

Martin, John P.

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POLICIES TO EXPAND DIGITAL SKILLS FOR THE MACHINE AGE¹

by

JOHN P. MARTIN

¹ Former OECD Director for Employment, Labour and Social Affairs; Adjunct Research Fellow, UCD Geary Institute for Public Policy; Member of the Irish Government's Labour Market Council; Member of the French Prime Minister's Employment Policy Council; IZA Research Fellow. This paper is a slightly revised and extended version of IZA Policy paper No. 123 which was released in January 2017. It is based on a presentation to the UBS International Center of Economics in Society 2016 Forum for Economic Dialogue on "The Rise of the Machines", 7th November 2016, Zurich. I am very grateful to David Dorn, Ron Gass and William Thorn for helpful comments and suggestions on a previous version of the paper. The views expressed are my own and cannot be held to be those of any of the institutions and bodies with which I am associated.

ABSTRACT

POLICIES TO EXPAND DIGITAL SKILLS FOR THE MACHINE AGE

A new technological epoch is underway – the so-called Machine Age –reflecting advances in artificial intelligence, digitalisation and Big Data. Some commentators have claimed that this epoch is different from previous ones in that it will produce large-scale technological unemployment, while others argue the contrary. Only time will judge who is right on this crucial debate. But the Machine Age will lead to major shifts in the demand and supplies of skills, especially digital skills. In this paper, I review the available cross-country evidence on the distribution of such digital skills across the adult populations within and across a large sample of OECD countries. I also review the evidence on participation rates in adult learning. Finally, I outline how education, training and labour market policies could help expand the supply of digital skills.

JEL classification: I28, J24, J68, O33

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Corresponding author:

John P. Martin
Geary Institute for Public Policy,
University College Dublin
Belfield
Dublin 4
Ireland
E-mail: seanomartin@gmail.com

A new technological epoch – the so-called “Machine Age”-- is now underway. It brings together artificial intelligence, digitalisation and Big Data in ways that can enable machines and robots to undertake tasks that were previously performed by workers. This new wave of technology has sparked a furious debate as to its potential implications for the world of work. On the one side, many technologists, futurologists and some economists are predicting that it will lead to the advent of mass technological unemployment, claiming that the machines/robots will destroy far more jobs than they create. On the other side, many economists and historians tend to be much more sanguine about the potential implications, pointing out that past technological epochs gave rise to the same fears about mass unemployment which never materialised in reality (see Box 1 for a brief review of this ongoing debate). At the same time, they acknowledge that the Machine Age could exacerbate earnings and income inequality.

Box 1. Will the Machine Age be Different or Not?

Technology experts and futurologists tend to be pessimistic about the likelihood of large-scale technological unemployment resulting from the Machine Age, see, for example, Ford (2015) and Kaplan (2015). The titles of their books are revealing: “The Rise of the Robots: Technology and the Threat of a Jobless Future” for the former; “Humans Need Not Apply: a Guide to Wealth and Work in the Age of Artificial Intelligence” for the latter. Some economists have lent support to these fears. For example, an oft-cited paper by Frey and Osborne (2013) has used a novel methodology to estimate the probability of computerisation for over 700 specific occupations. Their estimates suggest that 47% of US jobs are at risk of being replaced by machines. Others have applied their method to a wide range of OECD countries and come up with similarly large estimates for the proportion of jobs at risk.

However, the Frey-Osborne approach has been criticised by Arntz *et al.* (2016). They point out that it is occupation-based and assumes that it is entire occupations which are at risk from computerisation. But they highlight the fact that jobs are composed of different tasks and not all such tasks are susceptible to computerisation. They make use of data from the OECD Survey of adult Skills to highlight the heterogeneity of tasks within occupations. When a task-based approach is used using a similar approach to the Frey-Osborne method, they find that, on average across 21 OECD countries, only 9% of jobs are at risk of automation – their US estimate is similar.

Autor (2015) is much more optimistic about the employment prospects for the Machine Age. He highlights the fact that fears of technological unemployment are nothing new. Keynes (1930) raised it when he coined the term “technological unemployment”. But the fears have never translated into reality, even though the various technological epochs have witnessed huge shifts in the demands and supplies of labour across sectors, occupations and countries. Instead, employment rates have risen over time. So he, and economic historians such as Mokyr *et al.* (2015), argue that there is no reason to expect large-scale unemployment as a result of the Machine Age. Dorn (2015) argues, however, that the Machine Age may well lead to rising inequality among workers.

However, there are some points of agreement between the two opposing schools in this debate. First, there will be major shifts in the demands and supplies of skills and in the structures of industries, both within and across countries – as argued by Brynjolfsson and McAfee (2014). Second, the transition to the Machine Age will take a long time, at least several decades or more before the full impacts on the labour market will become clear.

Since the Machine Age is still in its infancy, it is too soon to take a position on whether it is different or not from previous technological epochs in terms of its likely impact on employment and unemployment. Only the passage of time will answer this conundrum.

However, even if the Machine Age does not generate large-scale technological unemployment, there is universal agreement that it will likely lead to large shifts in demands for skills across occupations, regions and countries. The skills in question will encompass a wide range of cognitive and non-cognitive skills, and our education and training systems will need extensive adaptation in order to ensure adequate supplies of these skills. The mantra of “lifelong learning for all” will need to be put into practice with a vengeance and this will prove to be no mean task.

In this paper, I focus on these challenges. In particular, I will concentrate on so-called “digital skills” which are vital to the exploitation of the new technologies and the creation and diffusion of new goods and services which will be generated as part of the process. First, I outline what we know already about the distribution of such digital skills among the populations and work forces of many OECD countries. Second, I review the evidence on participation in adult learning as a possible vehicle for upgrading adult digital skills. Finally, I discuss possible policy options to expand the supply of such skills.

Adult ICT-Literacy Skills across Countries: the Stylised Facts

It is important to begin the discussion with some comparative evidence on the levels and distribution of digital skills among the populations and work forces of OECD countries. Happily, we have a recent source of data on this to hand in the form of cross-country evidence from the OECD Survey of Adult Skills – a large-scale representative survey of adults aged 16-65 which was first undertaken in 2011-2012, with a second wave in 2014-2015 (see Box 2).

The OECD Survey provides data on skill proficiency among adults in literacy, numeracy and problem solving in a technology-rich environment. The latter skill is defined as “using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks. This specific skill domain in the Survey focuses on “the abilities to solve problems for personal, work and civic purposes by setting up appropriate goals and plans, and accessing and making use of information through computers and computer networks.”² Thus, the skills being tested in this domain in the OECD Survey are not narrow digital skills such as programming or software design, but are rather the ability to collect and use information from computers and other digital devices such as mobile phones to solve problems at work or in daily life. In the rest of this paper, I use ICT-literacy/digital skills as a shorthand for problem solving in a technology-rich environment.

The OECD survey is unique in that it provides comparable measures of ICT-literacy skills for a large sample of OECD countries for a recent year, how they are distributed across the population and work force and how they are related to economic and social outcomes. Figure 1 shows the distribution of ICT-literacy scores across the four scales for the 20 countries which tested this skill in the 2011-2012 wave of the Survey. It

² OECD (2016c, p.53). Dorn (2015, p.24) argues that education and training systems in the Machine Age need to “strengthen skills..., for instance by fostering problem-solving abilities and communication skills through case study projects, group work, and other modern forms of teaching that complement a more traditional mode of instruction based on lectures and memorization”.

also shows the proportions of adults in each country who were not able or willing to take the assessment on a computer. On average, this was close to almost one in four adults, a worryingly high proportion.

Test scores for ICT-literacy are grouped into four Proficiency Levels: Below level 1 (the lowest), Level 1, Level 2, and Level 3 (the highest). Here I follow OECD (2015; 2016c) in taking Levels 2 and 3 as a benchmark for above-average performance in ICT-literacy. Figure 1 ranks the countries in descending order of the proportion of adults who scored at Levels 2 and 3 on the ICT-literacy scales. On average across the 20 countries, one in every three adults perform at the highest levels, ranging from lows of around 20% in Poland, Ireland and Slovakia to a high of 44% in Sweden. It is noticeable that the four Nordics come out on top together with the Netherlands, while the United States records a below-average percentage of adults scoring at the highest proficiency levels. Data from the second wave of the Survey (not included in Figure 1) show that the proportion of adults in New Zealand performing at the highest levels of ICT-literacy skills was similar to that in the Nordics and the Netherlands.³ One factor accounting for the relatively good performance of New Zealand is that older adults in that country performed well above-average in terms of ICT-literacy skills.

Box 2. The OECD Survey of Adult Skills

The Survey assessed the proficiency of working-age adults in literacy, numeracy and problem-solving in a technology-rich environment, i.e. in so-called “ICT-literacy”. It also collected a rich data set of background information on demographic characteristics of the respondents, their education and labour market history, their use of ICT at work and in social life. It included an innovative module about the use of a range of generic skills such as collaborating with others and time management. Respondents were also asked whether their skills and qualifications matched their job requirements.

The survey was implemented in two waves. In the first round, in 2011-2012 around 166 000 adults aged 16-65 were surveyed in 24 countries/economies, 22 of which were OECD countries/economies (a) and the other two were the Russian Federation and Cyprus. The second wave took place in 2014-2015 and 9 countries participated, 6 of which were OECD countries. Over 50 000 adults were surveyed in the second wave and a third wave is scheduled to begin shortly (b).

Of the 24 countries/economies which participated in the first wave, four opted not to assess ICT-literacy skills: Cyprus, France, Italy and Spain. Sample sizes in each country/economy were designed to be representative of the relevant population. Some countries boosted their samples in order to generate statistically reliable estimates of skill proficiency at the regional level and/or for selected sub-groups such as immigrants or indigenous peoples.

The results from the assessment are reported on a 500-point scale, with higher scores indicating greater proficiency of the skill domain in question. For interpreting the scores, the scale is divided into proficiency levels. Literacy and numeracy have six such levels, from below level 1 – the lowest- to Level 5 – the highest. ICT-literacy has four proficiency levels, from below Level 1 – the lowest – to Level 3, the highest.

For more details on the OECD survey and its publications, see www.oecd.org/skills/piacc.

a. The OECD countries in the first wave were as follows: Australia, Austria, Belgium (Flanders), Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, the Slovak Republic, Spain, Sweden, the United Kingdom (England and

³ See OECD (2016c, Figure 2.16).

Northern Ireland only), and the United States. The OECD countries who participated in the second wave were; Chile, Greece, Israel, New Zealand, Slovenia and Turkey.

b. Six countries are scheduled to participate in the third wave over the period 2016-2019. Three are OECD countries: Hungary, Mexico and the United States (which also participated in the first wave).

Analysis of the results shows that youth, adults with above-average literacy or numeracy skills had above-average ICT-literacy scores. Having a tertiary degree was also associated with above-average skills, even after controlling for other relevant characteristics. Finally, there is a small but significant gender effect: men in most countries record somewhat higher digital skills than women.⁴

ICT skills matter in the labour market: the evidence shows that adults with the highest ICT skills are more likely to be employed and earn higher wages than those adults with low ICT skills after controlling for a range of other relevant factors.

Finally, as noted above, one key finding from the OECD Adult Skills survey is that there are many adults in OECD countries who lack the necessary ICT skills to diagnose and solve problems which are typically encountered at work or in everyday life. These adults are very vulnerable in the Machine Age. Hence, there is an imperative need to expand access to ICT and its use for these adults. Adult learning has a key role to play here and I now turn to the evidence on this from the Survey, before setting out my views on how policies might stimulate investment in ICT skills.

1. Adult Learning

Adult learning is the weak pillar in lifelong learning systems. In all countries, investment in human capital tends to be frontloaded towards the periods of early childhood, formal schooling and the decade or so afterwards. One cannot deny the importance of these early investments, especially if they are of high quality and focussed on the development of key cognitive and non-cognitive skills. However, now that the OECD countries are facing into an era of ageing populations and workforces and rapid technological change, it is important to increase human capital investment for workers in mid-career, especially in those scarce ICT skills identified above. This means focussing on those aged 30-55 with low skills. It is harder to motivate older workers and their employers to invest in skill upgrading, though that may change as older workers remain in the work force longer.

What do we know about adult learning? Once again, the OECD Survey of Adult Skills provides comparative data on adult participation rates in learning activities, both formal and non-formal (including on-the-job training), across countries in 2011-21 or 2014-2015. Figure 2 shows that, on average across all the countries and subnational entities which participated in the first two waves of the Survey, 50% of adults aged 25-64 participated in adult learning activities in the 12 months prior to the survey⁵. It also highlights very unequal

⁴ A similar result was found for 15-year-old boys in PISA in 2012 when problem solving was added to the assessment. They tended to outperform girls even though girls outperformed boys on both literacy and numeracy in most countries.

⁵ The survey also contains data on the intensity of participation in non-formal education in the 12 months prior to the survey. On average across countries, each participant spent 121 hours on non-formal learning. To put this into some perspective, this time is equivalent to almost 7% of average annual hours actually

participation rates in adult learning, both formal and in-formal, across countries. However, just as with ICT literacy skills, New Zealand, the Nordics and the Netherlands lead the way in terms of participation rates in adult learning.

When one compares the data on ICT-literacy scores in Figure 1 with the data on participation rates in adult learning in Figure 2, one is struck by the fact that those countries with high participation rates also score highly on ICT-literacy scores. The Spearman rank correlation coefficient is highly significant ($\rho=0.82$).⁶ This suggests that policies which foster adult learning will also foster the spread of ICT-literacy skills. For the moment, this is only an hypothesis which rests on simple correlation analysis and it warrants further study.

The OECD survey data also highlight the so-called “Matthew effect”, coined by the sociologist Robert Merton, drawing on the well-known quotation from the Gospel of St. Matthew: “For unto everyone that hath shall be given, and he shall have abundance”.⁷ When applied to adult learning, the data show clearly that those workers who have the highest educational attainment and literacy skills participate much more in adult learning than those with low educational attainments and literacy skills. It is, however, noticeable that the Matthew effect is much less pronounced in the Nordics and the Netherlands than it is in other OECD countries. This is partly due to history and social preferences towards equality of opportunity, but it can also be attributed to institutions – e.g. unions play an important role in adult learning in the Nordics and the Netherlands – and policies. I now turn to the latter.

2. Policies to foster adult learning and ICT skills

If, as seems highly likely, the Machine Age will give rise to significant shifts in the demand for and supply of skills, especially ICT skills, this process will generate winners and losers. That, in turn, will raise the inevitable question of whether the gainers from the Machine Age will be able to compensate the losers and still be better off i.e. whether the technology shock leads to a potential Pareto improvement or not. Even if that does indeed prove to be the case, this immediately raises the further question of whether the compensation actually occurs or not, and in what form. In reality, the losers are often not compensated or, if they are, the compensation is usually incomplete or it may give rise to further efficiency losses.

Now compensation is usually discussed in monetary terms (e.g. severance pay or unemployment benefits), but it can also take the form of services supplied to individuals to enable them to improve their skills and employability in line with changing labour market requirements. Relevant services include a range of labour market, education and training policies which could enable workers to upgrade their skills, especially their ICT skills, in the Machine Age epoch⁸. Unions, reflecting their privileged contacts with workers and

worked per person employed in OECD countries. See OECD (2016a, Figure C6.3) for data on the intensity of adult participation; and OECD (2016b, Statistical Annex Table L) for data on annual hours worked.

⁶ The sample is the 19 OECD countries in Figure 1 plus New Zealand.

⁷ Matthew 25:27, King James version.

⁸ Of course, other policies will need to be effectively coordinated with labour market, education and training policies in order to ensure an effective policy response to the skill challenges posed by the Machine Age, e.g. product market and regulatory policies, regional and local development and macroeconomic policies. However, in this paper I focus solely on the former.

workplaces, can play a vital role in fostering lifelong learning opportunities for workers and encouraging them to avail of them.⁹ In the rest of this section, I discuss the pros and cons of such policies.

Expand access and usage of ICT

I have already highlighted the significant numbers of adults in OECD countries who lack basic ICT skills. Raising their digital skills has to be a top priority. This can be facilitated by expanding access to ICT and use of ICT at work and in everyday life. The ambition should be to raise access and usage rates in all countries towards the 70-80% range currently reported in the Nordics and the Netherlands, and then push on towards virtually universal access.

Governments can play a leading role in this process by pushing full steam ahead with e-government initiatives, and by developing user-friendly websites for those many adults who either lack basic ICT skills or the opportunities to develop these skills.

Activation/Active labour market policies

Another policy lever which could help foster adult learning is active labour market policies (ALMPs). The Economist, for example, has been preaching recently the virtues of ALMPs as an instrument to enable workers to adjust better to technology and/or trade shocks, and also to compensate the losers in order to ward off Luddite or protectionist responses¹⁰.

At first sight, this looks like a useful policy lever. Policies that can help displaced workers acquire new skills, especially digital skills, and move quickly to avail of new job opportunities look like a win-win investment. However, the devil lies in the details of the design and implementation of such policies, as well as the scale of public investment in them. As I have argued in Martin (2016a, b), the key is to develop an effective activation strategy which takes account of the potential interactions between unemployment and related welfare benefits and public spending on ALMPs. This requires striking the appropriate balance between so-called “carrots” (spending on effective ALMPs) and “sticks” (monitoring the job-search activity of the unemployed under the threat effect of a benefit sanction). Rigorous evaluations have shown that the design and implementation of these carrots and sticks matter for the outcomes and that the appropriate balance between carrots and sticks varies across countries.

In addition, there is the vexed question of scale. The stylised facts on ALMPs are not reassuring against the scale of the potential challenges posed by the Machine Age. The public spending effort on them is typically “small beer”¹¹. On average across OECD countries in 2014, less than 0.6 % of GDP was spent on ALMPs

⁹ The potentially important role of unions in fostering adult learning opportunities is stressed by The Economist (2017) which cites good practices in this regard by Danish and British unions.

¹⁰ See the Economist (2016a) for a special report on the Machine Age; and the Economist (2016b) for a special report on globalisation.

¹¹ Not everyone agrees with me on this point. For example, Crepon and van den Berg (2016, p.1) argue that “ALMPs take up a sizeable fraction of public expenditure and that sizeable fractions of unemployed individuals are enrolled at some point in their spell out of work”. But it is hard to argue that an average public spending effort of around 0.5% of GDP is a sizeable fraction of public expenditure.

while public spending on unemployment benefits was almost twice as large. The public spending effort on ALMPs ranged from well over 1% of GDP in Denmark, Sweden and Finland to as low as 0.1% in the United States¹². For ALMPs to help the unemployed find new jobs against the background of possibly higher inflows into unemployment, it will be vital to expand the public spending effort in most OECD countries with the possible exception of the Nordics. It might be necessary to envisage at least a doubling of the average annual ALMP spending effort to 1% or more of GDP in order to arrive at a reasonable degree of compensation for the losers from the Machine Age.

But more ALMP spending on its own will not be enough. It is vital that increased spending passes a cost-benefit test. Thanks to a surge in rigorous evaluations of ALMPs in recent years, we know a lot more about what works and what does not, and for what groups. Job search counselling and monitoring of job-search behaviour are very often cost-effective, in that they encourage a rapid return to work. However, the evaluation evidence suggests that they often push the unemployed into low-wage jobs, with few career prospects. In principle, training programmes should help foster career progression for displaced workers.¹³ But public training programmes have a mixed record. However, more recent evaluations which follow participants for a significant period of time after they have participated in a training programme tend to show more positive outcomes, provided the programmes are linked closely to labour market needs. Increased spending on training should also seek, to the extent possible, to improve the ICT skills of participants. Targeted wage subsidy programmes, if well-designed and monitored with the aim of minimising deadweight and displacement effects, can also prove to be cost-effective. Public sector job creation schemes, on the other hand, rarely pass a cost-benefit test, even though they continue to be a popular political response to unemployment, especially to long-term unemployment.

In sum, investing more in an effective activation strategy is likely to prove to be a sound public investment to enable the work force to cope with the challenges of the Machine Age.

Individual learning/training accounts

A second potentially interesting policy instrument is individual learning/training accounts attached to workers which they can use to purchase training in the event of being laid-off or if they need to upgrade their existing skills, especially digital skills. Such schemes exist in several OECD countries. For example, the UK Individual Learning Account (ILA) was established by the then Labour government in the 1999 Budget. It provided tax incentives to employers and a cash grant of GBP150 to adult learners, with a focus on the acquisition of digital skills. However, the scheme was abolished after two years of operation when it was revealed that there was significant fraud arising from educational providers claiming for non-existent or

¹² Norway is the exception among the Nordics in that it only spent 0.5% of GDP on ALMPs in 2014 commensurate with its relatively low unemployment rate (3.5%) and high employment rate (75.3%). However, it should be pointed out that a relatively large proportion of the working-age population in Norway suffers from health problems, and public spending on disability and sickness absence benefits amounted to 5% of GDP, the highest level in the OECD.

¹³ Another possible ALMP to foster career progression for displaced workers is employment retention and advancement services *after* they have found a job. Such services can include career advice, mentoring in work and financial incentives. Unfortunately, very few countries have experimented with such services and the few rigorous evaluations of them are not very encouraging in terms of their outcomes.

worthless training.¹⁴ Though the UK scheme was targeted at low-skilled individuals, it turned out that many highly-qualified adults benefitted from it.

The US Workforce Investment Act has as one of its instruments an Individual Training Account (ITA). Instead of public employment services prescribing the type of training that an unemployed worker should get, the worker gets a voucher (ITA) which they can cash in at an eligible training provider of their choice. Vouchers are limited in terms of amount and time. The modal amount of an ITA in 2012 was \$ 5000. While much more generous than the UK ILA, the US ITA still seems “small beer” relative to the potential needs of the Machine Age. After all, a 10% rate of return on the modal award – which would be towards the high end of estimates of returns to public training programmes – would only yield an annual earnings gain of \$500.

France launched at the beginning of 2015 another variant of an ITA called the *Compte Personnel de Formation* (CPF).¹⁵ It should be noted that data from the OECD Survey of Adult skills for 2012 show that the participation rate in adult learning in France was well below average (see Figure 2), as was the average intensity of this participation in terms of the number of hours spent in learning.¹⁶

Each worker acquires a CPF as soon as they enter the work force and the account is tied to the worker and is portable between employers. The account is a time-based system, not a cash voucher. Full-time workers accumulate 24 hours in their CPF for five years, then 12 hours per year, up to a maximum ceiling of 150 hours; for part-timers rights are computed proportionate to their hours worked. For low-skilled workers, the CPF is more generous in an attempt to counteract the Matthew Effect; they can accumulate 48 hours per year up to a ceiling of 400 hours. The amount of training hours in a CPF account can be topped up by employers, regions or the public employment service. CPF rights can be used when a worker becomes unemployed. The system is intended to be financed by a redistribution of the existing training levy.

As the CPF is so new, there is no evidence on its effectiveness in spurring adult learning in France. However, since it lacks financial incentives for adult learners, this might hinder its take-up, as might the fact that the rights can only be used for training schemes approved by the relevant branch collective agreement. It is unclear to what extent the approved list of training schemes will favour the acquisition of digital skills.

The Nordics, New Zealand and the Netherlands seem to manage much better on the adult learning front through a combination of attractive financial incentives for learners and employers, and a greater willingness to collaborate with unions on such initiatives. As we have seen above, they also do better on the acquisition of digital skills by adults. Hence, other countries could look to see what good practices they might be able to adapt from these countries to their own specific circumstances and institutions.

¹⁴ However, the Scottish Executive launched an ILA Scotland in 2004 to replace the original ILA. It provides up to GBP 200 a year for a variety of approved courses. It is available to those with below-average incomes who are not in full-time education or who are on benefits,

¹⁵ The CPF replaced an earlier French ITA called the *Droit Individuel a la Formation* (DIF) which was introduced in 2004. The conditions surrounding access and usage of the DIF were fairly restrictive and it was not judged to be a great success. Hence, the decision to replace it by the CPF. In turn, the CPF has been rolled into a new individual account called the *Compte personnel d'activite* (CPA). The CPA became operational on the 1st January 2017 for all private-sector workers and the unemployed, and it will include the self-employed from 1st January 2018. It includes several additional entitlements to those available under the CPF.

¹⁶ See OECD (2016a, Figure C6.3).

Finally, The Economist (2017) has highlighted an interesting new initiative in this area in Singapore under its Skills-Future programme. Since the beginning of 2016, every Singaporean aged over 25 has been a S\$500 credit that can be used to fund any training course provided by a large number of approved providers. The credit can be topped up by generous public subsidies. The Singapore authorities are putting significant public funding behind this initiative and it will be very important to assess whether it expands lifelong learning opportunities significantly and the degree to which it serves to offset the “Matthew Effect” for low-skilled workers or not.

Tax incentives

Investment in lifelong learning can also be promoted via the tax system. The basic argument is that, if investment in capital, land and R&D can be subsidised by tax incentives, why not apply the same logic to investment in human capital. Indeed, many OECD countries use a range of tax incentives to promote such human capital investments by workers and firms¹⁷. The LSE Growth Commission (2017) has called for a Skills and Training tax credit to be introduced in the UK in order to overcome persistent skills gaps and help boost UK productivity growth.

With respect to firms, the standard practice is that spending by them on training their workers is treated as a deductible expense against profits. However, Cedefop (2009) points out that in three of the six countries it examined in detail, firms could deduct more than 100% of their education and training expenses for their workers, thereby creating an incentive for them to invest more in training their workers. However, it is important to note that these deductions in most cases apply only to external training and not to investment in on-the-job training.

As for workers, there are a wide variety of tax incentives available to them for investments in education and training. Since personal income tax rates are progressive in almost all countries, the value of these tax breaks is greater for high-wage workers who generally already have above-average human capital endowments.

There is not a great deal of evidence available on the effects of such tax incentives. Evidence quoted in Cedefop (2009) suggests that “tax expenditures”, defined as the loss in tax revenues associated with such human capital tax incentives, are tiny fractions of total public spending on education and training: for the six countries in question, they ranged between 0.5% and 3% in 2003.

There are obvious concerns about possible large deadweight effects being associated with such tax incentives, especially for skill investments by large firms and high-skilled workers. In addition, tax incentives are likely to be very subject to the “Matthew Effect” highlighted above. It is possible that careful design and monitoring of such tax incentives, e.g. by targeting them to low-wage workers, could minimise this bias in favour of high-skilled workers. It could also be the case that such tax incentives could be targeted to investments in digital skills in order to overcome the large skill gaps identified above.

However, further evidence is needed on the costs and benefits of such tax incentives in terms of achieving their objectives before one could conclude with any certainty that this is a promising route to overcoming digital skills gaps.

¹⁷ Cedefop (2009) presents a detailed description of such tax incentives in 6 EU countries: Austria, Finland, France, Germany, Ireland and the Netherlands.

Wage insurance

Another possible policy measure would be the introduction of a wage insurance programme so that workers who lose their job as a result of a trade or technology shock and who can only find a new job at a lower wage would have part of their earnings loss reimbursed by the public purse. Such a measure could help reduce earnings inequality in the Machine Age.

It is noteworthy that President Obama made a strong plea for a more generous and widespread wage insurance programme in his 2016 State of the Union Address. The US actually has a wage insurance scheme as part of its long-standing Trade Adjustment Assistance programme. The wage insurance part – now called Reemployment Trade Adjustment Assistance for Older Workers—subsidises laid-off workers aged over 50 whose previous wage was less than \$50 000 a year and who start a new job within six months after lay-off. They receive a wage subsidy of half the gap between their old and new wage, up to a maximum subsidy of \$10 000, for up to two years. But this scheme is very small beer: in 2014, only 6% of total TAA spending of over \$600 million went on it and only a few thousand workers benefitted from it.

A wage insurance scheme would be most effective in terms of offsetting wage inequality if the subsidy were long-lasting. But this would create moral hazard issues for workers and encourage employers to cut wages for eligible hires. So any large-scale experimentation with wage insurance would involve some difficult design and monitoring choices.

In-work benefits

Wage insurance bears a close resemblance to in-work benefits such as the U.S.'s Earned Income Tax Credit (EITC) or the U.K. Working Tax Credit. In-work benefits serve to supplement the incomes of low-wage workers and their families, thereby serving to boost employment and cut poverty rates. Unlike wage insurance, many OECD countries have such schemes and several are not small beer. For example, the EITC is now the largest single anti-poverty measure in the US: in the 2015 tax year, over 26 million working families and individuals received the EITC – the average annual payment was almost \$ 3200 for a family with children compared with just under \$300 for a family without children. Evaluations of the EITC and the WTC have shown that they have significantly boosted employment rates of low-wage workers, especially lone parents.

But in-work benefits are not a panacea. As they have to be phased out once a certain earnings or income level is achieved, they give rise to high marginal effective tax rates (often in excess of 70% or more) which can have negative effects on the labour supply decisions of second earners in an eligible household and/or may weaken incentives to invest in skill upgrading. Nonetheless, some combination of minimum wages and wage insurance/in-work benefits can play a role in tackling earnings inequality.

Conclusion

If the Machine Age does not lead to unprecedented increases in technological unemployment and rising inequality, the kinds of education and training and labour market policies outlined above, if expanded on a suitable scale, well-designed and evaluated rigorously, should foster labour market adjustment to changing skill requirements, especially for digital skills. The available data on distribution of digital skills both within and across OECD countries show there is a crying need to expand such competences.

One lesson from past major technology or trade shocks is that it is important to have in place adequate compensation mechanisms for the losers, and that compensation occurs in reality rather than being potential in nature. Such compensation can, and should, include measures designed to help the losers upgrade their

skills and compete for the new jobs that the Machine Age will generate in addition to adequate income support.

If, however, the worst fears about the Machine Age were to materialise, such measures would likely only be palliatives and more drastic measures (e.g. a basic minimum income, a specific robot tax or widespread employee ownership of the Machines) might be required to compensate the losers. But that story is for another paper!

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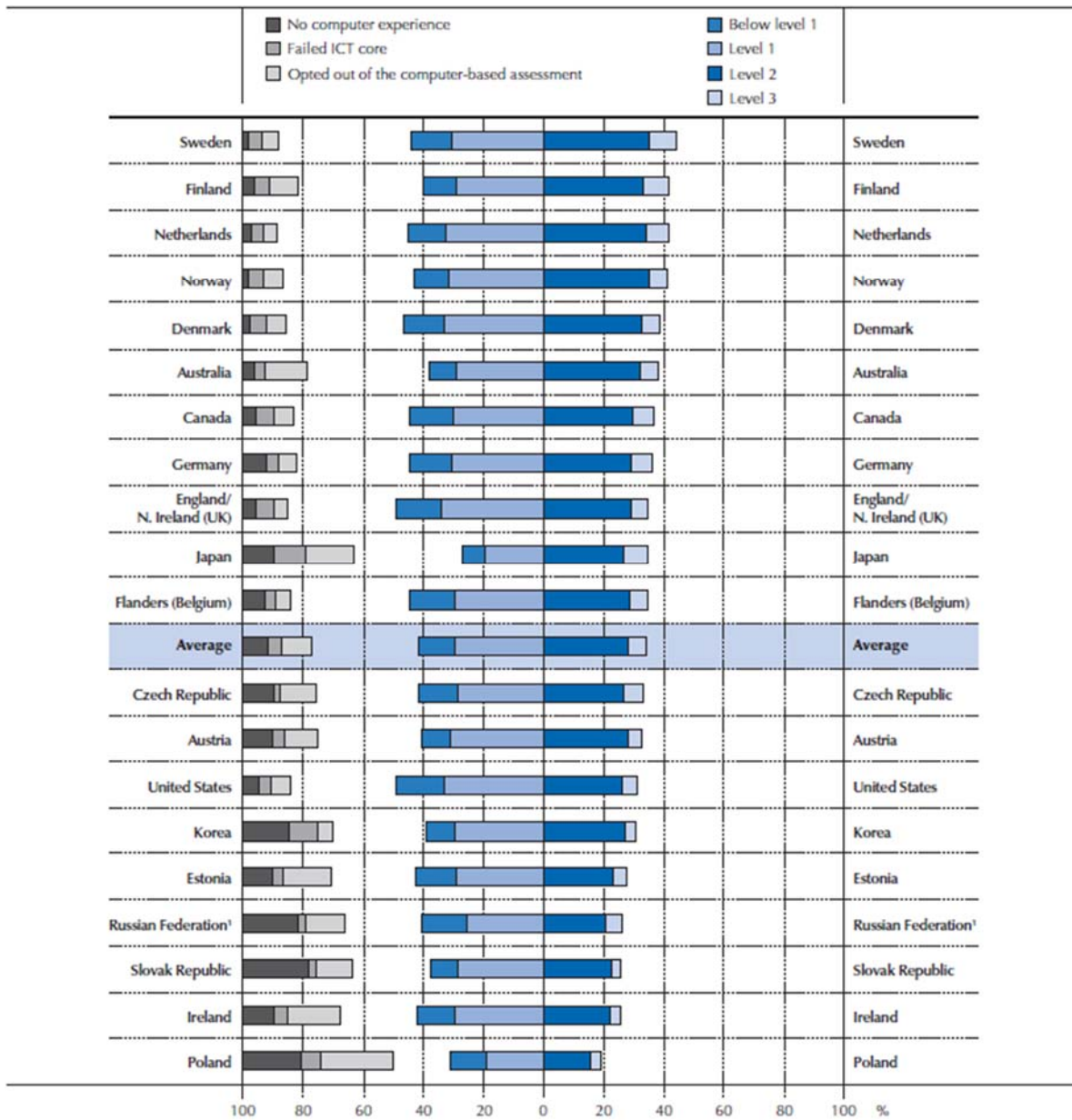
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Figure 1. The Distribution of ICT-Literacy Skills in OECD countries, 2011 - 2012 (1)



1. The data refer to proficiency levels of the test scores for "problem solving in technology-rich environments" which, for shorthand, are called ICT-literacy skills.

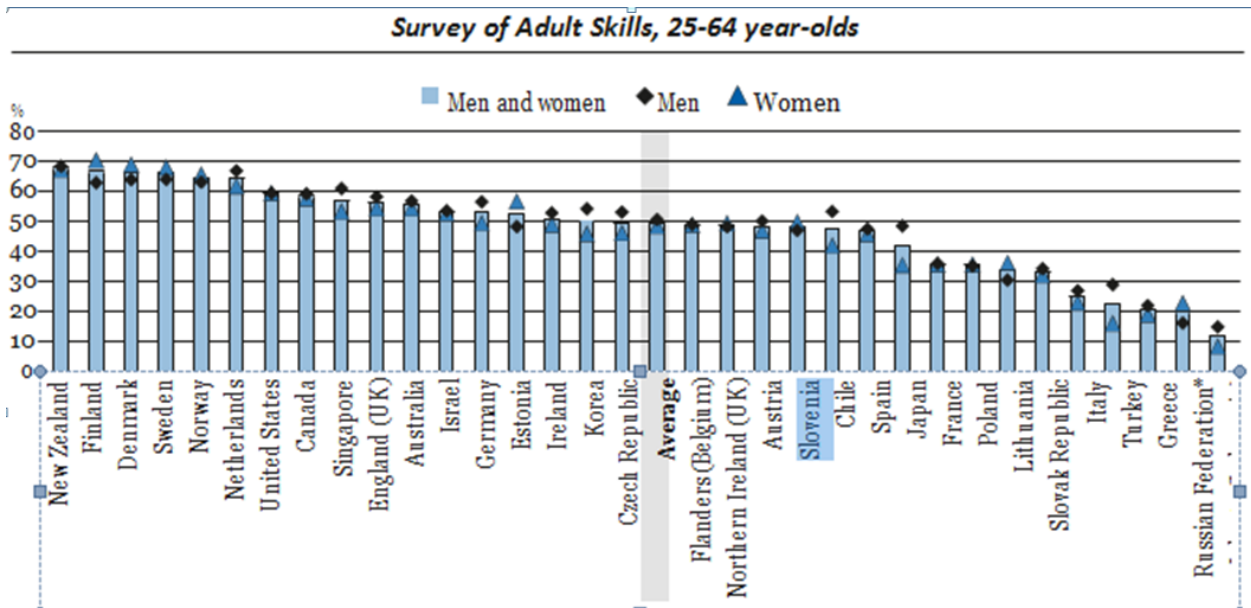
2. The sample for the Russian Federation excludes the population of the Moscow municipal area.

Countries are ranked in descending order of the percentage of adults scoring at Levels 2 and 3 on ICT-literacy skills.

Source: OECD (2015, Figure 2.2).

Statlink: <http://dx.doi.org/10.1787/888933365903>

Figure 2. Participation in formal and/or non-formal education, by gender (2012 or 2015)



Note: Chile, Greece, Israel, Jakarta (Indonesia), Lithuania, New Zealand, Singapore, Slovenia, Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for the Russian Federation exclude the population of the Moscow municipal area.

Countries and subnational entities are ranked in descending order of the percentage of 25-64 year old men and women who participate in formal and/or non-formal education.

Source: OECD (2016a), Table C6.1. See Annex 3 for note (www.oecd.org/education/education-at-a-glance-19991487.htm)

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