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AGE, AGEING AND SKILLS: RESULTS FROM THE SURVEY OF ADULT SKILLS

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AGE, AGEING AND SKILLS: RESULTS FROM THE SURVEY OF ADULT SKILLS

Abstract

This paper presents a comprehensive analysis of the link between age and proficiency in information-processing skills, based on information drawn from the Survey of Adult Skills (PIAAC). The data reveal significant age-related differences in proficiencies, strongly suggesting that proficiency tends to "naturally" decline with age. Age differences in proficiency are, at first sight, substantial. On average across the OECD countries participating in PIAAC, adults aged 55 to 65 score some 30 points less than adults aged 25 to 34 on the PIAAC literacy scale, which is only slightly smaller than the score point difference between tertiary educated and less-than-upper-secondary educated individuals. However, despite their lower levels of proficiency, older individuals do not seem to suffer in terms of labour market outcomes. In particular, they generally earn higher wages, and much of the available empirical evidence suggests that they are not less productive than younger workers. Older and more experienced individuals seem therefore able to compensate the decline in information processing skills with the development of other skills, generally much more difficult to measure. On the other hand, proficiency in information-processing skills remain a strong determinant of important outcomes at all ages: this makes it important to better understand which factors are the most effective in preventing such age-related decline in proficiency, which does not occur to the same extent in all countries and for all individuals. Two broad interventions seem to be particularly promising in this respect. First, it is important to ensure that there is adequate and effective investment in skills development early in the life-cycle: as skills beget skills, starting off with a higher stock of human capital seems also to ensure smaller rates of proficiency decline. Second, it is equally important that policies are in place that provide incentives to individuals (and firms) to invest in skills across the entire working life. In this respect, changes in retirement policies can not only have the short-term effect of providing some reliefs to public finance, but have the potential to radically reshape incentives to stay active, to practice their skills and to invest more in training, thus helping to maintain high levels of proficiency.

Résumé

Ce document présente une analyse approfondie du lien entre l'âge et les compétences en traitement de l'information, sur la base de données tirées de l'Évaluation des compétences des adultes (PIAAC). Les données mettent au jour des différences significatives de niveau de compétences en fonction de l'âge, portant fortement à croire que le niveau de compétences tend à diminuer « naturellement » avec l'âge. Les différences de niveau de compétences en fonction de l'âge sont, à première vue, substantielles. En moyenne, dans les pays de l'OCDE participant au PIAAC, les adultes âgés de 55 à 65 ans obtiennent des résultats inférieurs d'environ 30 points à ceux des adultes âgés de 25 à 34 ans sur l'échelle de compétences en littératie du PIAAC, un écart de score seulement légèrement inférieur à celui observé entre les diplômés de l'enseignement tertiaire et les individus dont le niveau de formation est inférieur au deuxième cycle du secondaire. Cependant, en dépit de leur niveau plus faible de compétences, les individus plus âgés ne semblent pas lésés en termes de résultats sur le marché du travail. En particulier, ils perçoivent en général des revenus plus élevés, et d'après la plupart des données empiriques disponibles, ne sont pas moins productifs que les travailleurs plus jeunes. Les individus plus âgés et plus expérimentés semblent donc en mesure de compenser la baisse de leurs compétences en traitement de l'information par le développement d'autres compétences, généralement beaucoup plus difficiles à mesurer. En revanche, la maîtrise des compétences en traitement de l'information reste l'un des principaux facteurs déterminants de résultats importants à tous les âges : il apparaît donc essentiel de mieux comprendre quels facteurs sont les plus à même de prévenir une telle baisse du niveau de compétences avec l'âge, l'ampleur de cette dernière n'étant pas la même dans tous les pays et pour tous les individus. Deux grandes interventions semblent

particulièrement prometteuses à cet égard. Tout d'abord, il est important de veiller à l'adéquation et à l'efficacité des investissements dans le développement des compétences dès le plus jeune âge : les compétences engendrant les compétences, un stock de capital humain plus élevé au départ semble également garantir un degré moindre de déclin des compétences. Deuxièmement, il est tout aussi important de garantir la mise en œuvre de politiques offrant aux individus (et aux entreprises) des incitations à investir dans les compétences tout au long de la vie active. À cet égard, les changements apportés aux politiques de retraite peuvent non seulement avoir un effet à court terme en allégeant quelque peu les finances publiques, mais sont également susceptibles de remodeler radicalement les incitations à rester actif, à entretenir ses compétences et à investir davantage dans la formation, contribuant ainsi à maintenir des niveaux élevés de compétences.

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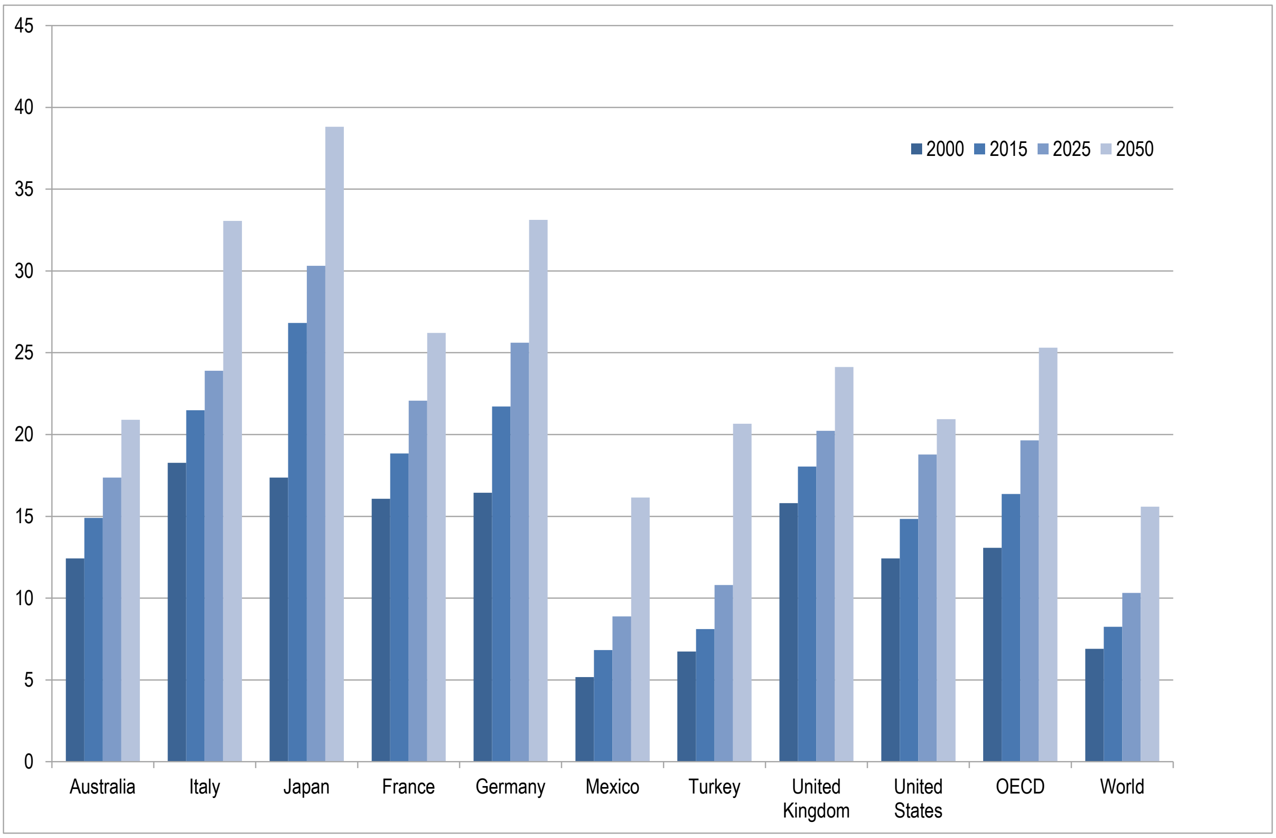
1. WHY AGEING MATTERS? ECONOMIC AND POLICY CHALLENGES FOR THE FUTURE DECADES

The world's population is steadily ageing. OECD countries in particular are facing declining fertility rates and constant increases in life expectancy, which will inevitably lead to a steep increase in the share of elderly individuals in their populations. According to the most recent estimates, in 2050 the share of individuals above 65 years will almost double worldwide, jumping from the current level of 8.2% to 15.6%. OECD countries will experience a less steep growth, but start from a higher base. In 2050, people above 65 will constitute more than a quarter of the overall population (25.3%), well above the current share of 16.4%. Similarly, the share of individuals above 80 years of age will more than double, both worldwide (from 2.0% to 4.8%) and in OECD countries (from 4.4% to 9.5%), while the share of people below 15 years old will experience a smaller decrease (from 26.0% to 21.3% worldwide, and from 18% to 15.8% in OECD countries). Figure 1 graphically illustrates such trends for a number of selected countries.

Figure 1. Individuals aged 65 or more, as a share of total population



Source: OECD historical population data and projections (1950-2050). Available at stats.oecd.org

Although such long-term estimates are necessarily imprecise and subject to possible (and sometimes significant) revision, there is little doubt that we are in the middle of an unprecedented demographic transition, that will certainly pose significant challenges to policymakers around the world.[1]

An ageing population may constitute a serious drag on economic growth, mainly through a reduction in labour supply and a decrease of saving rates (Heijdra and Ligthart, 2006; Heijdra and Romp, 2008).

Ageing is also likely to place increasing strain on public finances, through higher healthcare costs and increases in public pension spending, notably in pay-as-you-go systems were a shrinking working population finances the pensions of a growing number of retirees (Gertler, 1999). Moreover, productivity could decline as people age (Skirbeek, 2004, 2008). Liang, Wang and Lazear (2014) point out that having a large share of elderly individuals in the population may reduce entrepreneurship, not only because older workers are less innovative, but also because, when they occupy key positions, they tend to block younger workers from acquiring business skills. According to Gruescu (2007), education policies can, at most, have a short-term moderating influence on the negative effects of population ageing: in the long-term, family policies are needed to increase fertility rates and the accumulation of human capital.

The dim prospect of permanent stagnation (or even decline) in income per capita and living standards, though, is far from being inevitable, and a number of authors have already pointed out that current debate on ageing is generally characterised by excessive pessimism. There are four broad classes of reasons for thinking that the consequences of population ageing are possibly not that bad as they might seem: (i) the negative effects (on individual productivity, or on health outcomes, for instance) that are commonly associated to ageing might not be inevitable; (ii) people will likely change their behaviour in response to changes in the age structure; (iii) policies have an important role to play and can effectively reduce the negative consequences of population ageing; (iv) technological progress and the consequent increase in productivity could offset some of the effects of ageing on per capita incomes. A number of countries have already undertaken action to cope with the ageing challenge, most notably through reforms of pension systems, something that has long been recommended by the OECD (see OECD, 2006).

Bloom et al. (2010) point out that most current projection exercises are likely to overestimate the negative effects of ageing by failing to take proper account of behavioural changes triggered by changes in the age structure. Simple accounting exercises are mostly based on the assumption that age-specific behaviour remains unchanged as the age structure evolves, the behaviour of employers remains constant and that policies do not change.

Prettner (2013) builds an endogenous growth model in which decreasing mortality positively affects long-run growth, while decreasing fertility has the opposite effect. Which of the two effects prevail depends on assumptions on population growth rates and technological spillovers. The models in Vogel, Ludwig and Börsch-Supan (2013) and Börsch-Supan, Härtl and Ludwig (2014) explicitly assess how adjustments in domains such as international capital flows, endogenous investments in human capital, reforms of the pension systems and of the labour market, and behavioural adaptations to such reforms, can dampen the detrimental effects of ageing. They conclude that both the direct quantity effects of reforms and the indirect behavioural responses are large. In particular, endogenous human capital formation in combination with increases in statutory retirement age has the potential to strongly reduce the negative impacts of population ageing.

Indeed, education and skills policies are crucial ingredients in any comprehensive strategy that aims at providing an effective response to the challenges of population ageing. If a smaller labour force has to sustain a larger population of retirees, while at the same time preserving current trends in the growth of living standards, labour productivity has to increase. Highly skilled individuals are therefore needed, to promote innovation and technical change, and make the most of the opportunities opened up. Individuals facing longer working careers can be assumed to require training in order to update their competencies and be able to cope with rapidly evolving work environments. Last, but not least, education and skills have been shown to be related to better health outcomes, thus possibly limiting the negative effects of ageing.

This paper takes advantage of data from the Survey of Adult Skills (PIAAC) to investigate the relationship between ageing and proficiency in key information-processing skills, such as literacy and numeracy. As it provides accurate measures of proficiency in these skills for the entire adult population, PIAAC offers many useful insights concerning the evolution of proficiency over the life-cycle. Better understanding the process of skills formation (and, possibly, the loss of skills) is crucial to better inform policies that aim to tackle the challenge of population ageing, such as retirement, education and adult training policies.

Chapter 2 provides a detailed picture of the relationship between age and proficiency. Chapter 3 takes advantage of the richness of the background questionnaire to investigate the links between proficiency and a wide range of outcomes, and how these links change over the life-cycle. Finally, Chapter 4 takes a cross-country perspective, trying to identify the factors that are likely to have an impact on the evolution of proficiency over the life-cycle. These include investments in formal education and in adult training, the skill content of occupations, and retirement policies. Chapter 5 draws some broad conclusions.

Note

[1] Samir et al. (2010) provide population projections that also take into account evolution in educational attainments.

2. AGEING AND SKILLS IN THE SURVEY OF ADULT SKILLS

Introduction

This chapter provides a detailed picture of the relationship between age and proficiency in key information-processing skills as measured in the Survey of Adult Skills (PIAAC), drawing and expanding on OECD (2013a). In particular, it will first look at the age-skill profile and at differences in proficiency between different age groups, as well as to how dispersion of proficiency changes in the various age groups. It will then discuss the extent to which such proficiency differences can be really interpreted as age-induced changes over the life-cycle, making also use of data from previous surveys (e.g. the International Adult Literacy Survey, IALS), which allows to look more precisely at the evolution of proficiency over time.

PIAAC is a cross-sectional survey, meaning that individuals are only tested at a single point in time. As a consequence, when looking at age-related differences, the reader should always keep in mind that the analysis is not about how individual proficiency changes over time, but rather about comparing different people, born in different years, at different points of their life cycle. In more technical terms, it is not possible to separate *age effects* – the direct consequences of growing older – from *cohort effects* – the consequences of being born at different times (which include, for instance, the effect of being exposed to different education system, or to a different set of rules concerning retirement). Furthermore, *period* effects – consequences of influences that vary through time, affecting in a similar way proficiency of all groups defined by age and cohort – could also play a role. Unfortunately, it is extremely hard to separately identify age, period and cohort effects, since each of them is, by construction, a linear combination of the others (Winship and Harding, 2008).

Most of the results presented in this study will therefore necessarily be a combination of age, cohort and period effects, and should accordingly be read as a description of age differences between individuals at one period in time. Later on in this chapter, however, information contained in previous international skills surveys will be used in order to try and separate age and cohort effects for a subset of countries.

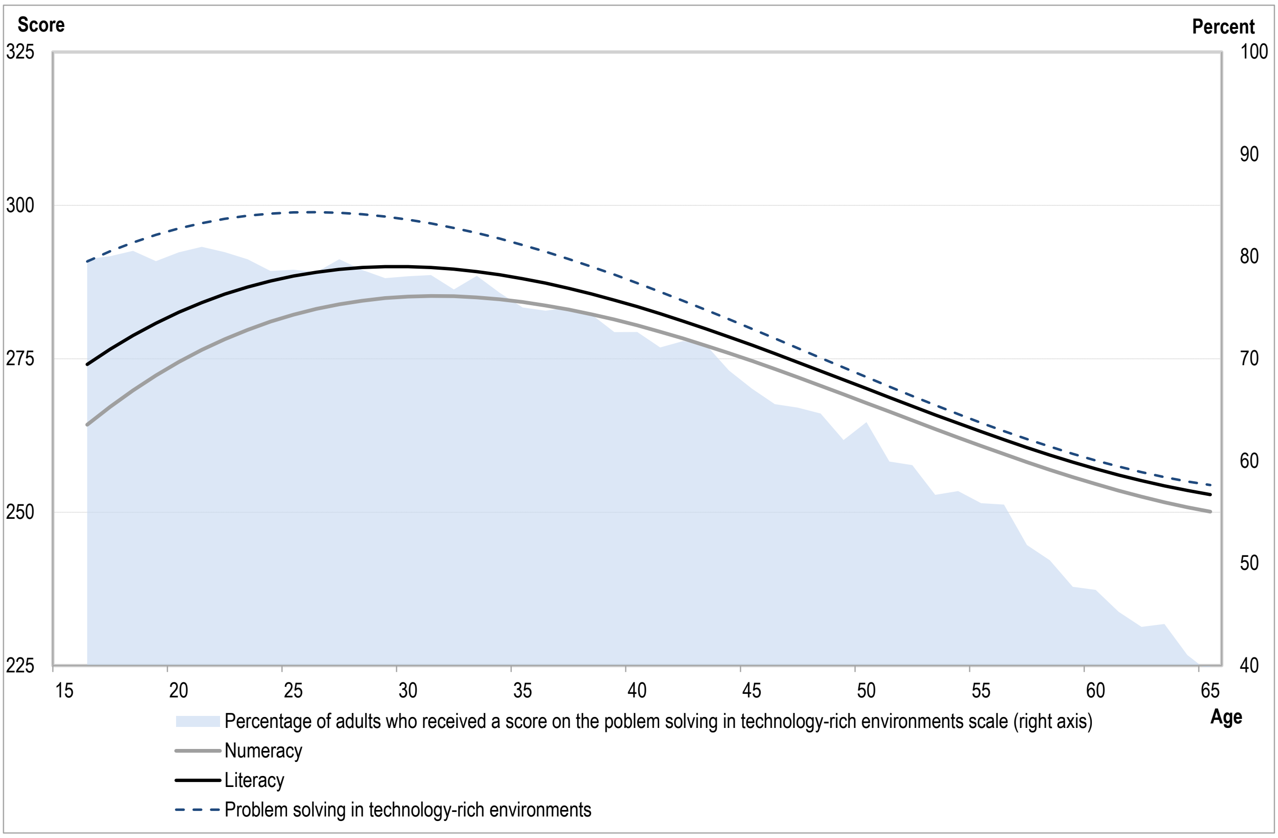
The empirical analysis throughout the paper will be restricted to native-born individuals. There are several reasons for this. Inflows of migrants constitute major changes to the composition of the population base. Furthermore, the age structure of the migrant population, the choice of the destination country and the distribution by country of origin are likely to be influenced by a large number of idiosyncratic factors, and it is well beyond the purpose of this study to track them or take them into account in the empirical analysis.

The share of foreign-born individuals over total population in the total population varies tremendously across countries and, within countries, across age groups. In OECD countries that took part in PIAAC, foreign-born make up, on average, approximately 10% of the population, but at the country level the incidence of immigrant is as high as 20% in Canada and Australia, and is virtually zero in Poland, the Czech Republic, Japan and Korea. More importantly, each country has its own peculiar distribution of immigrants across age groups. While the typical age profile follows an inverted-U shape, with the incidence of immigrants peaking somewhere between 25 and 40 years of age, many countries present a much flatter profile (Japan, Korea, the Netherlands, Finland, France, Poland, the Russian Federation, Flanders (Belgium)), while in others the incidence of immigrants increases almost monotonically with age (Australia, Canada, Estonia).

Age differences in proficiency

Figure 2 presents the average relationship, across OECD countries, between age and proficiency. Problem solving in technology-rich environment is not directly comparable to literacy and numeracy, for at least two reasons. First, not all countries administered the problem solving module. Second, respondents who did not show enough familiarity with the use of information and communication technologies (ICTs) were allowed to opt out (OECD, 2015). For this reason the picture also reports the share of individuals who did get a score in the problem solving module, which is an indirect measure of proficiency in the use of ICT.

Figure 2. Average age-skill profiles in OECD countries



Source: Survey of Adult Skills (PIAAC) (2012).

Youth are generally less proficient than adults in their mid-20s to their early 30s. The highest levels of proficiency are in fact recorded for individuals around 30 years old. Beyond this point, measured proficiency tends to gradually but steadily decline. If we were to interpret such profile as a pure age effect, it could be broadly mapped into three distinct phases of the lifecycle. In the first phase, young adults (16-24 years old) are accumulating skills while completing formal education. In the second phase, prime-age individuals (25-44 years old) enter the labour market and start their career. They are still able to increase their proficiency during the first years of their professional careers; then, after age 30, proficiency starts to decline. Finally, mature individuals (45-65 years old) experience a steady decline in skills, and proficiency of individuals above 55 is generally lower than proficiency of 16 year-olds. At the time the Survey of Adult Skills was conducted, some 30% of mature respondents were out of the labour force, and approximately 15% were already in retirement. Table 1 reports average proficiency in different age classes for the countries that participated in PIAAC.

Table 1. Literacy and numeracy proficiency in different age groups

Country	16-24	25-34	35-44	45-54	55-65
Literacy					
Australia	285.0	291.9	291.3	278.7	269.6
Austria	281.1	286.5	281.7	268.4	253.2
Flanders (Belgium)	287.2	296.0	287.1	274.2	256.2
Canada	278.3	291.6	287.8	275.4	266.3
Czech Republic	280.7	286.2	275.9	266.4	262.7
Germany	282.2	288.0	282.5	268.2	256.2
Denmark	278.5	292.6	286.4	270.5	254.7
Spain	266.6	269.3	265.1	251.2	227.4
Estonia	287.3	286.3	279.2	272.2	265.7
Finland	299.5	313.9	304.3	287.7	260.6
France	276.3	283.4	273.7	257.8	246.1
England/N. Ireland (UK)	268.5	286.8	283.3	272.6	267.1
Ireland	271.7	281.2	272.3	259.9	249.5
Italy	265.0	264.8	256.5	250.3	233.4
Japan	299.4	309.5	307.2	297.3	273.3
Korea	294.1	290.8	278.1	259.1	244.3
Netherlands	297.3	305.0	301.4	283.9	264.9
Norway	279.0	300.7	296.2	281.7	263.1
Poland	281.5	277.1	268.1	259.1	249.2
Slovak Republic	276.0	278.5	278.3	270.3	265.8
Sweden	290.2	303.8	300.7	285.8	267.7
United States	273.8	281.7	279.4	272.7	268.3
Average	**281.8**	**289.3**	**283.5**	**271.1**	**257.5**
Numeracy					
Australia	271.1	278.8	278.4	265.7	258.0
Austria	283.3	290.8	289.3	277.5	261.7
Flanders (Belgium)	285.3	299.8	294.0	282.4	260.8
Canada	270.2	282.8	279.0	266.4	257.0
Czech Republic	278.3	288.1	278.2	272.9	264.2
Germany	278.8	288.9	286.4	273.3	259.8
Denmark	275.7	297.2	295.2	281.4	267.3
Spain	257.6	263.5	260.4	244.9	221.3
Estonia	278.6	283.9	276.3	270.7	262.8
Finland	287.3	307.2	297.7	283.3	261.0
France	264.8	276.0	270.4	251.3	239.4
England/N. Ireland (UK)	259.7	275.4	274.4	261.1	259.4
Ireland	257.8	269.2	260.6	249.6	236.7
Italy	254.9	265.9	253.8	245.0	229.2
Japan	283.1	297.6	296.8	291.7	273.2
Korea	281.8	281.7	271.1	251.6	232.0
Netherlands	288.4	299.4	296.2	284.6	266.8
Norway	275.5	298.8	298.7	285.4	266.4
Poland	268.6	270.4	261.7	254.3	244.0
Slovak Republic	278.0	279.1	281.4	275.5	265.1
Sweden	285.7	302.1	299.7	286.7	274.2
United States	251.5	265.4	262.6	255.9	252.5
Average	**273.4**	**284.6**	**280.1**	**268.7**	**255.1**

Source: Survey of Adult Skills (PIAAC) (2012).

Comparisons with other data sources and studies suggest that the profile depicted in Figure 2 is likely to capture (at least to some extent) the actual individual evolution of proficiency over the life-cycle. A Canadian longitudinal study that retested nine years later young adults who had taken the 2000 PISA assessment (OECD, 2012), showed that reading proficiency increased substantially between the age of 15 and the age of 24. Moreover, the increase was rather similar across individuals who undertook different educational pathways.

As far as the evolution of proficiency for older individuals is concerned, there are no longitudinal studies that are fully comparable to PIAAC. There is, however, a large literature (reviewed in box 1) that has investigated the extent to which cognitive abilities change with age. However, these studies mainly look at measures of cognitive functioning (e.g. memory, reasoning, perceptual speed, vocabulary knowledge) or various measures of IQ. While such measures are likely to be related to proficiency in information-processing skills (as measured in PIAAC), they are conceptually distinct constructs, and the reader should always exercise some caution when making comparisons between PIAAC and studies that draw on structurally different datasets.

Box 1. Age-related decline in cognitive skills. A brief literature review

The relationship between cognitive abilities and age has been the subject of a large number of studies, carried out in different disciplines, and using different data and methodologies. This box will provide a brief overview of the findings of such literature, largely drawing from the more detailed paper by Desjardins and Warnke (2012).

The first point to stress is that the process of cognitive deterioration related to ageing is highly dependent on the type of cognitive skills under consideration. This is true not only from an empirical point of view (all measures of cognitive skills have their particular limitations) but also conceptually.

An important distinction in this respect is between fluid and crystallised intelligence (Cattel, 1971 and 1987). Fluid intelligence refers to the ability to learn and understand things independent of prior knowledge, and it is thought to be primarily determined by genetic and biological factors (Baltes, 1993). Crystallised intelligence comprises instead knowledge, skills and wisdom, abilities that are acquired or learned, and that are primarily socially and culturally determined.

Fluid and crystallised intelligence are expected to rise together in the early phases of the lifespan. Fluid intelligence, however, is predicted to peak in early adulthood, and then decline rapidly, while crystallised intelligence may keep rising, levelling off much later in life (Horn and Cattel, 1967).

Evidence from a wide range of studies, from different disciplines and using different methodologies, tends to confirm such theoretical predictions. Measures of crystallised intelligence generally increase steadily through most of the life-cycle, peaking in the mid-50s and declining only in the late 70s. The decline in measures of fluid intelligence, on the other hand, sets off much earlier, and tends to be steeper, broadly mirroring the age profile of cognitive foundation skills, such as numeracy and literacy proficiency as measured in the Survey of Adult Skills.

Another important empirical finding is the large variation observed in individual patterns of cognitive ageing. Depending on biological, behavioural, environmental and social influences, individual trajectories vary considerably (Barnes et al., 2007; Depp and Jeste, 2006; Kliegel, Moor and Rott, 2004; Yaffe et al., 2009). Even more importantly, research on the brain's plasticity suggests that people can learn anew into late adulthood (OECD, 2007). According to the "cognitive-enrichment hypothesis", the age profile of cognitive abilities can differ over the life span in response to various types of behaviour (Hertzog et al., 2008). Thus, the question shifts immediately to the identification of the individual and social traits and practices that could possibly slow down the age-related decline in proficiency.

Different survey designs also tend to affect the results of different studies. Taking the Seattle Longitudinal Study as a reference point, Desjardins and Warnke (2012) conclude that cross-sectional age-skill profiles for fluid intelligence measures tend to start from a higher level and decline more steeply than in longitudinal profiles for the same measure. Longitudinal studies are intuitively attractive, because they allow controlling for unobserved within-person characteristics that are time-invariant. However, they do have limitations. In particular, it remains difficult to separate intrinsic neurological and behavioural maturation effects, and the extrinsic effects due to changes in the environment surrounding the individuals. Moreover, results from longitudinal studies may be biased because of non-random attrition (Frees, 2004) and retest effects (Salthouse, 2009 and 2010). Salthouse goes as far as to claim that cross-sectional findings provide a more accurate picture of the age-related decline in cognitive skills, although such claims are contested by many researchers (Abrams, 2009; Schaie, 2009).

The measures of fluid and crystallised intelligence discussed so far are classified by Desjardins and Warnke (2012) as *basic cognitive skills*, which they identify as concepts and measures devised in disciplines linked to the cognitive science, for the purpose of studying cognitive functioning. *Cognitive foundation skills*, such as literacy and numeracy skills measured in surveys like IALS, ALL and PIAAC, are more complex and involve higher order thinking skills, requiring an integration of the basic components mentioned above.

Cross-sectional measures of cognitive foundation skills tend to display a pattern similar to that of fluid intelligence, with declines beginning as early as in the mid-20s. Green and Riddell (2013) use IALS and ALL data for Canada, Norway and the United States to construct synthetic cohorts, which allows them to separate age and cohort effects. They conclude that the weak negative slope of the skill-age profile found in the cross-sectional data is the result of offsetting age and cohort effects. As more recent cohorts have both lower levels of proficiency and more years of education, once controls are added for cohort effects (and years of education), the age-related decline in literacy becomes more pronounced.

There are a few longitudinal studies that assessed cognitive foundation skills similar to those assessed in IALS, ALL and PIAAC. On the basis of an analysis of the New Zealand Competent Learners Study, Wylie and Hodgen (2007) conclude that literacy appears to be fixed early in life, given that the correlation in performance on tests measuring literacy seemed to be high after the age of eight. Similar conclusions were reached by Bynner and Parsons (2009), who analysed data from the British Cohort Study.

On the contrary, using data from the Longitudinal Study of Adult Learning, Reder (2009) finds that literacy and numeracy continue to develop into adulthood (peaking at around 35 years of age), and that the longitudinal profiles of skills measured in the survey were remarkably consistent with the cross-sectional profile found in IALS and ALL.

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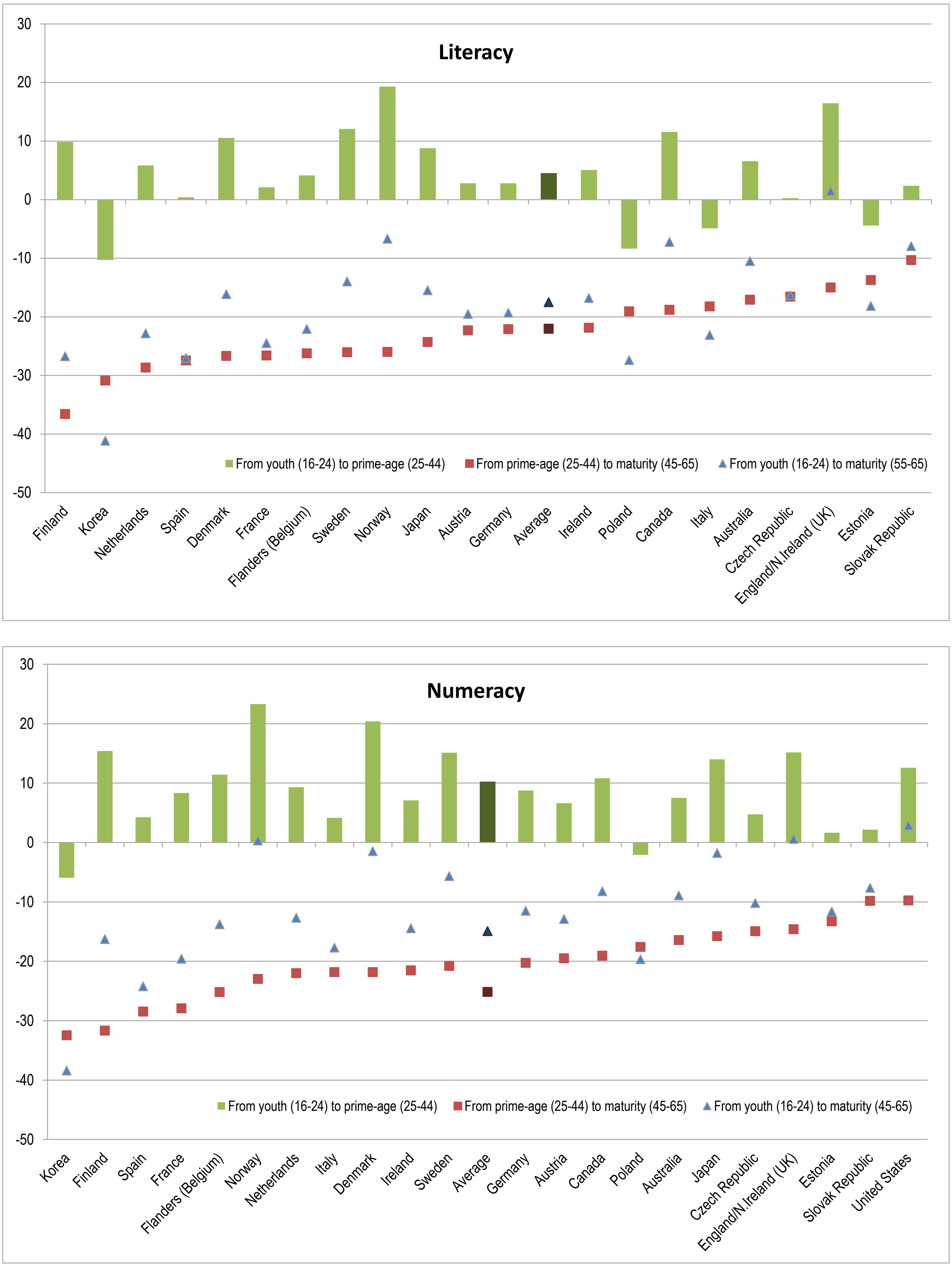
The profile depicted in Figure 2 is common to most countries participating in PIAAC. Figure 3 shows how average proficiency evolves for young, prime age and mature adults. The green bars show the difference in proficiency between prime-age and young individuals. That difference is generally positive, because proficiency is higher among prime-ager than among young adults. The red squares show the difference between mature and prime age-individuals, which is always negative, since it compares the most and least proficient group. The blue triangles show the difference between mature and young individuals.

Age differences in proficiency are substantial. In most countries mature individuals score 20 or more points lower than prime-agers, and only in Estonia and the Slovak Republic the gap is smaller than 15 points. As a comparison, the gap in literacy proficiency between tertiary and lower than upper secondary educated individuals is close to 50 points in most countries.

Countries in Figure 3 are sorted according to the size of the differences in proficiency between prime-age and mature workers. The ranking of countries does not change significantly when comparing literacy and numeracy, but the age-proficiency profiles differ somewhat. In the case of literacy, the gap between young and prime-age adults are generally smaller (something apparent also from Figure 1), and are actually negative in Korea, Poland, Italy and Estonia (and virtually zero in Spain, France, Austria, Germany, the Czech Republic and the Slovak Republic). Smaller differences between young and prime-age individuals are, mechanically, associated to larger differences between young and mature individuals. In the four Nordic countries, England/Northern Ireland, Canada and the United States the proficiency differences between young and prime-age adults are particularly high.

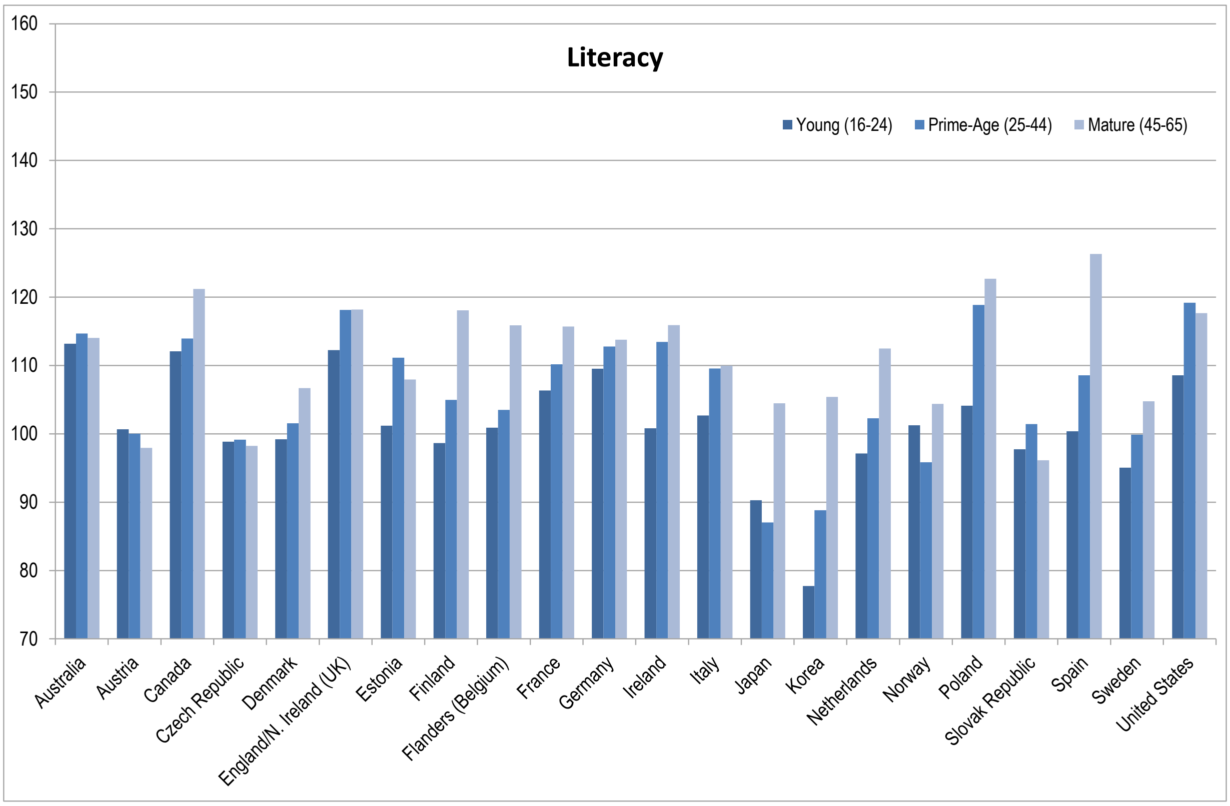
While average proficiency tends to decline with age, its dispersion (measured by the distance between the top and the bottom decile of the distribution of proficiency within each age group) is generally higher amongst older individuals, as shown in Figure 4. This is not particularly surprising. Younger adults form a more homogeneous group than do older adults. With the passage of time, individuals follow increasingly different life trajectories.

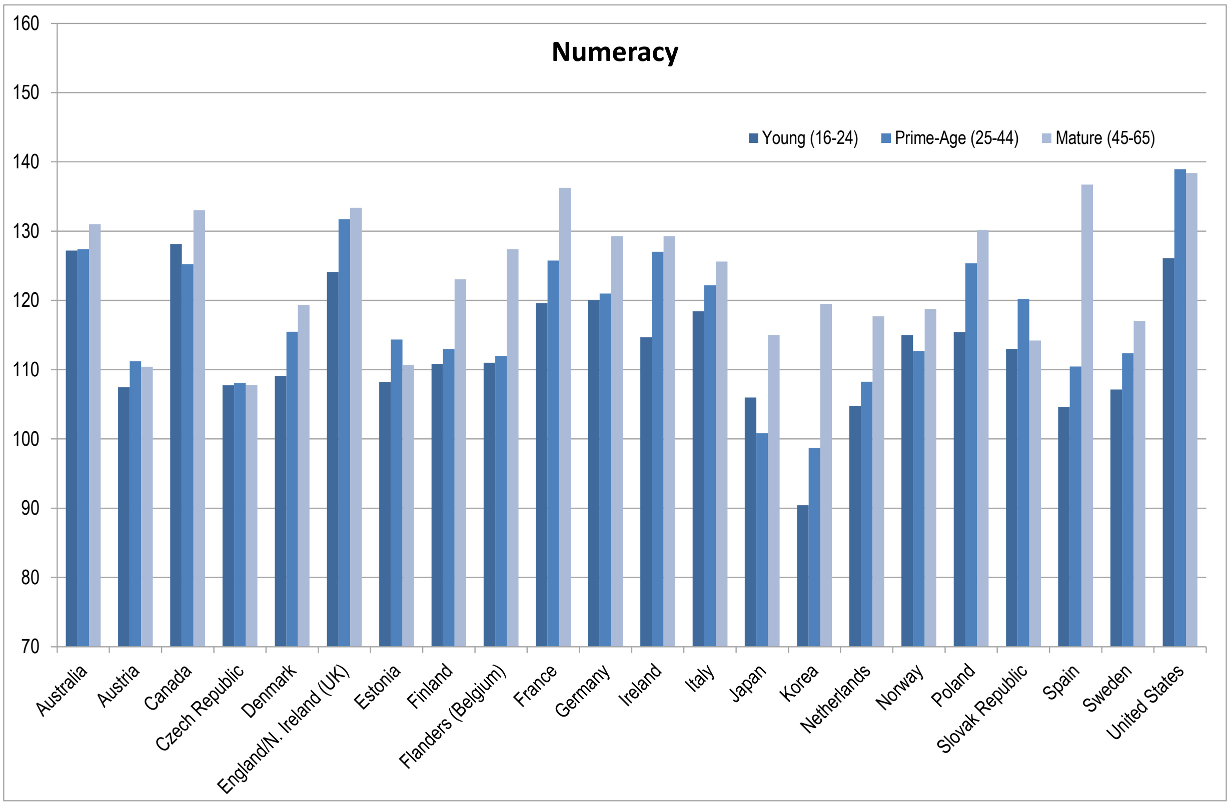
Figure 3. Proficiency differences between age groups



Source: Survey of Adult Skills (PIAAC) (2012).

Figure 4. Proficiency dispersion in different age groups





Source: Survey of Adult Skills (PIAAC) (2012).

Age and Cohort Effects

As briefly mentioned above, *age effects*, *cohort effects*, and *age differences* are three different concepts, and each one of them is more or less relevant depending on the particular question or problem at hand. Identifying the "pure" (biological) effect of age, net of any other characteristic at the individual or at the aggregate level, can be useful to provide an upper bound to the effects that can be expected from policy interventions (at least in areas related to education, training and the labour market) and to perform more accurate projections about future levels of proficiency of the population. Cohort effects can offer information relevant to assessing the effectiveness of policies. If younger cohorts are more proficient than older cohorts, this may indicate that education and training policies have been effective in raising human capital (either through more schooling, or through improvements in the quality of education). Age differences in proficiency are a combination of age, period and cohort effects, and are helpful to assess actual disparities and to identify the groups that are most in need of policy interventions.

Cross-sectional data do not allow the isolation of age and cohort effect. However, it is possible to take into account observed differences across individuals regarding some of the factors that influence proficiency. Two variables that are relevant in this respect are levels of educational attainment and socio-economic background. These variables are particularly important in analysing age differences because of the dramatic increase in educational attainment that many countries experienced in the last century. The PIAAC background questionnaire contains information on highest level of educational attainment, years of schooling and parental education. In the analysis that follows, individuals below 25 years are excluded from the estimation sample. This is because individual proficiency also influences the propensity to attain higher levels of education, and in turn schooling affects proficiency. A cleaner analysis would therefore only look at individuals who have completed their education. [2]

Figure 5 presents the adjusted and unadjusted difference in proficiency between prime-age and mature individuals (25-44 and 45-65, respectively) by country. In all countries, adjusted differences are much smaller than unadjusted differences, for the simple reason that older cohorts have completed fewer years of education (and have even lower levels of parental education), on average, than their younger counterparts.

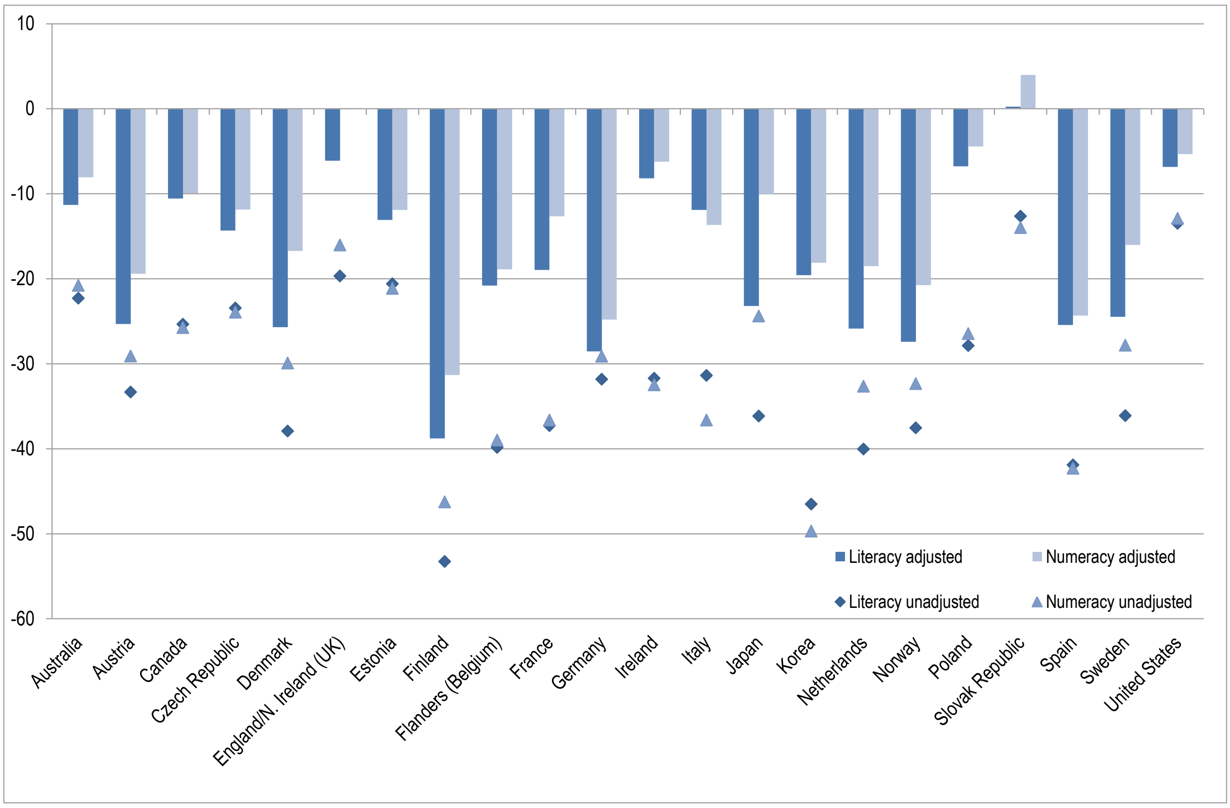
While the adjustment on average halves the observed age differences, in some countries the effect is much stronger. Compared to an average reduction of age differences of about 15 points, the effect is as high as 30 points in Korea, and above 20 points in Poland, France, Ireland and Italy. These are in fact countries in which years of completed education increased enormously across generations (3 years in Poland, France and Ireland, more than 4 years in Italy and Korea). As a consequence, these are also countries in which unadjusted differences are much more likely to reflect cohort effects rather than "true" age effects.

It is not obvious whether adjusted or unadjusted differences are more interesting from a policy perspective. On the one hand, adjusted differences may provide a better approximation of any age effect, but they do not take into account unobservable differences, such as quality of education or changes in school curricula (not to mention possible changes over time in the way in which education affects the evolution of proficiency over the life cycle). On the other hand, if the interest lies in identifying individuals particularly at risk because of their low level of skills, it is not particularly relevant to know whether their proficiency is higher or lower than is predicted from their educational qualification, nor what level of proficiency they had 15 or 20 years ago.

The cross-sectional nature of the Survey of Adult Skills necessarily limits the present study to an analysis of age differences and, therefore, some care should be taken with the interpretation of the results. However, the availability of previous international skills surveys can help in disentangling age and cohort effects, thus providing a rough idea of what is captured by the observed cross-sectional age differences.

We selected thirteen countries that participate in both the Survey of Adult Skills and in the International Adult Literacy Survey (IALS), which was conducted between 1994 and 1998.[3] PIAAC was specifically designed to be comparable with IALS in the domain of literacy, and IALS scores have been rescaled and put on the PIAAC scale.

Figure 5. Age differences in literacy and numeracy proficiency



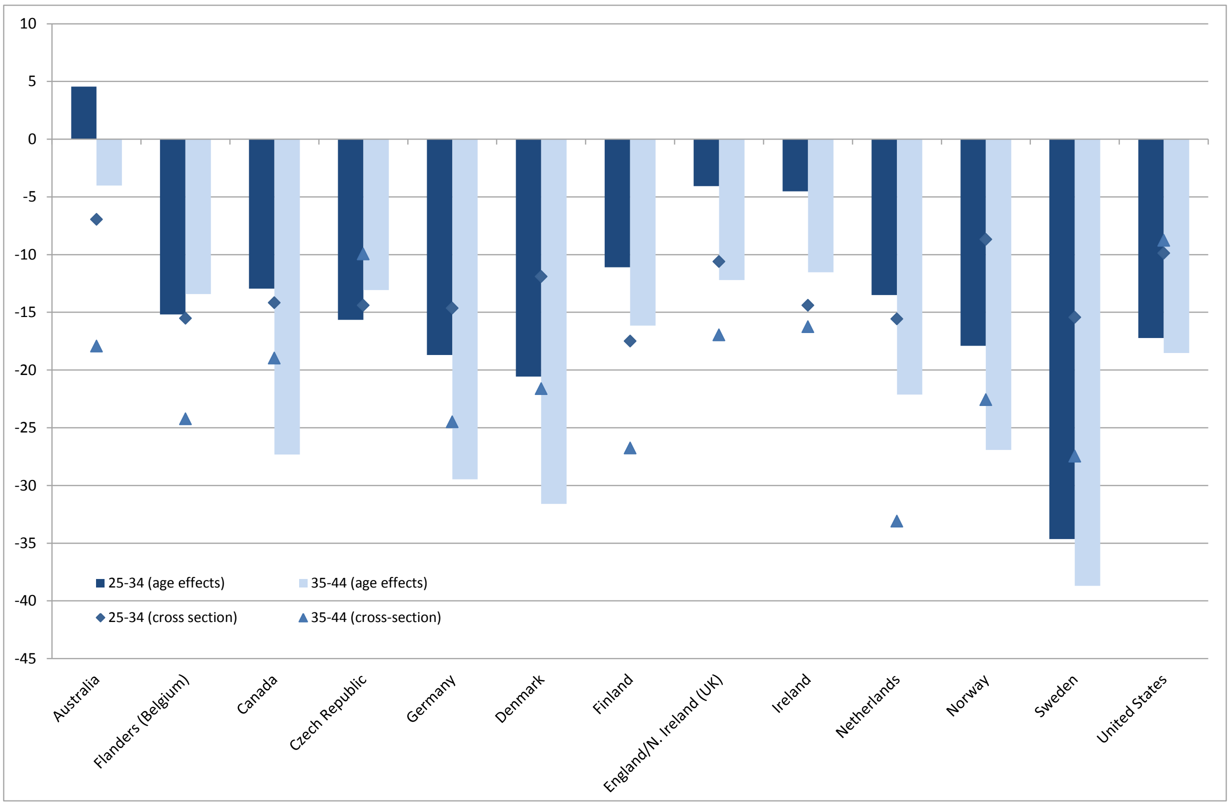
Notes: The figure report differences in literacy and numeracy between individuals aged 25-34 and individuals aged 55-65. Adjusted differences control for gender, highest level of educational attainment, and parents' highest level of educational attainment.

Source: Survey of Adult Skills (PIAAC) (2012).

It is not possible to follow single individuals from IALS to PIAAC. However pooling information from the different surveys allows one to follow so-called "synthetic cohorts" over time and look at the evolution of the average proficiency of a given age group over time. For example, it is possible to compare the average proficiency of adults born in 1962 who were aged 32 years old at the time of the administration of in IALS and 50 years at the time PIAAC was administered. Furthermore, it is of interest to compare the age differences as estimated from the cross-sectional data with age effects estimated exploiting synthetic cohorts, in order to assess how much the two measures diverge with the objective of gaining insight into the findings from the simple analysis of cross-sectional data.

Given relatively small sample sizes, however, it is more practical to pool observations and to analyse larger cohorts (e.g. 5 year age cohorts) than cohorts defined by a single year of birth. An analysis of this type has been undertaken by Green and Riddell (2013), examining the evolution of literacy proficiency in Canada between IALS and the Adult Literacy and Life Skills Survey (ALL, administered in Canada in 2003).[4] For the reasons already identified above, the analysis will focus on individuals above 25 years old.

Figure 6. Age Effects and Cross-Sectional Differences



Notes: The bars report the evolution of literacy proficiency between IALS and PIAAC for individuals aged 25-34 and 35-44 in IALS. Depending on the country, such people were aged 39-48 (49-58), 41-50 (51-60) or 43-52 (53-62) in PIAAC. The diamonds and the triangles compare the same groups of individuals using only the cross-sectional information available in PIAAC.

Source: International Adult Literacy Survey (IALS) (1994-1998) and Survey of Adult Skills (PIAAC) (2012).

For ease of exposition, Figure 6 displays the results of an analysis performed using cohorts defined over 10-years intervals. The proficiency of individuals aged 25 to 34 and 35 to 44 in IALS is compared to the proficiency of members of the same age cohort assessed in PIAAC. Given that different countries participated in IALS in different years, in 2012, such individuals were either 43 to 52 (53 to 62), either 41 to 50 (51 to 60), or 39 to 48 (49 to 58).[5] The changes in proficiency for the same cohorts are labelled "age effects". The diamonds and the triangles show instead the cross-sectional differences in proficiency for the same age groups in PIAAC, (i.e., the average proficiency of individuals aged 43 to 52 in 2012 is compared to the average proficiency of individuals aged 25 to 34 in 2012).

Results are mixed. In half of the countries (Canada, the Czech Republic, Denmark, Germany, Norway, Sweden and the United States) the cross-sectional differences underestimate the age effect. The opposite is true in the remaining countries. Ageing effects are low in Australia, England/Northern Ireland (UK), and Ireland. In all countries, both methods suggest that the decline in proficiency tends to accelerate with age. The light blue bars, in fact, show that people aged 35-44 at the time IALS was administered experienced larger declines over the same time span than people aged 25-34 (the only exceptions being Flanders (Belgium) and the Czech Republic). Similarly, in all countries other than the Czech Republic and the United States, PIAAC reveals larger proficiency differences between individuals aged 50 to 60 years and individuals aged 35-44 (the triangles in figures 6) than between adults aged 40 to 50 years and those aged 25-34 years.

A different (and more flexible) way to analyse age effects and age differences is to run regressions that pool information from IALS and PIAAC. Such a method also allows one to control for other observable characteristics such as years of education and parental background (that are not expected to change over time, given the focus on individuals above 25). This is the same approach as is undertaken by Green and Riddell (2013). More precisely, we run, for each country, a regression of literacy scores on a set of dummies for age groups (35-45, 45-54 and 55-65, with 25-34 being the omitted category) and on a set of cohort dummies that identify the age of individuals in IALS. The coefficients can then be compared with a similar regression using PIAAC data only, with and without controlling for education and parental background.[6] Contrary to figure 6, in this approach coefficients should be interpreted as point differences with respect to individuals aged 25 to 34 (the reference omitted category in the regression analysis). Table 2 summarizes the results of the analysis, reporting the average of the estimated coefficients over the 13 countries in the analysis. Table A1 in the Appendix reports estimates for individual countries.

Table 2. Age differences and age effects

	Age differences (unadjusted)	Age differences (adjusted)	Age effects (unadjusted)	Age effects (adjusted)
35-44	-5.43	-2.82	-7.94	-12.02
(standard error)	*(0.68)*	*(0.62)*	*(0.96)*	*(0.88)*
45-54	-18.52	-10.72	-18.00	-22.25
(standard error)	*(0.66)*	*(0.62)*	*(0.90)*	*(0.84)*
55-65	-31.73	-18.93	-32.59	-40.27
(standard error)	*(0.68)*	*(0.67)*	*(1.16)*	*(1.09)*

Note: The table reports the average of estimated coefficients from a series of country-level regression of literacy proficiency on age-group dummies. The omitted category consists of individuals aged 25-34. Coefficients in the first two columns are estimated using only PIAAC data, with and without controlling for years of education and parental background. Coefficients in the last two columns are estimated pooling observations from IALS and PIAAC, controlling for cohort dummies. Cohorts are defined according to the age of the respondent in IALS, grouped into 10-years.

Source: International Adult Literacy Survey (IALS) (1994-1998) and Survey of Adult Skills (PIAAC) (2012).

Results from the pooled regression indicate stronger declines of proficiency with age (age effects), especially when educational attainment is controlled for than were found above. The coefficients of cohort dummies generally increase with the age of the cohort, indicating that older cohorts were on average less highly educated but more proficient in literacy. These results are broadly consistent with the findings of Green and Riddell (2013) for Canada, Norway and the United States when comparing IALS and ALL. This suggests that controlling for educational attainment in the cross-sectional data will lead to a severe underestimation of age effects. The estimated age effects from the pooled regressions (with and without controlling for education) are quite similar to the coefficients estimated from the cross-section without controls, implying that the simple approach of only looking at the cross-sectional age-proficiency profile and interpreting it as “age effect” would probably not lead to significant biases.

Conclusions

The Survey of Adult Skills (PIAAC) reveals clear differences in proficiency in information processing skills between individuals of different ages. While adults in their late 20s to early 30s have the highest measured level of proficiency, proficiency appears to decline as people get older. Interpreting this pattern as an “age effect”, however, is problematic. As PIAAC is a cross-sectional survey that measures proficiency at a single point in time, it is difficult to disentangle the effect of aging from many other possible factors that differentiate individuals born in different years (cohort effects).

Both age differences and age effects are of high interest from a policy perspective. Age differences provide a picture of the current state of elderly individuals relative to that of their younger counterparts. They can, therefore, be useful to identify immediate interventions to better target individuals at higher risk of marginalisation because of their relatively low levels of proficiency. Estimates of (biological) age effects are, on the other hand, crucial in a longer term perspective: anticipating the possible evolution of proficiency of the population, as well as policy interventions able to steer such evolution in a more favourable direction, are essential ingredients in any strategy to effectively address the challenges of population ageing.

Evidence from a number of different other sources suggests that the age-proficiency profile that shows up in PIAAC does capture, at least qualitatively, the effect of age on proficiency. Depending on whether and how one tries to adjust for differences in observable characteristics, individuals aged 55 to 65 can be estimated to score between 17 and 30 points below individuals aged 25 to 34. Estimated proficiency losses range between 6 to 15 points in the United States, the Slovak Republic and England/N. Ireland (UK), and 30 to 50 points in Finland.

Notes

[2] While some 25% of individuals aged 25-29 report that they studied for a formal qualification in the 12 months prior to the survey, this share quickly declines to 14% for individuals aged 30-34, to 11% for individuals aged 35-39, and to less than 5% for individuals above 45.

[3] The selected countries are Australia, Flanders (Belgium), Canada, the Czech Republic, Germany, Denmark, Finland, England/Northern Ireland (UK), Ireland, the Netherlands, Norway, Sweden, and the United States. Italy and Poland were excluded because of the large number of coding inconsistencies in IALS, which cast doubts about the quality and reliability of the data.

[4] We do not make use of ALL data because only 6 countries participated in both IALS, ALL and PIAAC.

[5] Canada, Germany, the Netherlands, Poland, Sweden and the United States administered IALS in 1994; Australia, Flanders (Belgium) and England/Northern Ireland (UK) did it in 1996; the Czech Republic, Denmark, Finland, Ireland, Italy and Norway participated in 1998.

[6] IALS data for Australia do not contain a continuous variable on years of schooling, therefore the regression controls for a set of dummies that identify the highest level of educational attainment (below high school, high school, above high school).

3. WHAT DO PEOPLE DO AS THEY AGE?

Proficiency in information processing skills is not an end in itself. These skills are important in that they contribute to effective social functioning, for example, to positive outcomes in the labour market and in everyday life. The link between skills, age, and outcomes is complex, and it is shaped by the decisions that people take at different points in their life as well as by the impact of historical events, policy changes and broad sociological trends. Such decisions affect the evolution of skills, and in turn the level of acquired skills at any given point in time affects individual decisions. Moreover, the nature of the interrelationship between skills and outcomes can differ at different stages of the life cycle.

People are endowed with many more skills and attributes than are measured in the Survey of Adult Skills: they have job-specific expertise, general or specialised knowledge acquired through formal education or adult training, and personality traits and attitudes. These dimensions of an individual’s skill portfolio are all valued, to different extents, by the labour market, and the profiles of the different dimensions of skills are likely to vary in different ways in relation to age. As a consequence, at different points in the lifecycle, proficiency is likely to have a different impact on different individual outcomes and decisions.

This chapter analyses the complex interrelationships between skills, age, and outcomes, by exploiting the richness of the PIAAC background questionnaire. Looking at a variety of outcomes like labour market participation, earnings, formal and non-formal education, the type and the content of jobs, and their relation with proficiency, can potentially better inform on the true consequences of aging. Proficiency is certainly an important determinant of individual outcomes, but is not the only one. As people age, proficiency might decline, but other factors might have a different evolution over the lifecycle and contribute to offset the negative consequences of declining proficiency levels.

The chapter will first describe the age related patterns of participation in education and in the labour market, and how they are affected by individual proficiency. In terms of labour market outcomes, the focus will then turn to earnings, examining the age profile of wages and the wage returns to proficiency at different points of individuals’ life cycles. Attention will be devoted to the link between ageing and productivity, on the basis that productivity is likely to be a main determinant of both employability and earnings. Finally, the analysis will investigate occupational outcomes of young and old adults, including the skills content of the job, the use of skills at work, and the likelihood of being mismatched.

Patterns of participation in education and in the labour market

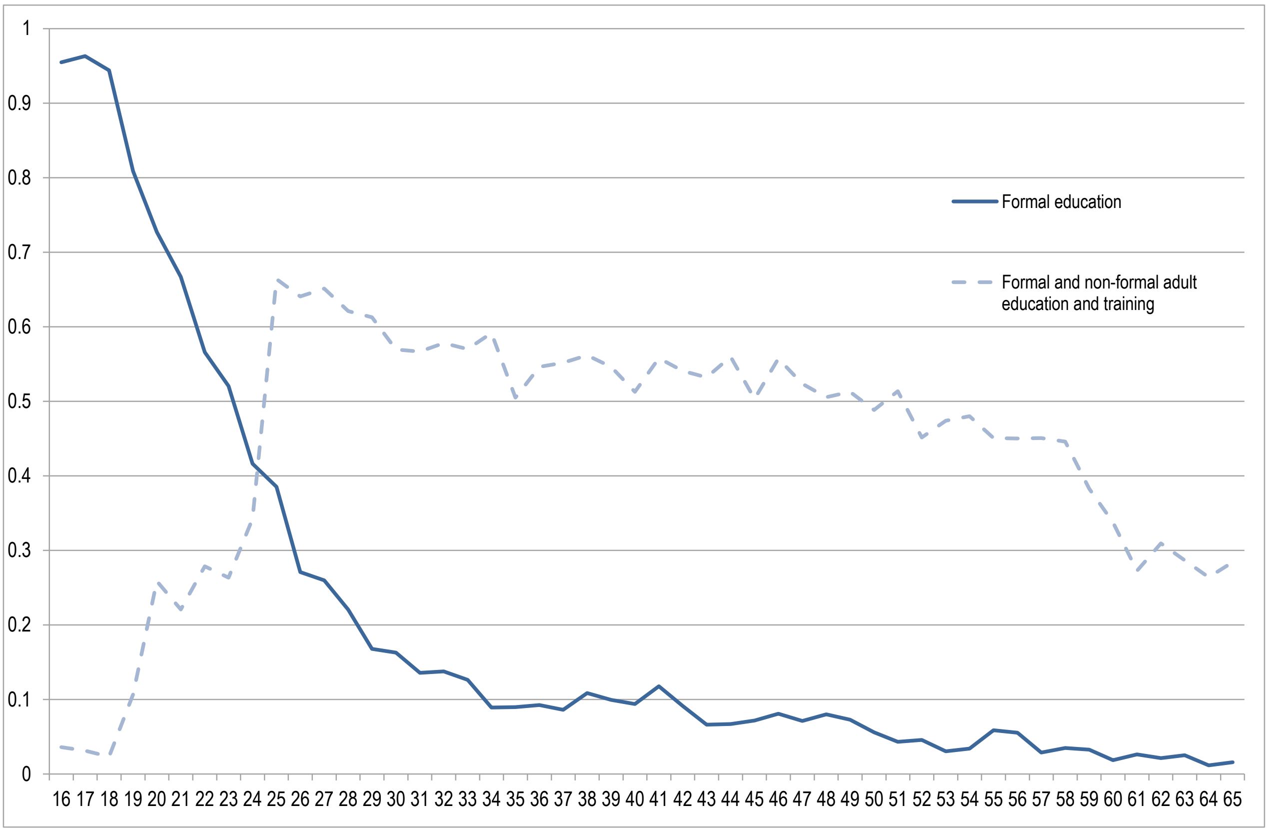
Educational attainment is probably the single most important determinant of proficiency. However, proficiency of adults that have the same level of educational attainment varies significantly across countries, as do differences in proficiency related to educational attainment (OECD, 2013). Schools and other educational institutions such as vocational colleges and universities are not the only place in which skills are developed, but they represent institutions that have the development of human capital of the population as their primary mission.

Participation in formal education is strongly related to age: the decisions about whether to stay in education or leave education to enter the labour market are often difficult to reverse and represent key stages in individuals’ life cycles. Indeed, the age-proficiency profile depicted in Figure 1 is closely related to broad stages of educational participation. Figure 7 also shows how the intensity of participation in formal and non-formal education varies with age. There is a clear turning point in the rate of participation in formal education at around the late 20s/early 30s, which is almost coincident with the age at which proficiency peaks. In fact, as rates of participation in formal education declines, the rate of growth in average proficiency slows down. With proficiency peaking at around age 30, it seems that people are able to accumulate information processing skills mainly during participation in formal education. Only in the first few years spent in the labour markets individuals appear to be able to further increase their level of proficiency, which then start to gradually decline.

Participation in adult education and training (be it formal or non-formal) follows a clearly different pattern, much less related to age-proficiency profiles. As individuals enter the labour market, participation rates in adult education and training increases, peaking at about 25 years and staying rather constant up to age 55, when they start to decline (essentially because of retirement). In fact, participation rates in adult education and training follow closely employment rates, as depicted in figure 8.

A better understanding of this process of skill formation (and learning) during the first years of labour market experience would be of great interest. However, this is well outside the scope of the current report, which is more focused on understanding the process of skills depreciation associated with ageing. Future research on the determinants of proficiency gains from age 15 to age 30, possibly exploiting information available in the PISA dataset, is called for to shed more light on this important issue.

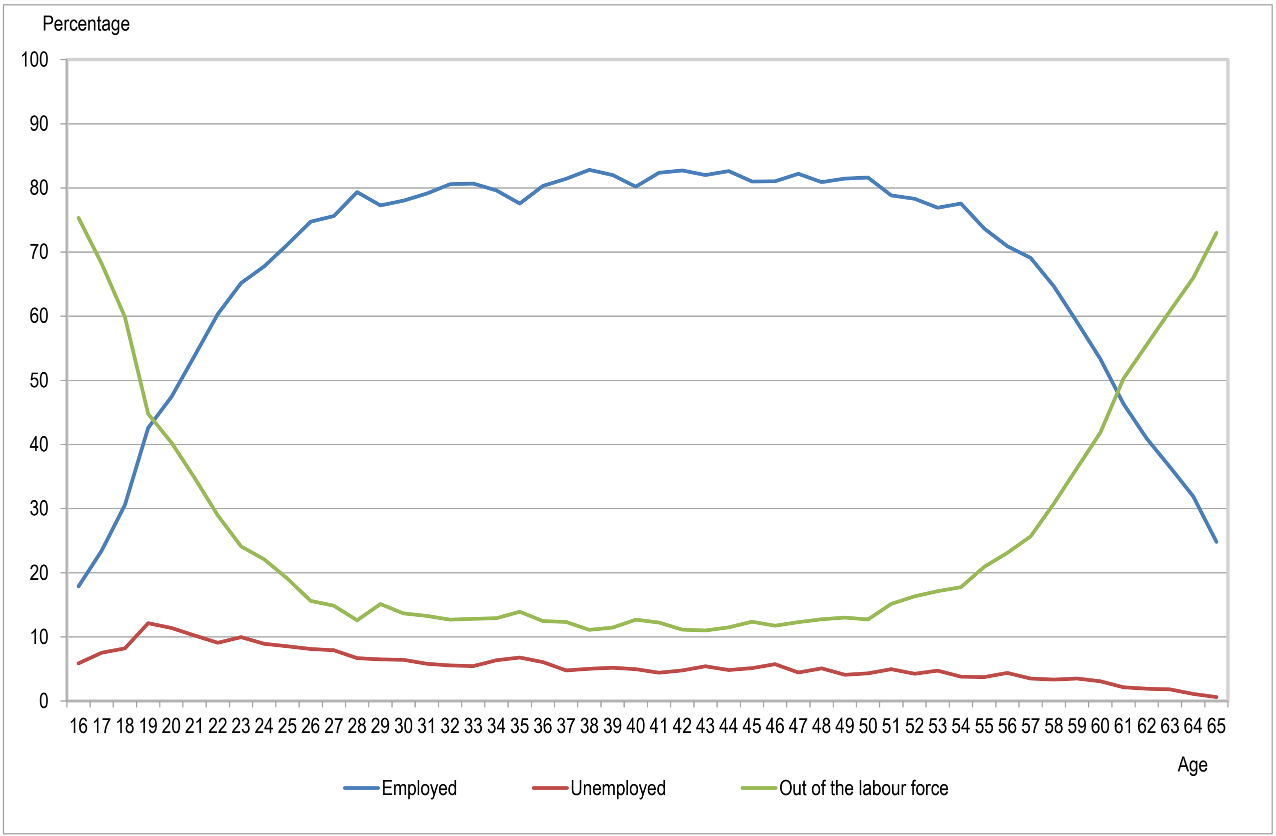
Figure 7. Participation rates in formal and non-formal education in the last 12 months



Source: Survey of Adult Skills (PIAAC) (2012).

The pattern of participation in the labour market follows a different profile (Figure 8). From age 25 onwards, employment rates are basically constant, declining abruptly about after age 55. Proficiency in information processing skills, however, declines much more smoothly with age. Particularly at older ages, decisions about participation in the labour market are likely to be significantly affected by institutional provisions such as statutory retirement age (and the possibility of early retirement).

Figure 8. Percentage of adults by labour force status and age



Source: Survey of Adult Skills (PIAAC) (2012).

How skills affect employability and earnings

Proficiency plays an important role in determining individual decisions about labour market participation and, more importantly, the chances of getting a job, as shown in Figure 9. Moreover, proficiency seems to matter much more for older than for younger individuals. Table 3 and the green and red lines in Figure 9 report the estimated effects of proficiency and years of education on the probability of being in employment. The effects are estimated using a logistic regression model that also controls for gender, marital status, and age class. Estimated marginal effects are reported as changes in the probability of being employed for a one standard deviation change in literacy proficiency and years of education for individuals belonging to different age groups.

On average across the countries participating in PIAAC, the impact of proficiency on the probability of being employed tends to increase with age. In contrast, the impact of years of education is very high for individuals aged 25 to 34, but then declines and does not vary significantly as people get older. While the pattern of coefficients is suggestive, the coefficients are estimated rather imprecisely. Only in Austria, Germany, Denmark, Finland and Poland are the differences between the oldest and the youngest age group found to be statistically significant.

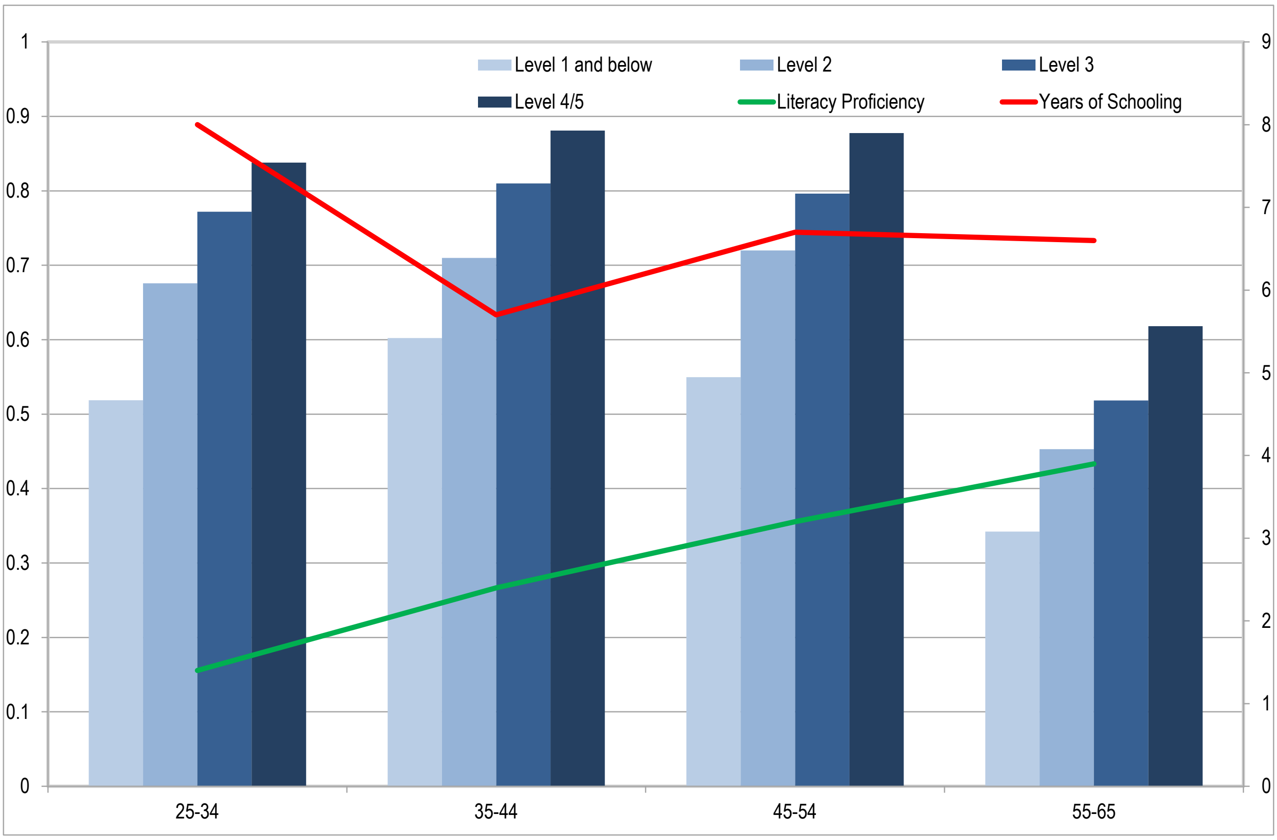
Table 3. Effect of literacy proficiency and education on the likelihood of being employed

	Literacy proficiency				Years of education			
Country	**25-34**	**35-44**	**45-54**	**55-65**	**25-34**	**35-44**	**45-54**	**55-65**
Australia	1.3	1.8	3.6	3.1	13.0	4.5	5.0	6.3
Austria	-0.3	1.3	1.7	6.8	7.4	2.9	4.3	7.3
Canada	2.3	3.5	2.5	4.3	7.1	3.8	6.3	3.7
Czech Republic	4.9	1.3	5.1	2.5	6.6	4.6	4.3	6.0
Germany	-3.3	5.7	3.2	7.9	10.0	3.0	3.6	5.6
Denmark	-3.4	1.8	5.0	7.3	10.7	5.3	5.0	5.5
Estonia	1.0	1.7	1.2	5.8	7.4	5.3	9.0	13.8
Finland	-1.3	0.4	4.4	10.5	7.0	5.6	3.6	5.2
France	1.8	-0.5	1.3	1.8	10.2	7.2	7.2	6.9
Ireland	5.6	1.4	4.8	2.2	12.6	12.1	10.2	4.5
Italy	5.8	2.8	2.2	0.9	3.5	8.5	15.0	10.2
Japan	-1.5	-1.6	0.8	0.6	1.7	1.5	2.2	-1.4
Korea	-2.2	1.1	2.4	-1.5	10.1	0.5	0.3	0.2
Netherlands	2.9	1.3	1.4	3.1	6.5	4.5	4.3	7.7
Norway	2.3	2.3	6.1	5.0	6.2	4.7	5.0	6.5
Poland	0.9	1.0	1.3	6.8	11.6	10.6	14.0	9.7
Slovak Republic	5.4	3.8	4.1	-1.9	10.7	13.4	12.3	17.4
Spain	-2.0	5.2	3.9	1.8	8.5	9.1	12.7	10.0
Sweden	4.3	2.4	5.7	10.1	5.9	5.1	2.6	4.9
United States	0.6	6.2	4.0	5.6	8.9	7.5	10.9	8.1
Flanders (Belgium)	2.6	2.5	3.1	2.4	3.6	3.8	4.8	10.0
England/N. Ireland (UK)	3.8	6.5	2.4	1.7	5.8	2.0	3.8	-2.3
Average	1.4	2.4	3.2	3.9	8.0	5.7	6.7	6.6

Note: The table shows the estimated change in terms of percentage points of a one standard deviation increase in literacy or years of education on the likelihood of being in employment.

Source: Survey of Adult Skills (PIAAC) (2012).

Figure 9. Adults in employment, by age and literacy level, and marginal effects of literacy and education



Note: The red and green lines (right-hand scale) show the estimated change in terms of percentage points of a one standard deviation increase in literacy or years of education on the likelihood of being in employment, from a logit regression that also controls for gender and marital status.

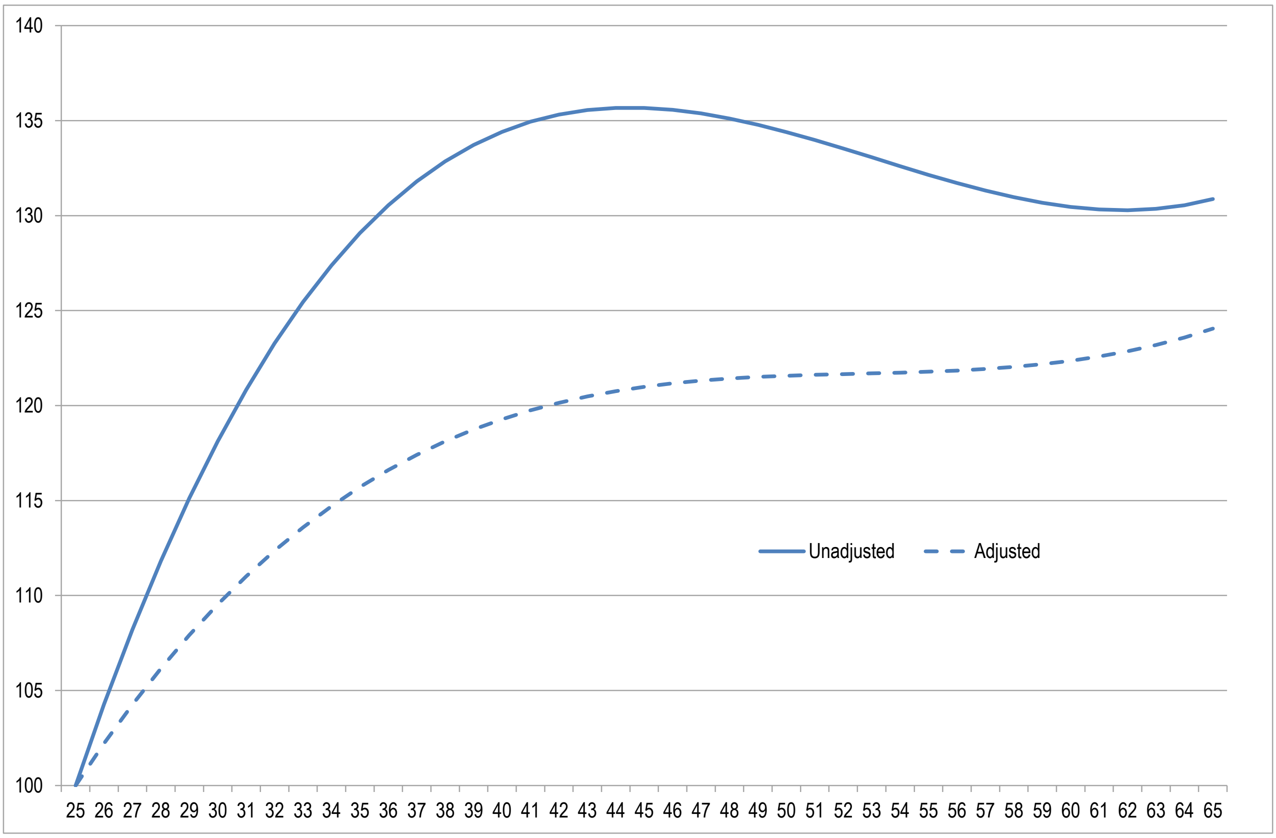
Source: Survey of Adult Skills (PIAAC) (2012).

In addition to increasing the likelihood of participation in the labour market and the chances of getting a job, skills proficiency has a positive and independent effect on earnings. This is to be expected. More proficient individuals are presumably more productive at work, and economic theory predicts that, in a competitive labour market, wages should be set equal to marginal productivity. However, such a simple and intuitively plausible relationship between skills, productivity and wages becomes much less clear-cut when looked at through the lens of the lifecycle. In virtually all countries, labour markets are characterised by the fact that wages increase with tenure (seniority wages). As a result, salaries generally increase as people age, which is clearly not what one should expect under the assumptions that: (i) wages are equal to productivity; (ii) skills proficiency proxies labour productivity; and (iii) skills evolve with age according to Figure 1.

Figure 10 plots the average relationship between hourly wages and age for the OECD countries that participated in PIAAC. Adjusting for a range of observable characteristics (such as gender, years of education, literacy proficiency, years of labour market experience and type of contract) does not change the shape of the curve, with wages increasing by age until approximately 45 years and then declining only very slightly.

There exist two broad types of explanations (not mutually exclusive) for the apparent discrepancy between age-proficiency and age-wage profiles. The first is that proficiency may be a poor proxy of individual productivity on-the-job. The tasks performed every day on the job are often not only very job-specific, but also firm- or establishment-specific. The broad information processing skills measured in the Survey of Adult Skills may make it easier for people to learn how to perform such tasks in an effective way, but many other things can only be learned through experience, which older adults possess to a greater extent. Moreover, the PIAAC data show that participation in on-the-job training is positively associated with proficiency. While training might not directly affect proficiency in information processing skills, it could endow people with a range of other job-specific skills, that increases productivity and, as a consequence, wages.[7]

Figure 10. Age-wage profile in OECD countries



Note: Hourly wages including bonuses as a function of age. Wages of 25 year old are set equal to 100. The unadjusted line shows the prediction from a regression of wages on a cubic polynomial in age. The adjusted line also controls for gender, a quadratic polynomial in labour market experience, literacy proficiency, years of education, and dummies for part-time and indefinite contract.

Source: Survey of Adult Skills (PIAAC) (2012).

The second line of explanation relates to the theory of implicit contracts, first put forward by Lazear (1979, 1981, 1986). According to this theory, in the presence of informational asymmetries (such as the difficulty of monitoring worker performance or of assessing workers' productivity at the time of hiring) firms and workers may enter into contracts in which wages rise more rapidly with seniority (within the firm) than with productivity. The vast literature that has investigated the link between age and productivity is reviewed with greater detail in Box 2.

Box 2. Age and productivity

The age profile of individual productivity is conceptually different from the age profile of individual cognitive skills, as surveyed in Box 1. Productivity on the job results from the application of (possibly) the entire range of skills workers are endowed with, which ranges from general cognitive skills, to physical skills, to job- and task-specific knowledge. Obviously, the relative importance of each of these dimensions varies with industry, occupation, and, possibly, worker's age: age-related declines in some dimensions of skills can be compensated with increases in other dimensions.

A further conceptual distinction can be drawn between individual productivity (defined as workers' ability to perform a given set of tasks), and the market value of that same set of tasks, which can very well change due, for example, to technological change (OECD, 2006). For instance, Salthouse (1984) found that old typists are as able as young typists, but that old typists might have found it harder to adapt to the introduction of personal computers. More recently, De Grip and Van Loo (2002) distinguish between *technical obsolescence*, related to either the wear or the atrophy of skills, and *economic obsolescence*, which may be due to technological or organisational developments, to shifts in the sector structure of employment, or to firm closures or reorganisation that cause the loss of firm-specific skills.

Surveying the literature on the link between age and productivity, Skirbeek (2004, 2008) concludes that job performance generally declines after 50 years of age. Declines are stronger in tasks that involve learning, speed, and problem solving, while ageing has smaller effects in jobs were experience and verbal abilities matter more. De Hek and van Vuuren (2011) provide a thorough review of the theoretical literature that has tried to rationalize the existence of differences between the age-productivity and the age-wage profile, as well as of the empirical literature that tried to find empirical support to those theories. This box will mainly review the empirical literature on the topic.

This literature generally has to face two very serious difficulties. First, selection biases are pervasive: older individuals who remain in the workforce are likely to be positively selected, and thus have higher productivity than those who left. Second, individual productivity is very hard to measure, unless one focuses on a small set of occupations, often extremely specialised with very particular characteristics, such as research economists (Oster and Hamermesh, 1998; van Ours, 2009), runners (van Ours, 2009), F1 drivers (Castellucci, Padula and Pica, 2011), or chess players (Bertoni, Brunello and Rocco, 2015). Van Ours (2009) finds that running performance declines after age 40, but that the productivity of academic researchers remains quite constant even at old age. On the other hand, Oster and Hamermesh (1998) find a declining age-productivity relationship for economists at 17 American top-universities, and Bertoni, Brunello and Rocco (2015) conclude that median productivity of chess players peaks at age 21 and then declines substantially, being 10% lower at age 50 than at age 15.

In the absence of individual measures of productivity, many studies have looked at productivity for groups of workers or for firms as a whole, often using imperfect indicators of productivity such as subjective assessments by supervisors. Medoff and Abraham (1980, 1981) use personnel data from large U.S. manufacturing firms and find no association between performance ratings given by immediate supervisors and experience, and a strong positive association between experience and earnings. The same results were confirmed by Flabbi and Ichino (2001), using data on employees of a large Italian bank and more objective proxies of productivity like absenteeism and misconduct.

More recent studies have taken advantage of the availability of matching employer-employee datasets, estimating the impact of the age composition of the workforce on firm's performance. Most studies find an inverted U-shaped work-performance profile (Skirbeek, 2004, 2008; de Hek and van Vuuren, 2011), with workers in their 30s and 40s displaying the highest levels of productivity. The evidence, however, is rather inconclusive: while the majority of studies conclude that firm's productivity does not increase with age as much as wages do, a sizeable minority fail to find evidence of a wage-productivity gap for older workers.

Hellerstein and Neumark (1995) find that both earning and productivity profiles in a sample of low-skilled Israeli workers are upward sloping and almost indistinguishable from each other. Hellerstein and Neumark (2007) use US data and conclude that both the wage and productivity profiles are rising, but the estimated relative wage profile is steeper than the relative productivity profile, consistent with models of deferred wages. In an earlier paper that used a more limited dataset, Hellerstein, Neumark and Troske (1999) were not able to detect statistically significant differences between the wage and the productivity profile. Dostie (2011), using Canadian data, Aubert and Crepon (2003) using French data, Cataldi, Kampelmann and Rycx (2011, 2012) for Belgium, and Ilmakunnas and Maliranta (2005) for Finland also find empirical support for the theory of implicit contracts formulated by Lazear. Lallemand and Rycx (2009) find that productivity in large Belgian firms is positively associated with the share of young workers and negatively associated with the share of older workers.

On the contrary, a number of studies do not find evidence in favour of the hypothesis that older workers are overpaid relative to their productivity: Mahlberg et al. (2013) for Austria, van Ours and Stoeldrajier (2011) for the Netherlands; Cardoso et al. (2011) even conclude that in Portugal older workers are underpaid relative to their productivity, which increases until age 50-54 (while wages peak around age 40-44).

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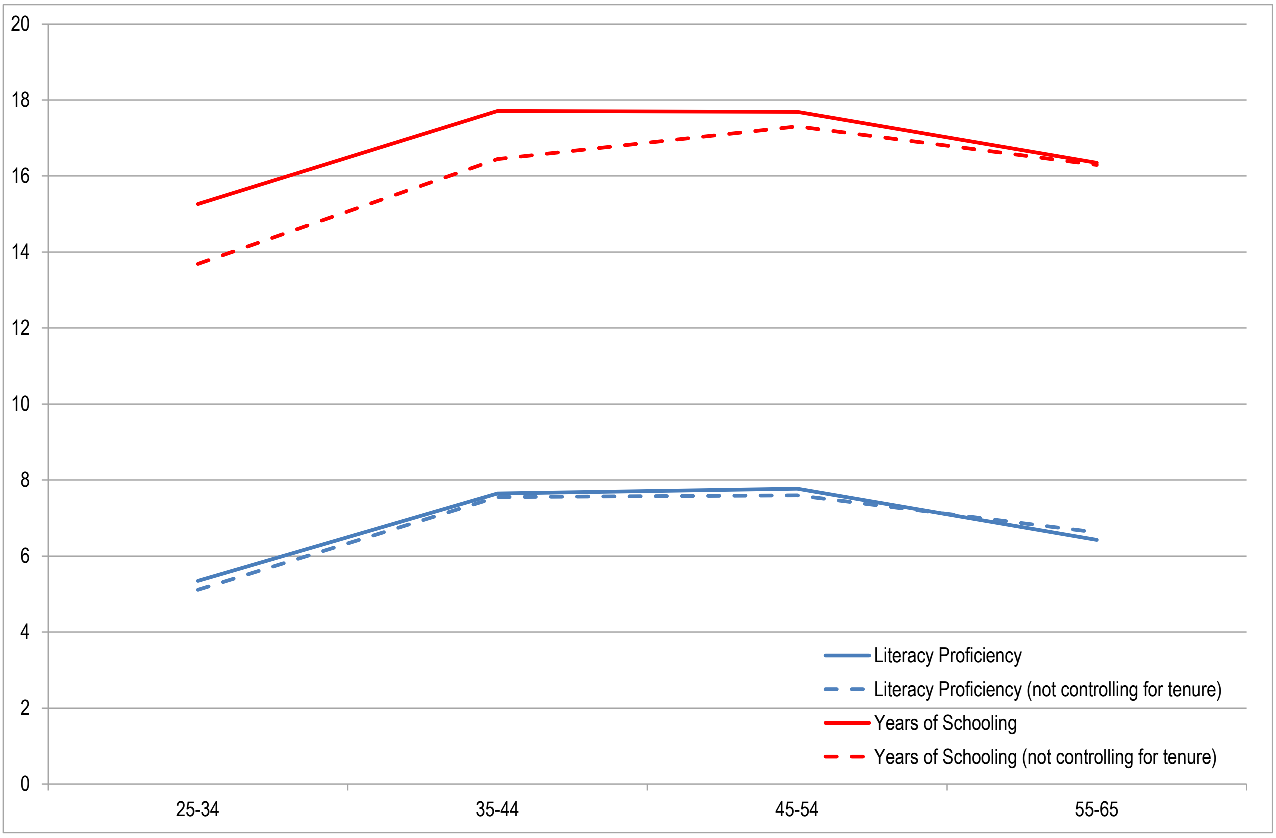
A related question is whether the importance of individual proficiency in information processing skills in determining wages increases relative to that of educational attainment with age. Altonj and Pierret (2001) were amongst the first to note that, in the United States, returns to skills increased with experience while, at the same time, returns to formal education decreased. This empirical finding is consistent with the theory put forward by Farber and Gibbons (1996), according to which employers make initial hiring decisions on the basis of easily observable signals of workers' productivity (such as educational qualification) but, as time goes by, employers get to know much more precisely the true productivity of workers (assumed to be determined more by skills than by a mere educational qualification). Broecke (2015) finds broad empirical support for this hypothesis (i.e., returns to proficiency increasing, and returns to education decreasing, with labour market experience) in a number of countries participating in PIAAC, although not in all of them.

Figure 11 presents the results of a similar exercise, which estimates the returns to education and proficiency by age, controlling, at the same time, for labour market experience.[8] The returns to literacy and to formal education follow almost exactly the same pattern, being highest for workers aged 35 to 54. For individuals aged 55 to 65 returns to proficiency and to education are not statistically different from the returns observed among people aged 25 to 34. Controlling or not for tenure does not change the results in a significant way. In should be noted that, contrary to Broecke (2015), the estimates presented in Figure 11 are based on a sample that excludes workers aged less than 25 years.[9] If it is true that most of the employer learning takes place in the first few years of the employment relationship, excluding individuals below 25 may result in missing out some of the effect predicted by the theory. Indeed, Hanushek et al. (2015) show that returns to proficiency increase strongly from age 16 to age 35, and then flatten out (see also OECD, 2014).

Figure 11. Age profiles of returns to proficiency and education



Note**:** Marginal effects from a one-standard deviation increase in literacy proficiency and years of schooling, from an OLS regression on log wages on interactions between age dummies and proficiency/education. The regression also controls for gender, part-time status and type of contract.

Source: Survey of Adult Skills (PIAAC) (2012).

Occupational outcomes and the use of skills at work

In addition to basic labour market outcomes such as employment and wages, the richness of the PIAAC background questionnaire makes it possible to analyse many other characteristics of the jobs of the survey's participants. Such an analysis is of particular interest, especially in the light of the recent economic literature that investigates the link between wage polarisation and wage inequality and the evolution of the demand for certain skills and certain tasks affected by worldwide trends such as globalisation and technological change. Autor, Levy and Murnane (2003) have shown that the share of non-routine analytic and interactive job tasks performed by American workers has increased steadily from the 1960s, while the share of routing cognitive and manual tasks (middle-skill jobs) declined, from a point roughly coincident with the introduction of computers and automation in the production process. Employment in ion-routine manual tasks, which are still difficult to be automated, stabilised in the 1990s. A similar polarisation of the occupational employment distribution has also been documented for European countries by Goos, Manning and Salomons (2009, 2014).

Both Autor and Dorn (2009) for the United States, and Bosch and ter Weel (2013) for the Netherlands, found that changes in the employment shares of different occupations are correlated with changes in the age structure within occupations. Shrinking occupations, occupations with a lower share of high-skilled workers, facing a higher threat of offshoring, and with a higher focus on routine-intensive tasks, are “getting old”. A likely explanation for this phenomenon is that, as workers age, mobility across occupations becomes more costly, partly because of higher investments in firm-specific human capital. If older workers get “trapped” into occupations that offer lower opportunities, negative consequences could arise in terms of lower job satisfaction and increasing incentives for retirement.

As PIAAC provides information on each respondent’s occupation (classified according to the International Standard Classification of Occupations - ISCO), it is possible to group occupations according to the level of proficiency presumably required in the job, distinguishing between skilled occupations (legislators, senior officials and managers, professionals, technician and associate professionals), semi-skilled with-collar occupations (clerks, service workers, shop and market sales workers), semi-skilled blue-collar occupations (skilled agricultural and fishery workers, craft and related trade workers, plant and machine operators and assemblers), and elementary occupations (cleaners and helpers, labourers in mining, construction and transport, food preparation assistants, refuse workers, street and related sales and service workers). Alternatively, it is possible to group occupations according to the average level of literacy and numeracy proficiency of their workers. Unsurprisingly, the two classifications overlap, but not perfectly. For instance, technicians and associate professionals have only next-to-highest average scores in literacy and numeracy, and most service workers fall in the category with lowest or next-to-lowest average proficiency.

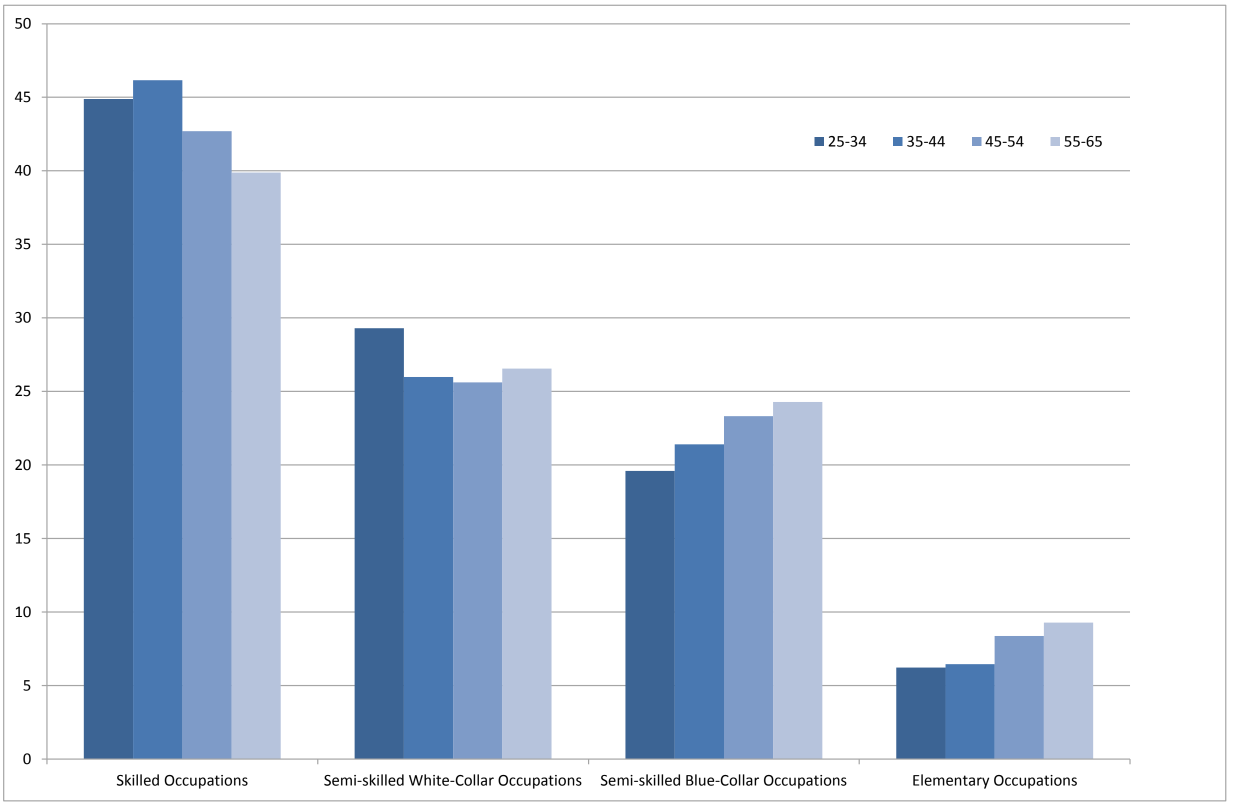
The cross-sectional nature of PIAAC does not allow tracking the relationship between changes in overall employment shares of an occupation and changes in its age structure, as in Autor and Dorn (2009) and Bosch and ter Weel (2013). We therefore limit ourselves to taking a snapshot of the age structure of different occupations, noting that the results of such analysis are likely to be plagued (especially for the oldest workers) by selection effects (in this case, individual decisions to stay or to quit the labour market).

Figure 12 displays, for three different age classes, the share of workers employed in four different occupational categories, where the classification of occupation is solely based on its ISCO code. Some 45% of workers aged 25 to 34 are employed in skilled occupations, compared to 40% of workers aged 55 to 65. The pattern is very similar if occupations are classified according to average levels of literacy proficiency. Almost 30% of adults aged 55 to 65 are employed in occupations with lowest average proficiency, compared with 22% of younger adults (25 to 34). As an indicator of skills level, the classification of occupation in terms of literacy proficiency is not independent of the proficiency of workers employed in these occupations. Consequently, the finding that older workers are more likely to work in less skilled occupations defined by literacy level might be mechanically driven by the fact that older workers have lower levels of proficiency. In any case, the fact that using either of the two classifications leads to the same overall picture can be seen as reassuring.

Once controls are included for years of education and literacy proficiency, the probability of working in a skilled occupation appears to increase strongly with age, as shown by Table 4. These results hold irrespective of the methodology used to classify occupations, and are consistent along the skill spectrum of occupations (i.e., the probability of working in elementary or semi-skilled occupations *decreases* with age).

For oldest workers (aged 55 to 65), the results are probably driven by the fact that adults in skilled or more rewarding occupations are less likely to quit the labour market than those in less rewarding jobs. However, the effect increases linearly with age, and is present (and non-negligible) even for workers aged 35 to 44, for which the issue of selection is certainly less relevant.

Figure 12. Share of workers, by occupational category



Source: Survey of Adult Skills (PIAAC) (2012).

Table 4. Marginal effects of age on the likelihood of being in a skilled occupation

Country	35-44	(s.e.)	45-54	(s.e.)	55-65	(s.e.)
Australia	3.8	(2.0)	5.5	(2.7)	8.5	(2.6)
Austria	4.2	(2.4)	6.3	(2.5)	5.2	(2.3)
Canada	6.7	(1.9)	5.1	(1.5)	5.6	(1.7)
Czech Republic	1.1	(2.8)	3.1	(3.3)	4.9	(2.6)
Germany	-1.1	(2.2)	2.6	(2.0)	3.1	(2.4)
Denmark	4.7	(2.0)	9.3	(1.9)	9.0	(1.7)
Estonia	2.8	(1.4)	-2.3	(1.6)	-3.6	(1.6)
Finland	7.4	(1.6)	10.4	(1.7)	13.4	(1.7)
France	6.8	(1.7)	12.6	(2.0)	16.5	(1.8)
Ireland	5.5	(1.9)	8.3	(2.2)	15.7	(2.2)
Italy	7.4	(2.0)	11.7	(2.2)	22.3	(2.4)
Japan	6.8	(2.2)	12.6	(2.1)	9.4	(2.5)
Korea	-0.5	(1.3)	3.8	(1.7)	7.6	(2.4)
Netherlands	3.9	(1.8)	7.6	(1.9)	10.3	(1.9)
Norway	9.9	(1.8)	10.1	(2.2)	17.7	(2.1)
Poland	7.8	(1.6)	9.6	(1.9)	15.5	(2.2)
Slovak Republic	4.3	(1.9)	7.0	(2.0)	5.7	(1.8)
Spain	0.0	(1.6)	4.7	(2.0)	10.3	(2.6)
Sweden	7.2	(2.1)	10.5	(2.3)	15.2	(2.4)
United States	5.4	(2.8)	11.1	(2.7)	11.2	(2.7)
Flanders (Belgium)	1.3	(2.0)	6.6	(1.8)	10.3	(2.1)
England/N. Ireland (UK)	6.0	(2.3)	3.5	(2.2)	6.4	(2.5)
Average	4.6	(0.4)	7.3	(0.5)	10.0	(0.5)

Note: The table shows the estimated marginal effect from a logit regression of the probability of being in a skilled occupation on literacy proficiency, years of education, age class and gender dummies. The omitted category consists of workers aged 25-34.

Source: Survey of Adult Skills (PIAAC) (2012).

As it collects information on the actual tasks workers perform on their job, the Survey of Adult Skills offers the means to describe the content of jobs in ways that to go beyond the broad characterisation of jobs at the occupation-level. Autor and Handel (2013) have recently shown the value of individual-level measures of job tasks. They find that the importance of analytical, routine and manual job tasks varies substantially also within occupations, and that this is related to robust predictors of wage difference among workers in the same occupation.

In the light of the evidence provided by Autor, Levy and Murnane (2003) and Autor and Price (2013) on the decline in the demand for jobs with routine tasks, it is of particular interest to look more closely at “routine jobs”. The decline in employment shares in these jobs is expected to continue in the foreseeable future, potentially putting workers currently employed in these jobs at higher risk of job loss. Furthermore, frequent performance of routine tasks is likely to negatively affect the ability of workers to develop – or maintain – high levels of information-processing skills.

In PIAAC, routine jobs can be identified through the answer to the question: “To what extent can you choose or change the sequence of your tasks?” Workers that answer “not at all” or “very little” are considered to be in routine jobs. On average, there are no large age differences in the probability of being in a routine job. The share of workers aged 25-44 years in routine jobs is 19% and rises to 21%, among workers aged 45 to 54 and 55 to 65. However, such (small) effects are entirely due to the fact that older workers have lower proficiency on average. After controlling for literacy proficiency and years of education, older workers are on average *less* likely to be in routine jobs, as shown by Table 5. Moreover, if further controls for occupations are added, any age differences become very small in scale, and, in most cases, are not statistically significant.

Table 5. Marginal effects of age on the likelihood of being in a routine job

Country	35-44	(s.e.)	45-54	(s.e.)	55-65	(s.e.)
Australia	5.4	(2.5)	2.5	(1.8)	1.3	(2.0)
Austria	-0.7	(1.6)	-1.8	(1.8)	-1.0	(2.2)
Canada	0.1	(1.8)	-1.0	(1.6)	-1.7	(1.7)
Czech Republic	3.0	(3.0)	4.5	(3.3)	3.1	(3.4)
Germany	-2.4	(2.1)	-0.2	(1.9)	-2.7	(2.1)
Denmark	-6.5	(1.7)	-4.9	(1.6)	-5.3	(1.8)
Estonia	2.0	(1.4)	6.1	(1.7)	8.3	(1.8)
Finland	-3.2	(1.7)	-3.4	(1.7)	-4.4	(1.7)
France	1.1	(2.0)	-4.5	(2.1)	-4.7	(2.3)
Ireland	-3.1	(2.7)	-6.2	(2.8)	-1.4	(3.1)
Italy	-0.6	(2.8)	-2.3	(3.2)	-9.2	(4.1)
Japan	-2.2	(1.4)	-1.9	(1.7)	-0.8	(1.6)
Korea	-3.8	(2.3)	-4.1	(2.1)	-11.4	(2.5)
Netherlands	-7.2	(2.0)	-5.2	(2.3)	-6.6	(2.3)
Norway	-5.9	(2.0)	-4.6	(2.2)	-3.5	(2.0)
Poland	-4.2	(2.4)	2.1	(2.3)	-3.9	(2.8)
Slovak Republic	-0.4	(2.7)	-0.7	(2.4)	4.8	(2.9)
Spain	-4.1	(2.6)	3.9	(2.7)	-4.4	(3.2)
Sweden	-2.7	(2.0)	-3.3	(1.8)	-3.2	(1.8)
United States	-4.9	(2.1)	-4.7	(1.9)	-4.4	(2.7)
Flanders (Belgium)	-2.8	(2.0)	-2.9	(2.0)	-7.4	(2.3)
England/N. Ireland (UK)	-3.7	(2.3)	-3.6	(2.5)	-1.6	(2.9)
Average	-2.1	(0.5)	-1.6	(0.5)	-2.7	(0.5)

Note: The table shows the estimated marginal effect from a logit regression of the probability of being in a routing job on literacy proficiency, years of education, age class and gender dummies. The omitted category consists of workers aged 25-34.

Source: Survey of Adult Skills (PIAAC) (2012).

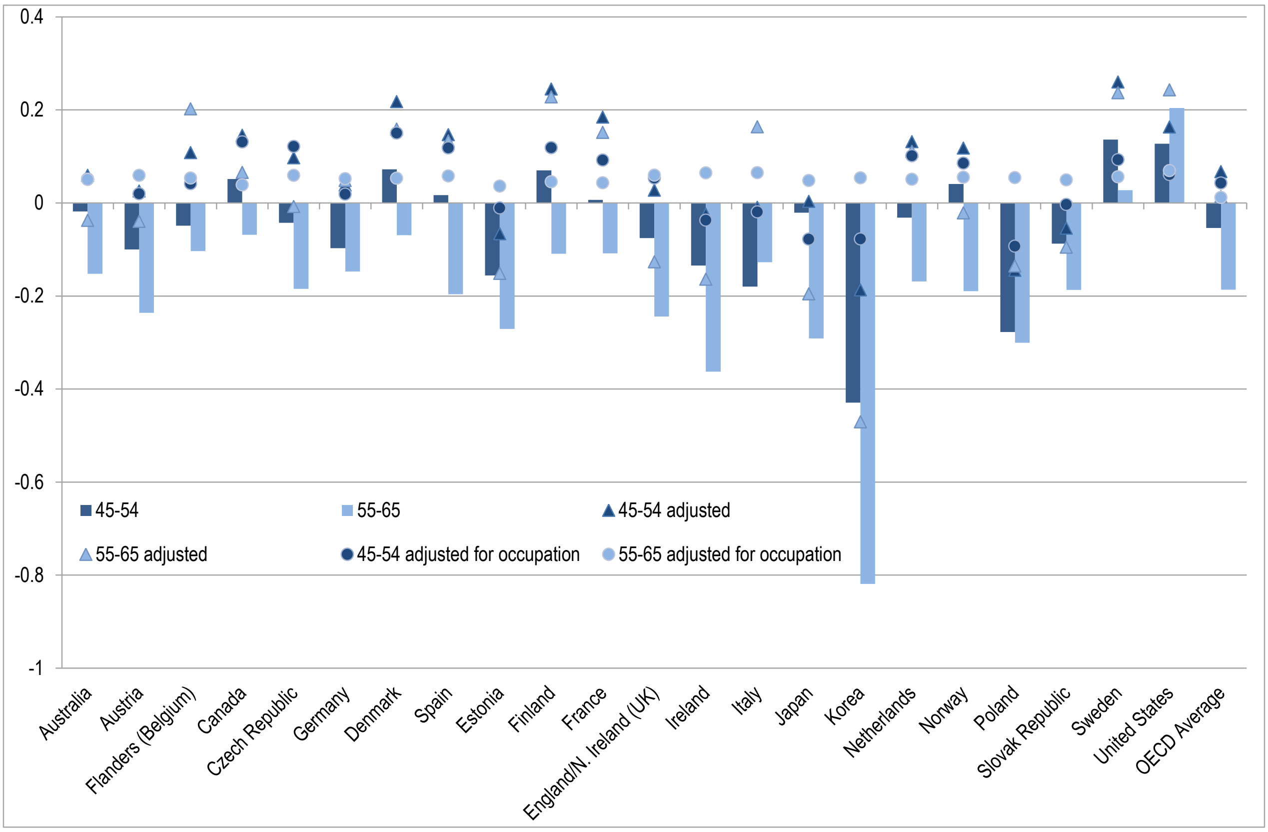
Information on the actual use of information-processing skills on the job is available from questions on the extent to which reading, writing, numeracy and ICT skills are used on the job.[10] Such direct measures of skills use are valuable if one wants to better understand the extent to which practicing skills at work helps in developing and maintaining proficiency. On the other hand, given that workers are sorted into occupations, and into tasks within occupations, based on their actual level of proficiency, disentangling the direction of causality between skills use and proficiency becomes extremely difficult.

Figures 13-16 show differences in the reported use of information-processing skills at work for workers aged 45-54 and 55-65 (for both age classes, the reference category consists of workers aged 25-34). Given that skills use indicators are standardised within countries (with a mean of zero and a standard deviation of one), the graphs report differences in terms of standard deviations.

The different pictures display a consistent pattern of the relationship between age and skills use. The bars report unadjusted differences in skills use. As can be seen, older workers make less use of information-processing skills at work than workers aged 25-34. Differences are larger for writing and numeracy skills (about 30% of a standard deviation on average across OECD countries), and are particularly pronounced in Korea, Japan, Estonia and Ireland. Only in Canada, the United States and the Nordic countries there is some evidence of older workers making a more intense use of information-processing skills than their younger peers.

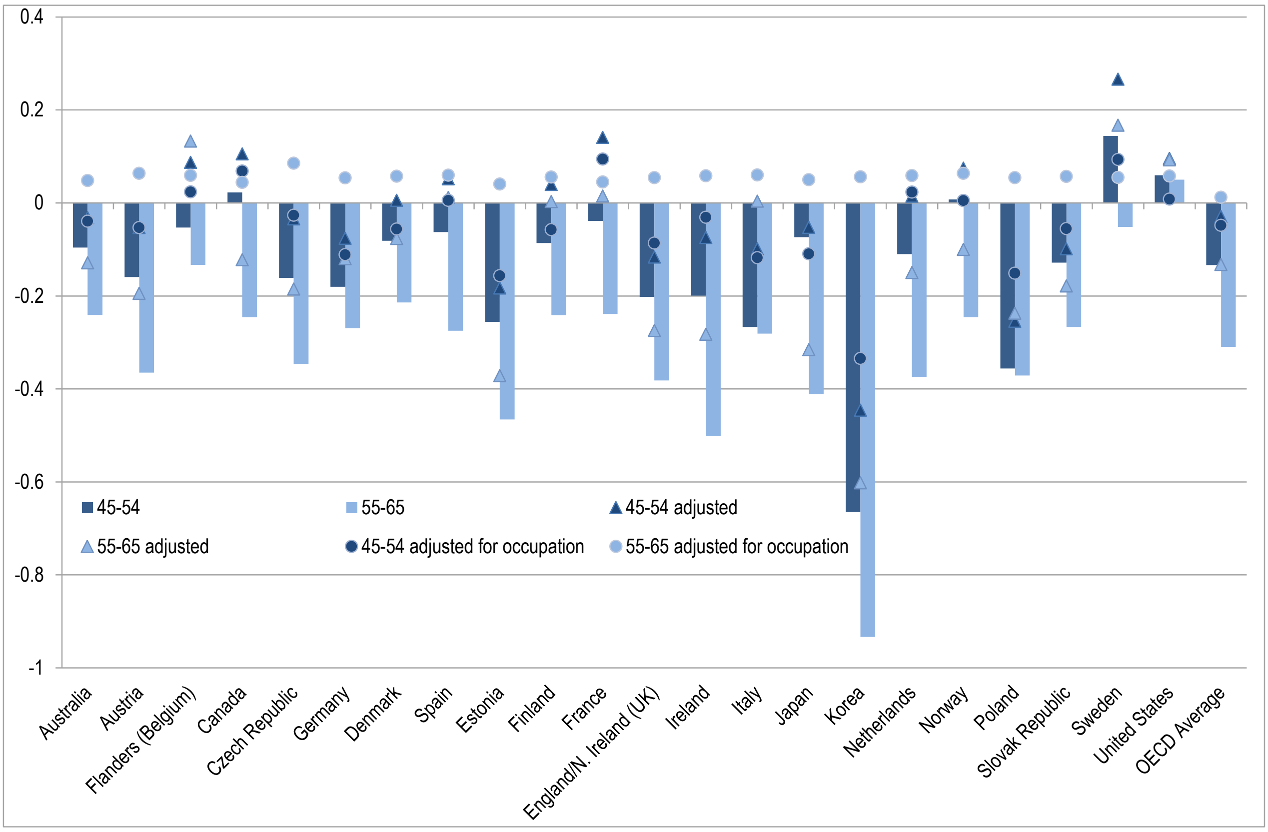
The gap in skills use is greatly reduced once controls are added for actual proficiency in literacy and years of education. In most countries, when proficiency and education are taken into account, workers aged 45 to 54 years actually use skills *more intensively* than workers aged 25 to 34. If one also controls for broad occupational categories (at the 1 digit level), a similar result is found for the oldest workers (aged 55 to 65).

Figure 13. Differences in the use of reading skills at work



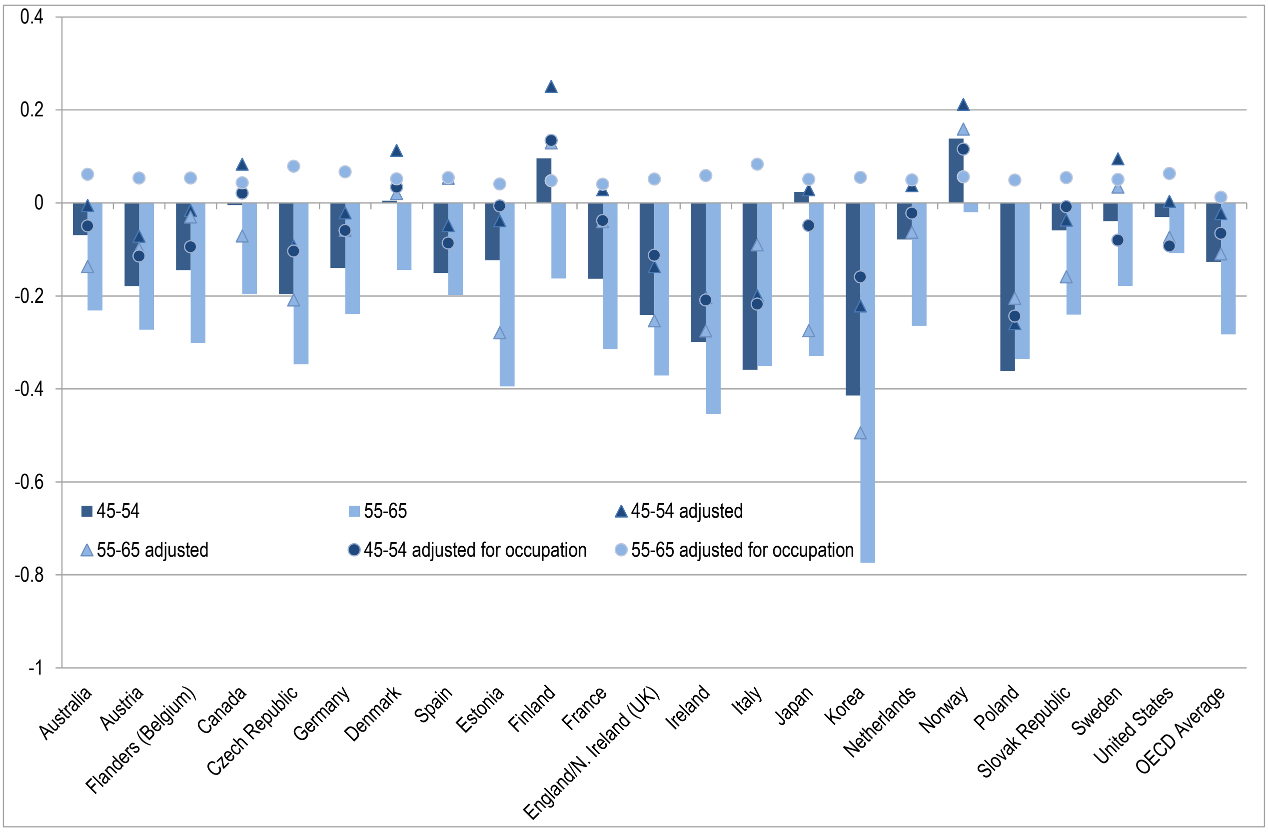
Source: Survey of Adult Skills (PIAAC) (2012).

Figure 14. Differences in the use of writing skills at work



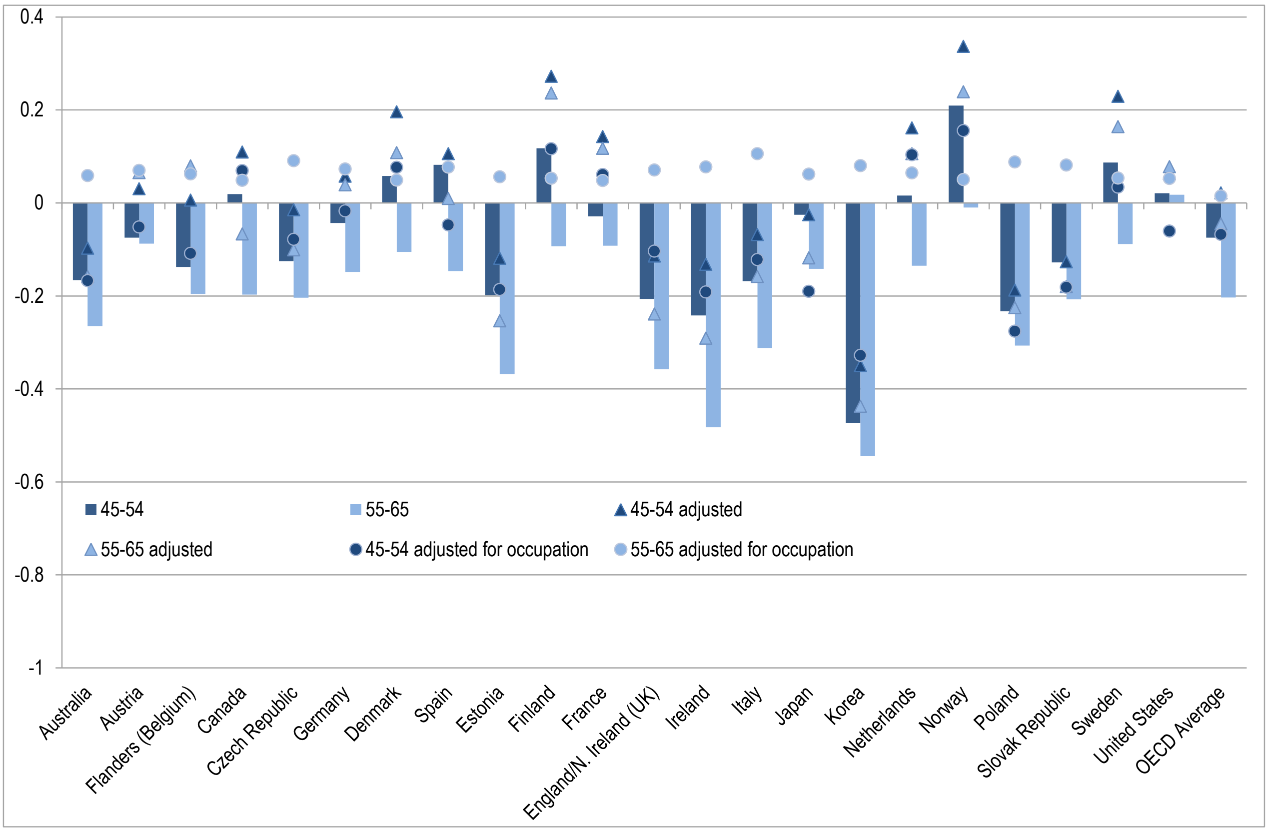
Source: Survey of Adult Skills (PIAAC) (2012).

Figure 15. Differences in the use of numeracy skills at work



Source: Survey of Adult Skills (PIAAC) (2012).

Figure 16. Difference in the use of ICT skills at work



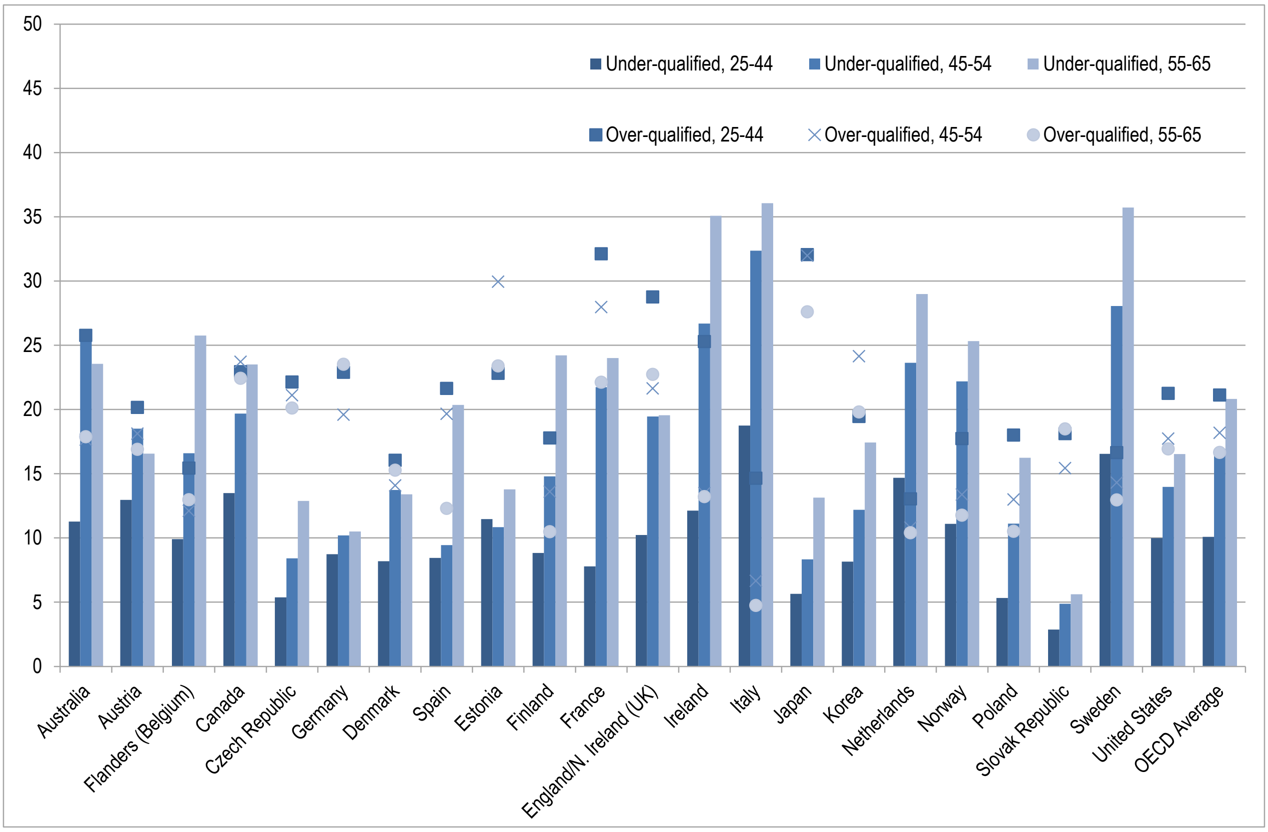
Source: Survey of Adult Skills (PIAAC) (2012).

Analysing the relationship between actual level of proficiency and skills use at work is tightly linked to the concept of mismatch (Quintini, 2011a, 2011b, 2014; Leuven and Oosterbeek, 2011). Mismatch can be broadly defined as a misalignment between what workers are able to do and what their position requires them to do. At the macroeconomic level, mismatch signals a sub-optimal allocation of workers to jobs, with possible negative consequence for aggregate productivity. At the individual level, mismatched workers can suffer from wage penalties and lower job satisfaction. More importantly for the purpose of the present paper, mismatch can be linked to insufficient level of training, or to insufficient practice of individuals' skills: both phenomena are likely to negatively affect the evolution of skills over the life-cycle.

Two dimensions of mismatch that can be measured in PIAAC are particularly relevant for the present study, namely qualification and skill mismatch.[11] Qualification mismatch is constructed by comparing the highest level of education of the respondent with his/her subjective assessment of what would be the level of education needed to get his/her job. Skills mismatch is constructed by combining information on self-reported skills mismatch, skills proficiency, and the actual skills content of individual occupations. After identifying workers who self-report being well-matched, the minimum and maximum skill levels required in a given occupation are identified by looking at actual proficiency of self-reported well-matched workers. Finally, workers are classified as under- or over-skilled if their proficiency falls below (or above) such minimum or maximum level.[12]

Figure 17 show that qualification mismatch is a rather pervasive phenomenon, involving approximately 30% of workers across OECD countries participating in PIAAC. The incidence of over-qualification tends to decline with age, while the incidence of under-qualification follows exactly the reverse pattern, being twice as large among 55-65 as among 25-44 years-old workers. Such a result is neither particularly surprising, nor particularly worrying, as it is reflects, to a large extent, the increase in the educational attainment of the workforce over the last 50 years and the corresponding upgrading of jobs requirements in terms of qualifications.[13] In other words, the fact that older workers are under-qualified does not necessarily imply that they do not possess the skills necessary to carry out their jobs.

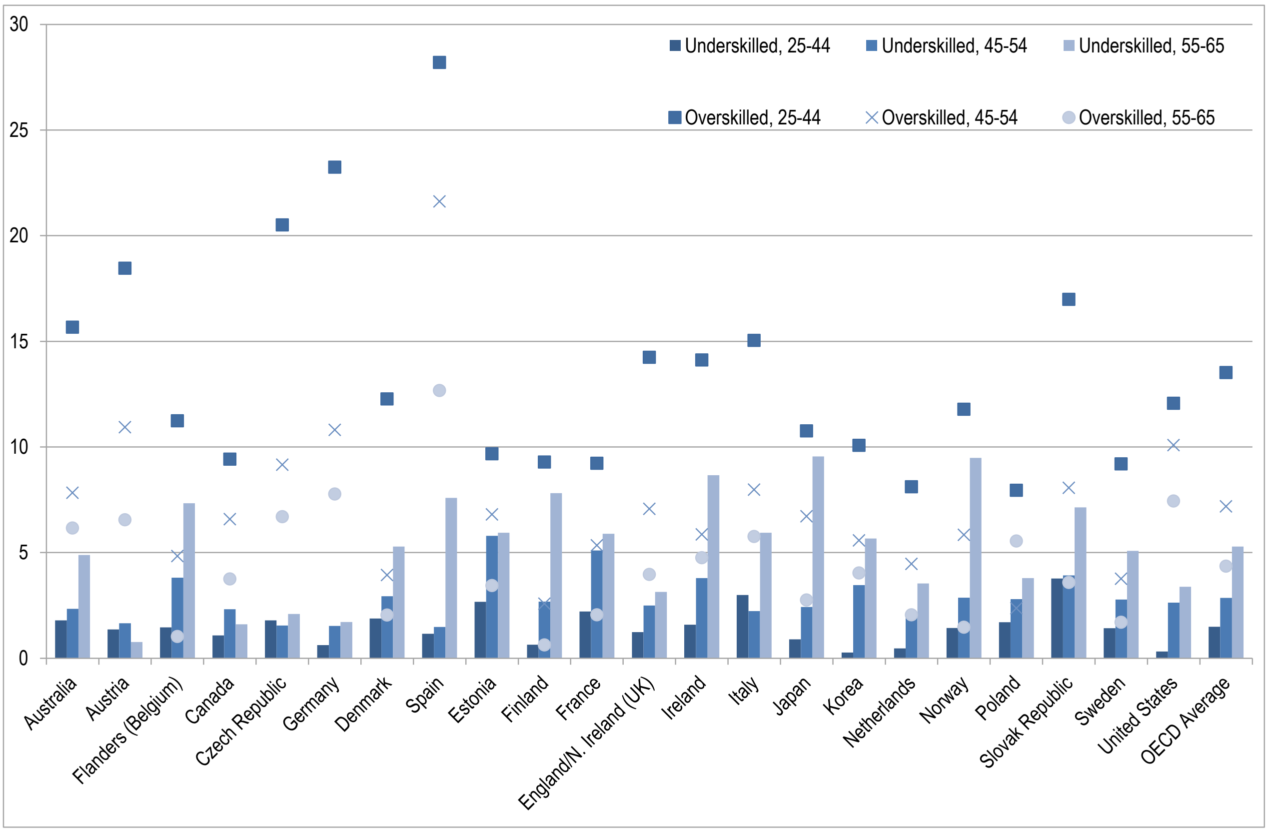
Figure 17. Qualification mismatch, by age class



Source: Survey of Adult Skills (PIAAC) (2012).

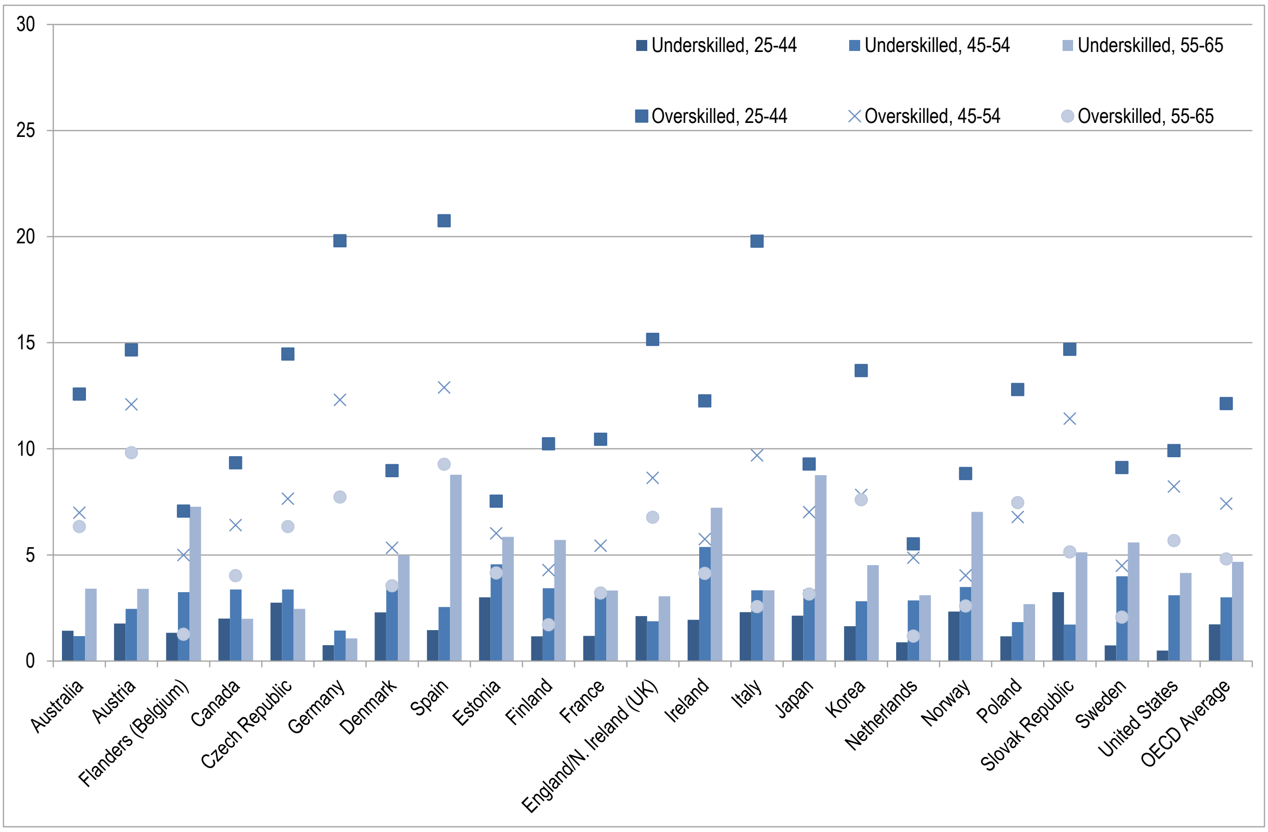
Figures 18 and 19 look instead at skills mismatch, in both literacy and numeracy (although there are no large differences across the two domains). Skills mismatch is a much less common phenomenon, involving on average approximately 15% of workers. As was the case for qualification mismatch, young workers are much more likely to be over-skilled, and older workers are much more likely to be under-skilled. This could in principle be read as evidence that a sizeable share of older workers do not have a sufficient level of proficiency to effectively perform on the job. This could signal inefficiencies, if under-skilled workers are able to keep their position because of employment protection legislation, or because they are more protected by the union. However, it should also be noted that, on average, in the oldest age class there are as many under-skilled as there are over-skilled workers, and that overall only 10% of workers are mismatched. Furthermore, it is also possible, as suggested by some literature cited in Box 2, that even under-skilled workers are not less productive than younger workers, and that they are able to use other skills to partly compensate for their lack of information-processing skills.

Figure 18. Skills mismatch in literacy, by age class



Source: Survey of Adult Skills (PIAAC) (2012).

Figure 19. Skills mismatch in numeracy, by age class



Source: Survey of Adult Skills (PIAAC) (2012).

Conclusions

This chapter analysed in detail the relationship between skills proficiency, age, and individual outcomes, focussing, in particular, on the labour market. We first noted how the proficiency-age profile is broadly consistent with participation of individuals in formal education: apparently, skills proficiency is mainly built up in schools, and starts to decline a few years after people have entered the labour market.

Proficiency in information processing skills has strong positive effects on employability and earnings. It is not easy to discern whether such effects change as people age, but there is some evidence that the impact of proficiency on employability is stronger for older adults.

In spite of the fact that older individuals are on average less proficient than their younger counterparts, they don’t seem to suffer in terms of labour market outcomes. In particular, older workers generally earn much higher wages, and much of the available empirical evidence suggests that they are not less productive than younger workers. Older and more experienced individuals seem therefore quite able to compensate the decline in information processing skills with the development of other skills.

Also, when looking at more qualitative labour market outcomes, such as the type of job and the use of skills at work, older workers do not seem to be in a position of particular disadvantage. It is true that older workers are generally over-represented in “routine” jobs (thus facing higher risks of displacement because technological innovation and advances in automation), and tend to make lower use of their skills in the workplace (which could contribute to faster decline, according to the popular “use-it-or-lose-it” hypothesis). However, such disadvantages are fully explained by lower levels of actual proficiency and education, suggesting the importance of investments aimed at raising proficiency levels of older individuals. The higher prevalence of skills mismatch (and of under-skilling in particular) among older workers further points towards the need to invest in training, in order to close existing skills deficits.

Notes

[7] Firms in principle could be reluctant to invest in the generic skills of their employees: such investments increase the market value of the workers, who could then have an incentive to move elsewhere, in which case the firm would not reap the benefits of the investment.

[8] The raw correlation between age and labour market experience is close to 90%.

[9] Mainly for consistency with the analysis carried out in the rest of this report.

[10] We refer to Quintini (2014) for a more detailed description of how such indices are constructed. In short, Cronbach's Alpha is used to summarize the information contained in more than one item into one single item, which is then standardised within each country, so that it has zero mean and unitary standard deviation.

[11] The other dimension is field-of-study mismatch, extensively analyzed in Montt (2015).

[12] The procedure and its theoretical underpinnings are extensively discussed in Pellizzari and Fichen (2013).

[13] Respondents are asked about the *current* required qualification, not about the qualification required at the time they got the job.

4. HOW TO TACKLE AGE-RELATED DECLINE

Introduction

Previous chapters have focused on age differences in proficiencies and in labour market outcomes. In this final chapter, some of the possible determinants of the observed age-related decline in proficiency are explored, as well as possible policy responses.

Following the economic and psychological literature, the analysis will focus on three broad groups of factors that could be reasonably linked to the evolution of cognitive proficiency over the life course: education, training and human resource management inside enterprises, the use of literacy and numeracy skills outside work, retirement policies and labour market structures. These factors relate to what happens before entry in the labour market (education), what happens within the firm, or more broadly in the context of individuals' careers (training and human resource management), somehow "external" macroeconomic policies (notably concerning retirement), and what happens outside the labour market (skills practicing outside work).

The four groups of factors are discussed separately to simplify the exposition. In fact, the effects of these factors on the evolution of proficiency over the life-cycle are not independent and are likely to interact in many different ways. For instance, the effect of education on proficiency could work through higher chances of participating in the labour market, greater exposure to training on-the-job, or the greater intensity of the use of relevant skills outside work. The propensity to undertake training is likely to be influenced also by expected age of retirement, and the decision to retire can be influenced by prior training and education experience. The following analysis will not try to disentangle all the interactions between these different factors.

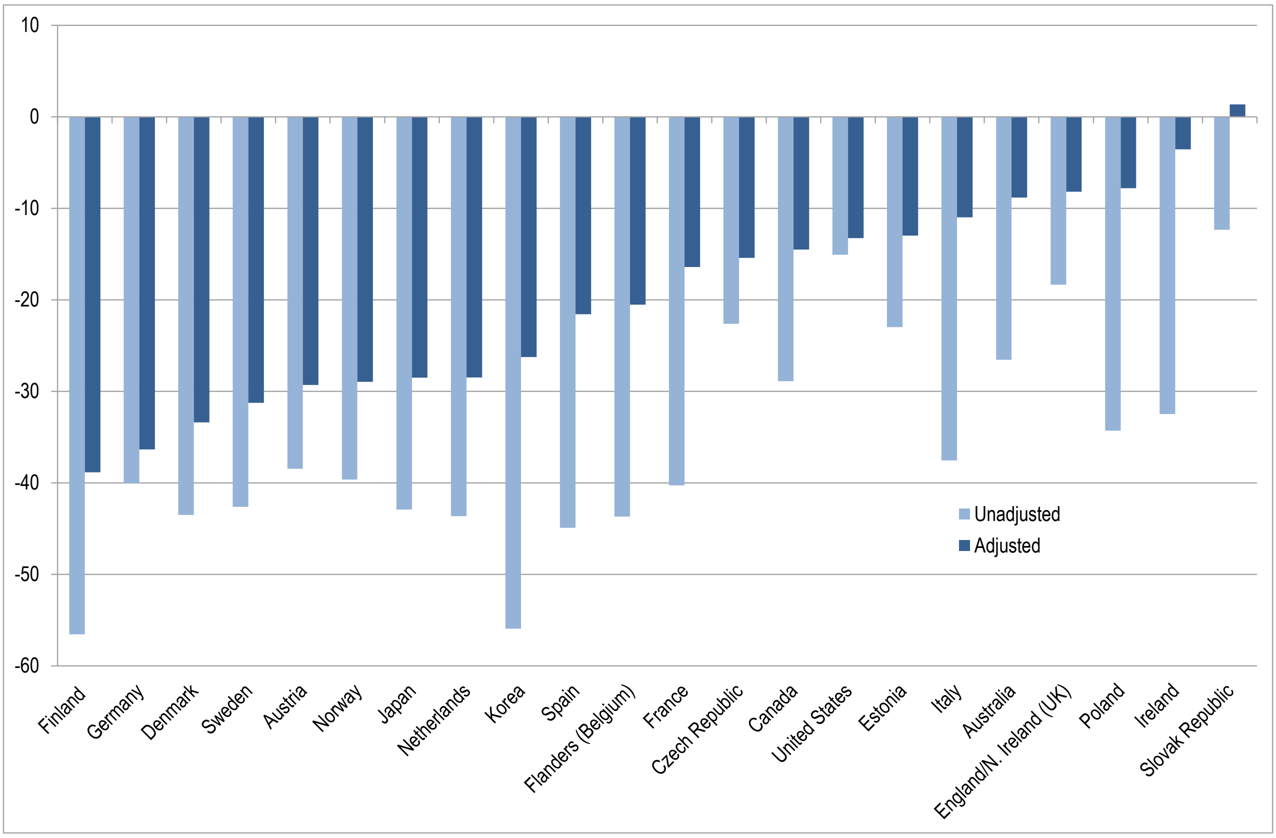
A common finding of the literature discussed in Box 1 is that individual patterns of cognitive decline vary substantially depending on biological, behavioural, environmental and social influences (Hertzog et al., 2008). Moreover, there is also significant variation across countries in the magnitude of age differences in proficiency, as shown in Figure 4. Unadjusted differences in proficiency between 25-44 and 45-65 year-old individuals range from 10 points in the United States to more than 35 score points in Finland, while adjusted differences are below five score points in Poland and in the Slovak Republic and around 20 points in Finland and Germany. The existence of relatively large cross-country differences in the age profile of proficiency (or better, in the magnitude of age differences between younger and older adults) suggests that policies can play a role in this respect, as recently argued by Skirbekk, Bordone and Weber (2014).

In almost all countries, proficiency in literacy and numeracy proficiency peaks at around the age of 30 years, and then gradually declines. In order to better capture the decline between the peak and the trough of the age-skill profile, this chapter will focus on narrower age groups, taking the difference in literacy proficiency between individuals aged 25-29 and 60-65 (restricting the sample to native-born individuals above 25 years) as the baseline measure of age-related decline in proficiency in each country.

Measured this way, age differences range from 12 points in the Slovak Republic to 57 points in Finland (with an average of 36; see Figure 20). After adjusting for years of education and parental educational attainment, the average is 20 score points, with a minimum of 4 in Ireland (not statistically significant) and a maximum of 39 in Finland. The Slovak Republic is the only country with an estimated positive difference (1 point), although not statistically different from zero. In relative terms, scores in literacy for the oldest age group are 7.4% lower than for the 25-29 year-old age group. The cross-country correlation between adjusted and unadjusted differences is high, at 75%. However, in some countries the adjustment does make an important difference to the relative rankings, most notably in Korea, Canada, Italy, Poland, and Ireland. In Finland the effect is large, but it does not change its position in the ranking.

Table 2 showed that, for countries that participated in both IALS and PIAAC, controlling for education in the cross-sectional data may lead to underestimation of the true age effect, since older cohorts are generally less educated but more proficient (a finding consistent with Green and Riddell, 2013). In order to maximise the coverage of different countries, this chapter will focus on the 24 countries in PIAAC, and will, in most cases, treat unadjusted differences as a proxy for age effects.[14]

Figure 20. Adjusted and unadjusted differences in literacy proficiency: 60-65 vs 25-29 years old



Source: Survey of Adult Skills (PIAAC) (2012).

Education

The positive relationship between proficiency and educational attainment (also found in similar surveys) should be of no surprise. However, establishing a causal effect from education to proficiency is much more complex, due to the fact that unobservable factors (e.g., innate ability) are likely to drive both proficiency and the choice to acquire more education.

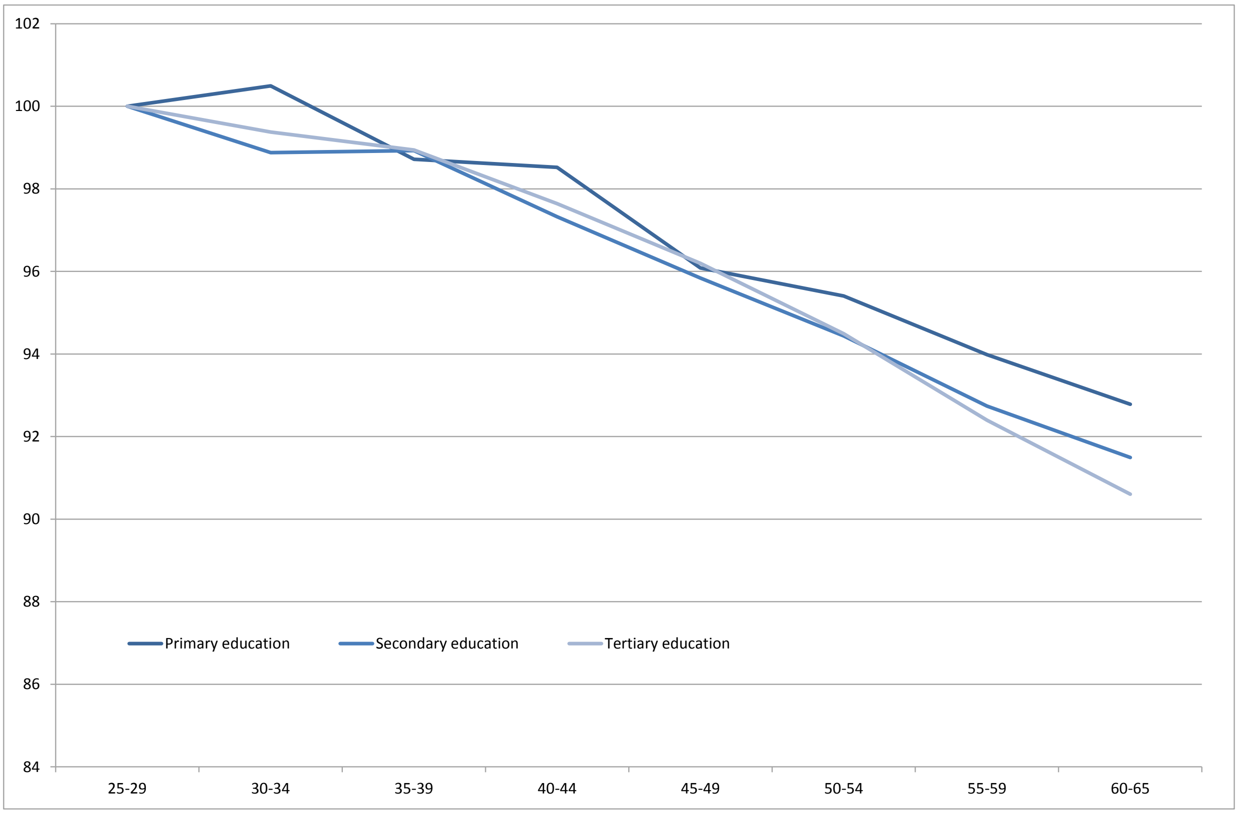
A relevant question in the context of the present paper is whether the positive effect of education on proficiency is present at all stages of the life-cycle; or, put it differently, whether education not only helps in increasing the level of proficiency at some point in time, but also plays a role in somehow preventing proficiency decline as people age.

Glymour et al. (2008) and Banks and Mazzonna (2012) have been able to establish a causal link between schooling and cognitive abilities at old age. The focus of those papers is on the *level* of cognitive ability, rather than on its *rate of change*. Schneeweis, Skirbekk and Winter-Ebmer (2014) find some evidence for a protective effect of schooling on cognitive decline in terms of verbal fluency. De Grip et al. (2008) also find that higher levels of education are associated with slower cognitive decline, while Glymour, Tzourio and Dufoil (2012) and Piccinin et al. (2012) conclude that the association between education and cognitive changes is "small, domain-specific and potentially incorrectly estimated".

The measures of cognitive ability examined in these studies mainly relate to memory and verbal fluency and, thus, may not be directly comparable with broader measures of proficiency as measured in PIAAC. At the same time, the cross-sectional nature of PIAAC does not allow to rigorously estimating the causal effect of education on the individual evolution of proficiency over time.

When analysing (at the country level) the evolution of proficiency with age by highest level of educational attainment (primary, secondary, or at least tertiary) using PIAAC data, similar profiles are observed in most countries. To take into account initial difference in proficiency levels between individuals with different levels of education, we look at relative changes over time. Interestingly, a larger decline in proficiency is observed among individuals with more schooling experience, if anything. This is seen in Figure 21, which plots the evolution of literacy proficiency by highest level of educational attainment, setting equal to 100 all proficiency scores for individuals aged 25-29.

Figure 21. Evolution of literacy proficiency by educational attainment

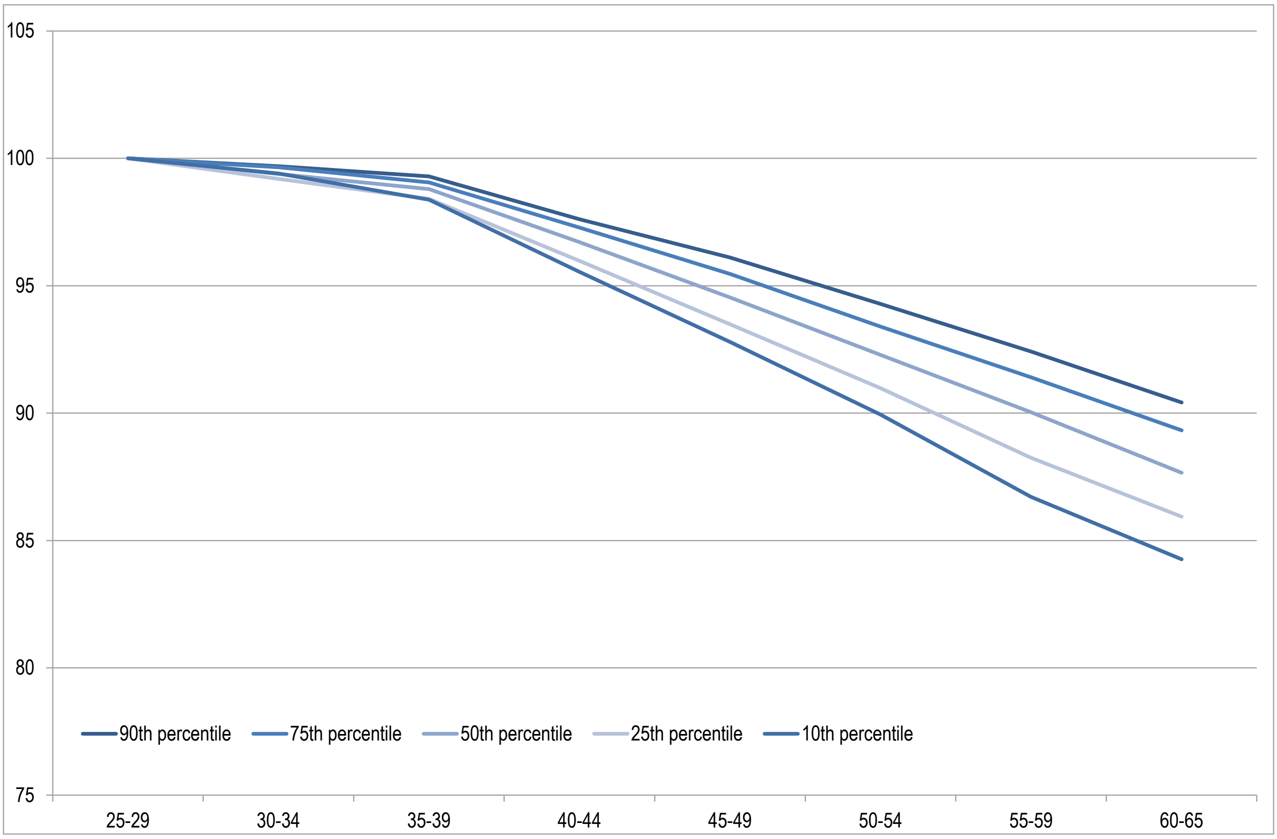


Source: Survey of Adult Skills (PIAAC) (2012).

This simple analysis ignores cohort differences in quality of schooling. A different approach consists of dividing the sample by individuals' position in the proficiency distribution for a given age group, rather than by educational attainment. The assumption made is that, within their cohort, people do not change their position in the proficiency ranking.[15] It should also be acknowledged that this approach does not control for differences in the composition of different age groups. Widespread increases in educational attainment, for instance, could shift the entire distribution of proficiency. Comparing different percentiles of the proficiency distribution across different age groups thus does not allow isolating in any way a "pure" ageing effect.

Figure 22 presents different percentiles of the distribution of literacy proficiency across different age groups. Age differences in proficiency are much larger at the bottom than at the top of the distribution, suggesting that more able individuals experience lower proficiency declines as they age. This is further indication that, while schooling certainly contributes to increase proficiency, the overlapping between schooling and proficiency is far from perfect: in order to have a positive effect on the subsequent evolution of proficiency, countries should therefore invest primarily in the quality of their educational systems, ensuring that people leave formal education with the highest possible level of proficiency.

Figure 22. Evolution of different percentiles of the distribution of literacy proficiency

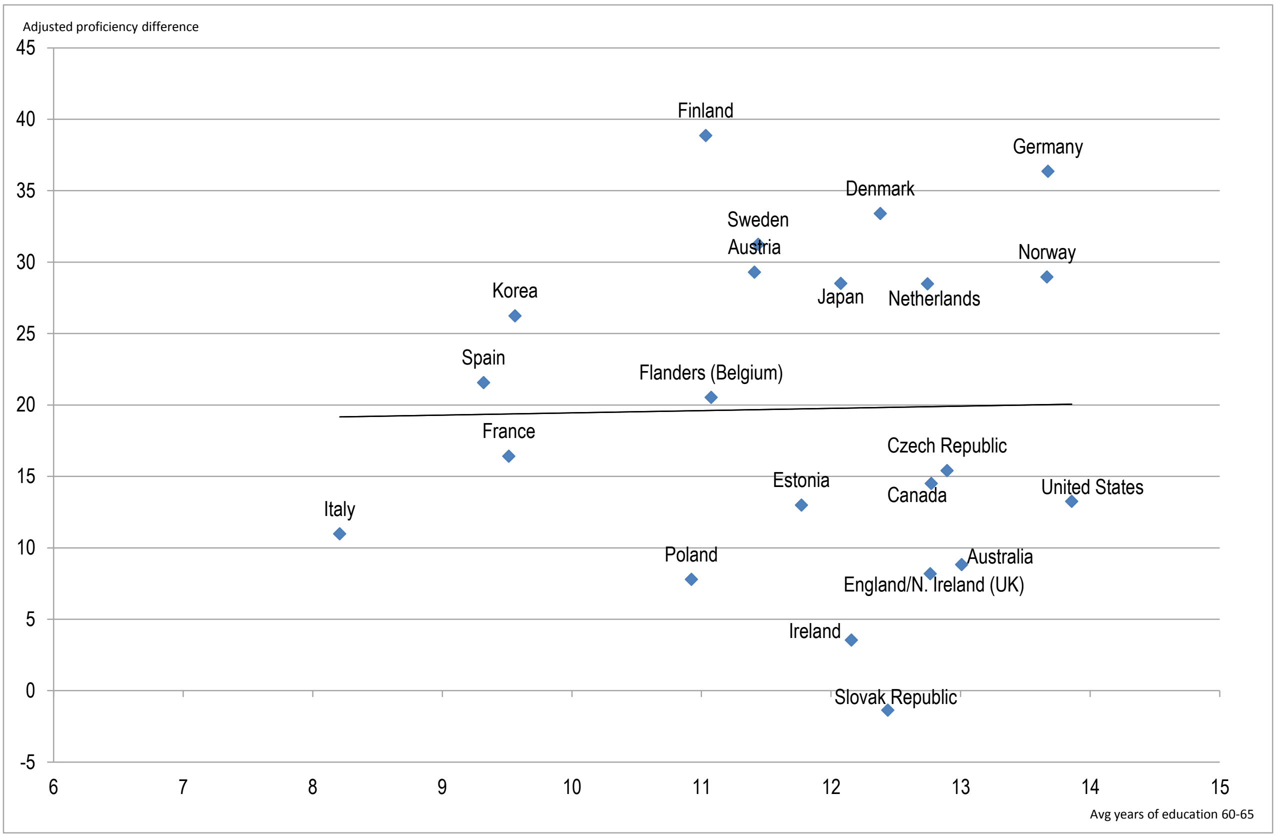


Source: Survey of Adult Skills (PIAAC) (2012).

Another way to look at the relationship between education and age-differences in proficiency is to exploit the large amount of variation at the country level, both in terms of age differences (as explained above) and in terms of levels of educational attainment. To do so, we examine the association between a country's average level of educational attainment (or literacy proficiency) and age-differences in proficiency. The choice of the measure of age-related decline (whether adjusted or unadjusted differences) has a strong impact on the results. Adjusted differences are virtually uncorrelated with average years of education (both computed on the entire population aged 25+ and on the restricted sample of individuals aged 60-65), but this result might be driven by the fact that adjusted differences are computed *controlling for education* (although the adjustment is performed within countries). Adjusted differences, on the contrary, are strongly positively correlated with average level of literacy proficiency in the overall population aged 25+ (with a correlation coefficient of 0.4), and mildly negatively correlated (with a correlation coefficient of -0.1) with average level of proficiency among 60-65 year-old individuals.

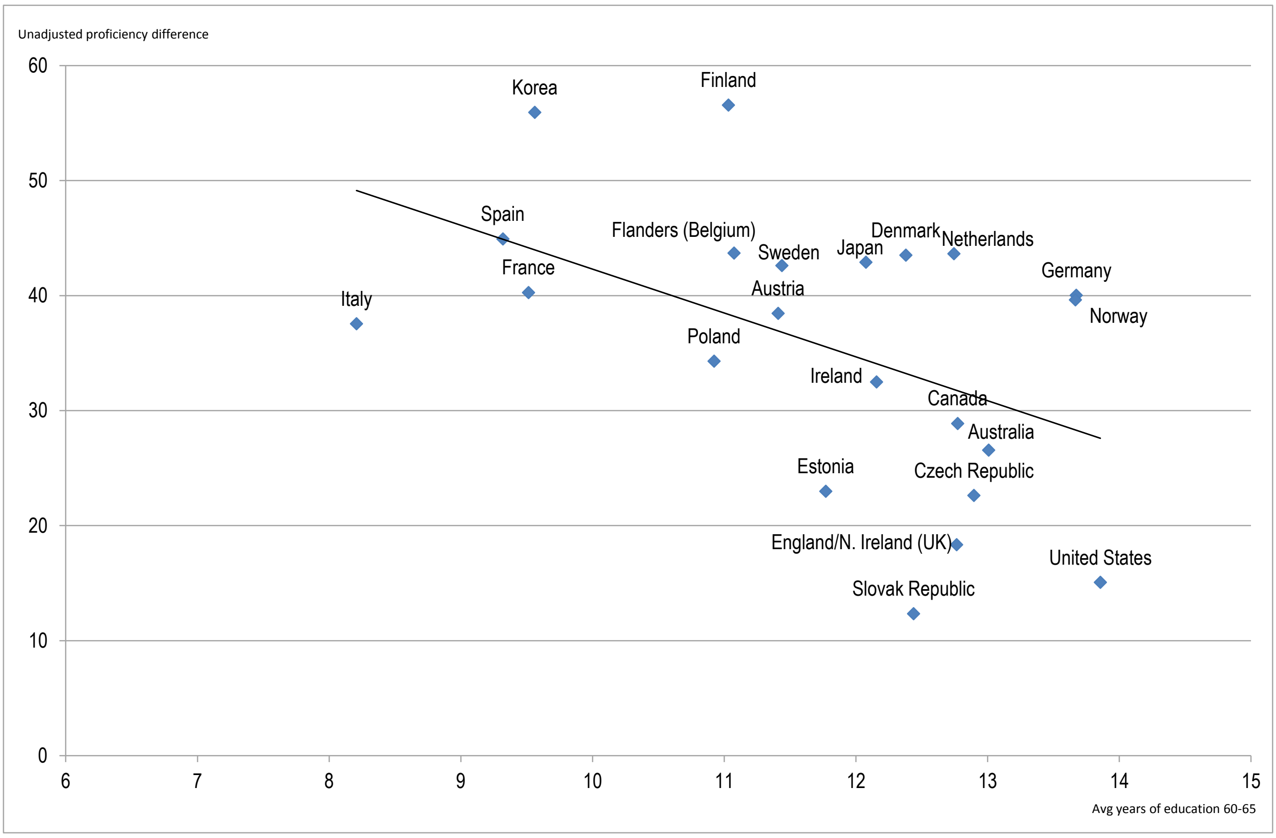
On the other hand, unadjusted differences are strongly negatively correlated with average years of schooling, both in the entire population (-0.3) and among the oldest individuals (-0.5). The correlation with average overall proficiency is very small, while that with proficiency of the oldest group is (mechanically) quite large, at -0.5. Figures 23 and 24 summarise the main results of this analysis.

Figure 23. Adjusted proficiency differences and education of 60-65 years old



Source: Survey of Adult Skills (PIAAC) (2012).

Figure 24. Unadjusted proficiency differences and education of 60-65 years old



Source: Survey of Adult Skills (PIAAC) (2012).

Workplace training and the skill content of the job

The process of human capital accumulation does not end with schooling and formal education. The fast pace of technological change require individuals to continuously update their knowledge and competencies, suggesting an increasingly important role for life-long learning and training, particularly on the workplace. A strand of research suggests that cognitive skills are malleable also in adulthood (OECD, 2007), and that individual behaviours and personal engagement in the continuous practicing of skills can be effective in combating the deterioration of skills during the life course, thus contributing to "successful ageing" (Reder, 1994).

In this respect, PIAAC contain information on participation in adult education and training (mostly for job-related reasons), and the extent to which workers use their skills in the workplace. Both factors should, in principle, contribute to slow down the decline of proficiency over time.

Numerous studies, often based on longitudinal datasets, have documented the positive impact of training (most commonly in the form of workplace or on-the-job training) on individual labour market outcomes (in terms of wages and job security) and productivity at the firm level (OECD, 2004). Training is often advocated as the appropriate policy response to cope with an increasingly rapid pace of technological change. Policy attention is also justified on the ground that training is characterised by market failures, which call for government intervention to compensate possible under provision of training (see Bassanini et al., 2007, for a comprehensive discussion of these issues).

Such arguments should be even more pertinent in the case of older workers. Given the long period during which they have been out of formal education and the likely decline in cognitive ability caused by the passing of time, older workers should be the ones most in need of training and of an updating of their knowledge and skills. However, the propensity to undertake training systematically declines with age. Behagel and Green (2010) find that older workers in low-skilled occupations are strongly penalised in terms of training opportunities when firms implement advanced information technology, while age does not seem to matter in high-skilled occupations. Behagel, Caroli and Roger (2014) conclude that training has a positive impact on the employability of older workers, although it is not fully capable to close the age bias associated with new technologies and innovative work practices.

Picchio (2015) identifies three types of barriers that could discourage older workers from undertaking training. Economic barriers stem from the fact that the decision to participate in training (and, for firms, the decision to offer training opportunities) is driven by a comparison of costs and expected benefits. Participation of older adults is therefore discouraged, because of the relative shorter period of time over which the benefits can be realised.

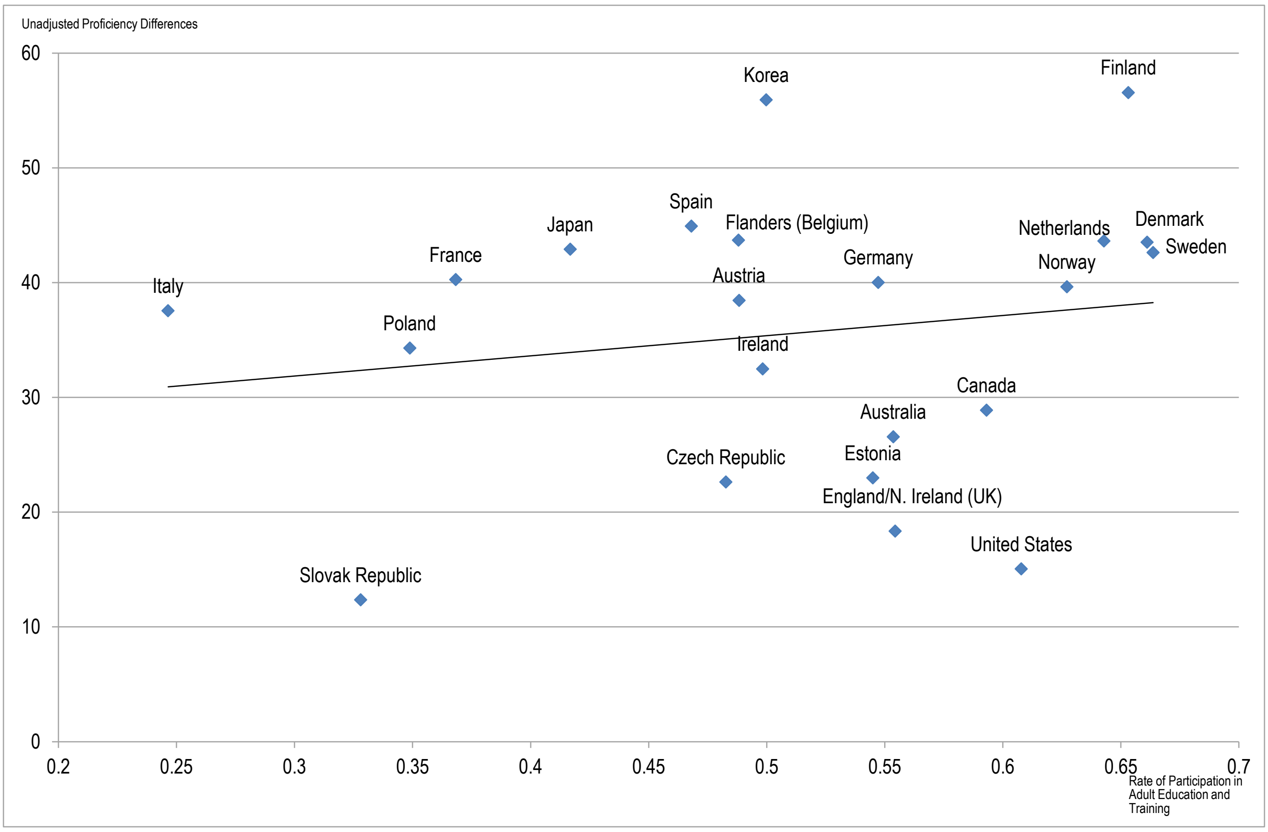
Attitudinal barriers have to do with negative stereotypes or incorrect beliefs about the effectiveness of training older workers. Such beliefs concern both employers and employees. Many studies have found training to be less effective for older workers (Kubeck et al., 1996; Charness and Czaja, 2006; Zwick, 2011). However, this result is probably driven largely by the fact that older workers have different learning styles: when training (and more generally personnel measures and workplace practices) are adapted to the specific need of older workers, they yields more benefits in terms of improved learning and productivity (Göbel and Zwick, 2013; Zwick, 2011; Picchio and van Ours, 2013).

Institutional barriers can reinforce negative stereotypes by setting procedures and practices that do not meet the specific needs of older workers. These include, for instance, the length of training courses, or the strictness of job-search requirements (in the case of programs targeted to job seekers).

Participation rates in adult education and training vary considerably across countries that participated in the Survey of Adult Skills, exceeding 60% in the Nordic countries and in the Netherlands, and being below 30% in Italy. In all countries, chances of participating in training are much higher for more proficient individuals, suggesting the existence of a virtuous cycle for the adults with high proficiency, and of a vicious cycle for the less proficient (OECD, 2013a).

Higher overall participation in adult education and training, while being positively correlated with average overall proficiency, does not seem to be effective in reducing the age-related decline in proficiency. Figure 25 in fact shows that the countries in which participation in training is more widespread are also characterised by large differences in proficiency between younger and older adults. The correlation is even stronger if proficiency differences are adjusted for educational attainment and parental education, with the correlation coefficient rising from 0.17 to 0.54

Figure 25. Age differences in proficiency and participation in adult education and training

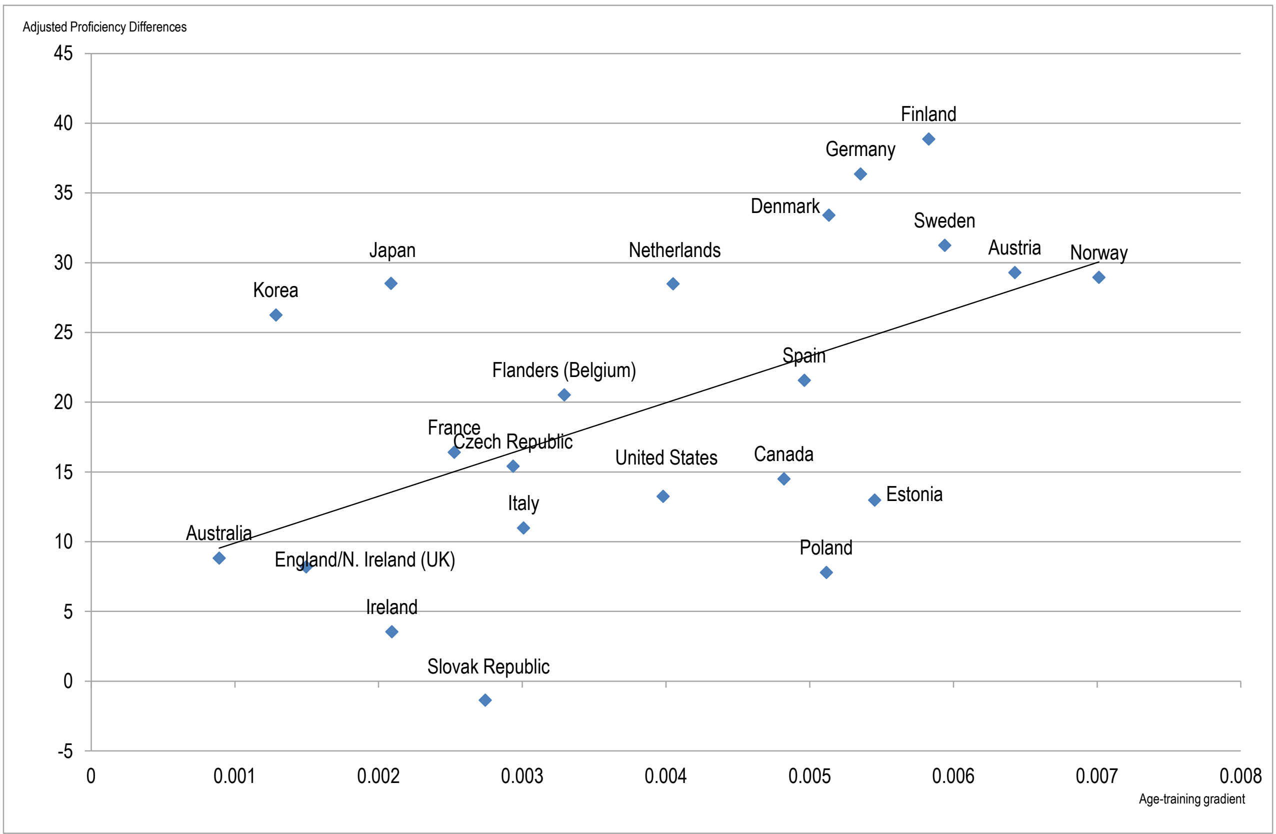


Source: Survey of Adult Skills (PIAAC) (2012).

The main explanation for this apparently counter-intuitive result lies in the fact that countries with high rate of participation in adult education and training are also the countries in which there are the largest gaps in training participation between younger and older adults. When the probability to undertake training is adjusted for observable characteristics such as gender, education, literacy proficiency, occupation and employment status, the coefficient associated with age (which measure the degree to which the likelihood of participate in training declines with age) presents a strong and positive association with (adjusted) age differences in literacy proficiency (correlation coefficient of 0.53), as shown in Figure 26. Such an adjustment is necessary to correct for the fact that proficiency increases the likelihood of participating in training, making particularly difficult to disentangling the direction of causality in this case.[16]

Although PIAAC does not allow estimating the amount of training that an individual has taken in the years prior to the survey, these results point towards the importance for training to be really “life-long”. In order to prevent the decline in proficiency associated with aging, training should be a continuous activity, and particular efforts should be made in order to increase participation in learning and training activities of older adults.

Figure 26. Age differences in proficiency and the age-training gradient



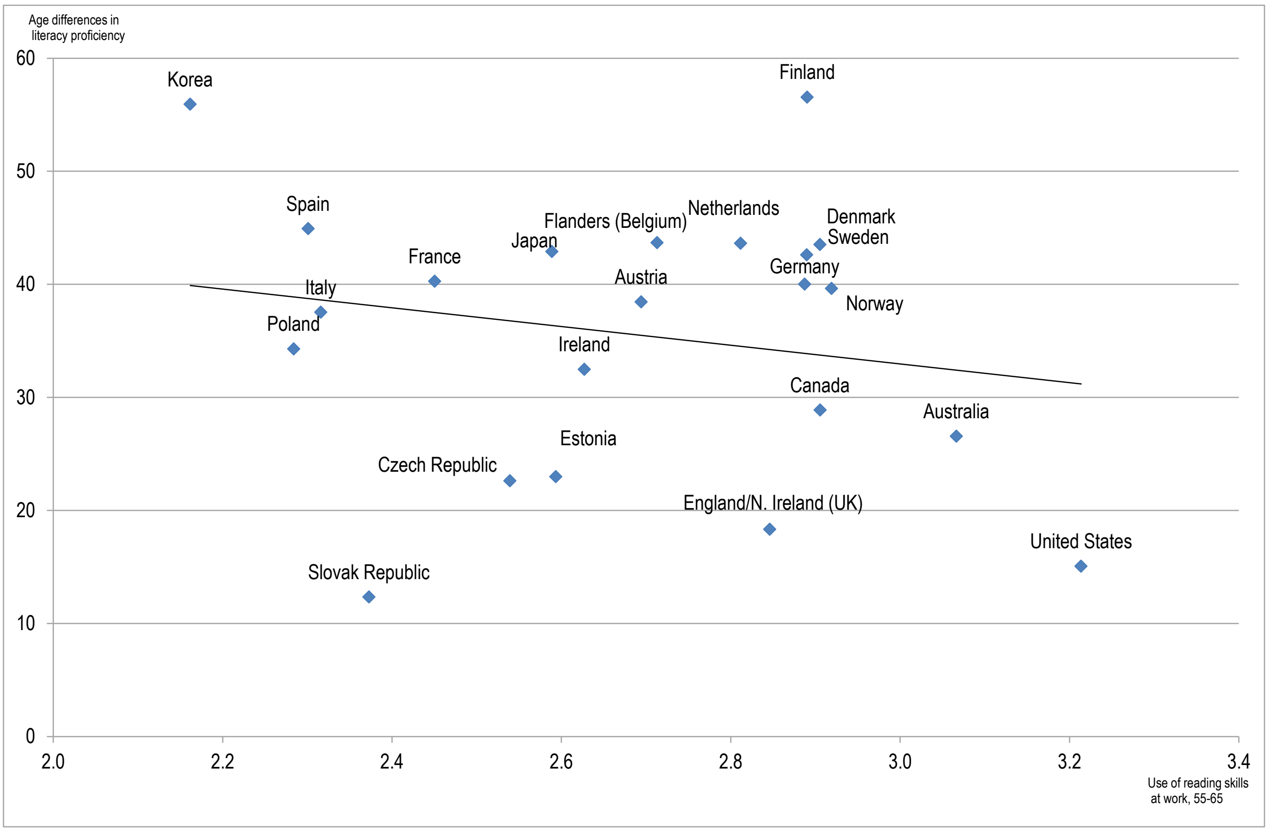
Notes**:** The age-training gradient is estimated through a linear regression of the probability of undertaking training on age. The estimated coefficient is then multiplied by -1, so that in the graphs countries with a higher age-training gradient are countries in which the probability of undertaking training declines more strongly with age. The regression also controls for years of schooling, literacy proficiency, gender, and occupation dummies.

Source: Survey of Adult Skills (PIAAC) (2012).

Looking at the frequency with which skills are used in the workplace can offer further insights concerning the relationship between proficiency decline and workplace practices.

As in the case of education or training, there is little evidence that higher overall use of reading skills at work is associated with a slower rate of decline of proficiency over time. The cross-country correlation between average use of reading skills and unadjusted age differences in literacy proficiency is in fact very close to zero. There is however a negative correlation between the use of skills among older employees (aged 55-65) and unadjusted age-differences in literacy proficiency, as shown in Figure 27. The correlation coefficient in this case is -0.19. There is a similar (positive) correlation of 0.24 between age-differences in proficiency and age-differences in the use of reading skills at work.

Figure 27. Age-differences in literacy proficiency and use of reading skills at work for workers aged 55-65



Source: Survey of Adult Skills (PIAAC) (2012).

The practice of skills outside work

The intensity of the use of literacy and numeracy skills outside work has a potentially positive relationship with the maintenance of proficiency as people age. Engaging in reading or writing outside work can signal high motivation to develop or maintain proficiency, and might be particular important for older individuals that approach exit from the labour market. Indeed, first results from PIAAC showed that practicing such activities outside work has an even stronger relationship with assessed proficiency than practicing corresponding activities while at work.

In order to see whether the importance of the intensity of literacy and numeracy use is different for individuals of different ages, Tables 6 and 7 present the results of a series of regressions, run separately by age groups, of literacy and numeracy proficiency on the extent to which respondents practice reading and numeracy outside work. The regressions all control for education, gender, and parental education.

Especially in the case of numeracy, it is evident that the relationship between proficiency and the intensity of skills use outside work is stronger for older individuals. The difference in estimated coefficients between the oldest (55-65) and the youngest age group (25-34) amounts to 0.9 points in literacy and to 1.8 points in numeracy. Even though it is difficult to determine whether higher proficiency that leads to greater intensity of use or vice versa, the results are consistent with the literature that argues that one key to successful ageing lies in “staying active”.

Table 6. Reading practice outside work and literacy proficiency

Country	25-34	(s.e)	35-44	(s.e)	45-54	(s.e)	55-65	(s.e)
Australia	10.8	2.1	7.6	1.7	8.1	2.0	11.6	1.9
Austria	8.4	1.8	9.2	1.6	7.1	1.3	5.4	1.5
Flanders (Belgium)	6.5	2.0	6.0	1.7	6.2	1.3	8.9	1.5
Canada	9.4	1.4	10.2	1.4	12.4	1.3	10.2	1.1
Czech Republic	9.2	1.7	10.4	2.4	5.5	2.2	7.6	2.2
Germany	10.5	1.9	12.3	1.9	11.5	2.1	9.1	1.6
Denmark	10.1	2.1	8.9	1.7	11.4	1.7	10.3	1.0
Spain	11.6	1.6	7.3	1.7	11.6	1.5	12.3	1.9
Estonia	6.1	1.4	8.9	1.4	5.7	1.4	7.9	1.6
Finland	9.8	1.5	12.6	1.7	11.5	1.9	9.7	1.3
France	6.5	1.5	6.1	1.3	7.7	1.1	9.2	1.2
England/N. Ireland (UK)	9.2	1.9	5.2	1.9	9.1	1.8	11.9	1.9
Ireland	5.5	1.8	8.2	1.9	11.6	2.1	9.8	2.1
Italy	9.4	2.0	8.9	1.7	7.7	2.0	13.1	2.1
Japan	6.2	1.4	5.2	1.6	6.1	1.2	6.9	1.3
Korea	8.5	1.3	6.8	1.2	5.8	1.4	12.6	1.5
Netherlands	7.8	1.7	6.7	1.5	9.7	1.5	9.6	1.4
Norway	7.9	1.5	6.7	1.5	7.2	1.5	8.2	1.5
Poland	8.4	1.8	8.7	2.1	10.2	1.8	7.4	1.9
Slovak Republic	5.9	1.5	3.3	1.4	5.7	1.5	10.7	1.5
Sweden	7.4	1.6	11.7	2.1	10.4	1.8	7.2	1.3
United States	8.8	1.6	4.3	1.8	8.5	1.8	4.6	1.9
Average	**8.4**	**0.4**	**8.0**	**0.4**	**8.7**	**0.4**	**9.3**	**0.3**

Source: Survey of Adult Skills (PIAAC) (2012).

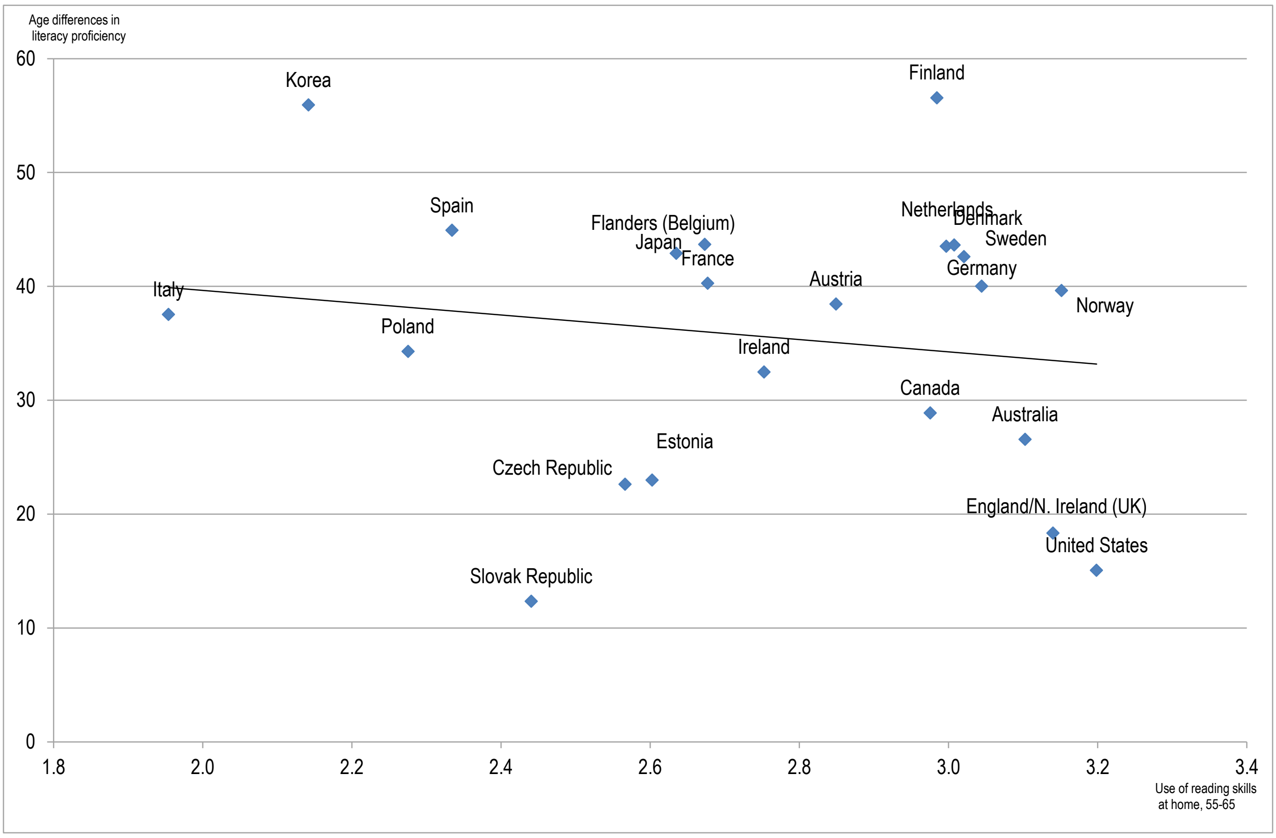
Table 7. Numeracy practice outside work and numeracy proficiency

Country	25-34	(s.e)	35-44	(s.e)	45-54	(s.e)	55-65	(s.e)
Australia	11.4	2.2	11.7	1.7	11.8	2.0	13.7	1.8
Austria	9.6	1.8	7.7	2.0	9.2	1.6	9.4	1.8
Flanders (Belgium)	7.8	1.5	7.8	1.5	7.5	1.6	9.4	1.7
Canada	9.4	1.5	8.8	1.3	12.4	1.1	11.9	1.4
Czech Republic	7.6	2.0	7.1	1.9	6.6	2.3	6.1	2.0
Germany	10.4	1.8	12.2	1.8	14.2	1.6	12.9	1.8
Denmark	9.0	2.2	8.7	1.5	10.3	1.9	12.2	1.1
Spain	9.6	1.3	6.4	1.5	9.1	1.4	10.6	1.9
Estonia	7.8	1.4	8.9	1.3	7.5	1.3	7.9	1.5
Finland	9.4	1.6	11.9	1.7	12.1	1.7	9.9	1.2
France	6.2	1.4	9.8	1.3	9.8	1.2	13.2	1.4
England/N. Ireland (UK)	9.7	1.8	8.4	2.6	12.0	2.2	14.8	1.8
Ireland	6.5	1.4	7.9	1.8	9.0	1.8	10.3	2.2
Italy	7.6	2.2	8.8	1.6	9.4	1.8	15.4	2.2
Japan	6.9	1.5	7.9	1.4	6.6	1.3	8.0	1.5
Korea	7.2	1.1	3.9	1.1	5.4	1.3	9.0	1.5
Netherlands	10.8	1.8	8.2	1.6	8.7	1.3	9.6	1.7
Norway	7.7	1.7	9.3	1.6	9.8	1.8	9.2	1.8
Poland	12.3	1.5	10.4	2.3	10.3	1.6	11.0	1.9
Slovak Republic	7.8	1.4	7.2	1.6	8.6	1.5	9.5	1.5
Sweden	10.5	1.7	9.4	2.4	12.8	1.8	11.4	1.5
United States	8.2	1.9	8.0	1.8	12.5	2.1	8.2	1.8
Average	**8.8**	**0.4**	**8.7**	**0.4**	**9.8**	**0.4**	**10.6**	**0.4**

Source: Survey of Adult Skills (PIAAC) (2012).

However, there is little evidence that the observed cross-country variation in the intensity of reading practices can help in explaining cross-country variation in age-differences in proficiency. As in the case of reading practices at work, the correlation between average reading practices outside work and unadjusted age differences in proficiency is close to zero (the reason being that, at the country level, reading practices at work are very highly correlated with reading practices outside work). There is a mild negative correlation, shown in Figure 28, between use of skills outside work among individuals aged 55 to 65 and unadjusted age-differences in literacy proficiency. The correlation coefficient equals -0.19.

Figure 28. Age-differences in literacy proficiency and use of reading skills outside work, adults aged 55-65



Source: Survey of Adult Skills (PIAAC) (2012).

Retirement policies

The most common policy response to the rapid ageing of the population consists in encouraging longer working lives, most notably through increasing the age at which people are eligible for retirement (OECD, 2006; Sonnet, Olsen and Manfredi, 2014). Such policies not only have a direct (mechanical) effect on the employment rates of older individuals, but may also influence the evolution of proficiency over time (possibly over the entire life-cycle).

Retirement policies can affect cognitive ageing in two ways. First, there is a direct effect of retirement. On the one hand, it could be argued that retirees have fewer opportunities and fewer incentives to put their cognitive skills into practice than workers of the same age. The popular "use-it-or-lose-it" hypothesis predicts that lower engagement in in intellectual activity will lead to faster cognitive decline. Intuitively, the overall effect should also depend on occupation prior to retirement, and, in particular, the skill intensity of their last job. On the other hand, it could also be argued that retirees have more free time, which they could well dedicate to the practice of reading or numeracy skills, an issue that will be more thoroughly discussed in the next section. Retirement policies may also affect the expected length of individuals' working lives. Through this channel, they also affect the incentives of workers to participate in adult training (as well as the incentives for employers to offer such training, or to cover part of the associated costs), which can then have an impact on the evolution of cognitive proficiency.

A recent literature in health economics, spurred by the availability of longitudinal surveys such as the European Survey of Health, Ageing and Retirement (SHARE), the English Longitudinal Survey on Ageing

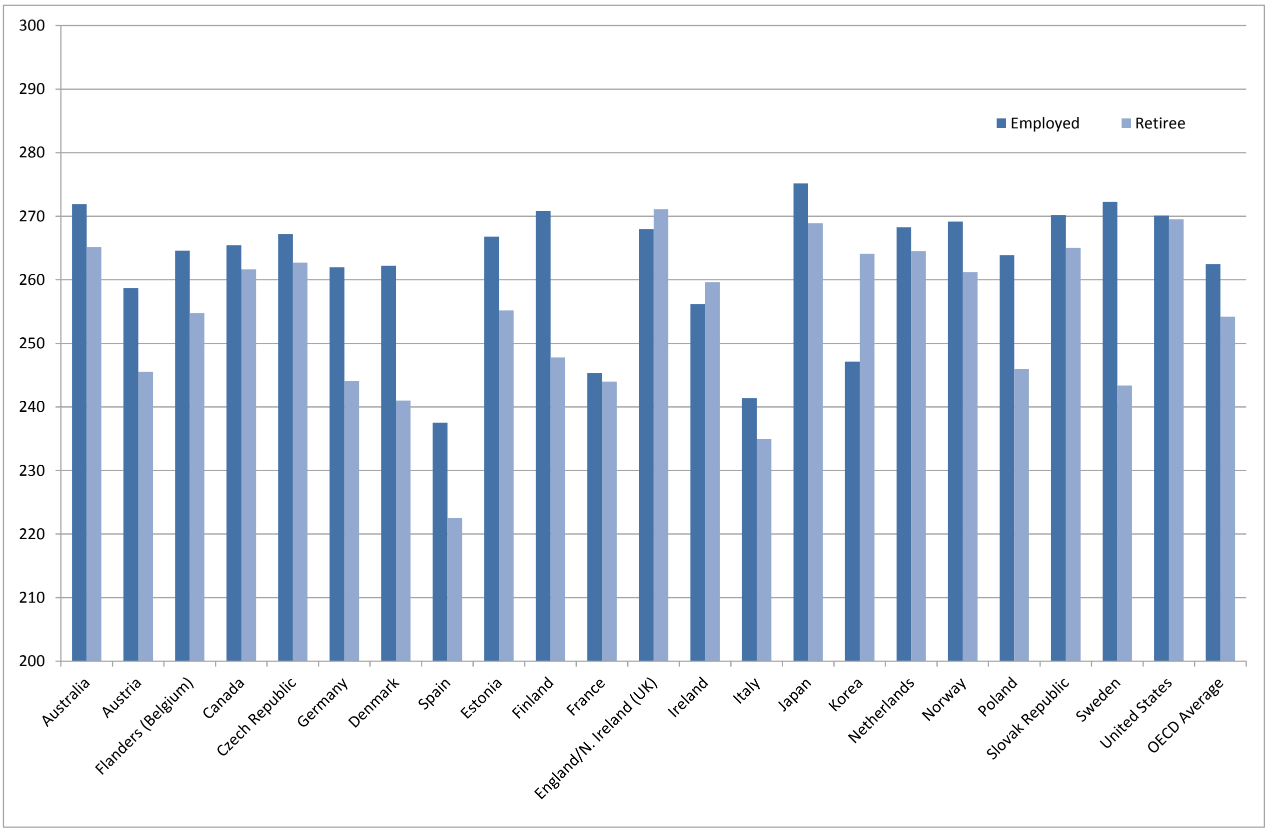
(ELSA) and the Health and Retirement Study from the USA (HRS has directly investigated the first effect. Adam et al. (2007) were among the first to highlight that old workers scored better than retirees on cognitive functioning; furthermore, they showed the gap to be increasing with time spent in retirement.

Subsequent studies have tried to identify the causal impact of retirement on cognitive functioning by exploiting between-country variation in statutory retirement age, again with data from SHARE, ELSA and HRS. Using this approach, Rohwedder and Willis (2010), Bonsang et al. (2012), and Mazzonna and Peracchi (2012), find evidence of a negative effect of retirement on cognitive abilities. On the other hand, Coe and Willis (2011) and Coe et al. (2012) fail to find an effect. The most recent (and most convincing) study is Mazzonna and Peracchi (2015), who exploit the longitudinal dimension of SHARE to estimate both the short and the long term impact of retirement on cognition. They conclude that retirement has an overall clearly negative impact on mental and physical health (depression and mobility limitation) and on cognitive ability, mainly attributable to the length of time spent in retirement, rather than on the discrete (short-term) switch from employment to retirement. Each year in retirement is estimated to decrease cognitive abilities by roughly 6% of a standard deviation, with a similar effect for both men and women. However, the effect is heterogeneous across occupations: individuals whose last job was in physically demanding occupation actually benefit from retirement, both in terms of health and of cognitive abilities.

The literature on the interaction between retirement policies and training participation is smaller. Montizaan et al. (2010) find that the 2006 pension reform in the Netherlands, that diminished pension rights of public employees born in 1950, pushed affected workers to postpone retirement and to increase participation in training. The effect is only detected for workers employed in large organisations, which presumably have more sophisticated human resource management policies and a greater capacity to offer training to employees. Similar results were found by Brunello and Comi (2015), who exploited a pension reform in Italy that increased minimum retirement age. Focussing on private sector employees, Brunello and Comi estimated effects more than twice as large as the ones estimated by Montizaan et al., a discrepancy likely due to the fact that the Italian reform affected relatively younger employees (40 to 56). Montizaan et al. (2015) argue that not only retirement policies can affect training, but that training policies (in particular, offers of training by employers) affect expected retirement ages of employees, irrespective of whether or not the offered training is taken up. Apparently, simple provision of the possibility of training is enough to motivate older employees, thus inducing them to postpone actual retirement.

In the Survey of Adult Skills, retirees have on average lower proficiency than individuals in employment. Restricting attention to individuals aged 55 or more, retirees score 8 points below the employed in literacy (Figure 29). In many countries, however, the gap is rather small, and is often not statistically significant (e.g. in Australia, Canada, the Czech Republic, France, Ireland, England and Northern Ireland, Italy, Japan, the Netherlands, Norway, the United States). In Korea retirees score almost 17 points higher than the employed, but estimates are so imprecise that the difference is not statistically different from zero. In a number of countries retirees score significantly below the employed, notably in Germany, Denmark, Spain, Estonia, Finland, Poland, and Sweden.

Figure 28. Literacy proficiency of individuals aged 55 and more



Source: Survey of Adult Skills (PIAAC) (2012).

Moreover, there is some evidence that length of time spent in retirement negatively affects proficiency, but not significantly in most countries. Table 5 reports the estimated impact on literacy proficiency of one additional year spent in retirement, netting out the effects of age, education, gender, and nationality. The average estimated effect is rather small, at 0.7 score points per each additional year in retirement and the effect is not statistically significant in the majority of countries. However, quite large effects are estimated in a small number of countries: the Czech Republic, Spain, Finland, France, and the Slovak Republic.

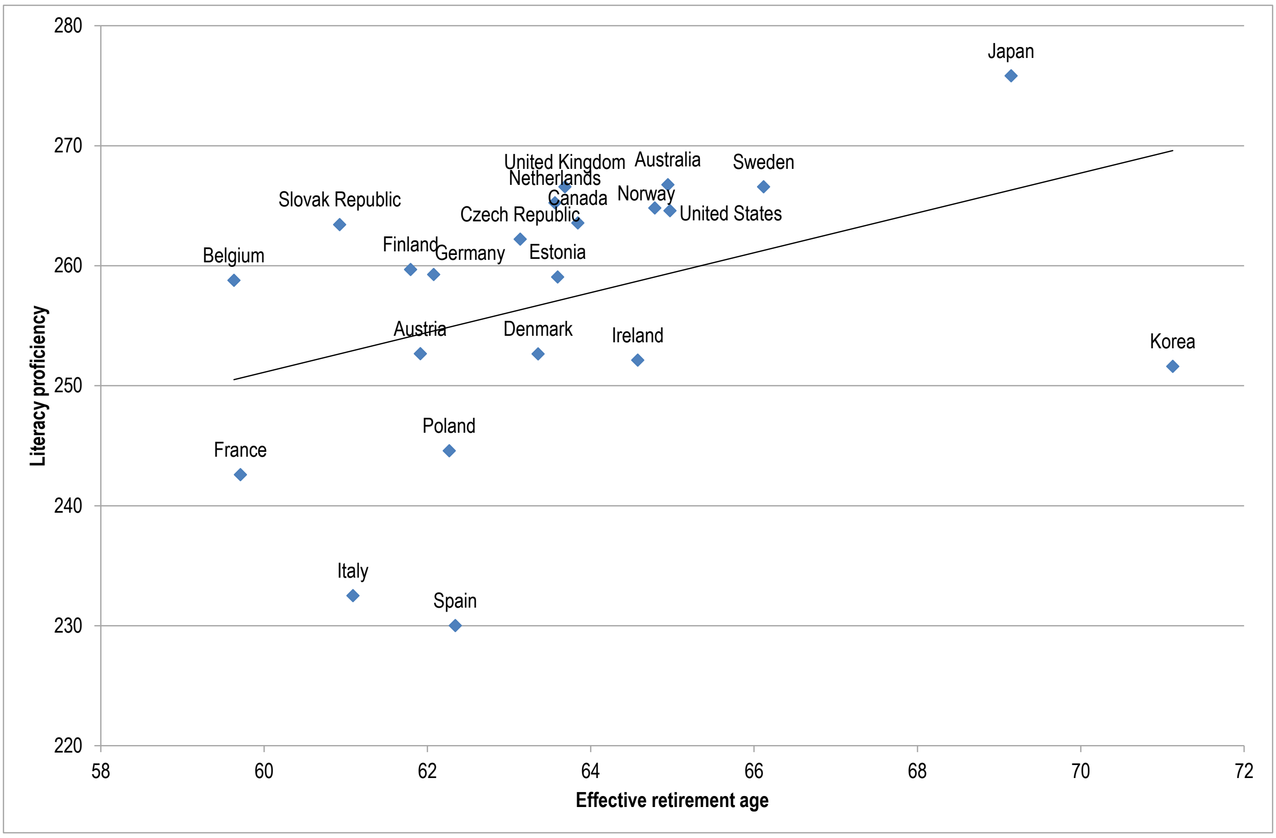
Table 8. Estimated effect on literacy proficiency of one additional year in retirement

Country	Estimated effect	Standard Error
Australia	-0.9	*0.4*
Austria	-0.3	*0.5*
Flanders (Belgium)	-0.3	*0.3*
Canada	-0.4	*0.2*
Czech Republic	-1.5	*0.6*
Germany	-0.8	*0.5*
Denmark	-0.7	*0.3*
Spain	-1.4	*0.6*
Estonia	-0.2	*0.4*
Finland	-1.2	*0.4*
France	-1.1	*0.3*
England/N. Ireland (UK)	0.1	*0.4*
Ireland	-0.2	*0.4*
Italy	-0.1	*0.3*
Japan	0.1	*3.1*
Korea	-1.5	*1.5*
Netherlands	-0.1	*0.5*
Norway	-2.7	*2.3*
Poland	-0.1	*0.4*
Slovak Republic	-1.1	*0.3*
Sweden	-0.3	*0.6*
United States	-0.6	*0.6*

Source: Survey of Adult Skills (PIAAC) (2012).

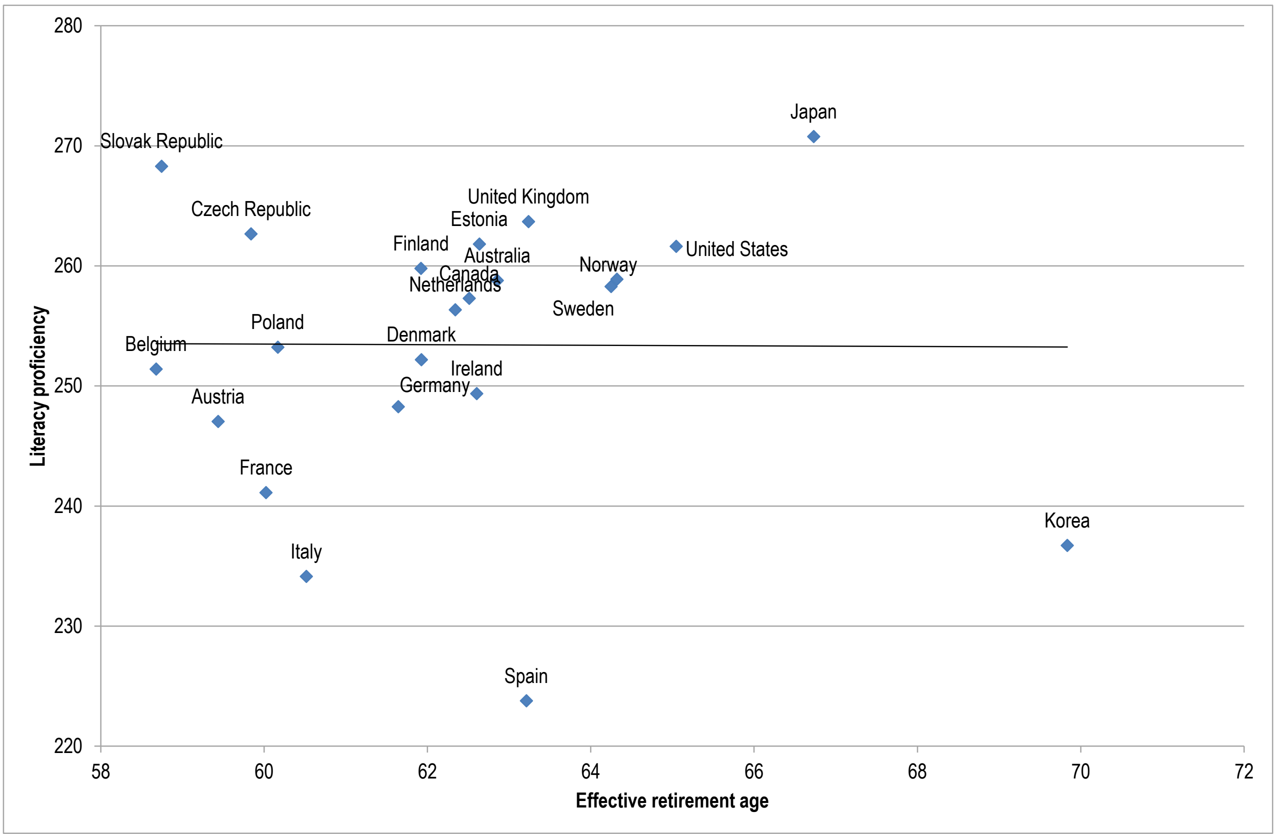
Similarly, there is evidence of a positive relationship between effective retirement age and literacy proficiency of individuals aged 55 or more. However, the relationship is evident for men only (correlation coefficient of 0.4), suggesting that for women retirement decisions are much more weakly linked to proficiency.

Figure 29. Effective retirement age and literacy proficiency - men aged 55 or more



Source: Survey of Adult Skills (PIAAC) (2012).

Figure 30. Effective retirement age and literacy proficiency - women aged 55 or more



Source: Survey of Adult Skills (PIAAC) (2012).

Conclusions

This chapter has investigated the factors that could possibly slow the age related decline in proficiency, mainly exploiting cross-country differences in the magnitude of proficiency gaps between old and prime-age individuals (i.e. between those with the lowest and highest average levels of proficiency). In particular, the chapter analysed four broad factors, commonly identified by the literature as relevant in explaining age-related cognitive decline: formal education, on-the-job training and the skills content of the job, skills practice in everyday life, and policies governing retirement. While the analysis was conducted separately on each factor for ease of exposition, it should be remembered that these factors often interact with each other.

As far as education is concerned, PIAAC provides only weak support for the existence of a possible “preserving” effect of higher levels of education with respect to cognitive decline. While education is one of the strongest determinants of literacy proficiency, highly educated individuals seem to experience a larger decline in proficiency as they age, though from a higher base. At the same time, countries in which older individuals are more educated also tend to be the countries in which age-differences in proficiency are smaller.

The “preserving” effect seems to be related to proficiency in itself, rather than educational attainment. Highly proficient individuals experience smaller declines than individuals at the bottom of the proficiency distribution (assuming individuals do not change their position in the proficiency distribution as they age). This is likely to be due to a self-reinforcing mechanism through which more proficient individuals have higher opportunities to invest in, develop and maintain their cognitive skills. This result reinforces the need to ensure that all young people (including those from disadvantage backgrounds) leave school with good literacy and numeracy skills. Reducing initial gaps is key to avoid the formation of even wider gaps over the life cycle.

Participation in adult training is one channel through which initial gaps in proficiency perpetuate and widen over time: more proficient individuals are in fact much more likely to engage in adult training. Higher overall participation in adult training at the country level, however, does not seem to be related with the magnitude of the age-related differences in proficiency. The main reason is that countries with high rate of participation in adult training are also countries in which the difference between young and older workers in the probability of participating in training is larger. It is therefore really important that training be really "life-long": in order to prevent age-related declines in proficiency, training should be undertaken at each stage of the lifecycle, and countries should increase efforts to make older people participate more in training activities.

Practicing skills, both at work and in everyday life, is also likely to contribute to maintaining higher levels of proficiency, according to the so-called "use-it-or-lose-it" hypothesis. While there is only a moderate cross-country correlation between age-differences in proficiency and the use of skills outside work, in all countries the positive relationship between proficiency and skills use is stronger for older than for younger individuals.

The "use-it-or-lose-it" hypothesis also predicts that retirement could have negative effects on proficiency, to the extent that, in leaving employment, people have reduced opportunities or incentives to practice their skills. In addition, retirement policies, by affecting the expected length of individuals' working lives, also affect incentives to invest in training. PIAAC provides some evidence, consistent with a number of other studies, that retirement has negative effects on proficiency. Not only do retirees have lower levels of proficiency than employed individuals, proficiency also appears to decline with time spent in retirement. The estimated effect is rather small, but this is probably due to the fact that PIAAC only covers individuals up to age 65, so that the number of years spent in retirement is necessarily limited. Moreover, there is a strong relationship between effective retirement age and literacy proficiency of (male) individuals aged 55 or more: countries in which people stay longer in the labour market are also countries in which proficiency levels of older individuals are higher.

Notes

[14] Thus disregarding the potentially very useful information contained in IALS.

[15] Deary et al. (2000), and Zimprich and Mascherek (2010) provide empirical support for this assumption.

[16] The correlation coefficient between the age-training gradient and unadjusted proficiency differences is still positive at 0.24.

5. CONCLUSIONS

Population ageing is one of the main challenges policymakers will have to face in future decades. This report tried to contribute to the debate by thoroughly investigating the link between ageing and proficiency in information-processing skills, as measured in the Survey of Adult Skills (PIAAC).

Understanding how human capital is accumulated, and how it depreciates over time, is crucial not only to address the challenges of population ageing, but also to improve the effectiveness of policies that aim to equip individuals with the skills needed in current labour markets, characterised by rapid technological change and by an increasing demand for skills.

PIAAC shows that information-processing skills have a large impact on a variety of both economic and non-economic outcomes: from employability to wages, from health to active participation in society. Losing skills over time, or ending up with low levels of proficiency, can therefore signal high risks of marginalisation, with large individual and collective costs. This is particularly relevant for the older segments of the population. If increases in life expectancy lead to increases in the duration of working life, maintaining adequate levels of proficiency will be a crucial factor in maintaining employability, as well as in preserving health.

Although the cross-sectional nature of PIAAC does not allow to separate in a rigorous way the "biological" effect of age from differences between individuals that were born and have been raised in different years and under very different circumstances (so-called cohort effects), the report provides evidence that suggests that the age-proficiency profile emerging from the data offers a reasonable approximation of the evolution of information-processing skills over the life-cycle.

Age differences in proficiency are, at first sight, substantial. On average across the OECD countries participating in PIAAC, adults aged 55 to 65 score some 30 points less adults aged 25 to 34 on the PIAAC literacy scale. This is only slightly smaller than the score point difference between tertiary educated individuals from individuals who did not complete upper secondary education. However, the observed decline in proficiency with age is very gradual. The average decline in literacy proficiency between the ages of 16 and 65 amounts to approximately 11%, but it is spread out over some 30 years.

A broader look at a wide range of outcomes collected through the PIAAC background questionnaire also helps, on the one hand, to stress the importance of proficiency, on the other hand, to dispel some of the worries associated with population ageing.

Proficiency is a powerful determinant of employability and earnings, possibly even more so as people age, and the importance of formal qualifications (such as educational degrees) tend to diminish in comparison with proven ability to perform tasks required by the job. Moreover, proficiency entirely explains why older workers are on average more likely to be in a routine rather than in a skilled job, and to use information-processing skills less frequently in the workplace.

Despite the apparent decline in proficiency with age, wages nonetheless tend to increase as people age. This could in principle signal a decoupling of wages and individual productivity, with the implication that older workers are, in some sense, "overpaid" and, therefore, more at risk of being laid off. However, a large body of empirical literature shows that productivity does not necessarily decline with age. This does not imply that proficiency in information processing skills is not important for productivity, but rather, than it is only one ingredient of the mix of skills attributes and knowledge that determines individual productivity. While people might lose proficiency in information processing skills as they age, they probably accumulate other valuable skills, through experience or further training.

Nonetheless, preventing (or somehow slowing) the age-related decline in proficiency remains an objective of paramount importance. PIAAC offers the possibility to investigate some factors that could plausibly help in preventing such decline.

Surprisingly, having high levels of formal education does not appear to slow the rate of proficiency decline. If anything, more highly educated individuals experience a steeper decline in proficiency than adults with lower levels of attainment. Even more worrisome, this could be a lower bound of the true decline, as there is some evidence that, at similar levels of formal education, younger cohorts are less proficient than older cohorts were at the same age.

The best insurance against rapid proficiency declines seems to be a high level of proficiency itself: the gap between people at the top and at the bottom of the distribution of literacy proficiency, in fact, increases with age, implying that adults with low proficiency in literacy experience a steeper decline.

Lifelong learning is another important factor in any strategy that aimed at preserving proficiency over time. However, cross-country differences in the propensity to participate in adult education and training are only very mildly related to the observed age-differences in proficiency. The reason for this result is that countries with higher rates of participation in adult training are also countries where the take up of training opportunities decline the most with age. This suggests the importance, even for apparently best-performing countries, to increase efforts to make learning truly “life-long”, notably by increasing participation rates of older individuals.

Encouraging the practice of skills, especially in everyday life, is also important. The relationship between proficiency and skills use, in fact, is found to be stronger for older individuals.

Finally, a prominent role needs to be played by retirement policies. Retirement directly affect the chances of individuals to stay active and to practice their skills. Furthermore, by affecting the expected length of workers’ careers, retirement policies also affect incentives for employee to take up training, and for employers to offer it. PIAAC provides evidence, consistent with an increasing body of literature, that retirement negatively affects proficiency.

To sum up, this report found evidence of age-related declines in proficiency. Such declines can potentially have important negative effects, although there is evidence that other dimensions of skills are likely to follow different life-cycle profiles, and partly compensate cognitive declines. Policies can play an important role in better equipping individuals with the skills needed to face current and future challenges. Higher quality education, as well as better targeting of adult training opportunities, is likely to be the most effective means of promoting higher levels of proficiency across the entire life-cycle.

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APPENDIX

Table A1. Age differences and age effects

	Age differences (unadjusted)	**Age differences** (adjusted)	**Age effects** (unadjusted)	**Age effects** (adjusted)
			Australia	
35-44	-0.51	1.87	5.60	0.27
(standard error)	*(2.52)*	*(2.14)*	*(2.90)*	*(2.62)*
45-54	-13.19	-4.11	3.86	-2.65
(standard error)	*(2.34)*	*(2.21)*	*(3.04)*	*(2.81)*
55-65	-22.25	-10.75	-4.04	-12.92
(standard error)	*(2.94)*	*(2.94)*	*(3.92)*	*(3.51)*
			Canada	
35-44	-3.83	-1.65	2.27	-7.31
(standard error)	*(2.09)*	*(1.92)*	*(4.94)*	*(4.42)*
45-54	-16.26	-7.52	-16.20	-18.50
(standard error)	*(2.03)*	*(1.91)*	*(4.11)*	*(3.93)*
55-65	-25.16	-10.95	-21.78	-31.57
(standard error)	*(1.84)*	*(1.80)*	*(4.84)*	*(4.66)*
			Czech Republic	
35-44	-10.25	-6.48	-12.22	-16.27
(standard error)	*(2.76)*	*(2.76)*	*(3.26)*	*(3.08)*
45-54	-19.74	-14.27	-21.51	-25.34
(standard error)	*(2.25)*	*(2.21)*	*(3.24)*	*(3.14)*
55-65	-23.38	-15.49	-28.47	-34.44
(standard error)	*(2.61)*	*(2.69)*	*(4.16)*	*(3.93)*
			Denmark	
35-44	-6.16	-3.35	-13.44	-11.27
(standard error)	*(2.59)*	*(2.37)*	*(2.63)*	*(2.53)*
45-54	-22.09	-12.71	-31.51	-24.75
(standard error)	*(2.41)*	*(2.21)*	*(2.44)*	*(2.33)*
55-65	-37.93	-25.70	-56.28	-47.93
(standard error)	*(2.11)*	*(2.08)*	*(3.24*	*(3.30)*
			Finland	
35-44	-9.58	-7.96	-7.66	-2.75
(standard error)	*(2.39)*	*(2.03)*	*(2.43)*	*(2.10)*
45-54	-26.16	-18.00	-15.53	-6.72
(standard error)	*(2.01)*	*(2.03)*	*(2.61)*	*(2.22)*
55-65	-53.28	-35.36	-34.74	-21.43
(standard error)	*(2.16)*	*(2.25)*	*(3.12)*	*(2.77)*
			Germany	
35-44	-5.37	-4.20	-10.00	-17.59
(standard error)	*(2.45)*	*(2.21)*	*(3.64)*	*(3.53)*
45-54	-18.77	-17.45	-21.09	-33.54
(standard error)	*(2.26)*	*(2.16)*	*(3.36)*	*(3.75)*
55-65	-31.85	-27.90	-43.37	-65.58
(standard error)	*(2.38)*	*(2.24)*	*(3.84)*	*(4.83)*
			Ireland	
35-44	-8.89	-1.66	-1.35	-25.40
(standard error)	*(2.21)*	*(2.06)*	*(3.73)*	*(3.34)*
45-54	-21.28	-5.27	-10.26	-45.16
(standard error)	*(2.71)*	*(2.53)*	*(4.75)*	*(4.48)*
55-65	-31.72	-5.77	-14.31	-60.49
(standard error)	*(2.61)*	*(2.39)*	*(6.73)*	*(6.08)*
			Netherlands	
35-44	-3.70	0.17	-4.08	-2.79
(standard error)	*(2.14)*	*(1.92)*	*(3.19)*	*(2.91)*
45-54	-21.21	-10.82	-15.75	-13.38
(standard error)	*(2.65)*	*(2.41)*	*(2.26)*	*(2.10)*
55-65	-40.17	-25.26	-28.25	-28.32
(standard error)	*(2.57)*	*(2.29)*	*(3.07)*	*(2.91)*

			Norway	
35-44	-4.33	-2.62	-12.26	-23.18
(standard error)	*(2.53)*	*(2.32)*	*(2.54)*	*(2.34)*
45-54	-18.91	-12.10	-26.22	-43.23
(standard error)	*(2.02)*	*(1.93)*	*(2.72)*	*(2.49)*
55-65	-37.44	-26.50	-49.26	-76.47
(standard error)	*(2.43)*	*(2.34)*	*(3.19)*	*(3.08)*
			Sweden	
35-44	-3.17	-3.33	-27.75	-27.24
(standard error)	*(2.65)*	*(2.50)*	*(3.64)*	*(3.20)*
45-54	-18.11	-13.86	-36.52	-34.88
(standard error)	*(2.40)*	*(2.30)*	*(2.88)*	*(2.59)*
55-65	-36.13	-25.04	-69.72	-68.00
(standard error)	*(2.22)*	*(2.28)*	*(3.96)*	*(3.43)*
			United States	
35-44	-2.35	-2.37	-12.16	-13.40
(standard error)	*(2.65)*	*(2.44)*	*(4.45)*	*(3.72)*
45-54	-9.05	-7.32	-18.19	-19.56
(standard error)	*(2.70)*	*(2.44)*	*(3.83)*	*(2.56)*
55-65	-13.46	-12.01	-34.54	-39.31
(standard error)	*(2.56)*	*(2.67)*	*(4.36)*	*(3.18)*
			Flanders (Belgium)	
35-44	-8.88	-5.19	-11.13	-9.17
(standard error)	*(2.23)*	*(2.01)*	*(3.69)*	*(3.70)*
45-54	-21.77	-10.94	-17.58	-15.24
(standard error)	*(2.27)*	*(1.89)*	*(3.28)*	*(3.13)*
55-65	-39.95	-19.10	-29.48	-26.20
(standard error)	*(2.40)*	*(2.50)*	*(4.16)*	*(4.10)*
			England/N. Ireland (UK)	
35-44	-3.49	0.10	0.93	-0.16
(standard error)	*(2.50)*	*(2.37)*	*(3.19)*	*(3.05)*
45-54	-14.23	-4.98	-7.47	-6.30
(standard error)	*(2.49)*	*(2.58)*	*(2.88)*	*(2.80)*
55-65	-19.70	-6.25	-9.41	-10.89
(standard error)	*(2.80)*	*(2.86)*	*(4.23)*	*(4.19)*

Note: The table reports estimated coefficients from a series of country-level regression of literacy proficiency on age-group dummies. The omitted category consists of individuals aged 25-34. Coefficients in the first two columns are estimated using only PIAAC data, with and without controlling for years of education and parental background. Coefficients in the last two columns are estimated pooling observations from IALS and PIAAC, controlling for cohort dummies. Cohorts are defined according to the age of the respondent in IALS, grouped into 10-years.

Source: International Adult Literacy Survey (IALS) (1994-1998) and Survey of Adult Skills (PIAAC) (2012).