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SKILLS FOR THE 21ST CENTURY: FINDINGS AND POLICY LESSONS FROM THE OECD SURVEY OF ADULT SKILLS

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John P. Martin

This working paper has been authorised by Andreas Schleicher, Director of the Directorate for Education and Skills, OECD.

John P. Martin (seanomartin@gmail.com), former OECD Director for Employment, Labour and Social Affairs; Adjunct Research Fellow, UCD Geary Institute for Public Policy; Member, Irish Government's Labour Market Council; Member, National Statistics Board of Ireland; IZA Research Fellow.

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Abstract

The OECD Survey of Adult Skills is the jewel in the crown of its Programme for the International Assessment of Adult Competencies (PIAAC). This paper argues that the findings and policy lessons from the project to date justify the high hopes which were placed in PIAAC when detailed planning for the project began in 2003. First, it presents a brief recap of PIAAC and its two predecessor international skills surveys. Second, it outlines the main themes which have been investigated to date using data from PIAAC. Third, the main findings and policy lessons drawn from PIAAC are highlighted. Finally, looking forward to the second cycle of PIAAC, for which planning is now underway, the paper suggests some priority areas for improvement to the survey design in order to add to its analytical usefulness and enhance its utility to policy makers.

Résumé

L'Évaluation des compétences des adultes constitue le couronnement du Programme de l'OCDE pour l'évaluation internationale des compétences des adultes (PIAAC). Le présent document indique que les conclusions obtenues jusqu'à maintenant et les leçons tirées pour l'action des pouvoirs publics justifient les grands espoirs suscités par le PIAAC lorsque la planification détaillée du projet a débuté en 2003. Tout d'abord, il propose une brève synthèse du PIAAC ainsi que des deux précédentes enquêtes internationales sur l'évaluation des compétences. Puis, il offre une vue d'ensemble des grands thèmes étudiés jusqu'à présent sur la base des données du PIAAC, avant de mettre en avant les principales conclusions et les orientations à prendre pour une action plus efficace des pouvoirs publics. Enfin, dans la perspective du deuxième cycle du PIAAC, dont la mise en œuvre est désormais en cours, le document identifie certains secteurs qu'il convient d'améliorer en priorité concernant la conception de l'enquête, en vue de renforcer son utilité tant sur le plan analytique qu'à l'adresse des décideurs politiques.

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Introduction

The OECD Survey of Adult Skills is the jewel in the crown of its Programme for the International Assessment of Adult Competencies (PIAAC). It aims to provide a comprehensive picture of key skills among the working-age populations in OECD and selected non-OECD countries, how these skills are used at work and in society, how they are modified by education, training and adult learning experiences, what are the outcomes of these skills in terms of wages, employment, economic growth and productivity and social well-being. This is a very ambitious agenda. But, as the first cycle of measurements under PIAAC is nearing completion, and planning is well underway for the second cycle to be launched in 2018 with the data collection planned for 2021-22, this paper will argue that the findings and policy lessons from the project to date justify the high hopes which were placed in PIAAC when detailed planning for the project began in 2003. The analyses have also highlighted certain areas of the Survey's design which, if modified for the second cycle, would add greatly to its analytical usefulness and strengthen its policy messages.

The structure of the paper is as follows. First, there is a brief recall of PIAAC and its two predecessor international skills surveys. Second, the main themes which have been investigated to date using data from PIAAC are outlined. Third, the main analytical insights and policy lessons drawn from PIAAC are highlighted. This section of the paper draws on a literature review which has been commissioned by the OECD from a consultant.[1] Finally, looking forward to the second cycle of PIAAC, some priority areas for improvement to the survey design are suggested in order to enhance its policy utility.

1. PIAAC and its predecessors[2]

PIAAC was not developed from scratch. It built upon the experiences learned from two previous efforts to measure adult skills across OECD countries. The first such survey – the International Adult Literacy Survey (IALS)—was developed as a collaborative effort between OECD, Statistics Canada and the US-based Educational Testing Service. IALS assessed three skill domains: prose literacy, document literacy and quantitative literacy. It was accompanied by a background questionnaire designed to elicit information about respondents' socio-demographic, education, training and labour market histories. In total, 22 OECD countries took part in IALS over the period 1994 to 1998.

Once IALS was completed and the first results were published, OECD and Statistics Canada began the development of a second international adult literacy survey, the Adult Literacy and Life Skills Survey (ALL). Like IALS, skills were assessed in ALL in the

[1] See OECD (2017b).

[2] This section draws heavily on Thorn (2009).

domains of prose and document literacy. However, the domain of quantitative literacy was replaced by that of numeracy and a new domain of problem solving was added to ALL. Only 9 OECD countries took part in ALL between 2002 and 2007 which was a disappointing take up.

The OECD began planning for PIAAC in 2003 and working closely with Member countries via the PIAAC Board of Participating Countries (BPC), elaborated a strategy for the new survey in late 2005. The European Commission has been a major collaborator in this process. It then took more than six years of detailed planning, expert discussions, and field trials before the new survey went into the field (see Box 1 for more details on the OECD Survey of Adult Skills).

PIAAC represents a significant improvement on both IALS and ALL in several key areas[3]. First, it has attracted much greater country buy-in: to date 39 countries/regions have participated in the first cycle or are about to do so, of which 30 are OECD countries. One manifestation of this is the stakeholder buy-in and active participation of the BPC with the OECD Secretariat in all the stages of designing and implementing the Survey. Almost all the participating countries/regions send representatives to the BPC from both their Labour/Employment and Education ministries, the two major stakeholders for a Skills Survey. Second, sample sizes are typically much larger than those in the preceding surveys, especially IALS, giving much more statistical reliability to the results. Third, the skill domains assessed in PIAAC have been refined and adapted in line with changing developments in the workplace and in society, notably in the area of problem solving in technology-rich environments[4]. Finally, the background questionnaire has been much refined and enriched in items in order to improve its analytical utility, with the addition of the innovative Job Requirements Approach proving to be especially useful in this regard.

[3] Another innovation in PIAAC is the use of a computer platform for the assessment of skills and the completion of the background questionnaire though allowance was made for a pen-and-pencil test for those who were unable or unwilling to use the computer.

[4] While PIAAC is a cross-sectional survey of skills, when it was being designed links were made between it and IALS and ALL for those countries which had participated in the preceding surveys so that some time-series comparisons might be made. This is possible for some of the items on literacy in both IALS and ALL, and also for some of the numeracy items in ALL. However, differences in the ways in which the three surveys were implemented and small sample sizes, especially for IALS, hinder the reliability of time-series comparisons of literacy and numeracy trends.

Box 1. The OECD Survey of Adult Skills (PIAAC)

The Survey assessed the proficiency of working-age adults in literacy, numeracy and problem-solving in a technology-rich environment. It also included a Background Questionnaire (BQ) which collected a rich data set of background information on socio-demographic characteristics of the respondents, their educational attainment, their labour market status and job characteristics, their working environment and their use of ICT at work and in social life. It included an innovative module (the Job Requirements Approach) where respondents were asked about the frequency with which they performed specific tasks at work and in everyday life. Data on the frequency with which the specific tasks were performed were then used to derive indicators of the use of information-processing skills at work: reading, writing, numeracy, ICT, and problem-solving skills. Respondents were also asked whether their skills and qualifications matched their job requirements. See Kirsch and Lennon (2017) for a more detailed description of the innovations introduced in PIAAC.

Responses to other items in the background questionnaire permit one to derive indicators of adults' "readiness to learn" and some elements of informal learning on the job. Finally, PIAAC also collected information on four elements of well-being: trust; political efficacy; volunteering; and self-reported health status.

To date, two rounds of data collection have been completed and a third is in progress at the time of writing. In the first round, in 2011-2012 around 166 000 adults aged 16-65 were surveyed in 24 countries/economies, 22 of which were OECD countries/economies (a) and the other two were the Russian Federation and Cyprus*. The second round took place in 2014-2015 and 9 countries participated, 6 of which were OECD countries. Over 50 000 adults were surveyed in the second round. Six countries (three of which are OECD members) are participating in the third round with data collection taking place in 2017-18(b).

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

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

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

* Note by Turkey: The information in this document with reference to "Cyprus" relates to the southern part of the island. There is no single authority representing both Turkish and Greek Cypriot people on the island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

* Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

a. The OECD countries in the first round were as follows: Australia, Austria, Belgium (Flanders), Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, the Slovak Republic, Spain, Sweden, the United Kingdom (England and Northern Ireland only), and the United States. The OECD countries who participated in the second round were: Chile, Greece, Israel, New Zealand, Slovenia and Turkey.

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

2. Main themes investigated to date with PIAAC

Skills are extremely important in the modern economy and in everyday life. It is commonplace to read that skill requirements are evolving very rapidly nowadays under the pressures of on-going structural changes, demography (exemplified by falling birth rates and ageing populations and workforces), globalisation and technological change (the so-called "New Machine Age/4th Industrial Revolution"). At the same time, the supply of skills often struggles to match these rapidly evolving demands.

In order to provide countries with the necessary information to help them develop policies to close these skills gaps and enable citizens to make informed choices about their education and training investments, PIAAC fills a large gap in the knowledge space. Not only does it supply participating countries with data on the levels and distributions of key cognitive skills within the adult population aged 16-64 so that they can benchmark themselves against competitors, but it also allows them to analyse the outcomes of education, training and human resource management decisions at the work place and in everyday life, and helps identify what policy levers might be used to influence them in desired directions.

To date, analyses of data from the OECD Survey of Adult Skills have tended to be grouped around a number of major themes as follows:

- *The Transition from School to Work*. High youth unemployment is a scourge in many OECD countries. One route to reducing it is to improve the transition from school to work, thereby enabling youth to gain valuable work experience to add to

their educational qualifications. Here the OECD has been able to exploit links between its well-known PISA assessment of 15-year-olds in school and how the cohort aged 16-25 in PIAAC has been faring in the labour market. Ideally, one would like to do this via longitudinal data following students sampled in PISA who were also sampled in PIAAC – a few countries are able to do this (Denmark, Canada, Germany). Others have to rely upon comparing synthetic cohorts computed from the cross-sectional data based upon single year of age or 5-year age intervals.[5]

- *Returns to Skills*. There is a vast literature documenting the returns to skills in terms of earnings and employment probabilities. However, the bulk of this literature proxies skills by measures of educational attainment. The advantage of PIAAC is that it provides comparable measures of key skills among the adult working-age population independent of educational attainment and thus serves to enrich the debate on returns to skills.

- *Skill Mismatch*. There is a large literature on the theme of skill mismatch. Economists have argued that skill mismatches, which arise when the skills that workers have are not well matched to the skill requirements of their current jobs, have negative impacts on wages, productivity, job quality and worker satisfaction. Typically, skill mismatch in this literature is proxied by either educational attainment or occupation. However, PIAAC, by virtue of its direct measures of skills, is able to produce new measures of mismatch which resonate more closely with the underlying concept.

- *Skill Use at the Workplace.* At the same time, the PIAAC background questionnaire allows one to assess how certain key information-processing tasks are undertaken in the workplace. This provides a very useful complement to the mismatch data and begins to dig into the important issue of how human resource practices within the firm impact on outcomes.

- *Changing Comparative Advantage and Global Value Chains (GVCs).* For many years, skills have been recognised as a source of a country's comparative advantage alongside land, capital and innovation. The standard approach to measure skills has been to disaggregate the labour input into low-skilled and high-skilled workers. Once again, the literature on the determinants of comparative advantage has typically opted to proxy skills by educational attainment or occupation for want of a more direct measure of skills. PIAAC can overcome this lacuna in the literature with its direct measures of workers' skills.

  In addition, the past two decades have witnessed a transformation of the globalisation process with the rapid growth of GVCs. Spurred by advances in ICT and large declines in transport costs, production of many goods and services has become more fragmented and dispersed across national boundaries. Offshoring of parts of the production chain to lower-cost locations abroad is one element behind the growth of GVCs. Skills and skill use are potentially important

[5] Obviously, it would be preferable to follow the cohort by single year of age as this would minimise compositional effects. However, in many countries this may be hampered by sample size.

determinants of countries' comparative advantage in GVCs and PIAAC can shine a new light on this phenomenon.

- *The Fourth Industrial Revolution.* Recently, there has been much media hype about the potential threat of large-scale unemployment as a result of the so-called "Fourth Industrial Revolution". The latter represents a new technological epoch driven by ICT, Big Data, the Internet of Things, and Artificial Intelligence. The concern is that many workers' skills will become redundant as the marginal costs of producing many goods and services will drop drastically as a result of the introduction and diffusion of the new technologies. Some commentators predict huge job losses in the future, whereas others are more sanguine, pointing to the fact that such gloomy predictions are nothing new but previous technological epochs did not lead to large-scale technological unemployment. Nonetheless, there is little doubt that the technological wave underway will have major impacts on the demands and supplies of skills.

  PIAAC, by virtue of its unique focus on skills and skill use at work and in everyday life, can illuminate this debate and help guide policymakers as they react to the potential benefits, as well as the threats, of this new technological wave.

- *Lifelong Learning*. In an era of rapid changes in skill requirements and ageing populations and work forces, investing in lifelong learning takes on an added urgency. Workers, employers and unions need to be alive to this imperative and take steps to increase their investments in upgrading skills throughout working life, and governments have an important role to play too in facilitating these investments.

  It is well-known that opportunities to avail of lifelong learning possibilities are very unevenly distributed among the adult work force: those that have the most skills and education get the lion's share of these investments. This is another manifestation of the so-called "Matthew effect", coined by the sociologist Robert Merton, drawing upon the well-known quotation from the Gospel of Saint Matthew: "For unto everyone that hath shall be given, and he shall have abundance".[6]

  PIAAC has data on education and training investments, both on and off-the-job, which can highlight the size of the Matthew Effect, and how it differs across countries. It can also indicate ways in which countries can seek to expand lifelong learning opportunities and mitigate the Matthew Effect.

- *Ageing-skills-productivity-wages*. Ageing populations and work forces pose specific challenges for skills policies, especially when they are considered against the context of seniority wage profiles which exist in all countries, though to varying degrees. There is a large literature which seeks to address the links between ageing, skills and productivity. It is not easy to establish casual links since many other factors can confound these links; nor is it easy to derive reliable

[6] Matthew 25:27, King James version.

measures of productivity for different age cohorts. Nevertheless, the PIAAC data can be used to analyse these links in a cross-country perspective.

- *Inequality*. Most OECD countries have witnessed growing wage and income inequality over the past two decades. The resulting shifts in income distribution has been associated with growing polarisation between the "haves" and the "have nots", a disappearing middle class, the rise of populist parties and sluggish economic growth over the past decade.

  One popular theory to explain the rising trend in inequality was first put forward by the Dutch Nobel Prize winner in Economics Jan Tinbergen over four decades ago.[7] He characterised wage inequality as being the outcome of a "race between education and technology". In this theory, technology increases the relative demands for more skilled labour while education increases the relative supplies of such labour. Thus, rising inequality implies that technology is winning this race.

  Of course, other determinants can influence inequality, e.g. globalisation, labour market institutions such as collective bargaining, labour market policies such as minimum wages and employment protection legislation, product market competition and redistribution policies through taxes and welfare benefits. Nonetheless, it is important to assess the role of skills in accounting for the recent trends in inequality. While PIAAC cannot supply time-series data to analyse the question, its direct measures of skills may help account for some of the cross-country differences in inequality.

- *Well-being*. There is much interest these days in links between skills and individual well-being. In order to shed some light on these links, PIAAC collected data on four dimensions of well-being: trust in others; political efficacy proxied by individuals' responses to a question about their influence on what governments do; a wide range of volunteering activities; and self-assessed health status.

  The above list shows the wide range of topics which have been investigated to date using PIAAC data. In the next section, we summarise the main analytical insights and policy lessons which have emerged from this research drawing heavily on OECD (2017b) and other studies using PIAAC data.

  Two caveats are in order at this point. First, the empirical literature using data from PIAAC to address the above and other issues is expanding rapidly and the next section cannot claim to be comprehensive in terms of its coverage.[8] Instead, it presents a snapshot of a rapidly-expanding and rich literature. Second, some important topics are relatively neglected. For example, the skills of migrants, how they compare with those of the native-born and their outcomes are important topics in a world characterised by significant flows of adults between countries. But there are relatively few studies of migrants using PIAAC data to date and

[7] See Tinbergen (1975).

[8] Some sense of this rich and growing literature can be gleaned from the PIAAC Research Database. For details, see *http://piaacgateway.com/piaac-publication-database*.

most of these focus on literacy issues.[9] Another important topic which receives less attention than it deserves in the next section is the impact of education systems on skills and their outcomes[10]. This omission reflects my lack of familiarity with this particular strand of the PIAAC research literature.

3. Main results and policy lessons from the OECD Survey of Adult Skills

3.1. The transition from school to work

PIAAC has highlighted that there are large numbers of youth in some countries with low skills. While there is much loose talk in the media about a "lost generation" of youth given the very high rates of youth unemployment in many OECD countries, it is hard to deny that the real *lost generation* concerns those young people with low competences in the key information-processing skills and digital skills that are in strong demand in the labour market.

A preventive strategy is needed for these youth with a long-term focus; there are no quick fixes for this. The strategy has to be coherent and based around three main axes. First, it is vital to invest more in early education and development, with a special focus on supporting children from disadvantaged backgrounds. Second, a high-quality basic education needs to be offered to all. As part of this process, the additional investments made during early childhood, especially for disadvantaged children, need to be sustained during the compulsory schooling period otherwise the initial gains in cognitive and non-cognitive skills may prove to be only transitory. Finally, for those countries which lack one, they need to put in place a modern vocational education and training system - note the emphasis on "modern" which implies a system which is closely aligned with the evolving demands for skills in the labour market, which has a significant component of work-based learning, is equally attractive to young girls as well as young boys, and offers meaningful opportunities for second-chance apprenticeships for older youths and adults.

A worry for policy makers in some countries has to do with evidence that the skills of young people have apparently not improved significantly over the past two decades and may even have diminished in some cases. Barrett and Riddell (2016) analyse the

[9] One technical reason for this is the relatively small sample of migrants in most countries' data sets though a few countries did oversample the migrant population, e.g. Canada. For a study which highlights the differences in literacy skills between immigrants and their native-born peers, see OECD (2017g).

[10] One example of such a paper is by Heisig and Solga (2015). They use PIAAC data for 18 countries focussing on the 30-44 age group to investigate the impact of tracking and vocational orientation of lower and upper secondary education on cross-country differences in the average numeracy skills of, and skill gaps between, adults with low and intermediate educational qualifications. Their results show that educational systems with more tracking amplify these skill gaps. On the other hand, systems which put greater emphasis on vocational skills tend to narrow the gap in numeracy skills.

relationship between ageing and literacy skills using cross-sectional data from IALS, ALL and PIAAC which span the period from the mid-1990s to 2012. Six countries (Australia, Canada, Italy, the Netherlands, Norway and the US) participated in all three surveys whereas five other countries (Belgium (Flanders), Denmark, Finland, Ireland and Sweden) participated in IALS and PIAAC.

Using the data from all 11 countries, they show that the relationship between literacy skills and age is negative beginning from the mid-40s on, after controlling for other factors which determine literacy. However, the authors acknowledge that the negative relationships found in these cross-section data from the three surveys confound age and "so-called generational (or cohort) effects", i.e. a person aged 30 in 2012 may differ from a peer aged 20 in 2012 not only because they are older but also because they are from an earlier birth cohort which may have experienced a different quality of education.

In order to separate true ageing from cohort effects, the authors construct so-called "synthetic cohorts" from the three surveys which allow them to follow a common birth cohort over time. Obviously, this is less ideal than using true panel data to follow the same individuals over time. But it does permit them to create a quasi-panel data set whose literacy skills they are able to track over time.

The synthetic-cohort analysis reveals that the negative literacy-age profile persists in 10 of the 11 countries – Italy is the sole exception. A worrying finding for policy makers is that in 8 of the 11 countries studied successive birth cohorts have lower literacy skills than previous generations – Finland, the Netherlands and Italy are the sole exceptions[11]. Unfortunately, the authors do not investigate the possible causes of the declining literacy skills across successive generations of youth. It will be vital to see if this pattern of falling literacy skills is replicated in the second cycle of PIAAC and, if it is, it will be a very high priority to analyse the reasons for it and design policies to ensure that successive generations of youth record improvements in skills proficiency on average.

Links between PISA and PIAAC[12]

Analysis of youth skills and the school-to-work transition can benefit greatly from links being established between the skill assessments of 15-year-olds in school in PISA, the test scores of young adults in PIAAC and their early career trajectories and labour market outcomes.

Krassel and Sorensen (2015) present a very interesting example of such work using matched data from the two surveys from Denmark. Their aim is to assess the returns to cognitive and non-cognitive skills and whether the timing of acquisition of these skills matters for labour market outcomes. They do this by measuring skills at age 15 prior to entering the labour market and then measure the same skills after several years in the labour market. PISA provides the former data for the year 2000, and PIAAC the latter for

[11] Wheater and Worth (2104) undertake a similar analysis with synthetic cohorts for England comparing the literacy skills of young adults aged 16-24 in IALS with those aged 32-40 in PIAAC.

[12] Such links can be used to analyse other issues than the school-to-work transition. Hanushek et al. (2104) use data on teachers' literacy and numeracy skills from PIAAC combined with micro data on student performance from PISA for the common sample of countries that participated in both assessments. The data are used to estimate cross-country education production functions that control for student, school and country fixed effects and also for parental education. Their results show that higher levels of teachers' cognitive skills raise pupil performance significantly.

the year 2012. What is rather unique about the Danish case is that the PIAAC sample is a subset of the PISA sample at age 27. Cognitive skills are proxied by the literacy test scores from both surveys and measures of non-cognitive skills are derived from the background questionnaires attached to the surveys.[13] The two labour market outcomes tracked are earnings and employment derived from a longitudinal administrative data base.

The results show that so far as earnings are concerned, both cognitive and non-cognitive skills are equally significant, while the former are more significant than the latter in terms of employment outcomes. The results also suggest that the timing of acquiring cognitive skills is a less significant factor.

Wheater and Worth (2014) make comparisons between the performance of English pupils in reading and maths in 2006 and 2009 from PISA with the literacy and numeracy skills of young adults in PIAAC who would have been aged 15 at the time of the PISA surveys. Unlike the Danish study comparing PISA and PIAAC results, this comparison for England is not based on longitudinal data. But it does show a worrying trend for England as it shifts from an average ranking on the PISA tests to a bottom ranking position on the PIAAC assessments for those in their late teens, and only a slightly better outcome for those in their early 20's. This finding poses a stark question for British policy makers: why did young people in other OECD countries make greater progress in literacy and numeracy skills between the ages of 15 and the early 20s than their English peers?

A recent study by Borgonovi et al. (2017) takes data from both PISA and PIAAC between the ages of 15 and 27 in the sample of countries which participated in both assessments to examine the evolution of both socio-economic and gender disparities. Their findings show that the socio-economic gaps are exacerbated between the ages of 15 and 27, especially in the case of low-achieving students. Gender differences in literacy are marked at the age of 15, especially among low-performing boys. However, by age 24, this gap in literacy proficiency has been closed between males and females. The evidence also suggests that young males tend to outperform young women in digital literacy skills. Given the trend towards increasing digitisation in work and everyday life, this gender gap, if it is confirmed by future studies, would pose an increasing challenge for girls and young females in the future[14].

Further analyses using matched data from PISA and PIAAC would be very valuable in throwing more light on the transition from school to work, how the skills acquired in school, both cognitive and non-cognitive, are matched to labour market needs and how they are modified by early labour market experiences. Building such a longitudinal design feature into the second PIAAC cycle could be a worthwhile investment in terms of the potential for additional policy insights, though it would have to be weighed against the extra costs involved in such an extension.

[13] In PISA, the measures draw upon both the Student Questionnaire and the Cross-Curricular Questionnaire while in PIAAC the measures come from its Background Questionnaire. With both surveys, the non-cognitive skills were constructed using factor analysis.

[14] See Martin (2017b) for a discussion of the gender gaps in skills comparing PISA and PIAAC results.

3.2. The returns to skills

Since the early 1970s, drawing on the seminal work by Jacob Mincer, there is a vast empirical literature documenting the returns to investments in schooling. This literature seeks to quantify the returns to schooling, proxied by educational attainment, while controlling for a wide range of other factors believed to influence these returns.

However, proxying skills by educational attainment, leaves open the question as to whether cognitive and non-cognitive skills acquired outside formal education have effects on returns, over and above those attributed to schooling. PIAAC data permit us to test this latter hypothesis. The good news is that empirical evidence confirms that the skills measured in PIAAC matter for earnings and employment outcomes.

A series of studies by Hanusek and co-authors demonstrate that the skills measured in PIAAC lead to significant wage premia.[15] They also show that the size of the skills-earnings premia differs significantly across countries: Hanushek et al. (2017) report that the earnings premium with respect to numeracy skills, for example, ranges from a low of 10% in Greece to a high of 45% in Singapore. They show that labour market institutions and policies, e.g. the strength of collective bargaining, the share of public employment and the strictness of employment protection, can partly account for the large country differences in the estimated returns to skills. The skills premium is also positively correlated with a country's GDP growth rate.

There is, of course, a causality issue arising in connection with such estimates of the returns to skills. A recent study by Hampf et al. (2017) tackles this question directly using PIAAC data. They apply several different methods used in the literature to correct for causality bias. Their results suggest that OLS estimates of skills premia in terms of both wages and employment outcomes may well provide a lower-bound estimate of the true returns to skills.

The empirical evidence summarised in OECD (2017b) also shows that both schooling and cognitive skills matter for labour market outcomes, though the jury is still out as to which is the more important determinant of returns.

There is also interesting evidence about the relative importance of the three cognitive skills measured in PIAAC in terms of their impacts on returns. Hanushek et al. (2015) and Lane and Conlon (2016) both find that the estimated returns to numeracy are larger than those of literacy. But they report radically different pictures as regards the relative importance of the returns to problem-solving in technology-rich environments which I will refer to in shorthand as "ICT-literacy skills". Hanushek et al. (2015) estimate that the returns to ICT-literacy skills are only half as large as those for numeracy and literacy skills. Lane and Conlon (2016), on the other hand, estimate larger returns to ICT-literacy skills and the impact of schooling on these skills is less marked than it is for literacy and numeracy[16].

The latter is an intriguing finding which, if confirmed by additional research, suggests that educators and policy makers should put greater stress on developing ICT-literacy

[15] See Hanushek et al. (2015, 2017).

[16] See Falck et al. (2016) for evidence using PIAAC data on the high returns to ICT-literacy skills. In their cross-country sample, the estimated wage premium is 8% on average for a one standard-deviation increase in ICT-literacy skills.

skills, both via formal schooling but also for adults through FET and on-the-job training opportunities. Such skills are very likely to become even more important for economic success in the Fourth Industrial Revolution (see below).

3.3. Skills mismatch

As noted above, economists have devoted a lot of attention to the issue of skill mismatch and its potentially negative consequences for individuals, firms and society. Many different measures of skill mismatch have been proposed in the literature and the traditional approach has been to use data on either education or occupation to derive proxy measures of mismatch.[17]

However, PIAAC and Cedefop's European Skills and Jobs Survey have enabled one to extend the measures of mismatch by asking workers to judge whether their existing educational qualifications or skills are well matched to the requirements of the jobs they currently hold. This has enabled analysts to derive measures of so-called "over-education and under-education" and "over-skilled and under-skilled"`; a third concept relates to "field of study" where mismatch arises when workers are employed in jobs which do not correspond to their formal educational qualifications. It is important to note, however, that these measures are based on subjective judgements by workers and do not take into account the views of employers about the education and skill requirements for specific tasks/jobs.

Work using PIAAC data to measure these different concepts of mismatch and assess their impact on labour market outcomes is reported in OECD (2013, 2014, 2017b).[18] These studies show that the various measures of skill mismatch are quite significant in most countries and that they have implications for estimated wage premia and employment outcomes. The estimated effects tend to wane as workers age or with job tenure, suggesting that most employers are reasonably good at matching workers' qualifications/skills to those required by the job.

There are some significant problems with these skill mismatch measures, however. First, as OECD (2017c), McGuiness et al. (2017) and Flisi et al. (2017) highlight, the many different mismatch measures proposed in the literature differ significantly in magnitudes and are generally not strongly correlated to one another. Second, McGuiness et al. (2017) argue that there have been relatively few policy initiatives at the national or EU level aimed at reducing skills mismatch. Instead, policy tends to tackle mismatch indirectly by making education and training systems more responsive to changing labour market requirements. OECD (2017d) identifies a range of good practices to reduce skills imbalances drawing upon five country case studies for France, Italy, Spain, South Africa and the United Kingdom. Measures in this area include occupational forecasting models, bringing together key actors in occupational or sectoral skills councils; improving career guidance and counselling services; and providing effective training to unemployed workers.

In order to overcome some of the weaknesses of standard skill mismatch measures and link them to measures of skills shortages, the OECD has recently developed the *OECD*

[17] See OECD (2017c) and McGuiness et al. *(2017)* for extensive literature reviews of the various concepts of skill mismatch.

[18] See also Quintini (2014) for a detailed discussion.

Skills for Jobs Database. It starts from five standard labour market indicators which are adjusted in order to extract signals as to which occupations reveal surpluses or shortages. The five sub-indices are then aggregated into an overall occupational shortage index. In a second step, this information is then mapped in a very detailed manner from occupations to measures of the skill requirements for each occupation. The latter data are taken from the U.S. O*NET database which covers cognitive and non-cognitive skills as well as tasks, work context and work activities. The final skill shortage indicator adjusts the different skill requirements for each occupation by the extent of the shortage computed in the first step.[19]

Since PIAAC contains data on the task content of skill requirements, it would have been possible to use these data to compute the skill shortage indicators. However, the PIAAC data on task-based skill requirements are not as detailed as those in O*NET, and this explains why they are not used in the new OECD Database. While the new Database is an undoubted advance over standard skill mismatch measures, it relies, among other assumptions, on the maintained hypothesis that the task content of occupations in the United States is identical to that in other countries. Given the large differences in technology, factor and goods prices across OECD countries, testing this assumption would be warranted.

3.4. Skill use at the workplace

A more promising approach perhaps than seeking to refine skill mismatch measures is the recent focus on *skill use at the workplace* drawing upon PIAAC data. This comes from information collected via the JRA module in the BQ which collects information on the *tasks* which respondents undertake in their jobs and maps them into the use of five information-processing skills, namely reading, writing, numeracy, ICT and problem solving. Workers are then asked to rate the *frequency* with which they perform these tasks on the job and their responses are aggregated to derive measures of skill use.

Evidence reported in OECD (2016) shows that workers who engage more often in tasks involving information-processing skills enjoy a wage premium after controlling for other factors such as education, skill proficiency and occupation. It is also shown that more effective skill use is correlated positively with employee satisfaction and self-reported well-being, once again after controlling for a wide range of other determinants including wages. Finally, skill use is also strongly correlated with productivity.

Henseke and Green (2016) make a novel use of PIAAC data on work tasks, combined with self-assessment by workers as to whether a tertiary-level qualification is required to do their job, in order to derive a new skills-based indicator of graduate jobs. They compute this indicator for 31 countries/regions and show that, on average across these countries, roughly one-third of jobs can be classified as graduate jobs. Their preferred indicator explains graduate wages and job satisfaction better than two alternative classifications which have been used in the literature on graduate jobs. Part of the cross-country variation in the proportions of graduate jobs can be explained by differing industry and firm-size characteristics. Another part can be explained by the relative quality of higher education systems across countries. But they admit that this still leaves large unexplained country differences in the prevalence of graduate jobs.

[19] See OECD (2017c, Chapter 2) for a detailed discussion of the methodology and the data sources underlying the indicators.

There is great policy interest in how the demand for graduate skills is evolving in a period of rapid technological change and the ways in which the supply of such skills is adapting to these signals. PIAAC data on skill use in the workplace is contributing to this debate via this new indicator[20]

Of course, measures of skill use which are based on subjective assessments by workers can be criticised, as can the fact that skill use is equated with the frequency with which specific tasks are performed on the job – no allowance is made for the complexity of tasks nor is the list of tasks assessed in the JRA exhaustive. Once again, it would be highly desirable to have an employer perspective on skill use to contrast with the views of workers[21].

3.5. Changing comparative advantage and Global Value Chains (GVCs)

Standard theories of the determinants of comparative advantage in international trade in goods and services have traditionally distinguished between two types of labour, low-skilled and high-skilled, with a focus on the degree of complementarity or substitutability between the two types of labour, capital and technology. In empirical applications of this theoretical framework, data on educational attainment or occupation are typically used to classify the workforce into these two skill groups.

As has been reiterated several times above, PIAAC represents a real advance over these traditional measures because it provides data on (a) key cognitive and non-cognitive skills; (b) the *task content of jobs*; and (c) attitudes to learning. The data on tasks are particularly important because recent studies on the impact of globalisation and technology on the labour market highlight the importance of this factor: jobs with a high *routine* content tend to be vulnerable to job loss and/or wage declines as a result of technological change or competition from low-cost competitors, whereas *non-routine cognitive* tasks are much less at risk[22]. In Martin (2017b), I speculated that the relative scarcity of ICT-literacy skills across countries revealed by PIAAC data could serve as an important determinant of comparative advantage in the new technological epoch now underway.

A recent OECD study, undertaken jointly by the Directorate for Education and Skills and the Directorate for Science, Technology and Industry, highlights the additional value which PIAAC data can bring to analyses of the changing patterns of comparative advantage. In particular, OECD (2017a) uses PIAAC data to show how skills impact on a new and rapidly-growing phenomenon in international trade, the so-called Global Value Chain (GVC). Such a chain arises when firms in different countries combine directly in the design, production, marketing and sales of the same goods and services. A classic example of a GVC is the intricate web which links the automobile industry in Canada, Mexico and the United States under the auspices of NAFTA. Measuring the extent of

[20] Green and Henseke (2016) use this new indicator to analyse the phenomenon of graduate underemployment across a large sample of OECD countries.

[21] See Green and James (2003) for an interesting attempt to compare workers' perceptions with those of their immediate line managers regarding skill requirements and the extent of autonomy in the job. While there was reasonable agreement between both parties with regard to the former, there was little agreement on the latter.

[22] See Acemoglu and Card (2011) for a detailed discussion of how the task content of jobs is key to understanding recent trends in international trade.

GVCs requires trade data by value added rather than conventional data on gross trade flows. New OECD data on value-added trade show that, on average in OECD countries, almost 40% of the value of manufactured exports and 20% of the value of business services exports come from abroad.[23] The corollary of this is that in many OECD countries up to one-third of jobs in the business sector are dependent on foreign demand.

These cognitive and non-cognitive skills are more important in export-oriented economies. OECD (2017a) estimates that countries whose workforces have the right mix of cognitive and non-cognitive skills in line with firms' requirements will have 8% higher relative exports compared with countries that have an average skill mix; this relative export gap could be as large as 60% between countries that exhibit very large differences in their skills mixes.[24]

OECD (2017a) develops six task-based skills indicators by applying factor analysis to more than 30 items from the PIAAC BQ: ICT skills; readiness to learn; management and communication skills; self-organisational skills; marketing and accounting skills; and STEM skills.[25] The best performers on cognitive skills in PIAAC tend to perform well on these task-based skills too, though there are some notable exceptions. For example, Japan and Korea who rank highly on cognitive skills are at the bottom of the country ranking in terms of readiness to learn, while the US which ranks average to below-average on cognitive skills performs better on task-based skills. Comparative advantage in GVCs arises when countries' skills mixes match well with industries' skills needs.

OECD (2017a) shows that not only do *relative skills endowments* matter for comparative advantage in trade and GVCs, but that the *dispersion* of skills within a country is also a key determinant. The latter is considered an indicator of the degree of complementarity between the skills of a worker and that of their co-workers. The theory underlying this hypothesis assumes that workers are heterogeneous in their skills and typically work in teams on the production process.

In order to improve their comparative advantage in trade and GVCs, countries need not only to invest in higher-quality education and training policies, they also need lower barriers to further investment in skills over the working life, especially for workers with low cognitive and non-cognitive skills. Success on these fronts requires a whole-of-government approach to ensure the necessary co-ordination and cooperation between education and training policies, migration policies, financing, innovation and trade policies.

3.6. The fourth industrial revolution

The advent of a new technological epoch – the so-called "Fourth Industrial Revolution" or the "New Machine Age" – has sparked renewed fears that it will lead to large-scale technological unemployment. Commentators, as Martin (2017a) points out, are very divided on this point. Some argue that the new era of digitalisation is different from previous technological epochs in that it will destroy far more jobs than it will create; others argue that it will not because the new processes, goods and services which will be created by the Fourth Industrial Revolution will generate more jobs than they destroy.

[23] See OECD (2017a, Figure 1.1).

[24] See OECD (2017a, Figure 1.6).

[25] See OECD (2017a, Box 3.1) for more details.

Both sides to this argument do agree on one point, however: that digitalisation will lead to major changes in the demands for and supplies of skills. Concerns about the impact of digitalisation on the future prospects for jobs and wages are also one factor behind the growth of populist sentiments in some OECD countries.

A catalyst for these concerns was a widely-publicised study by Frey and Osborne (2013) which claimed that almost one in every two jobs, on average across most OECD countries, was at high risk of being destroyed as a result of automation.[26] Other studies which applied the same methodology to specific countries came up with equally alarming estimates. However, the basic unit of observation chosen by Frey and Osborne was *occupation*: the implicit assumption is that if an occupation is assessed at being at risk of automation, all jobs in that occupation will be lost.

However, as noted above, jobs consist of different *tasks*, many of which are not susceptible to being automated or it will be very costly to do so. Since PIAAC contains new data on the task content of jobs, it provides a golden opportunity to assess the robustness of the Frey-Osborne method and its alarmist message. Arntz et al. (2016) used PIAAC data on the content of tasks carried out in jobs belonging to the same occupations. Their estimates paint a much less alarming picture: on average for the 22 OECD countries/regions in PIAAC, 9% of jobs were judged to be at high risk of automation with much less variation across countries than the Frey-Osborne estimates.

Work is ongoing under the OECD Going Digital Horizontal Project to refine and extend the Arntz et al. estimates using PIAAC data.[27] This shows slightly higher estimates of the share of jobs at high risk of automation: 13% on average across all countries in PIAAC compared with 9% in Arntz et al. Nevertheless, these findings are much less alarmist than the Frey-Osborne estimates and, as such, should provide some much-needed reassurance to policy makers and public opinion.

At the same time, the PIAAC data and the new OECD Project do not provide grounds for complacency in the face of the Fourth Industrial Revolution. They show that the task content of most jobs will be affected by digitalisation and this will put significant demands on the supplies of skills. For example, it is very likely that digitalisation will squeeze the demand for low-educated, low-skilled workers undertaking routine tasks and expand the demand for workers engaged in abstract thinking, creative work and problem solving. In order to ensure that this process does not lead to significant unemployment and rising wage inequality, governments with have to put in place a multi-pronged strategy encompassing education and training policies to promote lifelong learning, effective active labour market policies to assist displaced workers to find new jobs and tax/transfer policies to tackle inequality.[28]

[26] "High risk" in this study was equated with a 70% probability of a job being destroyed, as assessed by expert judgement.

[27] This ongoing work exploits individual-level occupational data from the Canadian PIAAC sample to give a finer mapping of the tasks-jobs-occupation nexus.

[28] See Executive Report of the President (2016) for an outline of such a strategy for the U.S. economy.

3.7. Lifelong learning

Lifelong learning for all is a laudable goal but it is far from being achieved in OECD countries. The data from PIAAC, as with other surveys on education and training activities, confirm this. Adult participation in education and training activities is far from universal and the degree of participation varies greatly across countries. The PIAAC data show that adult participation rates in formal and non-formal (including on-the-job training) education in 2012 or 2015 were highest in New Zealand, the Netherlands, the Nordics, the U.S. and Canada, while the lowest participation rates were recorded in the Southern European countries, Slovakia, Turkey, Poland and France.

At the same time, the PIAAC data confirm the ubiquity of the "Matthew Effect" in terms of the access by adults to lifelong learning opportunities. In all countries, those workers with the most education and skills participate far more in learning opportunities than their peers with less education and skills. At the same time, workers participate more than the unemployed who, in turn, participate more than the inactive of working age. However, it is noticeable that the size of the Matthew Effect differs significantly across countries. Some OECD countries, notably the Nordics, New Zealand, Australia and the Netherlands, seem to be better at ensuring more equal access to formal and informal learning opportunities for adults across age, education, skills and income.

Increasing adult participation in learning and reducing the size of the Matthew Effect would certainly boost the skills base in OECD countries and improve their ability to profit from the digitalisation boom. Martin (2017a) shows, using PIAAC data, that there is a very strong positive correlation across countries between their participation rates in adult learning and their average proficiency in ICT-literacy skills.

Some evidence suggests that motivation to learn and "cultural capital" (proxied by parental education, reading practices and levels of trust) are important supply-side determinants of adult participation in learning activities. It is also the case that demand-side factors play an important role too. The financial costs of investment in learning can bear heavily on the decision to participate or not and that barrier, in turn, raises the question of how these financial costs are to be split between the workers, their employers and the public purse. Nor are all barriers financial ones, the opportunity costs of investment in learning, e.g. the time constraint and foregone leisure, can prove very significant for workers in mid-career who have to balance family/caring responsibilities against learning investments. The latter trade-off is a particular burden for women to bear. Similarly, older workers and their employers may see little benefit to learning investments given the limited time remaining to amortise the costs before they retire.

Desjardins and Lee (2106) use PIAAC data to investigate a specific sub-sector of Lifelong Learning systems, Adult Higher Education (AHE). Their aim is to show how the patterns of AHE across the countries participating in PIAAC translate into employment and earnings outcomes. They also develop an indicator of the *openness of AHE systems* which they define as the incidence of adults completing higher education at age 31 and over to those who completed their courses at age 30 or less.[29] The aim is to distinguish between so-called "non-traditional students" i.e. those adults who completed their course at a later age, and those youth who entered higher education immediately or very soon after completing their second-level studies, so-called "traditional students".

[29] The age cut-off at 31 is arbitrary but the authors also experiment with a lower cut-off of 26 and over.

Desjardins and Lee (2106) show that in many of the countries which participated in PIAAC, a non-negligible proportion of adults completed their higher education as non-traditional students. In addition, there are large cross-country differences in the incidence of adults completing their higher education courses as non-traditional students. For example, about one in three adults completed their courses after the age of 31 in the Nordics (excl. Finland), while about one in four did so in the United Kingdom, Finland, the U.S. and Ireland. At the other end of the league table, less than one in ten adults beyond the age of 31 completed in France, Spain, Cyprus[30], Belgium and Japan. Not surprisingly, their results show that completion of AHE leads to higher earnings and employment for both traditional and non-traditional students.

This evidence suggests that there are positive benefits to having an open AHE system which provides *second chances* to many adults to upgrade their qualifications and skills. It will be important for policy makers to reflect on the reasons why certain countries, notably the Nordics, seem to be able to foster greater adult participation in learning activities and at the same time reduce the degree of inequality in access by age, education or income. One feature which may go some way to explaining this is the central role which the social partners play in the Nordic countries in supporting lifelong learning. Another may be the degree of public subsidies and tax credits which aim to lower the costs of investing in adult learning.

Further research is needed using PIAAC data to investigate the various barriers, both financial and non-financial, which hinder investments in adult learning by workers and employers. In particular, research needs to focus more on the underlying determinants of the large inequalities in access to adult learning opportunities by skill and income levels. Only when this is done will it be possible to devise policies which will increase investments in adult skills upgrading and make real progress towards achieving lifelong learning for all.

3.8. Ageing-skills-productivity-wages

Ageing populations and work forces are one of the major structural changes which OECD countries will have to cope with over the coming decades. In order to minimise the potential adverse effects of ageing on economic growth and living standards, possible solutions include raising the employment rates of older workers and/or increasing productivity growth.

Now, there is some good news on the former front. The long trend throughout much of the 20th century towards early retirement has been broken in almost all OECD countries over the past two decades. Employment rates for those aged 50 and over have risen in virtually all countries, sometimes by very large amounts. It is also noticeable that the rising trend in older worker employment rates was barely disrupted by the Great Recession. Increasing employment among older workers can be accounted for by two factors: (i) older workers staying longer with their firms before they retire; and/or (ii) an increase in the hiring of older workers. Evidence collected by the OECD for its thematic review on *Working Better with Age* shows that the former, as proxied by the *retention rate* for older workers, is the dominant factor. Hiring rates for older workers are typically much lower than those for younger or mid-career workers, and they have not risen in recent years despite the ageing of the work force.

[30] See the Note * to Box 1 above.

These trends on the older worker labour market raise questions about the links between skills, skill use, productivity and wages. Several studies using data from PIAAC and its two predecessor surveys have sought to address these issues. Barrett and Riddell (2016), Paccagnella (2016) and OECD (2017e) all show using PIAAC data that the age-cognitive skills profile peaks around the age of 30 before declining slowly among older cohorts. The data show, however, large dispersion in skills within age groups. They also show large cross-country differences in age-skills profiles, e.g. the raw differences in cognitive skills between those aged 25-44 and those aged 45-65 range from 10 points in the U.S. to over 35 points in Finland. However, once these age-skills profiles are adjusted for the effects of own education and parental education, the age gaps decrease though they still remain significant.[31] It is noticeable that the age gaps in skill proficiency are much larger at the bottom than at the top of the skills distribution, suggesting that the more able or motivated workers experience lower skill declines as they age.

Participation in adult education and training, and the extent to which workers make use of their skills on the job, could both help to slow the decline in cognitive skills as workers age. However, PIAAC data show that the propensity to engage in adult education and training declines slowly but steadily after it peaks in the mid-20s until the late 50s, after which it drops off steeply. Paccagnella (2016) notes that higher participation rates in adult education and training, while they show a positive correlation with higher average skills proficiency, are not effective in reducing the age-related drop in proficiency levels. He explains this by the fact that countries with high rates of participation in lifelong learning are those where the rate declines more steeply with age.

Skills use rates among older workers are lower than among younger workers, partly reflecting the fact that the former have lower average levels of education. At the same time, OECD (2017e), using the PIAAC data on tasks performed on the job, shows that older workers do not engage in the same tasks as younger workers: they tend to be more involved in supervisory roles and to have more autonomy in their work.

Unfortunately, it is very hard to measure age-productivity profiles and the cross-sectional data in PIAAC are not much help in this regard.[32] Instead, it is possible to use the PIAAC data to investigate the role of *seniority pay*, i.e. the degree to which wages are tied to job tenure within a firm. OECD (2017e) shows that in all countries wages typically rise with tenure until they peak when workers are aged in the mid-50s. At the same time, the tenure-wage profiles differ significantly across countries. The tenure-wage profile is regressed on a wide range of socio-demographic controls as well as cognitive skills, skill use and job complexity. While the latter three factors tend to lower the impact of job tenure on wages, the tenure effect remains strongly positive and significant.

Could seniority wages provide part of the explanation for higher retention rates for older workers and lower hiring rates? OECD (2017e) presents cross-country plots of (a) employment rates of workers aged 50-64; (b) retention rates[33]; and (c) hiring rates for

[31] See Paccagnella (2016) for the details.

[32] Paccagnella (2016, Box 2) contains a literature review but is forced to admit that the empirical evidence is inconclusive on whether productivity declines significantly with age or not.

[33] The retention rate is defined as all workers aged 60-64 with job tenure of five or more years as a percent of all workers aged 55-59 five years previously.

older workers[34] against a measure of the tenure-wage premium – the latter is proxied by the per cent wage growth as tenure increases from 10 to 20 years. The correlations with regard to the first two measures are negative but are not very significant. The correlation between the hiring rate of older workers and the tenure-wage premium is positive but again not very significant. Since hiring an older worker should, *ceteris paribus*, be less costly, this could suggest that a large seniority wage premium is a disincentive to hiring older workers.

But these are only simple cross-country correlations and not much can be read into them without controlling for other factors which determine hiring rates, e.g. the strictness of employment protection legislation, net replacement rates, the strength of collective bargaining, and the enforcement of anti-age discrimination legislation. Further investigation of these issues using PIAAC data, especially via the second cycle, would be very relevant for policy makers since it is vital to understand better the reasons for the very low hiring rates for older workers.

3.9. Inequality

The rising trend in wage and income inequality which most OECD countries have experienced over the past two decades has generated a large and growing literature exploring its causes and consequences. Much of the debate on the former centres around testing the well-known Tinbergen hypothesis cited above. Of course, the empirical evidence shows that other factors in addition to education and technology impact on inequality, notably a range of labour market policies and institutions (employment protection legislation, minimum wages, collective bargaining, active labour market policies), product market competition and the redistributive power of the tax/transfer system.[35]

Some cross-country studies, cited in OECD (2017b) and Broecke (2016), using PIAAC data show only weak evidence of a link between cognitive skills and wage inequality. But Broecke (2016) also shows that skills account for a significant share of the earnings gap between certain socio-economic groups, e.g. between men and women, youth and older workers, immigrants and the native-born, etc.

In order to get a full picture of the impact of skills on wage inequality, it is vital to bring both the demand and supply sides of the skills equation into the picture. A recent study by Broecke et al. (2017) does just that using PIAAC data. Their results show that skills do indeed have a significant impact on wage inequality, both the relative supplies of skills as well as their distribution across the work force in different countries. The relationship works through the relative *net* supplies of skills having a direct impact on *skills prices*. For example, the estimates reported by Broecke et al. (20170 suggest that the higher relative net supply of high-vs. middle-skilled workers in other countries accounted for 29% of the higher P90/P50 wage ratio in the United States. However, their estimates also suggest that the relative net supply of skills had no impact on the higher wage inequality at the bottom of the wage distribution. The authors also find that labour market institutions and policies are significant determinants of wage inequality across countries.

[34] The hiring rate is defined as workers with a job tenure of less than one year as a percent of total employees. The hiring data relate to 2014.

[35] See OECD (2011).

Paccagnella (2015) uses PIAAC data to assess the impacts of both skills proficiency and educational attainment on different segments of the earnings distribution. He finds that there is a strong positive correlation between inequality in both the distributions of skills and wages and the strength of the parental education gradient. This suggests that in more unequal countries adult earnings are more determined by parental education than they are in more equal countries. Further research is needed to understand better the impact of parental education on inequality of outcomes across countries and to indicate which policies might help mitigate this effect.

Green and Pensiero (2016) use data on literacy and numeracy skills from PISA and PIAAC to assess the contribution of different upper secondary education and training systems to inequalities in skills and outcomes. They focus on those aged 15 in PISA 2000 and the age-group 25-29 in PIAAC using a pseudo-cohort approach. Skills inequality is proxied by two measures: (i) the Gini coefficients corresponding to the distributions of literacy and numeracy skills; and (ii) the inequality of skills opportunity which is measured by the ratio of the mean skill levels of youth whose parents have upper secondary education or less to those of youth whose parents have a third-level qualification. The education systems of the 21 countries/regions in the study are classified into four types in line with their institutional structures, forms of curriculum and assessment and modes of governance/regulation.

Their results show that greater "parity of esteem" between academic and vocational tracks, as exists in German-speaking countries and the Nordics, has a positive impact in mitigating skills inequality. But more important influences in mitigating skills inequality are high completion rates from long-cycle upper secondary education and training and mandatory provision of maths and the national language in the curriculum.

Not only are skills a determinant of inequality; they are also a factor behind social mobility across generations. It is noticeable that most of the variation in the skills measured by PIAAC is *within* countries, not between them. This leads naturally to concerns about socio-economic disparities in cognitive and non-cognitive skills and their impact on social mobility. Alan Krueger, a former Chairman of the U.S. President's Council of Economic Advisers, coined the term the "Great Gatsby Curve" to describe the negative correlation across OECD countries between income inequality (proxied by the Gini coefficient) and a measure of social mobility (proxied by the elasticity of intergenerational earnings mobility which is the correlation between the earnings of sons with those of their fathers)[36].

Martin (2017b) uses PIAAC data to show a similar negative Gatsby-like curve between mean literacy scores across countries and a measure of intergenerational social mobility. This is, of course, only a correlation and says nothing about causality. But it highlights the need for further research using PIAAC data to explore the links between inequality, skills, and social mobility, both within and across countries.

3.10. Well-being

While most of the studies to date using PIAAC data have examined education, training and labour market issues, issues central to individual and social well-being have also been tackled. PIAAC contains data on trust, health status and participation in a range of activities such as politics, non-governmental organisations and volunteering.

[36] See Corak (2013) for a good discussion of the Great Gatsby Curve.

PIAAC data show large cross-country differences in a measure of interpersonal trust: it is highest in the Nordics and lowest in the Czech Republic and Italy. Studies reported in OECD (2017b) show that an individual's own education, as well as the education of their parents, is positively correlated with trust. Cognitive skills are a key intermediating mechanism through which education fosters trust[37]. Employment is positively related to trust but there are large cross-country differences in this relationship. Evidence also suggests that the countries having higher trust levels are likely to have lower income inequality.

PIAAC provides some limited evidence on the links between cognitive skills and self-reported health status based on a single item in the Background Questionnaire. OECD (2017b) shows, not surprisingly, that the cognitive skills measured in PIAAC are positively correlated with health status. Once additional socio-demographic controls are added, the positive and significant effect only holds for literacy skills.

Borgovoni and Pokropek (2016) analyse the links between human capital, measured by years of schooling and literacy proficiency, and health status using PIAAC data for 23 countries/regions. Education and skill gradients in health are largest in the U.S. and least in Italy, France, Sweden and Finland. Their estimates show that, on average, almost 6% of both the schooling and literacy gaps in self-reported health is accounted for by the higher trust levels that better-educated and more-skilled individuals report. However, since PIAAC only contains one item on health status, it cannot be used to delve deeply into the links between skills, health and trust.

Some evidence using PIAAC data reported in OECD (2017b) shows that cognitive skills are positively related to political participation, even after controlling for education. Vera-Toscano et al. (2017) analyse the links between education, skills, and participation in adult learning and two social outcomes from PIAAC: interpersonal trust and volunteering. They show that cognitive skills matter for social outcomes, over and above the impact of formal education. They also show that participation in adult learning has a significant impact on volunteering.

The encouraging conclusion from these studies is that cognitive skills have impacts on a range of social outcomes which contribute to individual and social well-being.

4. Suggestions for the 2nd cycle of PIAAC

In this section, I put forward four suggestions for changes to the design of PIAAC with the aim of enhancing its usefulness for policy making. In doing so, I am basing them on my experience with the development and implementation of the first cycle and the key findings and lessons summarised in the previous section. Now that planning for the

[37] Borgovoni and Burns (2015) stress that education fosters trust both directly by building cognitive skills for individuals and indirectly by encouraging the non-cognitive skills which play a vital role in developing and maintaining trust with others.

second cycle is underway, I offer these suggestions with the hope that the BPC may find them useful and be able to incorporate them in the revised survey design for PIAAC. Naturally, the cost implications of these and other suggested changes, as well as possible repercussions on response rates, would need to be weighed against the potential benefits from implementing them.

4.1. The need to incorporate an employer perspective on skills

PIAAC does a pretty good job on the supply side of skills though doubtless some improvements could be made on this front. However, the present survey design tells us almost nothing about the demand-side perspective on skills, how they are utilised in the workplace, what incentives and opportunities exist to upgrade skills and what role they play in hiring and retention decisions. For this, it is vital to bring employers' views on skills explicitly into the survey – a point which has been reiterated several times above.

If costs were not a constraint, the first-best solution would be to design a specific representative employer survey as a complement to the survey of working-age adults.[38] But designing, testing and implementing such a new survey within the timeline for the 2nd cycle seems too large a call, never mind the cost implications. Instead, adding a specific PIAAC-inspired module to an existing employer survey seems the most promising way to proceed. One possible candidate could be the EU's Continuing Vocational Training Survey which already contains a wealth of information about employer training investments. If this were done, it would enable one to compare and contrast workers' and employers' perceptions about skill use and skill mismatch and the priorities and barriers to skill investments. It would also shed light on the factors on the employer side which account for the Matthew Effect and possible ways to weaken it.

4.2. A revised measure of problem-solving skills

I have a confession to make here. I do not like the skill title "problem solving in a technology-rich environment". It is a real mouthful and I suspect that it makes little sense to most people outside the small world of PIAAC aficionados! I would suggest replacing it with a shorthand title such as "ICT-literacy skills".

The key challenge in this area for the 2nd cycle is to revisit this skill domain and develop additional items which could enable us to understand one of the mysteries which has emerged from the first cycle. Why is such a large proportion of the working-age adult population in all countries only able to perform at a very low level of proficiency – Level 1 and below- and only a tiny fraction (5.4% on average) able to perform at the highest level?[39] In addition, there is also the fact that, on average across the participating countries/regions in the first and second waves, 10% of adults stated that they had no computer experience and a further 14% either failed the ICT core test or opted out of taking it. If we added them to the adults who scored at Level 1 or below, we arrive at the

[38] Ideally, one would aim for a linked employee-employer survey. Some countries have such surveys in place, mainly via linked administrative data sets. But such surveys are not common in most of the countries participating in PIAAC, they are costly to set up and would be likely to create response-rate problems, especially for small and medium-sized firms. For these reasons, a linked employee-employer survey is a non-starter for the 2nd cycle of PIAAC.

[39] See Table 2.3 and Figure 2.16 from OECD (2016b).

astonishing figure that two out of three adults on average across the participating countries have low or no digital skills!

It should be a very high priority for the 2nd cycle to establish whether this is partly a measurement issue or is indeed an accurate reflection of the levels and distributions of digital skills in the adult populations in participating countries. If the latter is the case, countries need to assign a very high priority to devising ways to increase the level of proficiency in digital skills given that it is likely to play such an important role in the Fourth Industrial Revolution.

With this in mind, the proposals put forward in OECD (2017f) to develop an *adaptive* problem–solving domain for the second cycle is surely a step in the right direction since its aim is to combine cognitive and meta-cognitive processes in a way that would more accurately reflect the use of "digital skills" in work and everyday life.

4.3. Soft skills

There is a great emphasis placed nowadays on so-called "soft skills" such as communication, teamwork, empathy, self-motivation and leadership. Some would go so far as to argue that they are just as important, if not more so, than cognitive skills. But it has to be acknowledged that there is no consensus on the definition or measurement of soft skills.

The first cycle of PIAAC took some small steps towards measuring some soft skills via items in the BQ. But it has to be recognised that it is a major task to try to derive internationally comparable and robust measures of many soft skills. It would, however, be a major feather in the cap of PIAAC if it proved possible to add additional items on such skills to the 2nd cycle. This would demonstrate whether such skills are complements or substitutes to cognitive skills and the degree to which they are rewarded in the labour market.

4.4. Links between PISA and PIAAC

As noted above, there has been some work already linking the two surveys. Given the persistence of high youth unemployment in many countries and the evidence that this gives rise to significant economic and social costs – the so-called "scarring effects" – it should be a high priority to exploit the potential of the two surveys more in the future. This would throw greater light on the transition from school to work via alternative pathways, how dual labour markets impact on this transition, how well equipped recent youth cohorts are with digital skills. It would also answer the gender paradox which seems to emerge from a quick comparison of the two surveys (see above).

5. Concluding remarks

Skills are a vital ingredient for economic success and individual and social well-being, now more than ever before as the Fourth Industrial Revolution gets into its stride and ageing populations and workforces become the new norm. Against this background, it is vital for countries to have a reliable information source against which to benchmark the levels and distributions of key skills among their adult populations, how these skills are upgraded and adapted to match changing requirements, and which helps to identify effective policy levers to influence the supply and demands for skills. The material reported above shows that PIAAC, via its crown jewel – the OECD Survey of Adult Skills – is well on its way to fulfilling these goals and justifying the large investments participating countries have made in it. In addition, the planning now underway for the 2nd cycle will lead to improvements in PIAAC drawing upon lessons from the first cycle and further expert group work under the auspices of the BPC.

It is very encouraging to see the growing volume of research using PIAAC data to address a wide range of issues. Various academics, research institutes and the OECD Secretariat have been at the forefront of this process of diffusion of PIAAC data and policy lessons. For example, the various issues of the *OECD Skills Studies*[40] and recent editions of the *OECD Employment Outlook*[41] are strong outlets for diffusing PIAAC messages, as are the various international PIAAC conferences organised by participating countries and the OECD Secretariat. This process will gather momentum in the coming years so that I predict that, with time, PIAAC will become as well known and as influential in the world of adult skills as PISA is for schooling.

[40] For a full list of these studies, see *www.oecd-ilibrary.org/education/oecd-skills-studies_23078731*.

[41] See the chapters on skills in OECD (2014, 2015b, 2016a).

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