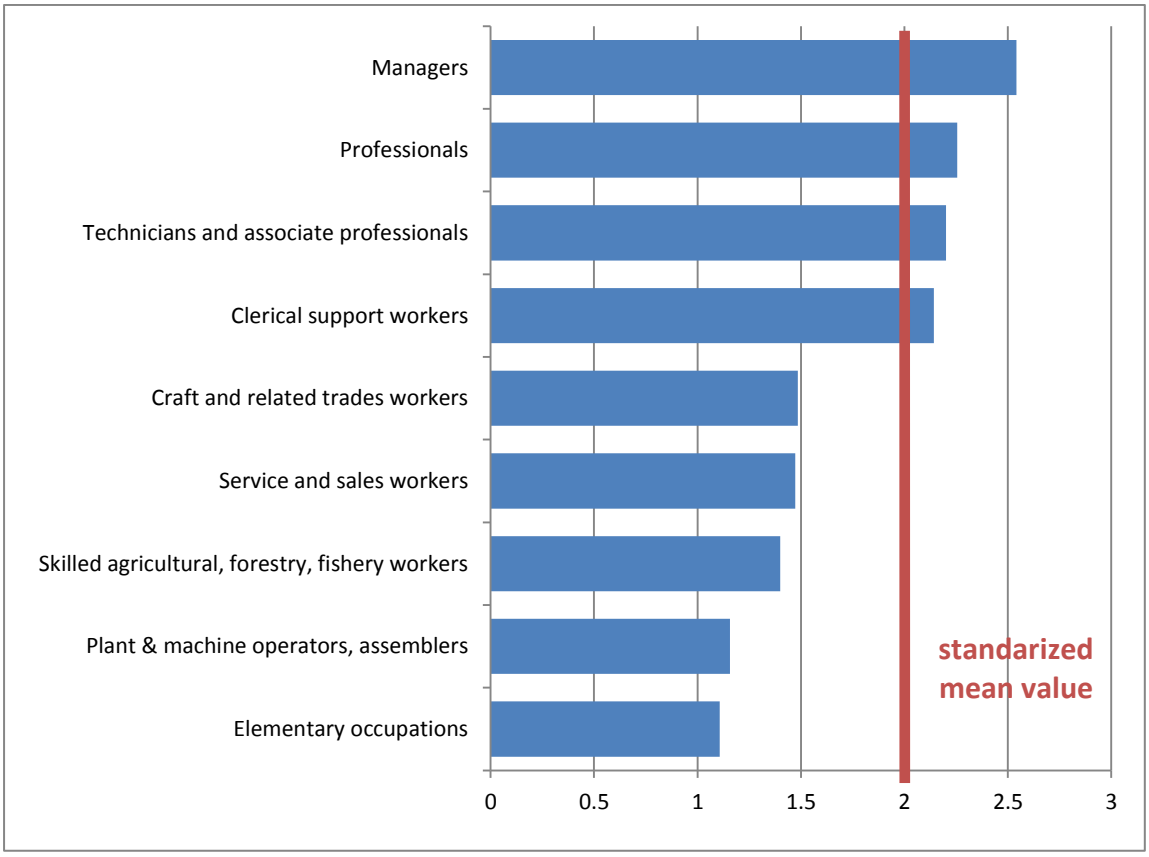
Different occupations have varying ICT skill demands and new OECD data shows which occupations require the most ICT skills at work. The OECD's Programme for the International Assessment of Adult Competencies (PIAAC) involved a Survey of Adult's Skills that provides a rich new data source for measuring adult skills. The survey was developed to provide information not only about access to and familiarity with ICTs, but also to understand the extent to which adults can use these tools efficiently and effectively to solve the types of problems that arise in their everyday lives as workers, consumers and citizens (Box 1). PIAAC data show that managers, professionals, technicians, and clerical support workers all use more ICT skills at work than the average occupation. Elementary occupations and machine operators report that substantially fewer ICT skills are needed to do their jobs. The differences between the reported skills needed by managers and those from people in elementary occupations can be substantial and range from 1.2 to 1.7 standard deviations. They are substantially larger than the variation across any of the other personal or job characteristics (Figure 9).

Box 1. PIAAC: Measuring Adult Skills

The OECD's Survey of Adult Skills (PIAAC, 2012) measures proficiency in problem solving in technology-rich environment. The overall purpose of the survey is to measure the abilities of adults to solve problems in which the information they use is accessed through ICT applications and the solution either requires the use of, or is made easier by the use of, ICT tools. The assessment involves a series of problem scenarios for users to address via the computer. Respondents must find a solution to a problem using the information and tools that are accessible in a simulated computer environment that contains applications, such as an Internet browser and web pages, or a computer-based room-reservation system and other common applications, such as e-mail, word processing and spreadsheet tools. The scenarios involve different levels of cognitive complexity.

Source : PIAAC (2012)

Figure 9. Use of ICT skills at work by occupation



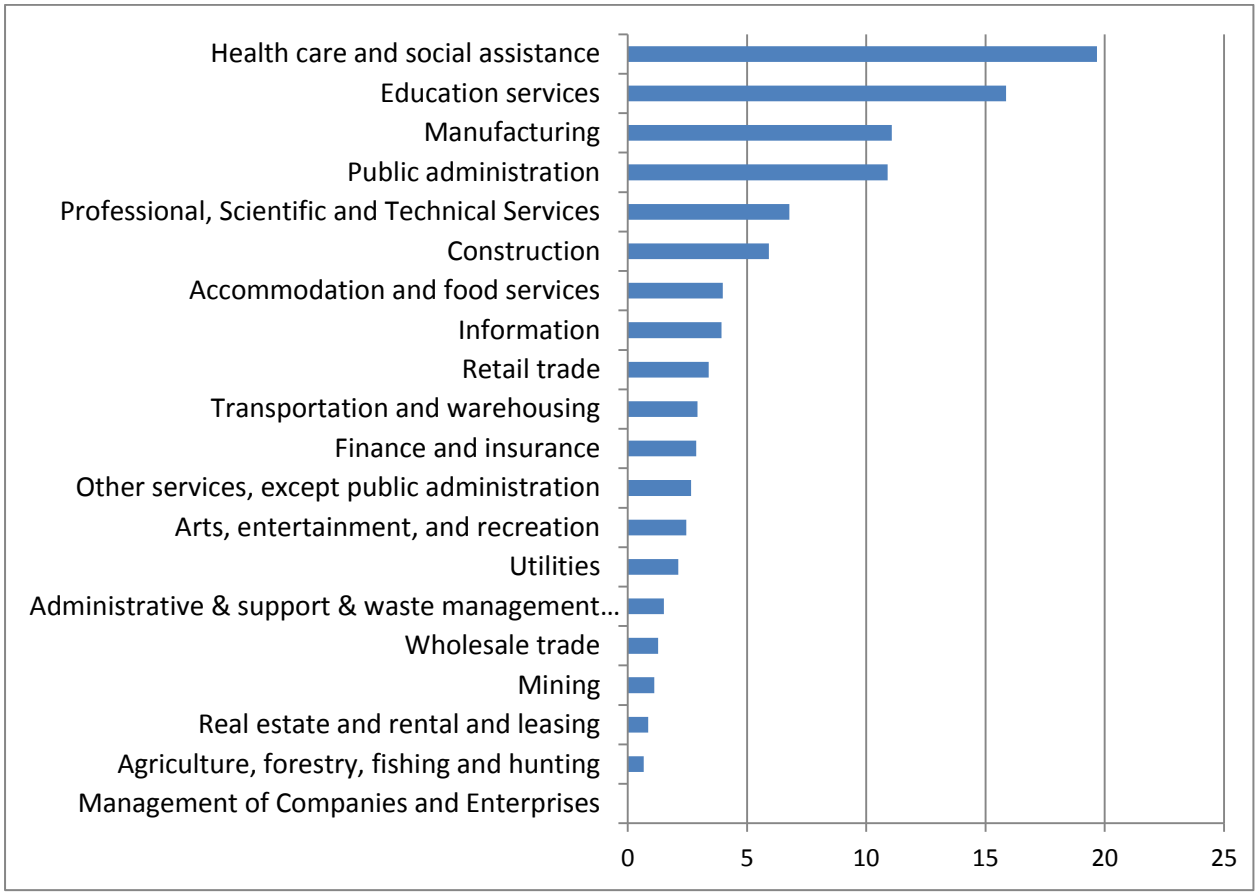
Source: Survey of Adults Skills (PIAAC) (2012)

ICT occupations in different sectors

The O*NET database is also a valuable resource for understanding which sectors in the United States have the highest number of ICT-related occupations. There will be demand for ICT skills, such as those used by database administrators, in all sectors as ICTs spread throughout the economy. Understanding the concentration of information technology occupations within a sector can also highlight areas where cross-sectorial training could be beneficial.

The O*NET data show that the health care and social assistance sector of the economy has the highest proportion of ICT-related occupations in the United States, by a significant amount (Figure 10).[2] Nearly 20% of all ICT-related occupations in the US are categorised in this sector. Education services, manufacturing and public administration also have high levels of ICT-related occupations. The manufacturing sector ranks third in its share of information technology occupations, highlighting the shift in the manufacturing landscape with the introduction of new ICTs.

Figure 10. ICT-related occupations – distribution across major industries



Source: OECD based on O*net online (http://www.onetonline.org/)

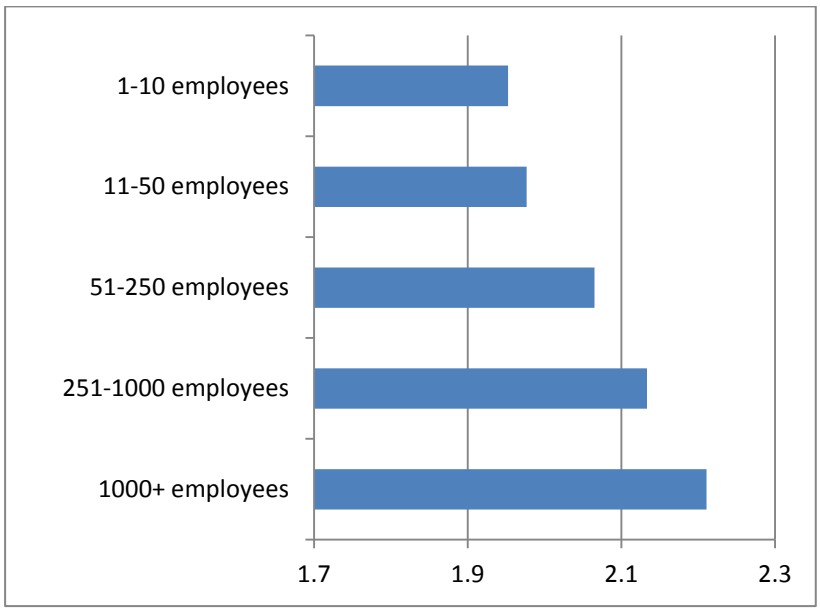
Notes: Data on ICT related occupations come from O*NET's ICT career cluster that groups occupations that require similar skills. It groups technical and professional occupations related to the design, development, support and management of hardware, software, multimedia, and systems integration services. Each occupation has its own unique code (O*NET-SOC Code).

Firm size

The demand for ICT skills varies according to the size of the firm. PIAAC data show that workers in larger firms make more use of ICT skills at work. Employees at smaller firms, particularly those with less than 250 employees, are less likely to report needing ICT skills at work than employees in larger firms (Figure 11). These findings are consistent with evidence that large firms employ more skilled workers and adopt more sophisticated production technologies (Brown and Medoff, 1989; Gibson and Stillman, 2009).

[2] It is worth noting that the O*NET data are not weighted by the level of employment in the occupation, but rather by the number of occupations categorised in the area.

Figure 11. Use of ICT skills at work, by firm size

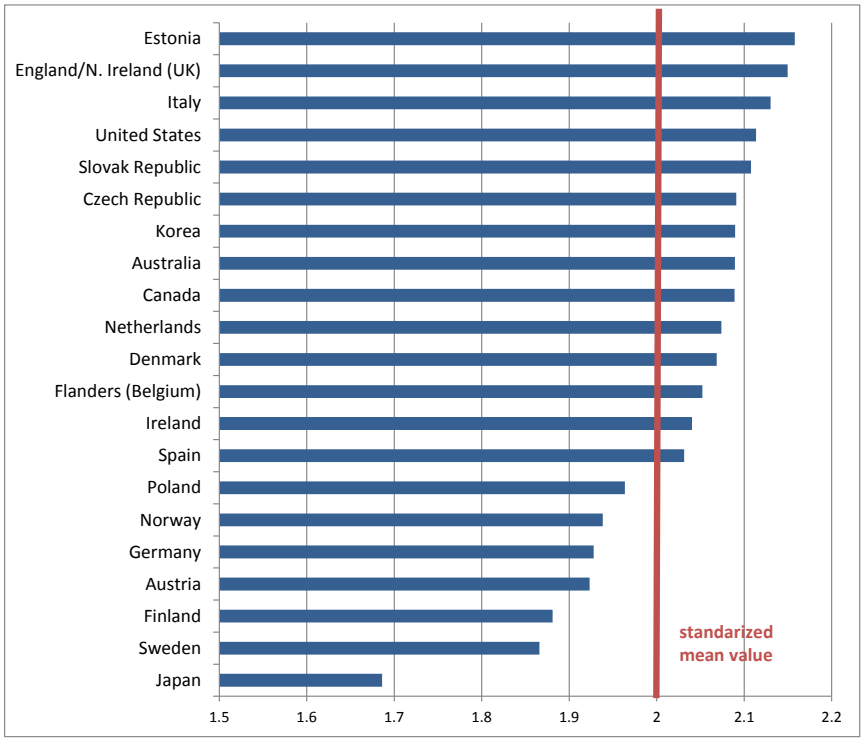


Source: Survey of Adults Skills (PIAAC) (2012)

ICT use at work by country

The demand for ICT skills at work can vary significantly across countries (Figure 12). Countries at the top of the list (Estonia, England/N. Ireland, Italy and the United States) have highest percentages of workers reporting that they use ICTs as part of their jobs than in other countries that were part of the survey. This is important for policy because the intensity of ICT use in firms has been linked to higher growth of output in concerned industries (Brynjolfsson and Hitt, 2003; Sapprasert, 2010, Kleis *et al.* 2012).

Figure 12. Average use of ICT skills at work, by country (2012)



Source: Survey of Adults Skills (PIAAC) (2012)

Summary: Demand for ICT skills

Workers will increasingly need to have both generic and specialised ICT skills to accomplish their tasks at work as the internet becomes more engrained in work processes. This need can manifest itself in something as simple as a small firm setting up a page on social media, or in larger ways such as the creation of entirely new occupations such as "data mining" to look for insights within large data collected by firms. Employers, job holders, job seekers, educators and policy makers benefit when data can illuminate the current and future needs for ICT skills in the workplace.

There is significant interest in understanding the ICT skill demands of jobs in the near and longer term. Data can help us identify particular industries, sectors and occupations where there is high demand for ICT skills and areas that are predicted to see growth in the future. As mentioned earlier, the analysis of the O*NET database in the United States shows that the information technology category of occupations has the highest percentage of occupations categorised as having an expected "bright outlook" in the near future. This sends a clear signal that there will be job growth in this area and there is a need to promote ICT skill development for future workers.

ICT-related occupations are spread throughout the economy but certain sectors have a much larger number of ICT-categorised occupations than others. The health care/social assistance sector has the largest number of ICT-related occupations, accounting for nearly 20% of all ICT-related occupations in the US. A combination of a rapidly ageing population and the potential cost savings possible from ICTs ensures that the sector will remain an important source of ICT-related jobs in the future. Educational services, manufacturing and public administration also have a high proportion of ICT-related occupations.

New data on adult skills illuminates sectors and occupations where people indicate they have a need for ICT skills to do their job. Sectors of the economy that require more ICT skills than the average include ICT, finance/insurance, professional services and real estate. PIAAC data also show that managers, professionals, technicians and clerical support workers use more ICT skills at work than other occupational clusters in the economy.

Finally, the PIAAC data show that workers in smaller firms are less likely to use ICTs than workers in much larger firms. Smaller firms typically lag behind larger firms at adopting ICTs but these firms will likely need to leverage ICTs more effectively in order to stay competitive in the Internet economy.

LACK OF ICT SKILLS IN THE ADULT POPULATION

Even as firms demand increasing ICT skills from employees, data show that **a significant portion of the adult population across countries lacks even the most basic skills to use a computer**. The levels of ICT skills vary across different demographic groups. This lack of ICT skills in the adult population should be an area of particular concern for policy makers because the groups with the least ICT skills tend to be the demographic groups at most risk of losing jobs in the current technological transformation of the workforce. This section looks at the results of the OECD's rich PIAAC data to examine the level of ICT skills in an economy and identify areas for targeted policy focus.

Firms need workers with generic and specific ICT skills to increase efficient and stay competitive. They look for workers in the job market and employ the people they find with the best skill sets for the job. Firms often depend on outside institutions such as schools to prepare workers with certain, baseline skills. Firms also invest in training their own employees, often focusing on specialised skills.

Workers bring with them a set of skills they have learned from their education, job-training or other life experiences. They supply employers with ICT skills as part of their jobs. People make investments in acquiring their own skills so it is important for them to have good information about the type of ICT skills that are needed in the labour market.

For societies as a whole, ensuring that workers obtain the right ICT skills and that those skills are used means that local economies can become more competitive and host better quality and better paid jobs, without greatly exacerbating income inequality.

Measuring ICT skills and predicting future ICT skills is challenging, but is important for policy planning. Policy makers need to understand which skills are available in the market, which are in short supply, and which are likely to be demanded in the future. The rapid evolution of the Internet economy and shifts in work tasks inevitably generate skills shortages. For instance, research in the United States suggests a shortfall of some 1.5 million managers and analysts with adequate understanding of the business benefits of data (MGI, 2011). Skills shortages may increase when firms look to expand the number of skilled employees as the economic recovery gains momentum. Consequently, there is an urgent need for upskilling the workforce to adapt to the Internet economy.

Adults

In nearly all countries, at least 10% of adults lack the most elementary computer skills. The PIAAC Survey of Adult Skills shows that a significant share of adults have trouble using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks. Across participating countries, 7% to 27% of adults report having no experience in using computers or lack the most elementary computer skills, such as the ability to use a mouse. In addition, there are also adults who lack confidence in their ability to use computers. Of the adults undertaking the problem-solving assessment, most are only capable of using familiar applications to solve problems that involve only a few steps and explicit criteria, such as sorting e-mails into pre-existing folders. Box 2 provides a summary of the different skill categories in the PIAAC assessment.

Box 2. Ranking Adult Skills: The PIAAC Assessment

The PIAAC assessment groups the results of individuals who took the exam were grouped into five main categories presented below.

Opt out: Some adults decided not to take the computer based assessment. This could be because they had no computer experience, or decided to "opt-out" for some other reason.

Below level one: Below level one, adults can complete tasks in which the goal is explicitly stated and for which the necessary operations are performed in a single and familiar environment.

Level one: Completion of tasks at level one typically required the use of widely available and familiar technology applications, such as e-mail software or a web browser.

Level two: At level two, success required the use of more specific technology applications, such as use of a novel online form, or some navigation across pages and applications.

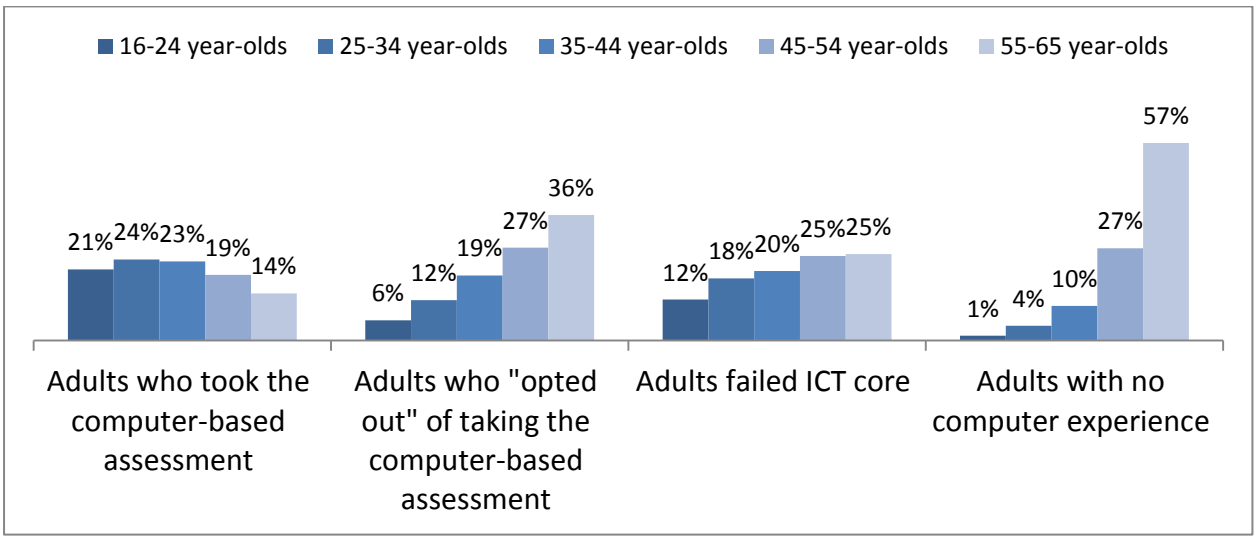
Level three: Adults at level three can complete tasks involving multiple applications, a large number of steps, impasses, and the discovery and use of ad hoc commands in a novel environment.

Source : PIAAC (2012)

Naturally, young adults are more likely than their older counterparts to have computer skills or to have higher proficiency in problem solving in technology-rich environments; yet in some countries, there are surprisingly small proportions of young adults who can solve more complex problems in computer environments. The Nordic countries and the Netherlands have been far more successful than other countries in creating an environment in which most adults have experience with computers and where relatively few have only the most basic computer skills. (PIAAC, 2012).

The data on whether adults chose to take the computer-based test can provide useful information about the adult population's familiarity and comfort level using computers. Figure 13 highlights differences in ICT skills across age groups of adults. The percentage of adults who opted out of taking the computer based assessment ranged from 6% of 16-24 year olds, up to 36% of 55-65 year olds. Older respondents were less likely to take the computer-based test. When the adults did take the assessment, their failure rates increased with age. The youngest adults had the lowest failure rate of 12% while adults 55 years and older failed the assessment at double the rate (25%).

Figure 13. Significant ICT skills differences, by age group

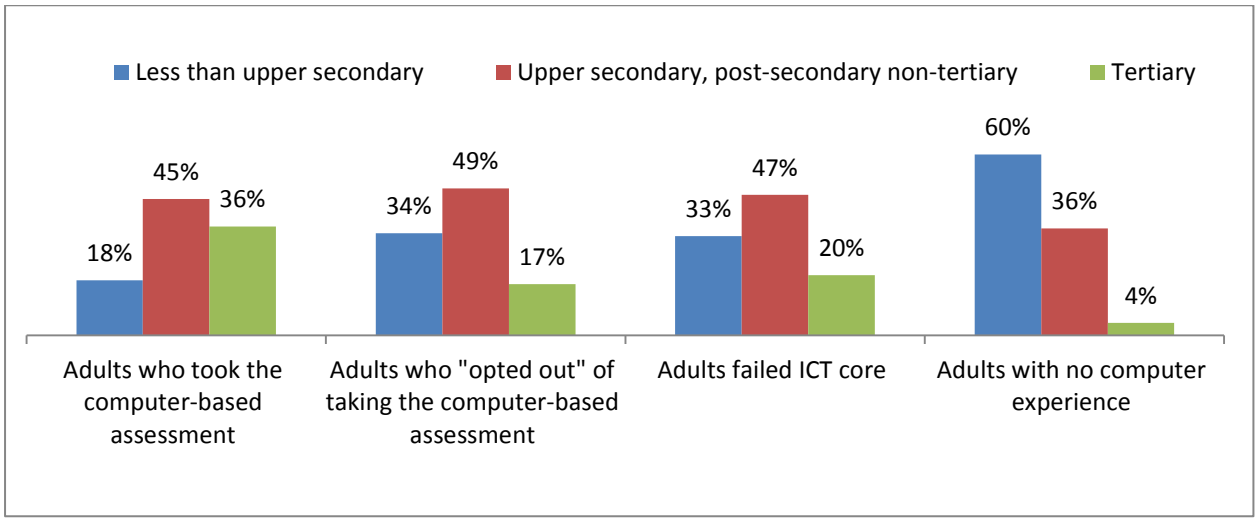


Source: Survey of Adults Skills (PIAAC) (2012)

One of the most dramatic differences across ages was among adults who had no computer experience. The youngest cohort of adults had near universal familiarity with computers compared to 57% of 55 to 65 year olds who had no computer experience. After age 44, adults are much less likely to know how to use a computer.

Another way to view the PIAAC data is to look at the level of ICT skills by educational attainment. Adults with a tertiary education failed the assessment at a lower rate than those with upper-secondary or less-than-upper-secondary levels of education (Figure 14). The largest gap in terms of educational attainment, however, is related to whether the adult had experience with a computer. Only 4% of adults with a tertiary education said they had no computer experience, compared with 60% of adults with less than an upper secondary education.

Figure 14. Significant ICT skills differences, by level of education

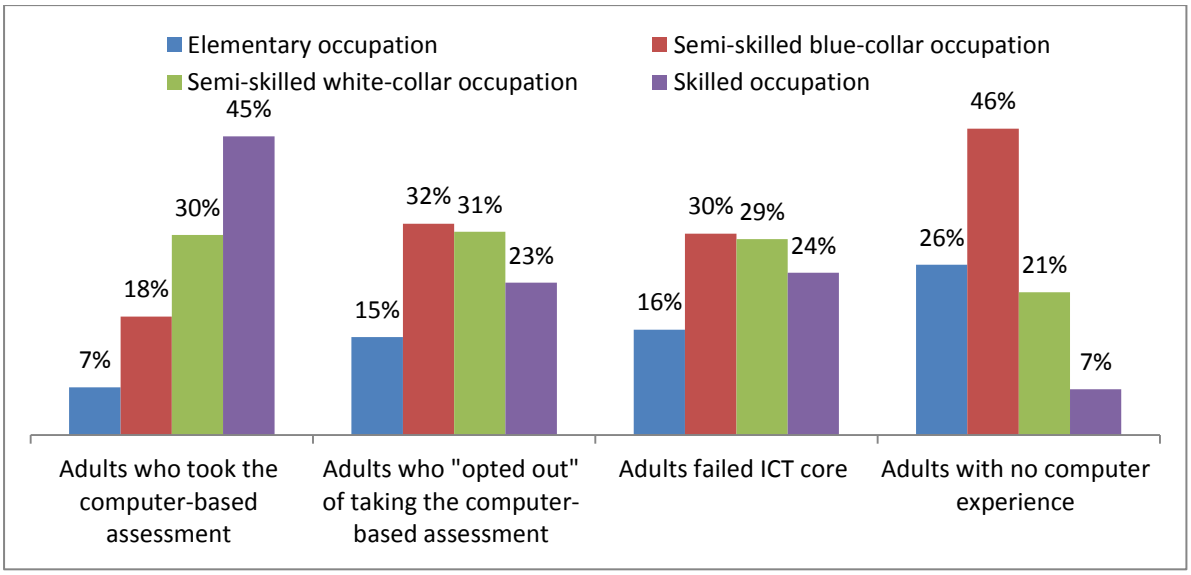


Source: Survey of Adults Skills (PIAAC) (2012)

There are also significant differences in computer experience by occupation (Figure 15). Semi-skilled workers (white or blue collar) were slightly more likely to fail the ICT core assessment. Those with an elementary occupation where much less likely to opt in for the computer-based assessment, but when they did, they passed at a higher rate than the other categories of workers.

Workers in skilled occupations were much more likely to have computer experience than people in semi-skilled blue collar occupations. Only 7% of workers in skilled occupations had no computer experience, compared with 46% among semi-skilled blue collar workers. These figures are of particular concern because recent trends in automation, manufacturing and employment have hit semi-skilled workers particularly hard, yet these are the workers with the least amount of computer experience.

Figure 15. Significant ICT skills differences, by occupation



Source: PIAAC: Survey of Adults Skills (PIAAC) (2012)

The PIAAC data begin to paint a picture about ICT core competencies and experiences with computers. Young adults, those with tertiary levels of education, and those in skilled occupations were the most likely to have the ICT core competencies and report experiences with computers. By contrast, the demographic factors most commonly associated with a lack of core skills and no computer experience are people aged 55-65, people with less than an upper secondary level of education, and people in semi-skilled blue collar occupations.

Across the sample, roughly 10% of adults opted out of taking the computer-based assessment. People can opt out of the computer-based assessment for a number of reasons, but the high number of people opting out should be of concern for policy makers. This could be an indication of the percentage of the adult population that would feel uncomfortable using a computer for various tasks. This poses a challenge to governments for a variety of reasons, including that this segment of the population would likely not be able to access online services provided by governments. Government efforts to move more public services online will still need to take account of this significant portion of the population for whom using a computer could be a challenge.

PIAAC scores can provide a broad snapshot of ICT skills across an economy in a way that has not been possible before. Much of our understanding of ICT skills in the population has been tied to household or business surveys that ask users if they use technologies at work or at home. The PIAAC Survey provides

new, rich data on how adults in the survey fared when asked to perform certain tasks on a computer related to problem solving in a technology-rich environment. Some key results are provided below.

Highly skilled (Level 3)

Data show that only a small percentage of the population is categorised with the highest level of ICT skills (Figure 16). On average, 6% of adults are in the top category where they were able to complete tasks involving multiple applications, a large number of steps, impasses, and the discovery and use of *ad hoc* commands in a novel environment. The percentages vary across countries, with a low of 3% in Canada and Flanders, Belgium up to a high of to 9% in Austria.

The percentage is of a similar magnitude to the percentage of ICT specialists in total employment, roughly 3% of all employment in the EU. The data are not directly comparable however, because people may have advanced ICT skills, but do not have a job that uses them.

Middle skilled (Level 1, Level 2)

The majority of adults (58%) fall into levels 1 and 2. They do not have the highest level of skills but are generally comfortable with a set of computer tasks. At the lower end, 29% of adults are considered in the skill category of being able to perform a task on the computer that requires the use of widely available or familiar technologies applications such as e-mail or web browsers. A similar percentage of adults (28%) had a slightly better set of skills and were categorised as being able to use more specific technology applications such as a novel online form or navigating across pages and applications.

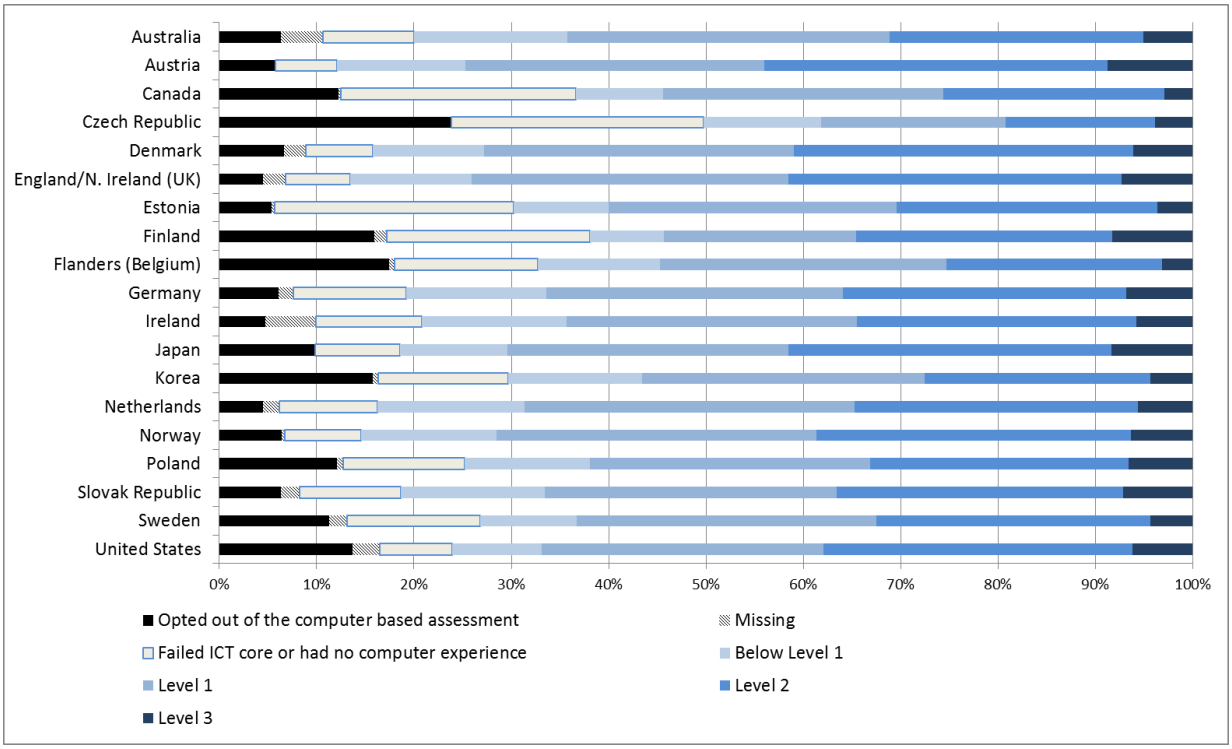
Basic skills (Below level 1)

Roughly 12% of the population can use a computer to complete a task where the goal is explicitly stated and for which the necessary operations are performed in a single and familiar environment. This constitutes the most basic skill level assessed by the survey.

No or very-low skills (Failed, opted out, or missing)

There is a significant segment of the population that is unable to effectively solve problems in a technology-rich environment. Across the economies tested, roughly 13% of adults who chose to take the computer example were unable to accomplish even the most basic tasks. This is in addition to the roughly 10% of individuals who opted out of taking the assessment and the 1% who could not take the exam for reasons such as a disability. These results imply that between 10% and 24% of the adults in the survey lack even the most basic computer skills.

Figure 16. Proficiency in problem solving in technology-rich environments among adults, 2012



Source: Survey of Adults Skills (PIAAC) (2012)

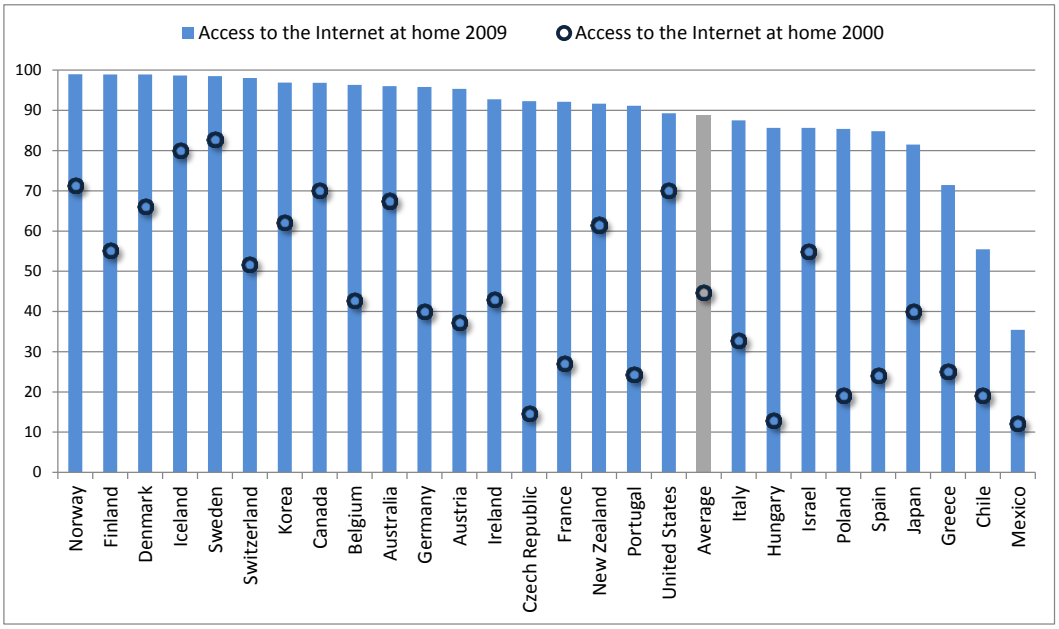
Youth

While significant numbers of adults lack basic computer and Internet skills, young students are nearly universally familiar with computers and have good access to the Internet at home. Data from the OECD's Programme for International Student Assessment (PISA) in 2000 and 2009 show that the percentage of students with a computer at home increased dramatically from 72% in 2000 to 94% in 2009. Less than 1% of 15-year olds reported that they had never used a computer.

The number of students with Internet access has grown even more sharply. On average across OECD countries, the proportion of students who reported having the Internet at home doubled from 45% to 89% over the same nine-year period to 2009 (Figure 17). Access to the Internet can represent a qualitative, as well as quantitative, difference in the educational resources available to students. Full participation in the knowledge society will require skills to effectively navigate and use the Internet. In the OECD countries, on average, 90% of students use the Internet at home (Figure 18). More than 70% of students use the Internet at school.

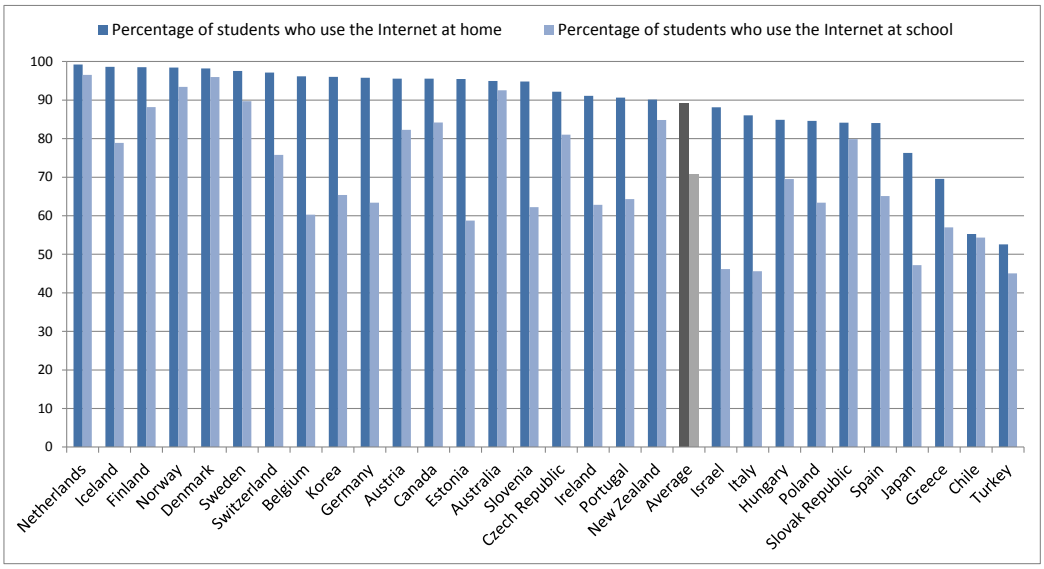
One of the interesting policy issues emerging from the PISA data is that more students report using the Internet at home than at school. The PISA study also checked whether using a computer at home and at school was related to digital reading performance. After accounting for students' academic abilities, the study concluded that the frequency of computer use at home, particularly computer use for leisure, is positively associated with navigation skills and digital reading performance, while the frequency of computer use at school is not. These findings suggest that students are developing digital reading literacy mainly by using computers at home to pursue their interests, rather than at school (OECD, 2011).

Figure 17. Percentage of students having access to the Internet at home (2000 and 2009)



Source: OECD (2011), PISA 2009 Results: Students on Line: Digital Technologies and Performance

Figure 18. Percentage of students who reported using the Internet at home and at school



Source: OECD (2011), PISA 2009 Results: Students on Line: Digital Technologies and Performance

Summary: Supply of ICT skills

ICT skills are becoming an important requirement for employment across the economy, but a significant part of the population lacks the basic skills necessary to function in this new environment. **In nearly all countries, at least 10% of adults lack even the most elementary computer skills.** Across participating countries, 7% to 27% of adults report having no experience in using computers or lack the most elementary computer skills, such as the ability to use a mouse.

Certain demographic groups are better prepared for the rapidly changing employment environment because they have stronger ICT skills than others. In general, younger adults have near universal familiarity with computers (99%), but a majority of adults aged 55-65 do not know how to use a computer (57%). Educational attainment is also strongly linked to ICT skills in adults. Only 4% of adults with a tertiary education have no computer experience, compared with 40% of adults with less than an upper secondary education. Workers in skilled occupations are much more likely to have computer experience (93%) than people in semi-skilled blue collar occupations (54%).

The PIAAC data begin to paint a picture about ICT core competencies and experiences with computers. Young adults, those with tertiary levels of education, and those in skilled occupations were the most likely to have the ICT core competencies and experience with computers. By contrast, the demographic factors most commonly associated with a lack of core skills and no computer experience are people aged 55-65, people with less than an upper secondary level of education, and people in semi-skilled occupations.

This lack of ICT skills in the adult population is of particular concern for policy makers because the groups with the least ICT skills tend to be the demographic groups at most risk of losing jobs in the current technology transformation of the workforce. For example, ICT-enabled automation has hit semi-skilled workers particularly hard, yet PIAAC data indicate that these workers have the lowest amount of computer experience and ICT skills demanded in the new economy.

An important bright spot is that while significant numbers of adults lack basic computer and Internet skills, young students are nearly universally familiar with computers and have extensive access to the Internet at home. Data from the OECD's Programme for International Student Assessment (PISA) in 2000 and 2009 show that the percentage of students with a computer at home increased dramatically from 72% in 2000 to 94% in 2009 (Figure 17) and more than 99% of 15-year olds have used a computer. The proportion of students who reported having the Internet at home doubled from 45% to 89% over the same nine-year period to 2009.

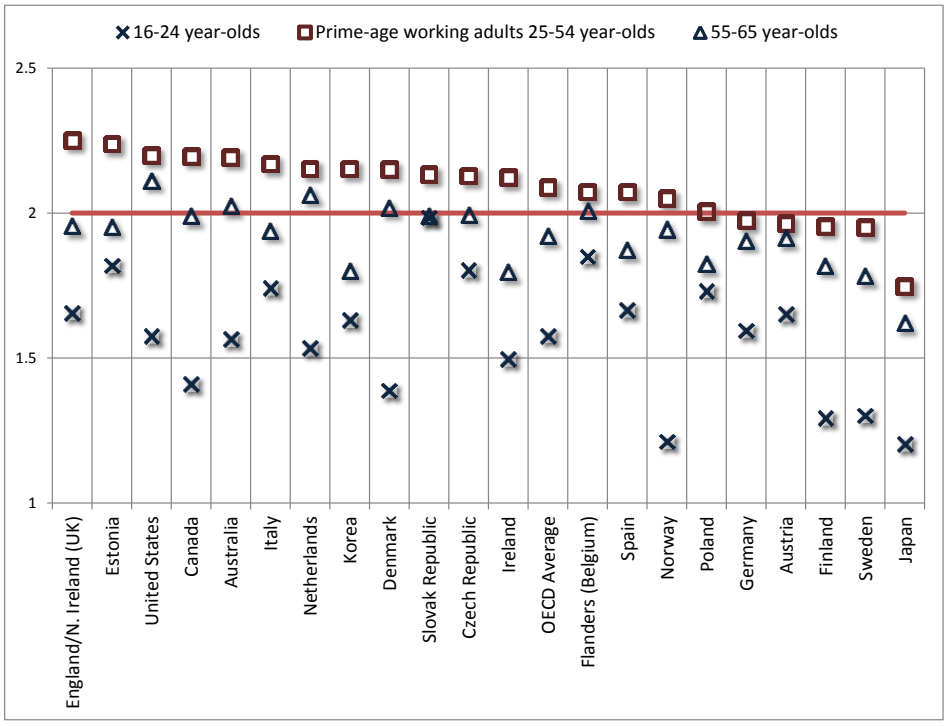
One of the interesting policy issues emerging from the PISA data is that more students report using the Internet at home than at school. After accounting for students' academic abilities, the study concludes that the frequency of computer use at home, particularly computer use for leisure, is positively associated with navigation skills and digital reading performance, while the frequency of computer use at school is not. These findings suggest that students are developing digital reading literacy mainly by using computers at home to pursue their interests, rather than at school and could lead policy makers to reconsider how ICTs are used for learning and the role of access outside the school environment.

MISMATCH IN THE ECONOMY BETWEEN THOSE WITH ICT SKILLS AND THOSE WHO USE THEM AT WORK

Recent skills data from the OECD highlight a potential mismatch between adults with the most ICT skills and those who actually use ICTs at work. Those with some of the strongest ICT skills (youth 16-24) are the least likely to use ICTs in their occupation in almost all economies (Figure 19). Prime-age working adults (25-54) are the most likely to report using ICTs at work, followed by older workers (55-65) and then young adults.

The differences can be significant. Northern European countries tend to have a very large gap between ICT use at work by prime age and young adults. Economies with a low use of ICTs by youth at work or large gaps between age groups could signal areas where labour market allocation and economic efficiency could be improved.

Figure 19. Mean use of ICT skills at work, by age group

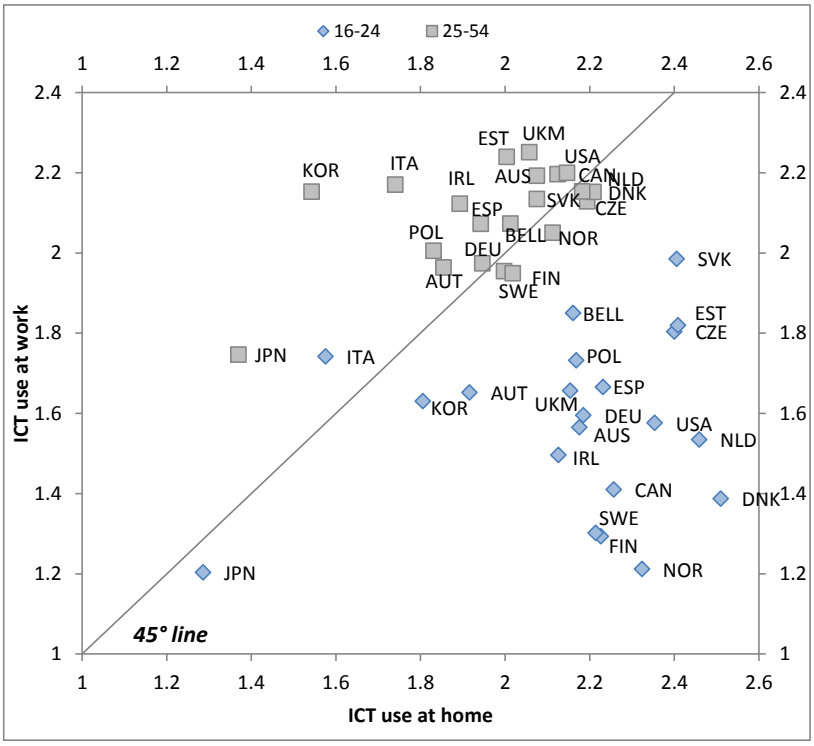


Source: Source: Survey of Adults Skills (PIAAC) (2012)

The data also show that youth are more likely to use the Internet at home, rather than at work (Figure 20). Youth in countries such as Norway, Finland, Sweden, Denmark and Canada have high ICT usage at home but much lower ICT usage at work than average (Figure 20). The Slovak Republic has the highest average of youth using ICTs at work and among the highest levels of ICT use at home. Japan has the lowest level of ICT usage at work and at home for youth across the study, despite having some of the best Internet infrastructure in the world.

The cohort of adults aged 25-54 tend to have slightly less ICT usage at home, but significantly more ICT usage at work than younger adults. Countries such as United States, Canada, the Netherlands, the United Kingdom, Denmark and the Czech Republic lead the OECD in usage at home and at work.

Figure 20. Mean ICT use at work and at home, by age group



Source: Survey of Adults Skills (PIAAC) (2012)

These data highlight a potential skills mismatch among those with the strongest ICT skills and those who actually use them at work. These results are likely the result of a multitude of factors including cultural attitudes and the average age youth enter the workforce, but they suggest room for policy makers to find ways to boost opportunities for youth to use their ICT skills in productive areas of the economy. Policy makers may want to consider ways to pair older and younger workers together as a way to make the best use of employees' skills.

NEED FOR A COMPREHENSIVE AND COHESIVE APPROACH TO DEVELOP AND PROMOTE ICT SKILLS

The growth of the Internet economy will require updated and new skills from most workers in the economy. The Internet will continue to create labour market disruptions and people, as well as governments, who prepare and position themselves with the right skills, will be at an advantage in the global economy. Labour market disruptions will hit some workers harder than others and often these people will be precisely the people with the lowest levels of ICT skills and who are least prepared to update their skills.

Governments could benefit from a comprehensive and coherent approach to develop and promote ICT skills throughout their population. The OECD has already developed a comprehensive skills strategy, which is currently being adapted to the national level, and ICT skills need to become an integral part of this strategy. Potential policy issues that could be addressed include:

Leveraging ICT use at home

PISA and PIAAC data confirm that students and young adults are more likely to use the Internet at home than at work or school. The home is clearly an important location for Internet access, but probably also for gaining ICT skills. This has implications for digital divide strategies as PISA finds that students with more intense Internet at home score better on digital reading that students who rely on computers at school.

Integrating ICTs throughout the curriculum rather than teaching as a separate subject

ICTs are commonly taught as a distinct subject in school and allocated relatively little time compared with other subjects (OECD, 2014b). There is a push to take a more holistic approach to ICT skills where ICTs become a foundation of learning and knowledge application in all subjects. This approach integrates ICTs with skills in other area and corresponds directly to how ICTs are used by workers in the economy.

Targeting ICT skills for those who are the most vulnerable to labour market disruptions

There will be labour market disruptions as the Internet, and ICTs in general, rapidly change the production and distribution of goods and services in the economy. These disruptions will likely affect certain segments of the working population in varying degrees. The workers at biggest risk of job displacement – and who could benefit from the retaining opportunities that the Internet provides – are often the very demographic groups that have the lowest ICT skills in the economy. Policy will need to find ways to help these workers gain basic ICT skills to function in the new economy.

Pairing ICT skills with other sector-specific skills

ICT skills are often more valuable when they are paired with sector-specific skills. As mentioned earlier in the paper, O*NET data shows that the health care and social assistance sector accounts for the largest proportion of ICT occupations in the US economy and this is set to continue. Governments may want to examine how sector-specific skills are taught and whether there is a way they can promote better integration.

NOTES

1 "Home based businesses", U.S. Small Business Administration, http://www.sba.gov/content/home-based-business

2 "Technology firms are struggling to find skilled graduates for 2,500 posts", Independent.ie, 10 May 2013, at: http://www.independent.ie/irish-news/technology-firms-are-struggling-to-find-skilled-graduates-for-2500-posts-29255525.html

3 "Mayor Bloomberg joins Silicon Valley push for high-skill immigration", The Hill, 25 February 2013, at: http://thehill.com/blogs/hillicon-valley/technology/284775-mayor-bloomberg-joins-silicon-valley-push-for-high-skill-immigration

4 http://articles.economictimes.indiatimes.com/2012-09-18/news/33926263_1_philippines-centres-usd

5 Over the past 15 years US Postal Service reported a 25% reduction of employment; mostly low-skilled jobs. http://www.salem604.org/stats.pdf

6 "Kodak Sells Digital Imaging Patents For $525m", Associated Press, 19 Dec 2012, at: http://bigstory.ap.org/article/kodak-receive-525m-patent-sale

7 "Instagram Is Now Worth $77 Million Per Employee", The Atlantic, 9 April 2012, at: http://www.theatlantic.com/business/archive/2012/04/instagram-is-now-worth-77-million-per-employee/255640/.

8 http://www.onetcenter.org/overview.html

9 There are 58 ICT-related occupations in the information technology cluster and occupations fall into four distinct subgroups: information support/services, interactive media, network systems, and programming/software development.

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