UNIVERSITAT DE BARCELONA

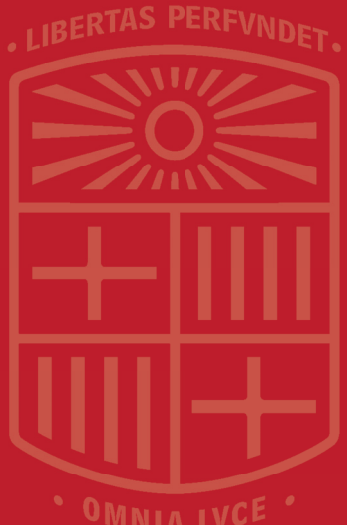
How are adult skills acquired? Three comparative essays based on PIAAC

Rosario Ivano Scandurra

PhD in Sociology

How are adult skills acquired? Three comparative essays based on PIAAC

Rosario Ivano Scandurra



UNIVERSITAT DE BARCELONA

PhD in Sociology

Thesis title:

How are adult skills acquired? Three comparative essays based on PIAAC

PhD student:
Rosario Ivano Scandurra

Advisors:
Elisabet Almeda Samaranch
Jorge Calero Martínez

Date:
July 2016

UNIVERSITAT DE BARCELONA

PhD in Sociology

Thesis title:

How are adult skills acquired? Three comparative essays based on PIAAC

PhD student:

Rosario Ivano Scandurra

Advisors:

Elisabet Almeda Samaranch and Jorge Calero Martínez

Date September 2016

Recommended Citation: Scandurra, R., 2016. *How are adult skills acquired? Three comparative essays based on PIAAC*. PhD thesis. Universitat de Barcelona.

Acknowledgements

The last four years have been a very enriching experience and this has been possible thanks to the many people I worked with in my field of education and research.

First and foremost, I want to express my gratitude to my advisor Jorge Calero, who has always kindly dedicated his time to discussing and challenging my work with rigour and has meticulously read and commented on countless revisions of this manuscript. It would be fair to say that Jorge's edits and suggestions are the reasons why a portion of this thesis has been considered for publication in a few international journals. The completion of this thesis would have not been possible without his guidance and support. I hope to one day be as good an advisor to my students as Jorge has been to me.

Additionally, I would like to thank Elisabet Almeda for her guidance during these years and the research group Copolis, which organized various seminars where I discussed parts of my research. I am also grateful to Marius Dominguez for the opportunity he gave me to be a teacher's assistant in the research design seminars. I appreciate the financial support from the FI-DGR 2013 of the Generalitat de Catalunya that funded the research in this dissertation and of the research project *Familias monoparentales del nuevo siglo. Retos y dilemas en tiempos de cambio* (CSO2011-29889).

I am also very grateful to Rafael Castelló and Fabian Gouret who have provided me with useful feedback and suggestions regarding my work at its early stages. I would also like to say thank you to Jordi Roca and Eva Saez for their effective support with the administrative issues related to the doctorate program.

In the second year of the elaboration of this thesis, I visited the Robert Owen Centre for Educational Change at the University of Glasgow. For the hospitality I received at the University of Glasgow, I must especially thank Oscar Valiente, for his suggestions regarding my dissertation. The ideas that emerged during that time were crucial in the development of my thesis. In my third year, I visited the Bremen International Graduate School of Social Sciences (BIGSSS) under the VII *Framework Programme* Ingrid project. For the support and kindness I received in Bremen, I would like to thank Florian Hertel and Olaf Groh-Samberg.

I am also indebted to different researchers with whom I have interacted during the PhD programme. Particularly I would like to acknowledge Alvaro Choi, Joan Guardia Alessia Matano, Jochen Mayerl, Ivan Mejía, Elisenda Renteria, Melanie Revilla, Peter Wagner, Adrian Zancajo, and Matias Zarlenga, who at different stage of my research provided me with comments and helped enrich my ideas. I would also like to thank Mario Novelli and Alan Smith for the things I learned during the seminars to which I was invited.

I would like to express my gratitude to some of the teachers, whom I have encountered during my time as a student. This list would be extremely long, but I would like to single out two of them: Maria Bisbano and Cosimo Cucinotta.

Very importantly, in my personal life, I want to say thank you to my friends for always being supportive during this time, especially Giuseppe, Lorena, Marco, Gianfranco, and Nela. Further, I would like to thank Little Louie, who contributed to change the music I like to listen and dance to.

Finally, I am deeply thankful to my parents and grandparents who have not only showered me with their love and care but have also provided me with the good values and work ethic which have allowed me to achieve all that I have. Last but certainly not least, I will always be grateful to Anna, whose infinite support and love have been fundamental in the almost ten years we have lived together. Thank you.

Content

List of figures

List of tables

List of abbreviations (in alphabetical order)

Adult Literacy and Life Skills Survey (ALL)

Comparative Fit Index (CFI)

Confirmatory Factor Analysis (CFA)

Degree of Freedom (df)

Economic, Social and Cultural Status (ESCS)

Educational Testing Service (ETS)

European Union (EU)

Information, Communication and Technology (ICT)

International Adult Literacy Survey (IALS)

International Labour Organization (ILO)

International Socio Economic Index (ISEI)

Literacy Skills Used in Daily Activities (LSUDA)

Mean and Variance Adjusted Weighted Least Squares (WLSMV)

National Adult Literacy Survey (NALS)

Organization for Economic Cooperation and Development (OECD)

Program of International Student Assessment (PISA)

Programme for the International Assessment of Adult Competencies (PIAAC)

Research and Development (R&D)

Root Mean Square Error of Approximation (RMSEA)

Structural Equation Modeling (SEM)

Tucker Lewis Index (TLI)

United Nations Educational, Scientific and Cultural Organization (UNESCO)

Weighted Least Squared (WLS)

Weighted Root Mean Square Residual (WRMR)

World Trade Organization (WTO)

Young Adult Literacy Survey (YALS)

Fatti non foste a viver come bruti, ma per seguire virtute e canoscenza.

Dante Alighieri, Inferno, canto XXVI

Without universal reading and decent wages, a government of public opinion is not possible.

John Stuart Mill, Essays on Politics and Society

In many people's opinion it is the poor, not the rich, who are social parasites, the more benign version of which opinion adds that the poor lack the ability to be productive.

Kenneth Arrow, Samuel Bowles and Steven Durlauf, 2000

Chapter 1. Introduction

1.1. Globalization and technology shifts

Globalization and technological progress have accelerated radical changes in contemporary societies (Piketty, 2014). This has implied modifications in the deep structures of capitalism and in its labour market. The two economic crises[1] of the seventies were the turning point when the saturation of some key markets brought a reconfiguration of contemporary capitalism. Many authors have named this process as Post-Fordism[2], describing the shift to new ways of consumption and production. Mass-production was partially replaced with diverse, less homogeneous and standardized goods and new forms of production emerged.

A plurality of macro processes have been changing the labour market from the demand side during the last four decades, such as: the degree of openness of the economy; the limits of a state's political intervention; the change in the composition of imported and exported goods and services; the specialization shifts of the economies; the use and development of advanced technologies and the trend of economic growth, which is very different compared to the previous period. From the perspective of the labour supply, population growth; the incorporation of hundreds of millions of workers into the global economy, mainly from China and India; the increasing migration inflows; the incorporation of women into the labour market and the increasing levels of education enrolment are some of the broad social changes which

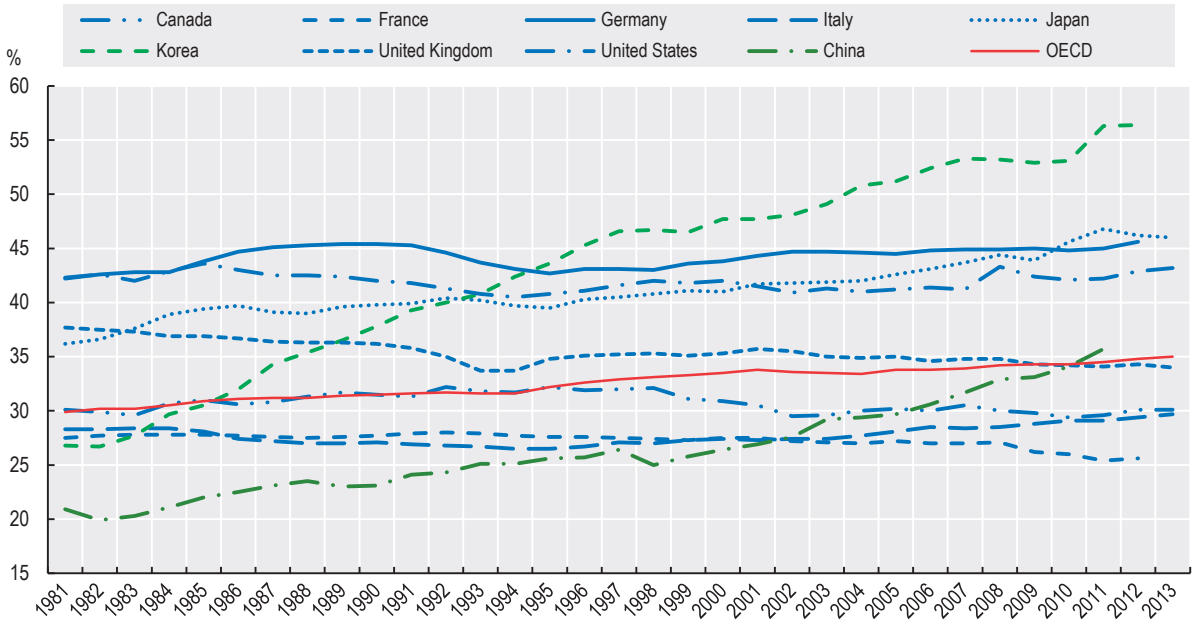
[1] The economic crises of the seventies were commonly related to a single process, which was misleadingly associated with the fast spike in the price of oil.. The first shock was in 1973, with the Yom Kippur War and the second one in 1979, with the Iranian Revolution. Nevertheless, the economic downturn started before 1973 and it was a classic overproduction crisis, which was reinforced by the United States' financing problems as well as its involvement in the Vietnam War.

[2] There has been an extended debate over the term Post Fordism. An extensive literature claimed that Fordist production did not disappear and, after the seventies, it evolved integrating others mode of production. Generally, Post-Fordism has been increasingly replaced by closely connected concepts such as post-industrial society, knowledge-based economy, information society.

have distinguished post-industrial societies. Those macro changes in the supply and demand have been reinforcing each other.

Automation of production and services, as well as the delocalization of manufacturing into low-wage developing countries, has reduced the demand for skilled manual jobs and unskilled jobs in advanced societies. The tendency is to automate low-skilled jobs and retain those that have both strategic and high-skilled components, although it is unclear whether we are experiencing an increase in creation of high skilled employment. Some authors have argued that the added value of the new economy is based on the competition of new ideas, knowledge and skills, instead of material capital accumulation (Drucker, 1993; Hanushek & Wößmann, 2008; Hanushek & Kimko, 2000). In this process of shifting towards a high-skills equilibrium, skills are becoming essential to labour market access.

Figure 1. Long term trends in employment in R&D intensive industries, 1980-2013



Source: OECD 2015

Some others have cited the increasing centrality of skills, claiming a reshaping of the relationship between the citizen and the state. In this line, a new social pact emerged, which is based on a "skill nexus". On the one hand, the state is responsible for providing the opportunity to develop and acquire skills and education as a tool to secure social justice and social cohesion.

On the other hand, individuals need to find employment for themselves and sell their own abilities, skills and knowledge in the global labour market (Brown et al. 2011; Reich 1992).

Since the 1980s, in all of the OECD countries, almost a third of jobs are directly related to information, communication and technology (ICT) and those workers who lack computer skills are increasingly marginalized. Additionally, the shift from physical to intellectual-creative labour has produced winners and losers in this changing labour market and has polarized labour outcomes and wage premiums. In the last four decades, inequality in income and wealth has increased sharply both in developed and developing countries (Brady, 2009; Milanovic, 2011). Part of this process could be seen in the increasing wage gaps, which are partially connected to the inequality of skills.

Much of the public debate has focused on the 1% of the population, referring to the consistent increase in the proportion of national income percentile concentrated in the richest families. Although this process is certainly relevant, an excessive attention might move away from the strong wage differentiation that has also occurred in the remaining 99% of the population. This phenomenon is very relevant and, in part, is explained by changes in education returns and more specifically, in the skills premium. The inequality of skills has an effect on wage gaps and has relevantly contributed to the overall levels of income inequality and to unequal social outcomes. The relation between the supply and demand of skills explains time fluctuations in wages and specifically, the reasons for the widening of the wage premium between college and high school graduates in recent decades.

The extreme levels of inequality not only represent a major challenge for social cohesion, but they are also associated with negative social outcomes in a number of areas such as health, welfare, political participation and social mobility (Janmaat & Green , 2013; Wilkinson & Pickett, 2009). Furthermore, these disparities could contribute directly to reducing levels of social trust, as some research has suggested (Green, Preston, & Janmaat, 2006).

And, above all, let us remember that the great purpose
of education is to give us individual citizens
capable of thinking for themselves
Let Us Face the Future, 1945

1.2. Education, but not just education

In developed countries, the pressure to increase productivity in order to maintain the living standards of the population, has pushed towards a production which is increasingly based on high value added goods and services and on the application of knowledge and skills (Brown, Lauder, & Ashton, 2008; ILO, 2011). For these reasons, policy reforms have sought to increase the skills levels. This strategic goal might be detected in a diversity of documents of multinational agencies such as the OECD, UNESCO (EU high level group of experts on literacy 2012; OECD 2013a; European Union 2007). These policy documents argue that investing in education is considered to be one of the few effective strategies for global competitiveness and for meeting the demand for a high skilled labour force.

This process has implied a certain recalibration of the objectives of education and training systems. In Jean Piaget's words, the key role for education is to instil a sense of curiosity, awakening the scientist in all of us. Using this short definition, there are different questions which need to be clarified, such as:

i. The basic purpose of learning from an individual point of view. Which is the foundational goal of learning? Is it for identifying what really matters to an individual? Is it for achieving sufficient resources in order to undertake whatever may be important to them? Is it to learn how to acquire those resources?
ii. The desire to learn relies on both an individual pulse, or need, and to the environment and the inputs of the individual experience. How can this desire be stimulated?
iii. Where does the capacity to learn reside? Is there a set of skills one needs to master in order to learn?
iv. When to learn? This point is closely related to the third one and specifically concerns whether there is a particular moment in life in which you need to develop a set of skills in order to master them or to be able to acquire higher-order skills.

These questions are closely connected to the functions of every education system: the cultural (socializing knowledge and identities), the economic (creating innovation and human capital), and the social (offset inequalities in order to ensure equal opportunities). These aspects of how we, as a society, conceive education have never been fixed and have been subjected to modifications depending on historical and social circumstances. In the last decades, many authors have detected a tendency towards emphasizing education as a *locus* of provision of high skills deemed necessary for economic competitiveness and growth in a globalized and changing economy. This is what Grubb & Lazerson (2004), have called an ubiquitous "education gospel" in the educational policy reform and discourse.

Some scholars have pointed to an increasing stress on the economic function of education and part of this justification could be related to the neoclassical economic approach. It conceives of education as an investment in the accumulation of skills and human capital which is a product of a rational calculation about how and which investment to make (Becker 1964). Human capital is basically the value of an individual's current and prospective earnings discounted to the present. In this perspective, the relationship between education and skills is conceived to be fairly linear and workers are treated as agents with exogenous preferences and aspirations. Accordingly, symmetrical information between employer and employees is assumed together with the exclusion of labour market imperfections.

What is left out from a classical human capital approach is the social context and the consideration of the individual as an agent with specific aspirations and preferences. Heterodox approaches have tried to problematize the inner process of skills acquisition as socially based. There is a plurality of factors, specified briefly as follows, which affect the relationship between education and skills both at a micro and macro level of analysis.

At an individual level, better schooling is associated with high levels of skills and better outcomes in the labor market in terms of employment and wages (Hanushek et al. 2015; Kerckhoff et al. 2001). Moreover, people with higher educational attainment and skills also experience a better level of health, a higher level of welfare, are less likely to engage in criminal activities and enjoy numerous other non-monetary benefits. Increasing the level of education and

skills has indirect effects at a macro-level and it has been positively associated with economic growth, social cohesion and civic and political participation (Hanushek & Kimko 2000).

At a macro level, comparative education research has identified how the intrinsic characteristics of the educational systems produce unequal educational attainment between and within countries (Green 2013; Green et al. 2015; Bol & van de Werfhorst 2013; Dupriez et al. 2008; Hanushek et al. 2011). To a large extent this type of research has been mainly qualitative and has focused on the historical and institutional processes and the related reasons for its evolution (Esping-Andersen 1990; Esping-Andersen 1999; Hall & Soskice 2001). Since the 1960s, there has been a proliferation of international studies which have looked at the relationship between education and skills across different countries.

The correspondence between education attainment and skills is not linear and some have highlighted the importance of the relative distribution of these skills in the national economy. Greater gaps between high and low skilled workers within the national economy and the average level of skills and social recognition of the low skills workers creates a stigmatization effect (Solga, 2002). This process is also connected to a higher polarization of occupations, rather than an overall occupational upgrading which is common to many OECD countries.

1.3. In search of an analytical and complex approach

One relevant aspect which is missing in the original postulation of human capital theory, is the consideration of the agent embedded in a social context. In this perspective, individuals are considered as separate islands without taking into account their aspirations and expectations which are not exogenous but are instead rooted in social norms and opportunities.

The present work intends to provide a complex picture of both the configuration of skills outcomes and their acquisition with the inclusion of a plurality of social factors in order to consider the lifelong path of skills acquisition. The overall approach of the thesis to the issue of skills acquisition is based, first, on a theoretical and complex perspective of a process which is inherently social. Second, it is guided by an analytical interest in examining and demonstrating how this social process is conceived and how a plurality of social factors contribute to it. Third,

it draws on an ethical point of view which aims at analysing the differentiation which prevents equal access to skills. This is closely connected to Amartya Sen capability approach (Sen 1992).

This work analyses adult skills as they were measured in the Programme for the International Assessment of Adult Competencies (PIAAC) as a final result of a complex process which is not exclusively produced within the education system. The overall approach goes deeper into different aspects of inequality. As one of its main objectives, this research contributes to the existing literature about the sources of adult skills inequalities between social groups. The purpose of this thesis does not focus on the ways in which skills are individually acquired; rather it explores the formation of skills in different social contexts by examining the differences between social groups.

The analysis does not seek any causal relationship for two reasons. First, because the objective is to provide an analysis of the social groups and every interpretation of the results should be read in this sense. Second, no experiment nor manipulation was made and it is rather pretentious to claim causality without having pursued those steps (Bollen & Pearl 2013; Pearl 1998). The analysis is based on a plurality of theoretical approaches and it is constituted by a sequence of pieces that have an internal coherence. I trace the internal coherence of the sequential pieces of the thesis in section 9, where the overall structure of the document is presented. Furthermore, the work applies diverse statistical techniques ranging from cluster analysis to structural equation modelling (SEM).

This study adopts an analytical and comparative approach, which assumes the existence of diverse variants of a single phenomenon (e.g. electoral systems, economy structure, etc.) and its possible comparability. Comparing active labour force population over some proxies of adult skills could be considered a way to measure "human capital". This is one of the motivations of such types of international assessments. One of the consequences of using these broad parameters to compare, or rank, one country to another is that this can lead to controversial and misleading interpretations. (Espeland & Sauder 2007; Porter 1996).

The intention of the thesis, therefore, is to the relationship between skill acquisition and a variety of social factors. Overall, the analysis uses direct measures of adult skills and provides a more comprehensive and multifaceted picture of skills acquisition. Most of the empirical analysis

is based on secondary data extracted from the PIAAC study. To the extent of my knowledge, this is the most suitable source of information to answer my research questions. It provides both direct measures of adult skills and related information about labour market participation and socio-demographic individual characteristics and it offers wide comparability both within and between countries. Nevertheless, it has to be acknowledged that the analysis has some limitations which are closely connected to the data source employed. PIAAC is based on a single snapshot at a given point in time and its proxies of adult skills are not strictly comparable with the ones provided by previous studies[3]. Furthermore, the source of data does not yield any direct information about the skills used at work and it is limited in the collection of individuals' social origin characteristics.

Humanity, justice, generosity, and public spirit,
are the qualities most useful to others
The Theory of Moral Sentiments, Adam Smith 1759

1.4. Conceptualization of skills

The etymology of the word derives from the Old English *scile* and the Germanic word *skil*, which has diverse variants. The meanings of these words are related to the capacity of an individual to discern or to separate. Skill is a polysemic word commonly used in the social sciences. It has various synonyms such as "ability", "expertise", "competence" or "talent", and very diverse translations in other languages. Its extended use in different disciplines and contexts have produced a lack of clarity and consensus over the concept and an array of unintended consequences (Green 2011).

On the one hand, psychologists have been using the concept of skill well before the word itself entered the public discourse. They were interested in the activities to pursue in order to learn a specific skill. In recent decades, they started to replace this word by using the word 'competence' defined as the standards required in order to perform specific tasks. Because psychologists focus on the creation and inner functions of skills, they centre their attention on

[3] In the next section, I will clarify the reasons.

the components of competence. This latter concept entered the human resource framework and it was largely used in personal recruitment and development process. On the other hand, policy makers generally prefer to use the term skill, sometimes using it interchangeably with competence. In policy discourse, skill is preferred to competence, because the main focus is to measure the attached social and labour outcomes, in other words "valuing" skill for its individual and social results.

Since the development of the first physical and physiological tests of Sir Francis Galton, there has been an extended focus on how to measure cognitive ability. Three decades ago, the Bell Curve (Hernnstein & Murnane 1994) generated a resurgence of this topic. These authors claimed the identification of a single factor –g– which was strongly associated with individual test scores and social outcomes. This study refreshed the deterministic view of a single individual trait responsible for "social success" and it was sceptical about the effectiveness of any policy interventions aimed at improving social performances. The criticisms to this approach were diverse and they provide evidence which support that –g– was not a single factor, but that other components were correlated with it (Heckman 1995). The uniqueness of a single dimension of cognitive ability was contended over more than a century, but nowadays there is an overwhelming consensus that cognitive abilities are inherently plural and this is also the reason why we refer to skills or competences in plural.

At the beginning of the nineties, the first macro attempts[4] were made to measure adult skills and their relationship to society and the economy. These surveys try to measure skills as a plural and multidimensional set of competences, which were thought to be developed socially as opposed to abilities, which are often deemed innate. They combine modern psychometric testing and use a competence approach in order to generate proxies of skills over different domains. These first global studies used a complex framework and provide various proxies of skills. However, they were generally defined as a set of core competences, which an individual has to master to "function in society, to achieve one's goals and to develop one's knowledge and potential" (OECD 2012).

[4] We refer to these attempts in section 6.

1.5. The process of commensuration of skills

Like all concepts in the social sciences, the act of constructing measures implies a selection of the dimensions (in Ancient Greek κατηγορια)[5], which have to be operationalized and thus, leads to a simplification of the object of study. This means a transformation of some qualities into a metric which is not just a technical process, but an important feature of social life (Desrosières 2008; Hacking 1999). This process is generally called commensuration and has been largely examined by different historians, statisticians, sociologist and philosophers (Espeland & Stevens 1998). From Plato and Aristotle, to Marx, Weber, Simmel and Foucault, the implications of commensuration have been analysed as a process that influences our valuation and the way we invest in goods and services.

The construction of a global measure of adult skills has some fundamental political implications. First, the establishing, recognition, and use of a statistical object of human capital is very appealing for the institution that creates it. Second, the interpretation and political use of new measures are a very powerful way to push forward a specific approach or even a political agenda (Meyer & Benavot 2013).

In the last decades, the emerging role of multi-national stakeholders in the skills debate has radically reshaped the processes of governance in education. This process has shrunk the power of the national state as a central decision-maker and provider of public services. The competitive involvement of transnational agencies of all kinds have reconfigured the political process of education by reforming and reframing the state's actions (Bonal 2003).

International agencies, such as UNESCO and the Organization for Economic Cooperation and Development (OECD), have been very influential in promoting skills as a policy issue over the last 50 years initially in developing countries, and, more recently, in the developed world. First, UNESCO advocates for "literacy as right" and this focus is traditionally central in its Global Monitoring Reports. The World Trade Organization (WTO), UNESCO or OECD, without any legal or financial power, are now key actors in policy agenda setting (Lingard 2014;

[5] In Latin "categoria".

Thomson et al. 2012) acting as a channel of transmission of policy recommendations and reforms. Specifically, the OECD is an important mediator and channel for promoting education policy. Some authors have described the role of the OECD as a constructor of policy problems which lead to changes in education governance in Europe (Grek 2010).

One important feature of the emerging role of the OECD as a leading global organization in education policy was the creation of global "governing tools" like PISA or general comparable statistics, like Education at a Glance. Through these products, the OECD has increasingly become a key actor in framing policy agenda and global space in education and training. The underpinning features in the rise of the OECD as a global actor is the constitution of a "space equivalence" through which cross-country comparability is enhanced (Desrosières 2002). This process is connected with an increasingly global economy, where the power of the states has been weakened and it has both direct (standardization) and indirect effects (it serves as a framework for policy justification) on national education policies (Dale 1999).

The OECD has put forward this strategy with PISA and, more recently, has released the survey PIAAC, which aims at evaluating adult skills and is commonly known as the PISA for adults. The PIAAC survey could probably have a larger impact compared to PISA as a governing tool in education for two main reasons: a) PIAAC evaluates skills post-schooling and, as a consequence, it could be generally interpreted as a measure of human capital; b) in a context of economic crisis, fostering skills could be a very powerful objective for increasing competitiveness and thus be considered as a *panacea* for economic recovery (Ostrom et al. 2007).

The OECD has been contributing to the reframing of education and skills as a central issue for economic growth and competitiveness. This has been accompanied by both a reduction in the OECD work in certain educational spheres, and the increasing emphasis on the economic significance of education. This economistic perspective supported by human capital orthodoxy has served to set this institution at the very centre of policy reforms at a global level.

One year and a half before the PIAAC public data release, the OECD set its own discourse on skills through the publication of two reports, the *Learning for Jobs* and the *Better Skills, Better Jobs, Better Lives*: *A Strategic Approach to Skills Policies* (OECD 2013a). These policy documents were

part of an integral strategy led by the Directorate for Education and joined by the Directorate of Employment, Labour and Social Affairs and the Programme for Local and Economic Development. In the *Better Skills, Better Jobs, Better Lives*, the OECD claimed that the most effective strategy to provide skills, which are necessary for national economies to grow, is securing public investments in a period of austerity and letting education and training systems align with market needs (Valiente 2014). This policy was created with the intention of creating highly skilled jobs and improving the employability of those who are currently excluded from the labour market with the ultimate goal of maintaining social cohesion.

Every construction of a statistical artefact has both an inner political goal and it is inherently subjected to the selection of the dimensions it measures. Moreover, sometimes the interpretation of the measure could be misleading. For this reason, it is necessary to deepen our understanding of every measure employed and interpret them accordingly by considering both their practical and political consequences.

1.6. A brief history of adult skills surveys

Three large scale cross-country assessments of skills of the adult population have been undertaken by various public institutions. The first was the International Adult Literacy Survey (IALS) implemented between 1994 and 1998, followed by the Adult Literacy and Life Skills Survey (ALL), which was taken between 2002 and 2006. Finally, their successor, the Programme for the International Assessment of Adult Competencies (PIAAC), was released in October 2013 by the OECD. UNESCO also developed an instrument, known as the Literacy Assessment and Monitoring Programme (LAMP), designed for developing economies and it was implemented, at the time of writing, in Paraguay, Mongolia, Jordan and Palestine.

The origins of this strand of programmes evolved from some pioneering works on young and adult skills assessments conducted in the 1980s and early 1990s by the Educational Testing Service (ETS) and Statistics Canada. In the United States in 1985, the Young Adult Literacy Survey (YALS) was conducted concentrating on job seekers. Later in 1992, the National Adult Literacy Survey (NALS) showed the possibility of combining advances in psychometrics and large reading scale assessment with household survey methodologies. The 1989 Canadian Survey

of Literacy Skills Used in Daily Activities (LSUDA) demonstrated that the methods used provide comparable information regarding the literacy skills of the English and Francophone populations in Canada. The results of these assessments generated a relevant interest from a policy point of view and demonstrated that a substantial share of the population achieved only low levels of literacy. It was noted that there was a widespread literacy "problem" in most countries. For these reasons, better evidence was deemed necessary for policy analysis. This has been having important implications for education and training policy.

In the early 1990s, Statistics Canada and ETS collaborated with the OECD and 9 countries to develop IALS. The survey was conducted in 1994 and 23 constituencies participated across three waves of data collection ending in 1998. The first round of IALS was controversial. When the preliminary results were available in 1995, 75% of the French adult population achieved the two lowest levels in the prose scale. France was the lowest performing country with the exception of Poland. These results were contested by the French authorities and later an independent review found that some design and implementation problems of the study threatened 'the validity of any comparisons of literacy levels across countries'. Yet, the project organisers acknowledge a number of shortcomings in the survey processes, but they claim that these should not compromise the data quality. Results of the first wave of IALS excluded French data and were published in 1995.

Table I. Countries participating in adults skills surveys

Survey	Date of data collection	Participating constituencies	Number of participants
IALS (wave 1)	1994	Canada, Germany, France, Ireland, Netherlands, Poland, Sweden, Switzerland (French and German speaking), United States	9
IALS (wave 2)	1996	Australia, Belgium (Flanders), Great Britain, New Zealand and Northern Ireland	5
IALS (wave 3)	1998	Chile, Czech Republic, Denmark, Finland, Hungary, Italy, Norway, Slovenia, Switzerland (Italian speaking)	9
ALLS (wave 1)	2002	Canada, Bermuda, Italy, Mexico (Nuevo Leon) Norway, Switzerland, United States	8
ALLS (wave 2)	2006	Australia, Netherlands, New Zealand, Korea, Hungary	5
PIAAC (wave 1)	2011	Australia, Austria, Belgium (Flanders), Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, Netherlands, Norway, Poland, Russian Federation, Slovak Republic, Spain, Sweden, United Kingdom (England and Northern Ireland), United States	24
PIAAC (wave 2)	currently (2016)	Chile, Greece, Indonesia, Israel, Lithuania, New Zealand, Singapore, Slovenia, Turkey	9
PIAAC (wave 3)	planned 2016-2019	Ecuador, Hungary, Kazakhstan, Mexico, Peru, United States	6

Source: Own construction.

The survey ALL included the elaboration of conceptual frameworks and the ambition to measure seven skills domains: prose literacy, document, literacy, numeracy, teamwork, problem-solving, practical cognition, and working with information technology. Nevertheless, it was not possible to construct measures of sufficient reliability for practical cognition, teamwork, and information and communication technology. Only the questions relating to familiarity with and use of ICT were retained.

Despite the financial and methodological efforts of international agencies, the adherence to ALL and IALS was rather limited. Overall 27 constituencies took either one of the assessments and 9 of them assessed adult skills in either one of the studies' waves. Additionally, the use of these large assessments was narrow either due to the difficulties in the inner technical data management or for the statistical and interpretational issues (Blum et al. 2001). Problems in the scale comparability, definition and dimensionality of literacy and the translation of items were detected.

Excluding research commissioned by public agencies, the studies which used IALS or ALL are limited. The IALS was more used compared to ALL for its higher number of participating countries. A brief review on the literature and the topics covered by these two programmes was written by one of the PIAAC methodological experts and it was published by the OECD (Thorn 2009).

On the basis of these former efforts, the OECD started the PIAAC in 2008. The new comparative study has four main objectives:

- Provide policy makers in each participating country with a profile of adult core skills which are considered to be crucial "to participate effectively in society"
- Assess the impact of these skills on a range of economic and social outcomes at the individual and collective level
- Estimate the performances of education and training systems in generating core skills
- Help shed light on some policy instruments which could improve the skills

1.7. What does PIAAC measure?

PIAAC is a computer based survey which assesses three domains: literacy, numeracy and problem solving in technology-rich environments. It seeks to ensure continuity with IALS and ALL. Like these previous surveys, it conceives each skills domain as a multidimensional construct. Literacy and numeracy are evaluated using 56 items distributed across three main tasks characteristics (medium, context and aspect) and differentiated between paper and computer-based questions. People who do not show ICT abilities have the option to complete a pencil questionnaire. In addition, for the reading component, interviewers timed respondents as part of the individual efficiency through the test (OECD 2013b).

The assessment tasks cover a broad range of difficulty. Those tasks deal with a range of cognitive processes believed to influence task difficulty. Assessment tasks and stimulus materials are drawn from a wide range of life contexts. The objective of the assessment is to describe the level and distribution of the adult population's skills as a whole, not to test the proficiency of each individual. The PIAAC framework and methodology used to generate direct measures of

adult skills are not the results of individual tests. In fact, skills are measured through ten plausible scores using Item Response Technique (IRT) and the Rasch model. This method of constructing scores goes beyond any attempt to interpret scores at an individual level. In other words, PIAAC is not intended to predictively assess adult skills, but to evaluate them in the context in which they are developed or inserted. Evaluating educational outcomes is a complex process and the methodologies of these large macro international assessments have been criticized. In a recent paper, some of the inaccuracies and misconceptions of the most commonly used IRT, the Rasch model, have been debated. The study points out that some of the weaknesses of this approach lie in the unidimensionality assumption of the model and the lack of sample distributional assumptions (Goldstein, 2015).

Table II. Skills competences domains assessed in adult skills surveys

IALS	ALL	PIAAC
Prose literacy	Prose literacy	Literacy (combined prose and document)
Document literacy	Document literacy	
		Reading components
Quantitative literacy		
	Numeracy	Numeracy
	Problem solving	
		Problem solving in technology rich environments

Source: Thorn 2009.

PIAAC measures three domains that are believed to be foundational for an individual to fully participate in society. It integrates prose and document literacy which were independently assessed in IALS and ALL and it provides a total measure for reading components. It also extends the assessed domains to problem solving in rich technological environments as previously done by ALL (See **Table II**). Results show that PIAAC provides wide comparability across languages and cultures and it does not have some of the methodological shortcomings encountered in IALS.

In all participating countries, the minimum sample size required for the standard target population speaking the main language of the country, was dependent on the optional components of the psychometric assessments administered. The sample ranged from 4.500 and 5.000 interviewees. Its target population consists of adults aged between 16 and 65 who reside

in the country at the time of data collection. People residing in institutions were excluded. Additional excluding criteria were specified by participating members (e.g. Armed Forces members living on military bases or residents of some sparsely populated areas). In order to respect the program's international requirements, once combined these standards should exclude less than 2% of the whole population in each participating countries. The sample and selection was adapted to every participating country, regarding their optimal and cost effective design[6]. Once the household was identified, one individual per household was selected at random.

The survey was administered in the respondent's home and the interview was composed of four main blocks:

i. The validation of the household and the interviewee's selection
ii. The background questionnaire
iii. The skills assessment
iv. The last component which aggregates all the information and provides the final outcome of the survey.

1.8. Presentation of the papers

This thesis[7] is composed of three chapters. The first research study is, "A comparative analysis of skills formation." It aims at providing an overview of how OECD countries differ in the configuration of skills competences. It explores whether there are any similarities or divergences between OECD countries and how life course factors contribute to the diverging education and training models. A decomposition analysis using Shapley rule was applied and then, the results were clustered. Findings show diverging models of skills formation which are compatible with the literature of education and training models. This study has been presented and discussed in three international congresses and part of it was submitted as an original research article.

[6] We refer to chapter 14 of the technical report of PIAAC (OECD 2013b) for a description of the sample approach of each country participating in the study.

[7] This thesis benefitted from the funding provided by the FI-DGR 2013 of the Generalitat de Catalunya and from the research project *Familias monoparentales del nuevo siglo. Retos y dilemas en tiempos de cambio* (CSO2011-29889).

The second research study, "An integral model of adult skills in OECD countries" examines whether it is possible to identify a model of adult skills acquisition which is common for the OECD countries. Additionally, it estimates how diverse life course factors intervene in the formation of adult skills. Results provide an overall model of configuration of skills acquisition and show how unequal access to education affects skills at a later stage in life. Moreover, skills practices in the workplace and in daily life have a consistent impact on skills. Part of this study was submitted as an original article and it is co-authored with Jorge Calero.

The third study, "How different education and training systems configure adult skills? A comparative analysis of five OECD countries using structural equation modelling" analyses whether there are differences between diverse education and training models in the acquisition of adult skills. Based on the framework of the second study, this work delves deeper into the differences between some country specific models', which are defined in the comparative education literature as a diverging type of skills formation. Part of this study was submitted as an original article and it is co-authored with Jorge Calero.

These three pieces of research are closely connected and might be considered in aggregate terms as they provide an overall picture of the research objective. The points of connections are basically three: a) the analysis of a common measure of educational outcomes; b) an assessment of a group of countries (e.g. OECD); c) a special attention to intergenerational inequality transmission and to diverse sources of inequality; d) the identification of the internal consistencies and divergences between the group of countries analysed in the first and third studies.

The implications of this research are two-fold. First, it illustrates with different statistical techniques the configuration of adult skills by using a newly implemented dataset. Second, it proposes an integral theoretical model of adult skills acquisition, providing evidence on the impact of diverse life-course factors.

References

Becker, G., 1964. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*, Chicago: University of Chicago.

Blum, A., Goldstein, H. & Guérin-Pace, F., 2001. International Adult Literacy Survey (IALS): an analysis of international comparisons of adult literacy. *Assessment in Education: Principles, Policy &Practice*, 8(2), pp.225–245.

Bol, T. & van de Werfhorst, H.G., 2013. Educational Systems and the Trade-Off between Labor Market Allocation and Equality of Educational Opportunity. *Comparative Education Review*, 57(2), pp.285–308.

Bollen, K. a & Pearl, J., 2013. Eight Myths About Causality and Structural Equation Models. In S. L. Morgan, ed. *Handbook of Causal Analysis for Social Research*. Springer, pp. 301–328.

Bonal, X., 2003. Educational and the Legitimation The Neoliberal Agenda old and new state strategies Crisis : *British Journal of Sociology*, 24(2), pp.159–175.

Brown, P., Lauder, H. & Ashton, D., 2008. Education, globalisation and the future of the knowledge economy. , 7(2), pp.131–156.

Brown, P., Lauder, H. & Ashton, D., 2011. *The Global Auction: The Broken Promises of Education, Jobs, and Incomes* Oxford Uni., Oxford: Oxford University Press.

Dale, R., 1999. Specifying Globalization Effects on National Policy: a focus on the mechanisms. *Journal of Education Policy*, 14(1), pp.1–17.

Desrosières, A., 2008. La statistique, outil de gouvernement et outil de preuve. *L'argument statistique I : Pour une sociologie historique de la quantification*, pp.7–20.

Desrosières, A., 2002. *The Politics of Large Numbers*, Cambridge, Massachusetts: Harvard University Press.

Drucker, P., 1993. *Post-Capitalist Society*, Oxford: Butterworth-Heinemann.

Dupriez, V., Dumay, X. & Vause, A., 2008. How do school systems manage pupils' heterogeneity. *Comparative Education Review*, 52(2), pp.245–266.

Espeland, W. & Sauder, M., 2007. Rankings and Reactivity. *American Journal of Sociology*, 113(1), pp.1–40.

Espeland, W.N. & Stevens, M.L., 1998. Commensuration.pdf. *Annual Review of Sociology*, 24, pp.313–343.

Esping-Andersen, G., 1999. *Social Foundations of Postindustrial Economies*, Oxford: Oxford University Press.

Esping-Andersen, G., 1990. *The Three Worlds of Welfare Capitalism*, Princeton: Princeton University Press.

EU high level group of experts on literacy, 2012. *Act now!*, Luxembourg.

European Union, 2007. *Treaty of Lisbon*, European Union. Available at: http://publications.europa.eu/resource/cellar/688a7a98-3110-4ffe-a6b3-

8972d8445325.0007.01/DOC_19 [Accessed January 7, 2016].

Green, A., 2013. *Education and state formation* third., London: Palgrave Macmillan.

Green, A., Green, F. & Pensiero, N., 2015. Cross-country variation in adult skills inequality: Why are skill levels and opportunities so unequal in anglophone countries? *Comparative Education Review*, 59(4), pp.595–618.

Green, F., 2011. What is Skill? An Inter-Disciplinary Synthesis. *Centre for Learning and Life Chances in Knowledge Economies and Societies*.

Grek, S., 2009. Governing by numbers: the PISA "effect" in Europe. *Journal of Education Policy*, 24(1), pp.23–37.

Grek, S., 2010. International Organisations and the Shared Construction of Policy "Problems": problematisation and change in education governance in Europe. *European Educational Research Journal*, 9(3), p.396.

Hacking, I., 1999. *The social construction of what?*, Cambridge: Harvard University Press.

Hall, P. & Soskice, D., 2001. *Varities of Capitalism*, New York: Oxford University Press.

Hanushek, E.A. et al., 2015. Returns to skills around the world: Evidence from PIAAC. *European Economic Review*, 73, pp.103–130.

Hanushek, E.A. & Kimko, D., 2000. Schooling, labor-force quality, and the growth of nations. *American Economic Review*, 90(5), pp.1184–1208.

Hanushek, E.A., Woessmann, L. & Zhang, L., 2011. General Education, Vocational Education, and Labor-Market Outcomes Over the Life-Cycle. *National Bureau of Economic Research*, pp.1–51.

Hanushek, E.A. & Wößmann, L., 2008. The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature*, 46(3), pp.607–668.

Heckman, J.J., 1995. Lessons from the Bell Curve. *Journal of Political Economy*, 103(5), p.1091.

Hernnstein, R. & Murnane, C., 1994. *Bell Curve: Intelligence and Class Structure in American Life*, New York: Free Press.

ILO, 2011. *A Skilled Workforce for Strong, Sustainable and Balanced Growth: A G20 Training Strategy*, Geneva.

Kerckhoff, A.C., Raudenbush, S.W. & Glennie, E., 2001. Education, Cognitive Skill, and Labor Force Outcomes. *Sociology of Education*, 74(1), pp.1–24.

Labour Party, 1945. Let Us Face the Future: A Declaration of Labour Policy for the Consideration of the Nation.

Lingard, B., 2014. The OECD and the expansion of PISA: New global modes of governance in education. *British Educational Research Journal*, (May).

Meyer, H.-D. & Benavot, A., 2013. *PISA, Power, and Policy: the emergence of global educational governance*, Oxford: Symposium Books.

OECD, 2013a. *Better Skills Better Jobs Better Lives*, Paris: OECD Publishing.

OECD, 2012. *Literacy, Numeracy and Problem Solving in Technology-Rich Environments: Framework for the OECD Survey of Adult Skills*.

OECD, 2015. *OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society*, Paris.

OECD, 2013b. *Technical Report of the Survey of Adult Skills (PIAAC)*, Paris.

Ostrom, E., Janssen, M.A. & Anderies, J.M., 2007. Going beyond panaceas. *PNAS*, 104(39).

Pearl, J., 1998. Graphs, Causality, and Structural Equation Models. *Sociological Methods & Research*, 27(2), pp.226–284.

Porter, T.M., 1996. *Trust in numbers: The Pursuit of Objectivity in Science and Public Life*, New York, London: Princeton University Press.

Reich, R.B., 1992. *The Work of Nations: Preparing Ourselves for 21st Century Capitalism*, Vintage.

Sen, A., 1992. *Inequality reexamined*, Boston: Harvard University Press.

Thomson, P., Lingard, B. & Wrigley, T., 2012. Ideas for changing educational systems, educational policy and schools. *Critical Studies in Education*, 53(1).

Thorn, W., 2009. International Adult Literacy and Basic Skills Surveys in the OECD Region. *OECD Education Working Paper*, 26(August), pp.1–32.

Valiente, O., 2014. The OECD skills strategy and the education agenda for development. *International Journal of Educational Development*, 39(2014), pp.40–48.

Chapter 2. A comparative analysis of skills formation

Abstract

This article examines cross-country variation in adult skills and investigates how life course factors contribute to the diverging education and training models in OECD countries. In order to gain understanding of the relationship between potentially explanatory factors of adults' core skills, we broke down literacy and numeracy scores variance through six blocks of variables: demographic, social background, education, employment, on-the-job training and skills practices. Through cluster analysis, we searched for a common framework of adults' skills. Even accounting for all correlates, results show that education remains the most important variable in explaining literacy and numeracy among adults in the countries examined. The analysis shows a wide cross-country variation, in life course factors contributing to skills formation. This leads us to identifying common regularities among groups of countries in the way skills are structured and distributed, compatible with the literature on social policy regimes.

Keywords: skills, education, PIAAC, adults, formation, OECD, literacy

2.1. Introduction

In recent decades, the demand for skills and qualifications has greatly intensified, with automation of production and services making low-skilled workers easily replaceable (Mayer and Solga 2008). Moreover, the pressures for creating innovation and human capital has put emphasis on the economic functions of the education and training system, rather than on other functions such as cultural (socializing knowledge and identities) and social (offsetting inequities to ensure equal opportunities). As pointed out by Grubb & Lazerson (2004), a pervasive "education gospel" is spreading in the educational policy discourse. There is now a consensus that the essential role of education is to generate the high level of skills deemed necessary for economic competitiveness and growth in a globalized and changing economy. As a result, the focus in education and training has shifted to the core skills, which are a common ground required by non-routine job tasks that are cognitive and communication based. In such changing

labour market, a nation's growth increasingly depends on the capacity to develop and adapt the skills of their citizens (Damme 2013; Hanushek and Kimko 2000; Hanushek and Wößmann 2006) as an entry ticket to the labour market. In the process of redefinition of skill formation around the ideas of a knowledge-driven economy, some authors have seen a change in the model of "the worker citizen" (Brown et al. 1999).

At a macro level, evidence suggests that higher skills have a positive impact on the performances of the national economy, in terms of increased labour productivity, growth, competitiveness and innovation, political engagement, wellbeing, and social mobility (Green 2006; Janmaat and Green 2013; Pickett and Wilkinson 2007). At a micro level, higher skills are associated with higher earnings and incomes (Hanushek et al. 2013; Harmon, Oosterbeek, and Walker 2003), a higher level of welfare, and other, increased non-monetary benefits (Bedard and Ferrall 2003; Borgonovi and Pokropek 2016; Braga, Checchi, and Meschi 2013; Grossman 2006; Oreopoulos and Salvanes 2011). Comparative education research has identified major variation in skills outcomes both across and within countries (Hanushek, Wößmann, and Zhang 2011), and scholars have tried to disentangle common characteristics of the education and training system. This stream of literature also points out that more unequal outcomes are likely to occur when there is early selection to differentiated tracks and types of school, a lack of curriculum standardization and a local devolved funding system (Dupriez et al. 2012; Dupriez, Dumay, and Vause 2008; Mons 2007; Van de Werfhorst and Mijs 2010; Wößmann 2005).

On the other hand, in more institutionally oriented literature, structural indicators of social policy, and of education and training systems, have been used to identify cross-national characteristics and common regularities (Bulle 2011; Desjardins and Rubenson 2013; Green 2006; Nelson 2010). This stream of literature has sought to establish distinctive "educational regimes" and has identified regimes akin to social policy models (Esping-Andersen 1990, 1999). A seminal study (Allmendinger and Leibfried 2003) has depicted four models of competences production analysing PISA 2003 data of mean and distribution of competencies, which are similar to the social policy models of welfare. West and Nikolay, using (in)equality of opportunity indicators and education expenditure, identified four educational models in 16 OECD countries and pointed out that the differences between Continental and Mediterranean countries are relevant compared to other findings (Beblavý, Thum, and Veselkova 2011). Other

authors (Pechar and Andres 2011) analysed participation in higher education and attainment with regard to welfare policies. They explored the trade-off hypothesis (Heclo, 1985; Castels 1990) between education and welfare investment and found a certain relation between tertiary graduation rates and welfare regimes and higher education policy. Peter et al. (Peter, Edgerton, and Roberts 2010) analysed education inequality in secondary education decomposing educational outcomes in 15 OECD countries and found differences in education inequality between schools, highest in conservative welfare states and lowest in Nordic countries. These findings are in line with other studies (Hega and Hokenmaier 2002) which also show association between educational policies and social programs.

As pointed out by many authors, skills formation is embedded within an institutional, cultural, and political context (Brown 1999; Thelen 2004) that provides an explanation of these differences going back to historical paths and the organization of skills formation. These important features characterize, and partially delimit, the evolving possibility of future equilibrium (path dependency). The design of a welfare state influences the motivation, participation and outcomes at different stages of the learning process (e.g. transitions in life course, employer support and enrolment costs).

This article concentrates on adult skills and how different life course factors affect their acquisition using a comparative analysis. The novelty of this article resides in its focus on direct measure of skills[8] of the active adult population and the inclusion of a plurality of life-cycle factors that goes beyond a comparison of the institutional characteristics of the education and training system. The paper extends previous research including 23 constituencies in the analysis. Moreover, the study differs from former research because it is not based on macro policy indicators, but focusses on adult core skills (OECD 2012). This research applies Shapley decomposition, with the main advantage over other standard variance decomposition methods being treating all the factors in the model as if they were symmetric. This decomposition rule estimates the marginal impact of each factor as they are eliminated in succession and averages these marginal effects by taking into consideration all the possible elimination sequences.

[8] Throughout the text, we use the term skills, although we acknowledge that PIAAC evaluates competences, a term which corresponds better to the proxy used in the empirical analysis.

Since, to our knowledge, there is a lack of comparative international surveys on higher order, general or specific skills, adult skills are considered a proxy of ability in different life contexts. Core skills may be considered narrow, but they involve a level of functionality with potential to maintain and develop higher order and job-specific skills. Furthermore, core skills help people to cope with text-based processing tasks, applicable to a wide range of jobs and contexts. Through the paper, we will use the term skills or core skills interchangeably.

It has been pointed out (Cunha, Heckman, and Schennach 2010; Desjardins 2003; Saar, Ure, and Desjardins 2013) that the process of skills acquisition is an iterative process which involves different stages, environments and state institutions and organizations. Our assumption is that adults' core skills could be interpreted as a basic asset for 'functioning' in society and as a final outcome of education and training in a broader sense. Moreover, since skills are not fixed at a given moment in time and individuals gain and lose skills during their lifespan, a plurality of factors have to be considered. For this reason, the proposed model takes into account a wide variety of lifecycle factors not strictly related to the education and training system, in an effort to give a richer picture of how skills are configured in a comparative perspective. Here, we first discuss briefly the underlying rationality of the model and the correlates of skills introduced in the analysis, and then present the data and methods employed. In section four, the results are analysed and the conclusions are given in section five.

2.2. Correlates of literacy

Core skills such as literacy are acquired in different contexts. The literature depicts two divergent research paradigms of literacy (Reder 1998), tending to focus on the specificity or generality of literacy, namely the cultural practices paradigm and the individual skills paradigm. The former emphasizes that literacy skills and knowledge are learned within a specific practice context, whereas the latter views literacy as a set of de-contextualized, information-processing skills that are contextualized when an individual engages in specific literacy-related situations (Reder 1998).

This leads to the assumption that developing literacy is, from the outset, a social act (Carneiro and Gordon 2013). Theory suggests that performance on typical literacy-related tasks

is influenced by a number of factors, not least engagement or practice in literacy-related situations. In this line, we focused on the acquisition of literacy skills in a plurality of individual and contextual factors. This paper deals with the factors of age, gender, origin, education, employment status, occupation classification, and competence at work, in order to assess their relevance in explaining skills. In building the models, an individual's life course was approximated, i.e. starting with a block of demographic variables, then adding home background variables, education, current employment and occupation, on-the-job training activities and on-the-job skill use. A brief review of the correlates of literacy is presented below.

2.2.1. Education attainment

Education is the strongest predictor of skills (Boudard 2001). This is implicit in the education system objectives and the way of learning, since education is based on routines that are conducive to language instruction as well as motivation to use and master literacy resources. On the other hand, the way we were educated and the collective objective of education influence society's conception of a determined set of skills as important, at any given moment. Additionally, surveys focused on skills assessment are influenced by the way we envision the objectives of education and, to a certain extent, they are likely to be biased toward academic-related skills.

The relationship between education attainment and skills is strong, but not perfect, since a variety of other factors may play a role. The acquisition of skills is a result of engaging in a variety of spheres, such as home, work, leisure and daily practice. For this reason, we need to think of literacy acquisition as a dynamic stock of assets rather than a fixed and determined stock at a given point in time. Lifelong learning concepts and theories (Aspin et al. 2001) can form a useful framework for considering learning contexts beyond formal education. Education attainment in the model was considered as the highest level of initial education.

2.2.2. Home background

Since the 1960s, a wide range of studies have focused on the relationship between individual background and academic outcomes (Coleman 1966; Jencks and Others 1971). This has shown the importance of the family when it comes to educational attainment (Bukodi and Goldthorpe

2013; Jerrim and Macmillan 2015; Schütz, Ursprung, and Wößmann 2008). Home background plays an important role in shaping educational preferences, opportunity and access, as well as attitudes, values and behaviour. Various studies have differentiated between primary effects - the association between an individual's class background and the actual levels of academic performance - and secondary effects - the relevance of home background in shaping education preferences and attitudes (Boudon 1973; Gambetta 1987). In our analysis we were unable to differentiate between these two effects due to lack of information in the dataset.

The dataset does provide information on background aspects such as the language spoken at home and whether the person was born outside the country. In many countries, foreign-born and non-native speakers have lower literacy (OECD 2000). It could be expected that one is more proficient in his or her native language rather than in another, but this difference might also relate to social, economic and cultural cleavage that the education and training system partially fails to reduce. In this block, we included the language spoken at home, whether the individual was born outside the country where the assessment was taken, the highest education attainment of the parents, and the number of books at home.

2.2.3. Age and gender

Literacy tends to be lower for older adults, while those aged 26-35 have comparatively higher scores (OECD 2013). This process might be related to biological deterioration and the ageing process, but also to education expansion, where younger adults have been exposed to the education system for a longer period (Desjardins and Warnke 2012). Moreover, curriculum obsolescence and a reduced use of certain skills in daily life certainly play a role. As for gender, PISA has demonstrated that female students tend to have an advantage in reading, while boys have an advantage in mathematics.

2.2.4. Position in the labour market

Individuals who are employed have higher skills than the reserve labour force (OECD 2000, 2013a). The work environment gives a position for a better maintenance or development of core skills. The International Adult Literacy Survey (OECD 2000) shows how people with high literacy skills have more opportunities to use them in the workplace. Furthermore, people who

are employed in a skilled job position have higher literacy compared to non-skilled workers. We included, in this block of variables, the labour market status, occupational qualification at four levels, and the number of years of work experience.

2.2.5. Formal training in the workplace

Access to formal training in the workplace is crucial in skills development over the life course, and it has been demonstrated that specific training in the workplace can give access to improvement or maintenance of skills (Bassanini and Brunello 2008, 2011). Moreover, skilled employees are more likely to receive formal training in the workplace.

2.2.6. Skills use at work

Measures of occupational classification used in standard surveys discriminate vertically between different categories, but they do not perform well when we need to account for horizontal differences (within the same occupational status or category position). This is increasingly the case in a knowledge-based society where most of the population is employed in a skilled or semi-skilled job. In order to unravel the differences, we used two indicators related to tasks performed on a daily basis in the workplace, including numeracy and literacy use. The aim was to give a non-hierarchical occupational measure of skill use.

2.3. Data and methods

We extracted data from the Programme for International Assessment of Adult Competencies (PIAAC), a study commissioned by the Organisation for Economic Co-operation and Development (OECD). For each country, the PIAAC provides information based on large samples of the active adult population, aged between 16 to 65 years old, and allows complex analyses of education attainment and social outcomes. Data were collected in 2011-12 and the full results were available in October 2013. The OECD and other international organisations have produced global assessments of different skills in order to gain understanding of their distribution (Schleicher 2008). Prior to the PIAAC, the International Adult Literacy Survey (IALS) (1994-98) and the Adult Literacy and Lifeskills (ALL) Survey (2004-06) were the most important international sources of information. These surveys provided direct measures of skills

and involved large-scale educational assessment. The aim of all these programmes was to compare the "quality of education as a social outcome" beyond schooling. Once established, they become relevant tools of governance (Desrosières 2002; Grek 2009) which are also influential for the education agenda (Meyer and Benavot 2013). They have the advantage of being both a source of valuable information for comparative analysis and being completely independent from the national certification systems.

The novelty of PIAAC lies in the availability of different direct measures of adults' skills and its comparability. The standard survey mode was to answer questions on a computer-assisted personal interviewing (CAPI), but for respondents without computer experience there was also the option of a pencil-and-paper interview. Countries use different sampling schemes in drawing their samples, but these are all adjusted to known population counts by means of post-sampling weightings. The PIAAC combines household survey methodology with educational testing of adult population skills and has quite a rich background questionnaire, which includes the socioeconomic factor, education, training, the labour market, skills use, health and civic participation variables.

The literacy domain is defined as the ability to "understand and use information from written texts in a variety of interactive contexts and situations, which involves understanding, reflection and judgment". One of the assumptions of the PIAAC framework is that the three domains assessed represent a set of key skills, which enable in the introduction of higher order skills and retraining within a changing and increasingly demanding labour market. The skills domains tested are literacy, numeracy, and problem solving in technology-rich environments, the former was not implemented by all the participating countries. Literacy and numeracy are evaluated using 56 items distributed across three main tasks characteristics (medium, context and aspect), distinguishing between paper and computer based questions. In addition, for the reading component, interviewers timed respondents and this information is part of the measure of efficiency (OECD 2013b). Arguably, the most relevant omission of direct measures in the survey are specific skills used by individuals in their line of work, together with intrapersonal and interpersonal skills. PIAAC, as in other international educational assessments, uses item-

response techniques (IRT) to generate plausible values of the domains tested[9]. The three skill domains, with a mean of 250 points and a standard deviation of 50 points, are strongly correlated, with an individual-level correlation between numeracy and literacy (problem-solving) of 0.85 (0.76). The resulting scores cannot be interpreted at an individual level, because they are not the individual results of the tests.

Our sample included 107,178 individuals in 23 countries and sub-national units aged between 25 and 65. We excluded people aged between 16 and 24 because they are likely to not have completed their initial education. We also excluded the data of Australia, Russia or Cyprus from our analysis : the Australian data have restricted access; according to the OECD (2013), data collected for the Russian Federation is preliminary and not representative of the entire Russian population, because it excludes the Moscow municipal area; and, at the time of writing, data on Cyprus was not available in the public use file of the OECD web page.

In this paper, we used the direct measures of literacy to estimate the relationships between document literacy and numeracy, and a number of other factors, which are relevant to skills variation among adults. Some of these factors – for instance the use of numeracy and literacy-related practices at work – have not been extensively explored. The analysis uses Shapley decomposition in order to break down the variance of each successive block and disentangle their impact on skills. This approach means that the variables included in the model are not completely independent of each other. In fact, there is high correlation between some of the variables. For instance, a respondent's level of education tends to be similar to that of their parents. In this sense, Shapley values have an advantage over other variance decomposition methods when there is high collinearity between the explanatory variables (Owen, 1977). Shapley decomposition assigns a given value x of the k factor of the aggregate statistics (e.g. I). If X k (k = 1, 2,…, m) denotes a set of contributory factors which together account for the value of I, then

$$I = f(X_1, X_2, \ldots, X_m)$$

[9] Skills are measured through ten plausible values using item response theory (IRT) model. Individual response patterns are used to generate plausible values scores of achievement in the assessment (for details, see the technical report, OECD 2013).

where f is an aggregator function representing the underlying model. The final objective in all types of decomposition is to assign contributions C k for each factor X k, ideally in a manner that allows the value of I to be expressed as the sum of the contributions factor. It involves calculating the marginal impact of each of the factors as they are eliminated, in succession, and then averaging these marginal effects over all possible elimination sequences. It treats the factors symmetrically; the sum of contributions is equal to the amount which needs to be "explained", and the contributions can be interpreted as the expected marginal effects (Shorrocks 2013).

The estimations were performed using the REGO package in STATA 13. In the variance decomposition, the estimated values were replicated 80 times by the corresponding weighting factors calculated in the survey, and after normalisation by the actual sample of each country. For sensitivity controls, we compared the results using REPEST and PV packages. Further sensitivity analysis showed that using only one plausible value of literacy, in the variance decomposition, altered the coefficient only to a third decimal point, even though the standard errors vary slightly. All the results shown correspond to the literacy skill domain, although similar results were obtained on analysing numeracy skills.

Table III. Variables included in the model

Block name	Description	Codification
Demographic variables	Age	discrete (8 categories)
	Gender	dummy coded (male ref.)
	Language spoken	dummy coded (same language of the test ref.)
Parental background	Being born abroad	dummy coded (native ref.)
	Highest parental education	two dummy variables: post-secondary, tertiary (ref. mandatory education)
	Number of books at home	discrete (5 categories)
Education attainment	Highest final education credential attained	two dummy variable for post-secondary and tertiary education (mandatory education, ref.)
Labour market position	Employment status	two dummy variables: unemployed and out of the labour market (ref. employed)
	Qualification Occupation	three dummy variables: skilled, white collar and blue collar (ref. elementary occupation)
	Work experience in years	continuous two variables years and years squared
Participation in job related training activities	On the job training activities	dummy variable (Yes vs. No, ref.)
Use of skills in the workplace	Intensity of use of writing skills	Continuous. Index derived from 5 likert scales variables and log transformed.
	Intensity of use of numeracy skills	Continuous. Index derived from 5 likert scales variables and log transformed.
Literacy	Ten plausible values	Continuous. Mean 250 and standard deviation of 50
Numeracy	Ten plausible values	Continuous. Mean 250 and standard deviation of 50

Source: Own construction.

We then explored how different social factors influence skills formation, and any regularity emerging between countries. Based on the former Shapley variance decomposition, a cluster agglomerative hierarchical analysis was performed, using the values for each block of variables. In the cluster analysis, we employed the squared Euclidian distance as measure of similarity and the nearest neighbour as the aggregation method. Considering that the variables employed were all ratios[10], Euclidian equals Mahalanhobis distance. All the variables and their codification are shown in **Table III**.

[10] All percentages of the overall r squared is explained by each block of variables.

2.4. Results

The overall model fit accounts for 35% of variance in both literacy and numeracy domains for OECD countries. In six countries, Sweden, Francophone Canada, Flanders, Sweden, the United States and Norway, the full model explains between 40 to 45% of the variance in literacy. On the other hand, the model does not perform so well in explaining literacy skills in Estonia, Japan, the Czech Republic or the Slovak Republic (between 21 and 29%). The level of education attainment is the variable that best explains the level of skills of adults in line with former studies. On the other hand, home background is the most important block of predictors of literacy, with a third of the variance accounted for in the general model (31%), followed by education (28.4%), the labour market (17.8%) and skills use at work (13.2%). It is remarkable how skill use at work is influential in explaining skills even after accounting for all the other variables, especially the position in the labour market.

Comparing the results with numeracy as the outcome variable, the level of literacy skills seems to be less sensitive to the variables included in the model. Only the coefficients of education attainment and occupation qualification were higher when numeracy was taken into account as an outcome variable. This could be related to the fact that literacy is a more commonly used set of skills than numeracy and that the former is a set of skills more related to schooling, as IALS and ALL results have demonstrated.

Furthermore, numeracy is most intensively used by people with higher educational attainment and a qualified position in the labour market. Both models retain similar coefficients and corresponding sign, which indicates the robustness of our analysis. In the background variables block, speaking the native language and being born abroad were highly related to literacy. Having a tertiary academic credential represented, on average, a 34.8 point advantage in literacy and 38 in numeracy scores. Home background was very important in Austria, Denmark, Norway, Sweden and the United States, where it accounted for more than a third of the total variance of the model. For the Czech Republic, Estonia, Northern Ireland, Poland and Japan, home background was less relevant. Education was the most important explanatory block in Francophone Canada, Flanders, France and Korea.

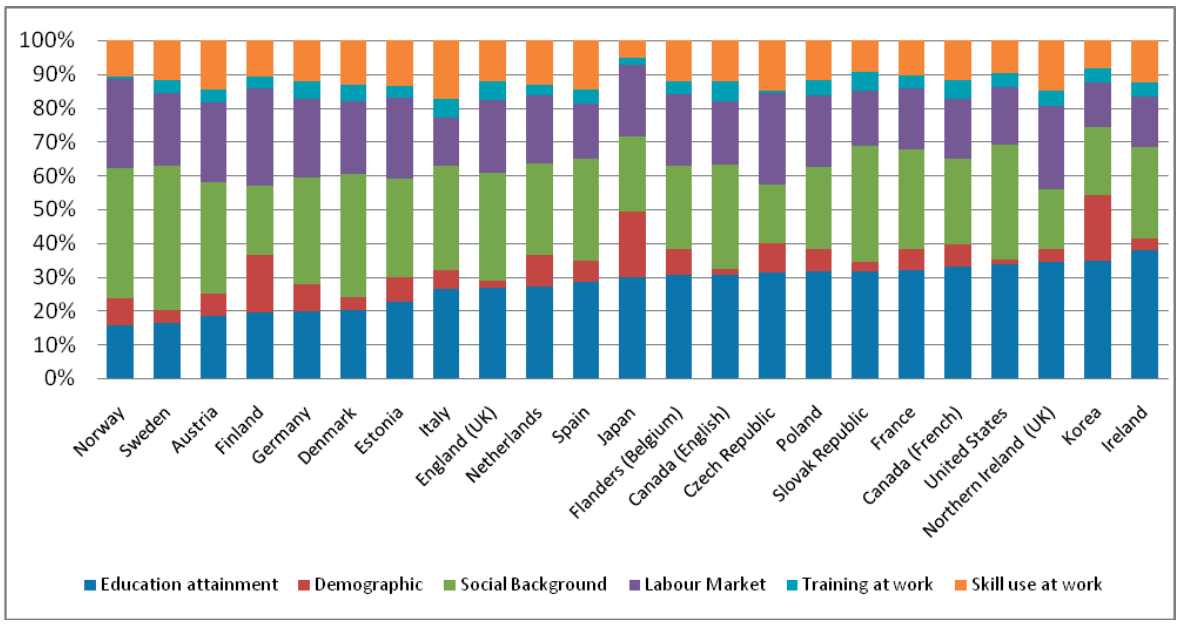
Table IV. General model for OECD, literacy

Group	Regressor	Coefficient		Std.Err.	Ind. %R2	Group %R2
1	gender	-2.477657	***	0.2631669	0.1532	5.2578
	age	-2.562658	***	0.1002643	5.1047	
2	nativelang	-13.39135	***	0.5630304	4.5351	31.0534
	for_born	-16.83106	***	0.5275057	5.0945	
	pared_2	4.083876	***	0.2950566	1.6932	
	pared_3	8.004799	***	0.3723604	5.6857	
	books	5.184069	***	0.0987299	14.0448	
3	educ_2	19.31349	***	0.386417	5.2884	28.372
	educ_3	34.88445	***	0.4370548	23.0836	
4	empl_stat_2	-1.543293	**	0.6400146	0.3303	17.9619
	empl_stat_3	3.516553	***	0.4302518	1.6744	
	skilled	13.38825	***	0.4874485	10.9857	
	white_collar	5.966194	***	0.4635674	1.2724	
	blue_collar	1.144075	**	0.5017981	1.6763	
	work_exp	0.4296694	***	0.0434078	0.9365	
	work_exp2	-0.0082848	***	0.0008616	1.0862	
5	nfe12jr	2.754804	***	0.2687665	4.368	4.368
6	num_work	1.134719	***	0.1146288	7.0268	12.987
	writ_work	1.409973	***	0.1018411	5.9602	
	Intercept	225.9607	***	0.6941291		
	Observations	108491				
	Overall R2	0.34005				

*** p<0.01, ** p<0.05, * p<0.1
Source: PIAAC 2013, Own calculation.

Figure 2 shows the negative relation between the amount of variance explained by home background and education achievement. This pattern was particularly consistent in Scandinavian countries and German-speaking countries, where home background variables were responsible for a large proportion of the variance in literacy. On the other hand, the reverse is true in most English-speaking countries, and Korea and Japan: education was more relevant than home background in explaining literacy. In Finland, the Netherlands, Spain, France, the Slovak Republic, Canada (English) and the United States, the pattern of these two dimensions in explaining literacy was more balanced, even though their levels between countries were very different.

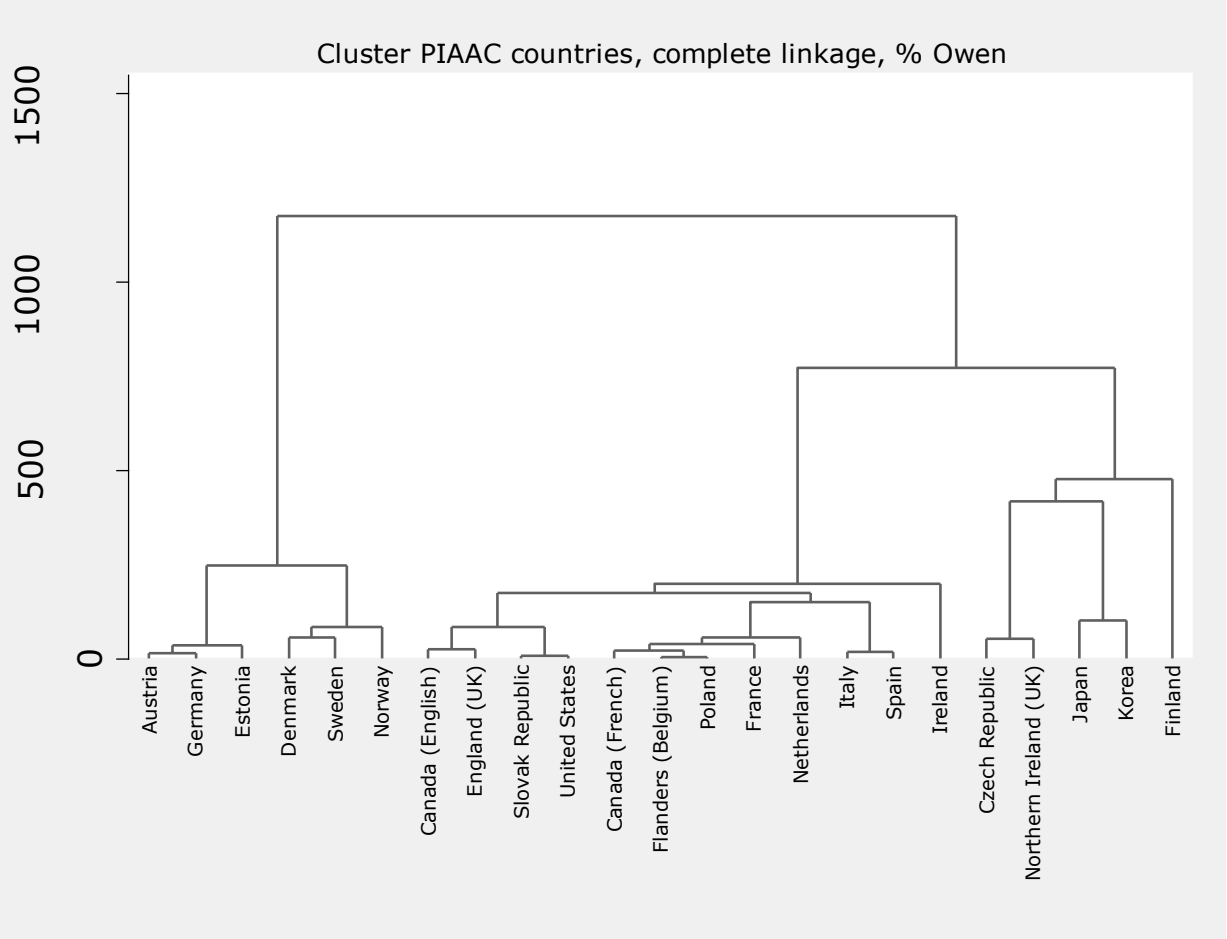
Figure 2. Percentage of total variance of literacy skills explained by block of variables, sorted by education



Source: PIAAC 2013, Own calculation.
*The height of the histograms represents the percentage of total variance explained by each successive block of variables

Within a common similarity of the OECD countries surveyed in the PIAAC, we detected a cross-country divergence of structuring skills. This is the assumption that led to the following step in the analysis. Based on the results of the Shapley variance decomposition, we proceeded to explore whether and how the life span factors of skills formation included in our model configured different typologies across OECD countries. The results of the hierarchical cluster were similar to those obtained from model-based clustering, and are presented in the form of a dendogram in **Figure 3**.

Figure 3. Hierarchical agglomerative cluster of skills factors formation



Source: PIAAC 2013, Own calculation.

The countries could be divided into three main groups. The first group included the Czech Republic, Northern Ireland, Finland, Japan and Korea. It was characterized by a very low impact of home background on literacy skills and, in contrast, a very high impact of the labour market position variables. On the other hand, this group had the lowest percentage of people at level 1 or below of literacy in PIAAC and, except Finland, these countries have very low dispersion in literacy compared to the OECD. This group could be divided in two sub-groups with Finland, Japan and Korea having the highest impact of demographic variables and the lowest in terms of home background. These countries have a very high percentage of tertiary education population and are among the countries, which have experienced the largest education expansion over the past decades. Overall, this group of countries was characterized by

more egalitarian skills training, where home background had the least impact on skills compared to the rest of the OECD.

The second group was formed by Austria, Estonia, Germany, Denmark, Norway and Sweden. These countries show a very high impact of the labour market and home background in the formation of skills with a moderate percentage of population with level 1 or lower of literacy. In these countries, the labour market appeared to be very stable and skill-demanding, with a high employment rate and skilled and semi-skilled population, and very high levels of working experience and on-the-job training. Moreover, being born abroad and being a non-native were strongly associated with skills in these countries. Within this group, the Nordic countries form another subgroup with a very high impact of home background on skills, very high parental education level and a rather low impact of education variables on literacy. These countries had both the highest percentage of individuals with tertiary education and high parental education attainment. In Nordic countries, home background was the most relevant block in explaining numeracy skills, with the exception of Finland where it was extremely low. This could be partially due to a fairly high percentage of non-native speakers and foreign born population. The acquisition of skills in this group was more work-oriented with the countries traditionally having a more stable labour market and where initial education is less important in relative terms.

The largest cluster was composed of Canada, England, the United States, the Slovak Republic, Flanders, Poland, the Netherlands, Spain, Italy and Ireland, where skills were explained by education attainment, whereas labour market position variables had a low impact on explaining skills. Within this cluster, we detected four subgroups. Italy and Spain form a group characterized by a high impact of home background, initial education attainment, and very high impact of skills use at work, but a low impact of labour market position. Additionally, these two Southern European countries are characterized by a very high polarization in the level of literacy having both the highest and lowest percentage of people respectively at level 1 or lower and level 4 or above. Even though the dispersion in terms of standard deviation is lower for Italy compared to Spain. This group had also the lowest percentage of individuals with parents with tertiary level education and a very high proportion of the population with only secondary or lower education. Moreover, it presented the lowest employment rate and people

employed in highly-qualified posts, and a very low rate of on-the-job training and skills intensive use on-the-job. Francophone Canada, Flanders, France, the Netherlands and Poland formed a group of countries where home background was less influential, while individual education was relatively more important than in the other countries. A further cluster of English-speaking countries, Canada (English), the United States and England, together with the Slovak Republic, formed a separate subgroup with the lowest impact of age and gender in explaining skills, while both home background and education level were highly related to skills. On the other hand, they tend to have a polarized distribution of literacy. For this reason, in these countries, skills distribution appears to be less egalitarian.

2.5. Discussion

Since the introduction of international comparative assessments on educational competences, a number of studies have attempted to identify the major factors influencing the acquisition, development and maintenance of skills. Presumably, the interest arises from the assumption that a set of key skills is crucial to communication and facilitates personal, social, and economic development. In other words, literacy is a basic and core skill for an individual to function in society. The outcomes of literacy are thought to be pervasive, involving potential benefits in health, personal and intellectual effects, as well as socio-economic success (OECD, 2013).

A vast strand of literature developed from a country-centred approach and established welfare and economic production systems covariation. The varieties of the capitalism approach (Hall and Soskice 2001; Soskice, Estevez-Abe, and Iversen 2001) stresses the complementarities of economic, institutional and social relation, while the welfare regimes tradition (Esping-Andersen 1990, 1999) focuses on class struggle and the historical configuration of a system of production. Constructing an empirical analysis of a national system implies an 'averaging out' of the actual complexities of the real world. In consequence, this 'averaged' representation of the national system does not necessarily describe what happens in specific parts.

Our analysis shows how a wide range of life course factors affects literacy, and detects major variation in its education and training within OECD countries. The way groups are formed support former institutional comparative literature (Green 2006; Janmaat et al. 2013; Soskice et al. 2001) on educational and training systems. The results show that countries in Northern

(Denmark, Norway and Sweden) and Central Europe (Austria, Estonia and Germany) have an occupation-centred model of skills formation, with marked inequality associated with individual home background (Bol and van de Werfhorst 2013). In contrast, the Czech Republic, Northern Ireland, Japan, Korea and Finland have a more egalitarian model of structuring differences in skills. In these countries, skills are not strongly associated with individual background, nor with the educational credential attained.

A residual, large number of countries are grouped together, even though subgroups emerge with common characteristics. Anglo-Saxon countries (Canada, England and the United States) and the Slovak Republic form a group where both home background and education attainment play a fundamental role in skills formation. In these countries, the balance of these two factors demonstrates the relationship between education credentials and skills, but also the strong link between individual home background and education attainment. Spain and Italy have a common model of skills which is very specific, with differences in skills being more a result of the combination of poor individual home background and a lower degree of educational attainment. Furthermore, the position in the labour market had a very weak impact on skills compared to the other countries. To some extent, the position in the labour market did not respond to skills, but to external factors. This finding was reinforced by the fact that skills use in the workplace had a higher impact on skills.

The "varieties of capitalism" and "welfare state regimes" approaches counter-balance the simplistic argument that globalization entails an inevitable tendency towards convergence of national economies. They are country-centred and avoid a unicum view of global convergence. They focus on significant differences in the ways in which the overall approach has been translated into national policy regimes, reflecting historically-constituted divergences not only in basic economic and social conditions, but also in deeply-rooted political values. Soskice et al. (2001) analysed what they term welfare production *régimes*, defined as characteristic national sets of product market strategies, employee skill trajectories, and the social, economic and political institutions that support them. In the welfare regime literature, the systematic variations in rates of participation in adult learning in different societies can be understood in terms of the structure and organization of opportunities to participate. These latter, in turn, reflect the equilibrium reached by a plurality of social actors in the respective types of welfare

state régime (Esping-Andersen 1990, 1999; Korpi 2006), which is based on the historical class struggle. What mainly differs in these approaches are the reasons for the rationality of the configuration of different models of modern capitalism. Moreover, the way of grouping countries is similar in this literature.

The analysis suggests that the characteristics of the system driving skills formation may be diverse at different stages of life. Without entering into the debate on the rationality of divergent models of capitalism, in this article we support the importance of diverse spheres in shaping core skills. The way of structuring these differences in skills varies in the analysed countries. These distinctions respond to divergent welfare regime models and the micro-macro organization equilibriums, which lie behind them. The results are based on a single year's observation, in 2012, which was one of the moments when the economic and financial crisis hit OECD economies harshly and unequally, and reflects only partially the characteristics of the education and training system. However, the dimensions analyzed captured long-term effects, which are likely to be less affected by the economic crisis. The challenge for future cross-national research on skills inequalities will be to use observations from other years and address endogeneity and reversal causality issues which may affect skills and their related acquisition factors. This could shed light on the effects of the different phases of lifelong learning and disentangle which policies and system characteristics have the greatest impact at each phase.

2.6. Conclusion

In this article we have argued that skills outcomes can be explained by different combinations and equilibria of social factors. We show that there is a certain regularity within countries which reflects production and welfare arrangements. This recurrence between education and training system outcomes and how welfare production regimes are articulated is based on a common heritage specific to each country. Moreover, these historical and institutional characteristics may affect each country's evolution of education and welfare arrangements. If education and training outcomes and production and welfare regimes are intertwined, policy makers may understand better the underlying links between the two. Thus, the overall objective of improving skills outcomes cannot be judged or obtained without referring to a broader social system.

References

Allmendinger, Jutta and Stephan Leibfried. 2003. "Education and the Welfare State: The Four Worlds of Competence Production." *Journal of European Social Policy* 13(1):63–81.

Aspin, David, Judith Chapman, Michael Hatton, and Yukiko Sawano. 2001. *International Handbook of Lifelong Learning*. Springer Netherlands.

Bassanini, Andrea and Giorgio Brunello. 2008. "Is Training More Frequent When the Wage Premium Is Smaller? Evidence from the European Community Household Panel." *Labour Economics* 15(2):272–90.

Bassanini, Andrea and Giorgio Brunello. 2011. "Barriers to Entry, Deregulation and Workplace Training: A Theoretical Model with Evidence from Europe." *European Economic Review* 55(8):1152–76.

Beblavý, Miroslav, Anna-elisabeth Thum, and Marcela Veselkova. 2011. *Education Policy and Welfare Regimes in OECD Countries. Social Stratification and Equal Opportunity in Education*.

Bedard, Kelly and Christopher Ferrall. 2003. "Wage and Test Score Dispersion: Some International Evidence." *Economics of Education Review* 22(1):31–43.

Bol, Thijs and Herman G. van de Werfhorst. 2013. "Educational Systems and the Trade-Off between Labor Market Allocation and Equality of Educational Opportunity." *Comparative Education Review* 57(2):285–308.

Borgonovi, Francesca and Artur Pokropek. 2016. "Education and Self-Reported Health: Evidence from 23 Countries on the Role of Years of Schooling, Cognitive Skills and Social Capital." *Plos One* 11(2):e0149716.

Boudard, Emmanuel. 2001. *Literacy Proficiency. Earnings and Recurrent Training: A Ten Country Comparative Study*. Stockholm: Institute of International Education, Stockholm University.

Boudon, Raymond. 1973. *L'inégalité Des Chances, La Mobilité Sociale Dans Les Sociétés Industrielles*. Paris: Colin.

Braga, Michela, Daniele Checchi, and Elena Meschi. 2013. "Educational Policies in a Long-Run Perspective." *Economic Policy* 28(73):45–100.

Brown, Phillip. 1999. "Globalization and the Political Economy of High Skills." *Journal of Education and Work* 12(3):233–42.

Bukodi, Erzsébet and John H. Goldthorpe. 2013. "Decomposing 'Social Origins': The Effects of Parents' Class, Status, and Education on the Educational Attainment of Their Children." *European Sociological Review* 29(5):1024–39.

Bulle, Nathalie. 2011. "Comparing OECD Educational Models through the Prism of PISA." *Comparative Education* 47(4):503–21.

Carneiro, Roberto and Jean Gordon. 2013. "Warranting Our Future: Literacy and Literacies." *European Journal of Education* 48(4):476–97.

Coleman, James. 1966. "Equality of Educational Opportunity." Retrieved December 23, 2015 (http://files.eric.ed.gov/fulltext/ED012275.pdf).

Cunha, Flavio, James Heckman, and Susanne Schennach. 2010. "Estimating the Technology of Cognitive and Noncognitive Skill Formation." *NBER Working Papers*.

Damme, Dirk Van. 2013. "How Closely Is the Distribution of Skills Related to Countries ' Overall Level of Social Inequality and Economic Prosperity ?" (105):1–16.

Desjardins, Richard. 2003. "Determinants of Literacy Proficiency: A Lifelong-Lifewide Learning Perspective." *International Journal of Educational Research* 39:205–45.

Desjardins, Richard and Kjell Rubenson. 2013. "Participation Patterns in Adult Education: The Role of Institutions and Public Policy Frameworks in Resolving Coordination Problems." *European Journal of Education* 48(2):262–80.

Desjardins, Richard and Arne Jonas Warnke. 2012. *Ageing and Skills. A Review and Analysis of Skill Gain and Skill Loss over the Lifespan and over Time.* Paris.

Desrosières, Alain. 2002. *The Politics of Large Numbers*. Cambridge, Massachusetts: Harvard University Press.

Dupriez, Vincent, Christian Monseur, Maud V. A. N. Campenhoudt, and Dominique Lafontaine. 2012. "Social Inequalities of Post-Secondary Educational Aspirations: Influence of Social Background, School Composition and Institutional Context." 11(4):504–19.

Dupriez, Vincent;, Xavier; Dumay, and Anne; Vause. 2008. "How Do School Systems Manage Pupils' Heterogeneity." *Comparative Education Review* 52(2):245–66.

Esping-Andersen, Gøsta. 1990. *The Three Worlds of Welfare Capitalism*. Princeton: Princeton University Press.

Esping-Andersen, Gøsta. 1999. *Social Foundations of Postindustrial Economies*. Oxford: Oxford University Press.

Gambetta, Diego. 1987. *Were They Pushed or Did They Jumped? Individual Decision Mechanisms in Education*. Cambridge: Cambridge University Press.

Green, Andy. 2006. "Models of Lifelong Learning and the 'knowledge Society.'" *Compare: A Journal of Comparative and International Education* 36(3):307–25.

Grek, Sotiria. 2009. "Governing by Numbers: The PISA 'effect' in Europe." *Journal of Education Policy* 24(September 2014):23–37.

Grossman, Michael. 2006. "Education and Nonmarket Outcomes." Pp. 577–633 in *Handbook of the Economics of Education.*, vol. 1, edited by E. . Hanushek and F. Welch. Amsterdam.

Hall, Peter and David Soskice. 2001. *Varities of Capitalism*. New York: Oxford University Press.

Hanushek, Eric A. and Ludger Wößmann. 2006. "Does Educational Tracking Affect Performance and Inequality? Differences- in-Differences Evidence Across Countries." *The Economic Journal* 116(510):C63–76.

Hanushek, Eric A., Ludger Wößmann, and Lei Zhang. 2011. "General Education, Vocational Education, and Labor-Market Outcomes over the Life-Cycle." *NBER Working Paper* Working Paper 17504.

Hanushek, Eric Alan and DD Kimko. 2000. "Schooling, Labor-Force Quality, and the Growth of Nations." *American Economic Review* 90(5):1184–1208.

Hanushek, Eric Alan, Guido Schwerdt, Simon Wiederhold, and Ludger Woessmann. 2013. "Returns to Skills around the World: Evidence from PIAAC." *NBER* Working Pa.

Harmon, Colm, Hessel Oosterbeek, and Ian Walker. 2003. "The Returns to Education: Microeconomics." *Journal of Economic Surveys* 17(2):115–56.

Hega, G. M. and K. G. Hokenmaier. 2002. "The Welfare State and Education: A Comparison of Social and Educational Policy in Advanced Industrial Societies." *Politikfeldanalyse/ German Policy Studies* 2(1):1–29.

Janmaat, Jan Germen, Marie Duru-Bellat, Philippe Méhaut, and Andy Green. 2013. *The Dynamics and Social Outcomes of Education Systems*. London: Palgrave Macmillan.

Janmaat, Jan Germen and Andy Green. 2013. "Skills Inequality, Adult Learning and Social Cohesion In The United Kingdom." *British Journal of Educational Studies* 61(March 2014):7–24.

Jencks, Christopher and And Others. 1971. "Inequality: A Reassessment of the Effect of Family and Schooling in America." Retrieved December 23, 2015 (http://eric.ed.gov/?id=ED077551).

Jerrim, John and Lindsey Macmillan. 2015. "Income Inequality, Intergenerational Mobility, and the Great Gatsby Curve: Is Education the Key?" *Social Forces* 94(2):1–29.

Korpi, Walter. 2006. "Power Resources and Employer-Centered Approaches in Explanations of Welfare States and Varieties of Capitalism: Protagonists, Consenters, and Antagonists." *World Politics* 58(02):167–206..

Mayer, Karl Ulrich and Heike Solga. 2008. *Skill Formation Interdisciplinary and Cross-National Perspectives*. Cambridge: Cambridge University Press.

Meyer, Heinz-Dieter and Aaron Benavot. 2013. *PISA, Power, and Policy: The Emergence of Global Educational Governance*. Oxford: Symposium Books.

Mons, Nathalie. 2007. *Les Nouvelles Politiques Éducatives: La France Fait-Elle Les Bons Choix?* Paris: Presses Universitaires de France.

Nelson, Moira. 2010. "The Adjustment of National Education Systems to a Knowledge-Based Economy: A New Approach." *Comparative Education* 46(4):463–86.

OECD. 2000. "Literacy in the Information Age." *Oecd & Statistics Canada*. Retrieved December 22, 2015 (http://www.oecd.org/edu/skills-beyond-school/41529765.pdf).

OECD. 2012. *Literacy, Numeracy and Problem Solving in Technology-Rich Environments: Framework for the OECD Survey of Adult Skills*. Retrieved (http://books.google.com.au/books?id=4aIFPSufTw0C).

OECD. 2013a. *OECD Skills Outlook 2013*. Paris: OECD Publishing. Retrieved (http://www.oecd-ilibrary.org/education/oecd-skills-outlook-2013_9789264204256-en).

OECD. 2013b. *Technical Report of the Survey of Adult Skills (PIAAC)*. Paris.

Oreopoulos, Philip and Kjell G. Salvanes. 2011. "Priceless: The Nonpecuniary Benefits of Schooling." *Journal of Economic Perspectives* 25(1):159–84.

Pechar, Hans and Lesley Andres. 2011. "Higher-Education Policies and Welfare Regimes: International Comparative Perspectives." *Higher Education Policy* 24(1):25–52.

Peter, Tracey, Jason D. Edgerton, and Lance W. Roberts. 2010. "Welfare Regimes and Educational Inequality: A Cross-National Exploration." *International Studies in Sociology of Education* 20(3):241–64.

Pickett, Kate E. and Richard G. Wilkinson. 2007. "Child Wellbeing and Income Inequality in Rich Societies: Ecological Cross Sectional Study." *BMJ (Clinical research ed.)* 335:1080.

Reder, Stephen. 1998. "Literacy Selection and Literacy Development: Structural Equation Models of the Reciprocal Effects of Education and Literacy. In (Ed.), (Pp. 139–157)." in *Literacy for the twenty-first century: Research policy, practices and the national adult literacy survey*, edited by M. C. Smith.

Westport, CT: Praeger.

Saar, Ellu, Odd Bjørn Ure, and Richard Desjardins. 2013. "The Role of Diverse Institutions in Framing Adult Learning Systems." *European Journal of Education* 48(2):213–32.

Schleicher, Andreas. 2008. "PIAAC: A New Strategy for Assessing Adult Competencies." *International Review of Education* 54:627–50.

Schütz, Gabriela, H. W. Ursprung, and Ludger Wößmann. 2008. "Education Policy and Equality of Opportunity." *Kyklos* 61(2):279–308.

Shorrocks, Anthony F. 2013. "Decomposition Procedures for Distributional Analysis: A Unified Framework Based on the Shapley Value." *Journal of Economic Inequality* 11(1):99–126.

Soskice, David, Margarita Estevez-Abe, and Torben Iversen. 2001. "Social Protection and the Formation of Skills: A Reinterpretation of the Welfare State." *Varieties of Capitalism: the Institutional Foundations of Comparative Advantage.* 145–83.

Thelen, Kathleen A. 2004. *How Institutions Evolve. The Political Economy of Skills in Germany, Britain, the United States, and Japan*. Cambridge: Cambridge University Press.

Van de Werfhorst, Herman G. and Jonathan J. B. Mijs. 2010. "Achievement Inequality and the Institutional Structure of Educational Systems: A Comparative Perspective." *Annual Review of Sociology* 36(1):407–28..

Wößmann, Ludger. 2005. "The Effect Heterogeneity of Central Examinations: Evidence from TIMSS, TIMSS-Repeat and PISA." *Education Economics* 13(2):143–69.

Chapter 3. An integral model of adult skills in OECD countries

Abstract

Research in the social sciences has focused extensively on the relationship between family background, educational attainment and social destination, on the one hand, and on the processes of skills creation and skills use, on the other. This paper brings these two branches of the literature together by examining the correlation between a range of social factors. The methodology we adopt provides an integral approach to the study of the channels through which literacy skills are acquired, taking into account the interrelation of family background, educational attainment, and the use of skills at work and at home. We use the Programme of International Assessment of Adult Competences (PIAAC) dataset and apply a structural equation model (SEM). Our results show that family background and education play an important role in the configuration of adult skills and skill practices. Unequal family access to resources has a strong impact at later stages in life and strongly affects educational attainment and skills outcomes. Additionally, skills use has a positive and direct impact on adult skills.

Keywords: Skills, education, family background, SEM, literacy, PIAAC

3.1. Introduction

In the last few decades, technological upgrading and an expanding knowledge-based economy have accelerated the transformation towards a high-skills equilibrium, which has brought about a radical shift in the labour profile from physical to intellectual-creative work. New technology eliminates jobs via increasing levels of automation, but it is unclear whether there has been a concomitant growth in the creation of high skilled employment. Some argue that the added value of this new economy lies in the competition of new ideas, knowledge and skills, as opposed to the accumulation of material capital (Drucker, 1993; Hanushek & Wößmann, 2008; Hanushek & Kimko, 2000). At the same time, globalization places strict limits on a country's ability to intervene in its economy, thus enhancing international competition. The only way to

maintain productivity and the standard of living seems to be to focus on high value added goods and services, based on the application of knowledge, skills and entrepreneurial ideas (Brown, Lauder, & Ashton, 2008; ILO, 2011).

For these reasons, investing in education is considered to be one of the few effective policy strategies for global competitiveness and for meeting the demand for a high-skilled labour force. The Organisation for Economic Co-operation and Development (OECD) Skills Strategy and the report on literacy in the EU *Act Now!* (EU high level group of experts on literacy, 2012; OECD, 2013a) set these political objectives as their strategic goals. Greater participation in education is one way to meet the demands of the changing economy and, in some OECD countries, more than half the population aged between 25 and 34 has tertiary education. As Brown, Lauder, & Ashton (2011) have demonstrated, the new settlement between the individual and the state is increasingly based on a *skills nexus*. Thus, while the state is responsible for providing the opportunity to develop and acquire skills and education as tools for securing social justice and social cohesion, individuals need to find employment for themselves and to sell their skills and knowledge in the global labour market (Brown et al., 2011; Reich, 1992).

This study seeks to disentangle the channels via which skills are acquired and it does so by focusing on the interrelations established across multiple social spheres. As such, the main aim of this paper is to validate a common hypothetical model of the acquisition of adult skills for all OECD countries. Although, many studies have found both within- and between-country variations in adult skills, there are sufficient similarities across the OECD to suggest we might be able to corroborate a general skill-formation model. However, we should acknowledge from the outset that our findings are not specific to any one country participating in the Programme of International Assessment of Adult Competences (PIAAC). To test whether common tendencies can be identified in the acquisition of skills, we use the maximum information available in the dataset. In the framework developed herein, social spheres constitute the context in which skills are acquired and include family background, educational attainment, and use of skills at work and at home.

Research in the social sciences has focused either on the relationship between family background, educational attainment and social destination, or on the process of skills creation

and use and the way to conceptualize the relationship between the individual and skills. Our paper seeks to merge these two branches of literature and to analyse their interactions. We avoid any interpretations that see these social phenomena as having single, direct effects, given that all the dimensions of interest typically intervene in the underlying process. In this sense, educational attainment mediates our model of skills acquisition. For this analysis, we use the PIAAC dataset and we apply structural equation models (SEMs).

Our results show that the role played by education is highly relevant in the configuration of adult skills. Education affects literacy directly and it has a strong influence on the practice of skills. Furthermore, structural elements, including family background, play an important role in shaping education, skills use in the workplace and in daily life. A relevant residual influence of family background is associated with adult skills, indicating that unequal access in the family to resources has a strong impact at later stages in life and strongly affects education and skills outcomes. Yet, skills practice and use have a significant and positive effect on literacy and this clearly points to the potential benefits of lifelong learning policies.

From a general policy perspective, it is critical to understand the role of education and social factors in the development of adult skills. Although unequal access to education affects literacy, active life-long learning policies, with objectives that are clearly compatible and integrated with individual aspirations, can allow for subsequent interventions.

The rest of the paper is organized as follows. First, we briefly present the way in which skills are conceptualized and measured, then we discuss the social factors affecting the skills included in our model and, in section 4, we consider the data and procedure used in the estimation process. Finally, in section 5, we discuss the results and conclusions.

3.2. Conceptualization and measurement of skills

Many empirical studies have shown skills to be an important predictor of socioeconomic success (Bowles, Gintis, & Osborne, 2001; Cunha, Heckman, & Schennach, 2010; Cunha & Heckman, 2007; Hanushek, Schwerdt, Wiederhold, & Woessmann, 2013; Heckman, 1995); yet, the definition of skills remains a highly contentious question in the social sciences (note, that we use

the term skills[11] in the plural, since they have been shown to be multiple in nature), though it is agreed they are intrinsically dynamic, being made up of various stages of acquisition and proficiency. It should be borne in mind that our results are based on a global assessment survey, which means our measurement of skills is only partial and is a proxy of literacy core skills at a given moment in time. The skills evaluated are taken from the theoretical framework of the PIAAC.

PIAAC is a large scale assessment that seeks to test adult skills. The antecedents of this programme were the International Adult Literacy Survey (IALS) (1994-98) and the Adult Literacy and Life Skills (ALL) Survey (2004-06); likewise, commissioned by the OECD. These programs aim to establish a benchmark of the "output" (or social outcomes) of the education and training systems by developing a comparable measure of skills performance. Global assessments of this kind are becoming more and more influential in international policy making and are an important tool in the reform of education and training systems (Grek, 2010; Meyer & Benavot, 2013). Moreover, they are rapidly establishing themselves as a tool of governance that can influence the decisions of the actors involved (Desrosières, 2002; Espeland & Sauder, 2007; Grek, 2009). In this paper, we consider PIAAC as a source of valuable information for comparative analyses but do not repeat discussions concerning the reliability of its skills measurement[12], but refer the reader to the PIAAC technical report (OECD, 2013b) for a full discussion.

The foundational skills assessed in PIAAC are a core set that are assumed to be essential for an individual to function in the knowledge economy. A major advantage here is that information is gathered about the skills that are actually rewarded in the labour market. Moreover, these skills are considered to be relevant in order to build higher order skills and to facilitate the retraining of individuals. In keeping with this aim, PIAAC adopts a "competence" approach – where competence is defined as the ability to apply knowledge and skills across environments and in

[11] There has been much debate about the measurement of cognitive skills. Two decades ago, the Bell Curve (Herrnstein & Murray, 1996) generated a resurgence of this debate. Throughout this text we clearly state the measure of cognitive skills used and identify the most relevant contributions on the question of reliability.

[12] Further information on measurement can be found in Gebhardt & Adams, 2007; Goldstein, 2004; Svend, 2011.

interactive contexts that involve understanding, reflection and judgement (OECD, 2012) – and explores whether people are able to implement their knowledge in multiple contexts.

The skill domains assessed in PIAAC are literacy, numeracy, and problem solving in technology-rich environments. These are evaluated using 56 items distributed across three main task characteristics (medium, context and aspect) and differentiated between paper and computer-based questions. In addition, for the reading component, interviewers timed respondents and this information is part of the measure of efficiency (OECD, 2013b). As in other international educational assessments, PIAAC uses item-response techniques (IRT) to generate ten plausible values of each domain examined. The resulting scores do not allow an interpretation at an individual level, because they are not the individual results of the tests. These items have a mean of 250 and a standard deviation of 50 points and are strongly correlated, with an individual-level correlation between numeracy and literacy (problem-solving) of 0.85 (0.76).

This paper focuses specifically on literacy skills, defined as "understanding, evaluating, using and engaging with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential" (Gal & Tout, 2014; OECD, 2011, 2012; Schleicher, 2008). The measure is used as a proxy of the sum of using, interpreting and understanding prose and qualitative information. However, the delimitation of a skills standard is generally questioned, since the construction of any statistical object implies the definition of a finite class of equivalences based on a given taxonomy (Desrosières, 2002, 2008; Espeland & Stevens, 1998; Grek, 2010; Lamont, 2012; Porter, 1996). For this reason, the definition of a complex, dynamic concept, such as core skills, is extremely critical and has been extensively debated (Andrew et al., 2014; Espeland & Sauder, 2007; Goldstein, 2004).

3.3. Factors influencing the acquisition of skills and a hypothetical model

Our aim is to provide a comprehensive picture of the social factors affecting the configuration of adult skills in OECD countries. The link between educational attainment and quality of schooling has been extensively analysed, but some authors identify a misspecification of this link (Wossmann, 2003). Here, we consider the extent to which educational attainment serves as a

gauge of adult skills and how their everyday use correlates with individual adult skills. Many factors affect skills acquisition and loss, and the interaction of these factors highlights the need for a complex analytical approach. The daily use of skills and educational attainment are strongly associated with adult skills, but a range of other prior factors also strongly correlate with the former.

Family background is deemed to affect both education and social destination directly and indirectly, as the social mobility literature has demonstrated (Bukodi & Goldthorpe, 2013). Drawing on the cross-national PIAAC survey, we propose an integral approach to the analysis of the way in which adult skills are configured. We examine the relationship between skills, their use in daily life and in the workplace, family background, and a range of socio-demographic covariates.

First, we examine whether the model as stated is suitable for all the OECD countries included in PIAAC**.** Then, we test the correspondence between education, use of skills in daily life and in the workplace and the literacy skills of the adult population, examining all the direct and indirect effects between them**.** Antecedents, such as family background, affect individual education positively and are strongly linked to skills use in the workplace and to literacy. In the model, we include the covariates of age, gender and being foreign born, which have relevant direct and indirect effects on the configuration of skills.

In the following sections, we introduce the factors impacting skills and briefly review previous theories forwarded in the literature regarding the variables included in the hypothetical model. We present the components that are central to our study of the configuration of skills: education, family background, use of skills in the workplace and use of skills in daily life. We also review the model's covariates of gender, age and being foreign born. Finally, we present the hypotheses together with a graphical representation of the model.

3.3.1. Education

In the social sciences, distinct approaches have upheld the importance of education credentials as a determinant for a wide array of social outcomes, including those related to the labour market, income and social prestige. Since the development of the status attainment model (Blau & Duncan, 1967) and the Wisconsin model of education and early occupation attainment (Haller

& Portes, 1973), a strong, positive association between education, social origin and individual occupation has been found (Carbonaro, 2007; Kerckhoff, 2001). Higher education attainment is also associated with higher earnings and incomes (Barone & Van de Werfhorst, 2011; Hanushek et al., 2013; Harmon, Oosterbeek, & Walker, 2003), better health, a higher level of wellbeing, and political participation (Bedard & Ferrall, 2003; Braga, Checchi, & Meschi, 2013; Damme, 2013; Hoskins, Janmaat, Han, & Muijs, 2014; Oreopoulos & Salvanes, 2011).

Various authors have examined the mechanisms thought to underpin these relations. Functionalists (Bell, 1973; Davis & Moore, 1945) argue that the labour market needs diversified skills, which are linked to individual levels of qualification. Human capital theorists (Becker, 1964) contend that the better educated enhance their individual skills and, hence, productivity, considering education to be a proxy for unmeasured skills. On the other hand, structuralists deem critical education to be a positional good, where education and skills are valuable to the extent that they offer greater access to a higher position in the job market. This perspective is shared by signal theorists (Arrow, 1973; Spence, 1973), who assert that education acts as a filter in the hiring process and is an imperfect measure of performance ability. Hence, rewards are based both on formal qualification and productivity. Others (Thurow, 1975) point out that skills are mostly acquired in the workplace and the relation between education, skills and productivity depends more on the position in the job market than on educational attainment (labour market queue theory).

On the other hand, more radical approaches, such as that proposed by the credentialists (Collins, 1979), claim that the expansion of educational attainment does not contribute to an increase in overall competences. Rather, a higher education qualification operates as a device of macro-social motivation to justify wage discrepancies in the labour market. All these theories recognize that both education and skills constitute an advantage for individual success, but they tend to disagree upon which factor is the most important. Thus, they diverge with regard to the level of correspondence between education, skills and labour market demands.

In our analysis, we disentangle these relationships and consider skills as being the final outcome of the process and the interaction of multiple components. In this respect, skills acquisition is complex and multi-causal, passing through various stages, the process being

socially and specifically determined. Additionally, the development of skills involves a continuum of gain and loss over the life cycle. In order to capture this process, we would need a panel of individuals and repeated measures of their skills over the life cycle. To our knowledge, this type of data is as yet unavailable.

3.3.2. Family background

The importance of family origin as a determinant of educational achievement and skills has been monitored from the 1960s and '70s (Boudon, 1973; Bourdieu & Passeron, 1964; Coleman, 1966) until the present day (Black, Devereux, & Salvanes, 2005; Chevalier, Harmon, O' Sullivan, & Walker, 2013). The accessibility and allocation of different forms of family capital directly and indirectly influence an individual's status at a later stage in their life (Blau & Duncan, 1967; Breen & Karlson, 2014; Erikson & Goldthorpe, 1992). Parental social and financial capacity and their incentives to invest in their offspring's education are prominent in this process (Jerrim & Macmillan, 2015). Parental education has an indirect effect on children's access to material and immaterial resources and their related quality within their family and this may consequently influence schooling decisions. This association has been described in the literature of social mobility as the intergenerational transmission of education.

It has proved difficult to differentiate between genetic transmission (nature) and environmental determinants (nurture) and this distinction may even be obsolete (Cunha et al., 2010; Heckman, 1995), as demonstrated from the last two decades of epigenetics research. An unexplained residual effect between parental education and skills, having controlled for education, shows the extent to which skills are related to family background. This could have both a nature and a nurture component. For this reason, we interpret this coefficient as the unaccounted (via education) impact of family origin on individual skills. Moreover, as the literature on social mobility shows, there is also an intergenerational transmission of social destination, demonstrated by the high correlation between family background and the occupational status of offspring. In our model we consider the level of skills use of the individual in the workplace as a proxy of their current job. We discuss this claim in the next section.

3.3.3. Skills use

Practice engagement theory suggests that individuals acquire skills through participation in multiple specific practices. Related to this is the 'use it or lose it' hypothesis (Krahn & Lowe, 1998). Individuals practice their skills daily with varying frequency and intensity, which impacts on the mastery (or deterioration) of their skill set. Moreover, the extent to which an individual acquires skills is well represented by the dichotomy presented by Guile & Okumoto (2007) between generic/transferable and context-specific skills (i.e., that determined practice generally is 'situated' in a specific environment). This latter position also represents the views of seminal thinkers such as Collins and Evans (2007) and Flyvberg (2001), who argue that it is only by developing context specific 'deep' (tacit) understanding that one can gain expertise. They also contend that much tacit knowledge is socially facilitated and is only gained through immersion in groups that already possess this knowledge (i.e., immersion with those already undertaking the role). A successful gain of tacit knowledge requires individuals effectively embedding themselves within the social group that embodies such specific expertise.

In our model, we distinguish skills practices in two separate dimensions: in the workplace and in daily life (at home). This construct is designed to measure the job related tasks reported by the interviewees, but it could be interpreted as a proxy for the use of intensive skills in the workplace. The latent variable of skills use in the workplace could be related to the individual occupation classification, although it is not based on relative measures of position and prestige in the labour market, for instance experience in the workplace, the occupation sector or the international occupation classification. The underlying hypothesis is that the actual use of skills in the workplace is a better proxy for the occupation status and prestige in the labour market. In fact, it is increasingly difficult in contemporary society to discriminate between very similar jobs. Most cross-national research adopts diverse occupational classifications, but when studying the occupation category the current job is not specifically considered. Occupation and job are not equivalent units of analysis, since the former is simply an aggregation of the latter (Baron & Bielby, 1980). In addition, each occupation category is intrinsically highly heterogeneous, much more so than most researchers have hitherto assumed.

For these reasons, in our model, we draw on the actual use of skills in the workplace rather than the individual occupation characteristics. Making use of these proxies enhances cross country comparability. Furthermore, the polychoric correlation between the latent constructs of skills use in the workplace and the international classification occupation (ISCO) was above 0.8 in all the countries examined.

3.3.4. Gender

Various studies show marked gender differences in performance in mathematics and reading. Analyses of global international assessments (i.e., PISA) show that boys outperform girls in mathematics, while girls do better at reading. The evidence, however, is mixed and these differences are inversely correlated across the four waves of PISA between and within countries (Stoet & Geary, 2015). Theoretical explanations relate these gaps to biological and socio-cultural causes, but research indicates the difficulty in isolating the two and reaffirms that both are important. In PIAAC, men outperform women in all three domains, that is, literacy, numeracy and problem solving, but after controlling for age and diverse social characteristics, these gaps seem likely to disappear. Furthermore, we should recognise that gender diversity in cognitive and personality traits affects the acquisition and loss of key skills, yet, these sources of difference lie beyond the scope of this paper. Gender might, on the other hand, be associated with unequal access to the labour market. After taking this difference into account, gender seems likely to have a non-significant impact on foundational skills. Moreover, a residual impact of gender on education reflects unequal access to opportunities in education, which is partially related to a historical unequal access to schooling between the genders.

3.3.5. Age

The evidence indicates that foundational skills tend to be lower among older cohorts. This pattern is consistent across countries if we examine ALL and IALS (Desjardins & Warnke, 2012) results. Younger adults (aged 26-35) have higher skills in the three domains evaluated in PIAAC (Rammstedt, Ackermann, Helmschrott, Klaukien, & Maehler, 2012). These results have both a biological explanation, related to ageing, and an explanation related to the asymmetrical access to education. Typically, in OECD countries, younger cohorts are exposed to longer periods in the education system than their older counterparts. It is likely that the greater amount of

education received by younger cohorts has a more positive impact on their skills level than the corresponding impact on the levels of the older cohorts (Calero, Murillo Huertas, & Raymond Bara, 2016).

A process of skills loss might result from the lack of training of a determined set of skills taught in the education system. In PIAAC, adults aged between 25 and 30 present an advantage of almost half a standard deviation in their skills scores, compared to those aged between 16 and 20. At the age of 45, skills deteriorate radically across all OECD countries. Since we are comparing multiple cohorts over a period of more than 30 years, we should take into consideration the heterogeneity of family backgrounds and the fact that younger people might have a richer family background. In fact, most of the countries participating in PIAAC have increased their overall level of educational attainment (education expansion) and this is most marked for the individuals interviewed and their parents.

3.3.6. Foreign born

The gulf in the educational outcomes of foreign born and the native population has been well documented. Many studies rely on explanations at the individual level that focus, above all, on the ascribed characteristics of cultural positions or the structural features of immigrant environments (Marks, 2005). An examination of cross-national studies suggests that the gap might also reflect macro-institutional factors, such as education systems and migration policies (Dronkers & Heus, 2013; Dronkers & Velden, 2013). These authors show that, in traditional immigration destinations, immigrant and native educational performances are similar. They also link these findings with the idea of a reduced social distance.

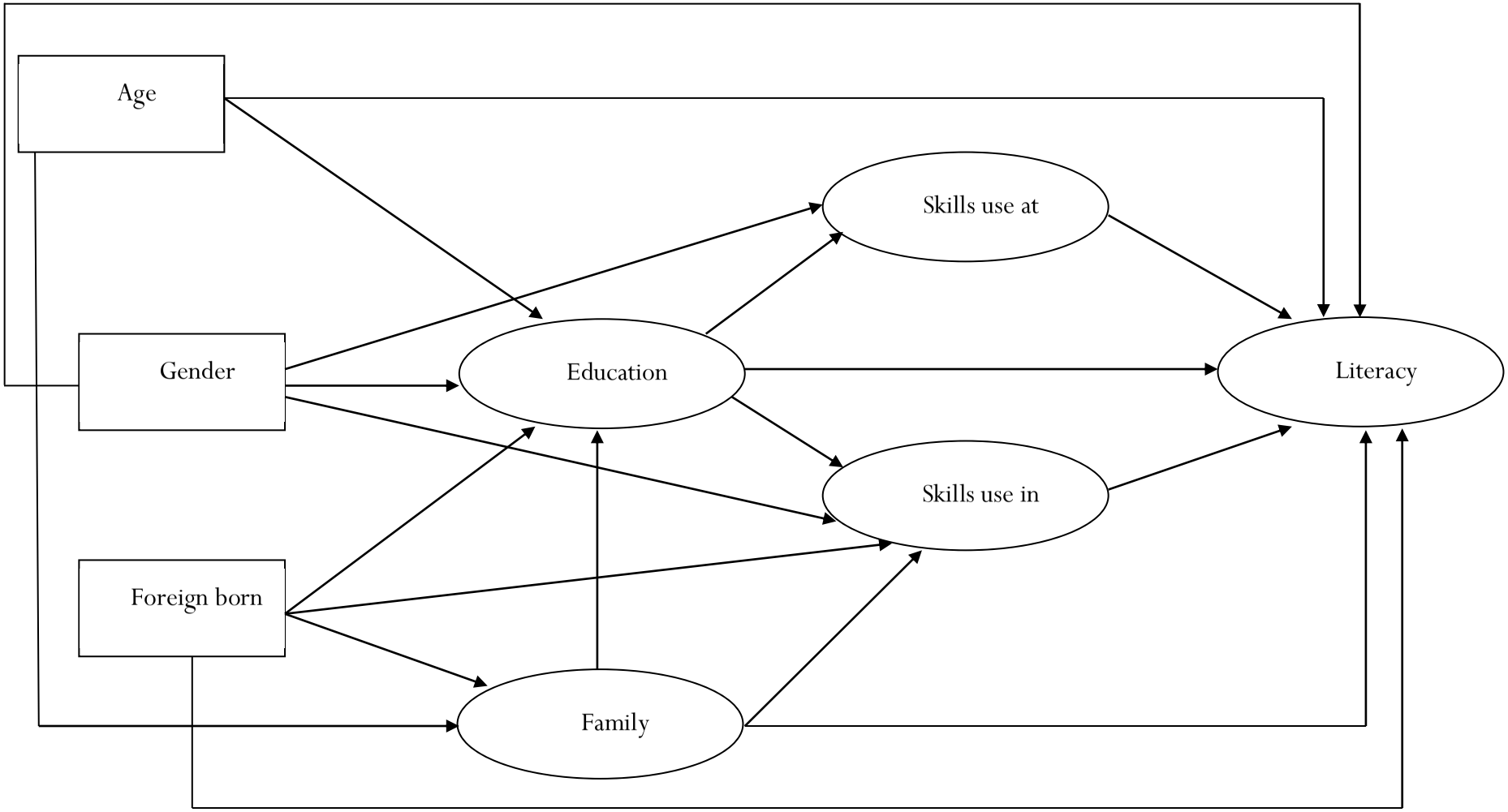
When examining adult skills, there are two main sources of disparity. One concerns the discrepancy within each country's education system and the difference in skills of foreigners and natives entering the labour market. The second factor is that the foreign born population is, in general, likely to have a poorer family background than that of natives.

3.3.7. Model hypotheses and graphical representation

Figure 4 is a graphical representation of the proposed model. Above, we have presented existing theories regarding the relationship between the variables included in the model. We

expect parental education to have a positive effect on offspring education (intergenerational transmission of education). Besides, an unexplained residual effect between parental education and skills demonstrates the extent to which skills are related to family background. Education has a positive and direct effect on literacy and on the practice of skills both in the home and in the workplace. In addition to this direct effect, a relevant mediating effect of these dimensions might have an impact on skills. Both skills practices have a positive effect on foundational skills. We control for different covariates and we expect a direct and negative effect of age on literacy.

Figure 4. Path diagram, visual representation of the model



*Circles represent the latent variables and rectangles the observed variables.

3.4. Data and methods

The study is based on the first wave of PIAAC, released in October 2013 and updated in March 2015. The data are made available on the OECD webpage and were retrieved in April 2015. PIAAC provides direct measures of skills together with rich information on the individual social environment for adults aged between 16 and 65 in 24 countries, mostly OECD members.

For the purposes of this analysis, we limited the sample to the population aged between 25 and 55, who reported having an occupation when the survey was conducted. Those aged between 16 and 25 were excluded, because of the likelihood of their still being in higher education. Additionally, those aged 56 and over were omitted, because of their being close to the age of retirement (depending on country legislation) and the likelihood of their having missing data on skills use in the workplace. We restricted the sample, therefore, to workers aged between 25 and 55, in order to have the best estimate of the skills structure of the active population. A robustness analysis confirmed the relevance of this sample restriction. Australia and Cyprus were excluded from the analysis owing to the public unavailability of data, and Russia for reasons of data quality and the absence of certain crucial variables used in the model. The final analytic sample consisted of 70,712 individuals who fulfilled the following criteria: workers aged 25 to 55, with full availability of data and good data quality.

Our ultimate goal was to disentangle the impact of various social factors and to estimate the extent to which each of them contributes to the development of core literacy skills, while at the same time accounting for interacting effects. The empirical foundation of the model was based on the seminal paper by Desjardins (2003). The central part of the model was also based on the social mobility literature and the widely used social origin-education attainment-social destination triangle (Breen & Karlson, 2014; Breen, Luijkx, Müller, & Pollak, 2009; E. Bukodi & Goldthorpe, 2012; Kuha & Goldthorpe, 2007). The main idea underpinning the model is that educational attainment mediates between family background and future social outcomes.

3.4.1. Selection of variables

The four components of skills acquisition were measured as follows: family background using the father's highest level of educational attainment; education using two items; and the practice

of skills in the workplace and in the home using four items. Below, we outline some of the decisions taken when selecting the variables to be used in the modelling process.

In line with much of the cross-national research literature, a collapsed three-category scheme of father's education was used for the latent construct of the respondent's family background (descriptive statistics are presented in **Table A31**). In general, parental education is deemed a good proxy for family background and social status. Scholars have also adopted other proxies of family background, including parental occupation or income. One example currently used in PISA is economic, social and cultural status (ESCS), which is a composite indicator derived from the International Socio-Economic Index (ISEI), a widely accepted classification of occupational status (Ganzeboom, de Graaf, & Treiman, 1992), parental years of schooling and three family resource indexes.

In PIAAC, as in most cross-national studies, there is no information about family income or parental occupation. The survey compiles information on the highest level of educational attainment of both parents and the number of books in the home when the respondent was 15 years old. Yet, as some authors claim, parental education might be preferable to other proxies of family background, because it captures a wide range of family inputs (Bukodi & Goldthorpe, 2012).

The latent education variable was constructed using two items: one provides information about the number of years of education (quantity) and the other records the time elapsed since achieving the highest formal qualification; thus, suggesting the obsolescence of the former. The time passed since the attainment of the highest level of education points to the obsolescence of educational curricula and their related skills sets. Years of schooling are directly converted from the information reported on the highest qualification attained. In PIAAC, each country performs its conversion into imputed years of schooling. Since the focus is on the degree to which education affects skills and their use, we tend to maximize this effect, by handling continuous variables. Hence, we use the imputed years of education on a continuous scale. As Germany does not report information on the imputed years of education for its respondents, for this country, we applied a recodification on the basis of the ISCED level of individual qualification, as provided by the OECD Directorate of Education. For missing data in the case of the

obsolescence of a qualification, we bypassed this lack of information by employing the multiple imputation technique, using the discrete variable of age and the covariates included in our model.

The latent variable of skills use in the workplace was based on four items: three record information about frequency of use of core skills (such as writing, numeracy and reading) and the fourth item captures the influence of these skills on the respondent's co-workers. The latent variable of skills use in daily life was constructed using records of skills use in the household. We included numeracy, reading, writing and the use of information technology. The items used to construct the latent factor are shown in **Table V**. Many studies do not draw a distinction between the spheres of skills practice, basically because of their high correlation (OECD, 2000). In our model, however, we opted to separate these two spheres of acquisition. The intensity of skills use was coded on the Likert scale and then log transformed.

Finally, the latent construct of literacy comprises the ten plausible values of literacy[13] generated through IRT as described in **Section 2**.

We also controlled for age, for being born outside the test country and for gender. **Figure 4** presents a path diagram of the model. A detailed list of the manifest and latent variables included in the model is given in **Table V** together with the Greek notation and the item description.

To test the hypothesized relationships between the constructs and to evaluate the theoretical model, we used a structural equation model (SEM). This is a broadly flexible set of statistical techniques which allows the representation of the constructs of interest and the measurement of the extent to which the data are consistent with a proposed theoretical model. The advantages of SEM over conventional regression analysis techniques are basically four. SEM allows us to describe the directed dependence of a set of observed and unobserved (or latent) variables. Second, latent variables are also more reliable than observed variables, as measurement error is accounted for and they permit the combination of almost any kind of item independently of the type of measurement. Third, SEM allows the researcher to include multiple dependent variables

[13] Treating the ten plausible scores as items of a latent variable is equivalent to estimating ten models separately and taking the mean of the parameters.

and to use them in the interpretation of the model. Four, multiple goodness-of-fit measures are produced which allow us to evaluate just how well the model fits the data.

Table V. Latent and observed variables used in the model

Latent variables			Observed variables		
Symbol	Label	Abbreviation	Symbol	Description	Type
ξ_1		Gender	x_1	gender	dichotomous
ξ_2		Age	x_2	age	ordinal
ξ_3		Bor_born	x_3	born in country	dichotomous
η_1	Family background	F1	y_1	Father's Highest Level of Education	ordinal
η_2	Education	F2	y_4	Highest Level Of Education	continuous
			y_5	Time elapsed since achievement of hi qual.	ordinal
η_3	Use of skills in the workplace	F3	y_6	Use Of Reading Skills At Work	ordinal
			y_7	Use Of Numeracy Skills At Work	ordinal
			y_8	Use Of Writing Skills At Work	ordinal
			y_9	Use Of Influencing Skills At Work	ordinal
η_4	Use of skills at home	F4	y_{10}	Use Of Reading Skills At Home	ordinal
			y_{11}	Use Of Numeracy Skills At Home	ordinal
			y_{12}	Use Of Writing Skills At Home	ordinal
			y_{13}	Use Of ICT Skills At Home	ordinal
η_5	Literacy proficiency	F5	y_{14}	Plausible value Literacy pvlit1	continuous
			y_{15}	Plausible value Literacy pvlit2	continuous
			y_{16}	Plausible value Literacy pvlit3	continuous
			y_{17}	Plausible value Literacy pvlit4	continuous
			y_{18}	Plausible value Literacy pvlit5	continuous
			y_{19}	Plausible value Literacy pvlit6	continuous
			y_{20}	Plausible value Literacy pvlit7	continuous
			y_{21}	Plausible value Literacy pvlit8	continuous
			y_{22}	Plausible value Literacy pvlit9	continuous
			y_{23}	Plausible value Literacy pvlit10	continuous

Source: Own construction.

3.4.2. The modelling process

For the overall process of estimation, having explored the data, we first performed a test of multivariate normality using the MvTest package. Similarly, we estimated stepwise regression models in STATA 13.1 (StataCorp, 2015). The variables' descriptive statistics are shown in **Table A31** in the appendix. Therefore, following the standard procedure in the SEM literature, our two-step modelling process included i) a measurement model, describing the way observed variables load onto latent constructs, and ii) a structural model, which estimates the pathways among all the variables, including the latent constructs (Byrne, 2012; Kline, 2016). A

confirmatory factor analysis (CFA) was performed to check for the consistency of each latent variable (measurement model). The factor loading of each unobserved latent variable is given in **Table VI**.

Table VI. Measurement model

	Estimate	S.E.	Est./S.E.	P-Value
Measurement model				
F1 ← FATED	0.718	0.001	594.841	0.000
F2 ← YRSQUAL	0.954	0.005	174.736	0.000
FIN_SCH	0.723	0.006	127.718	0.000
F3 ← READH_C	0.841	0.005	160.310	0.000
NUMH_C	0.694	0.006	107.980	0.000
WRITH_C	0.786	0.006	138.189	0.000
ICTH_C	0.704	0.006	108.898	0.000
F4 ← READW_C	0.875	0.005	182.438	0.000
NUMW_C	0.715	0.007	106.496	0.000
WRITW_C	0.778	0.005	142.473	0.000
INFLW_C	0.659	0.007	93.533	0.000
F5 ← PVLIT1	0.941	0.001	666.195	0.000
PVLIT2	0.940	0.001	656.937	0.000
PVLIT3	0.939	0.001	650.379	0.000
PVLIT4	0.942	0.001	687.337	0.000
PVLIT5	0.940	0.001	670.475	0.000
PVLIT6	0.938	0.001	637.149	0.000
PVLIT7	0.940	0.001	646.784	0.000
PVLIT8	0.941	0.001	673.226	0.000
PVLIT9	0.943	0.001	701.093	0.000
PVLIT10	0.939	0.002	609.771	0.000

Source: PIAAC 2013, Authors' calculations.

We tested whether the items that constitute family background, education, use of skills at home and in the workplace load onto their respective latent constructs, and a full SEM was estimated to test the relationships between the latent variables and covariates. Throughout the process, we rescaled sample variance values of the continuous variables, as some exceeded the 1-to-10 range and this can generate convergence problems, especially with models that combine discrete and continuous outcomes.

The estimator selected was robust weighted least squares (WLSMV), which is a modification of the weighted least squares (WLS) estimator, created to deal especially with a combination of ordinal, discrete and continuous data and a small to medium sample size. All the SEM estimations were conducted using Mplus 7.4 (Muthén & Muthén, 2015). We then scrutinized the modification indices and performed J-Rule using Jrule for Mplus version 0.91 beta[14] (Oberski 2009) which implements the method described in Saris, Satorra, & van der Veld (2009). Thus, we aimed to determine whether the factor structure of our model was invariant across the OECD countries[15]. We performed sensitivity tests including missing data and recoding the zero category of manifest indicators in the latent constructs of use of skills into missing data. Bootstrap estimation was performed using 2,000 iterations, yielding the same results as the WLSMV estimation[16]. All the parameters correspond at 5 decimals points to bootstrap and replicate weights estimation. The results of the model with listwise deletion method are available upon request.

3.5. Results

Good model fits were obtained for the pooled OECD countries ($\chi 2 = 3236.908$, df = 233, $p<.01$, $\chi 2/df = 13.892$, comparative fit index (CFI) =.977, Tucker-Lewis index (TLI) = .973, root mean square error of approximation (RMSEA) =.014). We report all the goodness-of-fit measures in the note to **Table VII**. When the model was considered separately for each country, the fit indexes were consistent across all countries, with respect to the standard CFI and TLI thresholds. The RMSEA was also below .05, pointing to the plausibility of the model. In

[14] This software program was developed by Daniel Oberski and can be consulted at his personal webpage https://zenodo.org/record/10657#.VpNwE_nhBD8

[15] A test of measurement invariance (CFA) was performed for each country to check whether the OECD countries in PIAAC could be treated as a single group of countries. We performed this analysis twice, first with listwise deletion (thus we excluded Austria, Canada, Germany and the United States) and then we used all the observations available using the multiple imputation technique to handle missing information. The results of this analysis are reported in the first paragraph of section 6.

[16] Sensitivity tests were performed by estimating the model with the exclusion of missing data. The results of both models present the same coefficient signs and sizes. The sensitivity analyses are available upon request from the authors.

conclusion, we can reject the null hypothesis of a divergent structure of configuration of skills across OECD countries. It is important to stress that when interpreting these findings, we need to bear in mind that they refer to all countries participating in the PIAAC study.

The parameter estimates and the indirect effects, which have been standardized to facilitate comparisons, are reported in **Table VII**. Each structural parameter should be interpreted as a percentage change in the standard deviation of the dependent factor for a single change in the standard deviation of the independent factor under consideration, e.g., .2 should be interpreted as a 20% change. The results point to a strong impact of parental education on the individual's level of education, providing strong empirical evidence of the intergenerational transmission of education (standardized coefficient .773 $p<.01$). Moreover, family background has a residual impact on skills (standardized coefficient .273 $p<.01$), which is mediated by the model's other latent variables. This illustrates the extent to which family environment directly and indirectly affects skills in the long term, even after taking into account the individual education achieved and the other controls.

In addition, a small indirect impact of family background via education affects the use of skills at work and, hence, the individual's occupation (standardized coefficient .048 $p<.01$). These results support the view that inequality in education and literacy is closely related to the resource inequality that exists between families of different social backgrounds. Age also has a negative impact on the individual's family background (standardized coefficient -.243 $p<.01$) and an effect on education (standardized coefficient .089 $p<.01$). Via family background, age affects education. In fact, younger individuals experienced a richer family environment, which has a positive effect in terms of educational achievement**.** This finding is in line with the belief that the increased access of younger age groups to education partially reduces the transmission of inequality in education.

Table VII. Model results

	Estimate	S.E.	Est./S.E.	P-Value
Structural parameters				
F1→F5	0.273	0.027	10.108	0.000
F4→F5	0.108	0.014	7.896	0.000
F2→F5	0.185	0.025	7.390	0.000
F3→F5	0.117	0.013	9.163	0.000
F1→F2	0.773	0.014	56.944	0.000
F2→F4	0.553	0.020	27.240	0.000
F1→F4	0.048	0.023	2.072	0.038
F2→F3	0.562	0.008	71.607	0.000
AGE→F1	-0.243	0.013	-18.621	0.000
FOR_BORN→F1	-0.068	0.014	-4.888	0.000
Age→F5	-0.031	0.009	-3.558	0.000
Gender→F5	-0.010	0.008	-1.279	0.201
For_Born→F5	-0.226	0.006	-37.127	0.000
AGE→F2	0.089	0.013	7.088	0.000
For_Born→F2	-0.002	0.011	-0.199	0.842
Gender→F2	0.072	0.010	7.520	0.000
Gender→F4	-0.130	0.008	-15.643	0.000
FOR_BORN→F4	-0.103	0.007	-14.740	0.000
Gender→F3	-0.015	0.009	-1.684	0.092
F3 ↔ F4	0.505	0.010	49.997	0.000
Indirect effects				
Gender→F5	-0.002	0.003	-0.696	0.486
GENDER→F3→F5	-0.002	0.001	-1.658	0.097
GENDER→F4→F5	-0.014	0.002	-6.872	0.000
GENDER→F2→F5	0.013	0.003	5.236	0.000
F2→F5	0.125	0.007	17.326	0.000
F2→F3→F5	0.066	0.007	9.084	0.000
F2→F4→F5	0.060	0.008	7.194	0.000
F1→F5	0.246	0.017	14.360	0.000
F1→F2→F3→F5	0.051	0.006	8.915	0.000
F1→F2→F5	0.143	0.019	7.634	0.000
F1→F2→F4→F5	0.046	0.006	7.149	0.000
F1→F4→F5	0.005	0.002	2.134	0.033
AGE→F5	-0.018	0.003	-5.630	0.000
AGE→F1→F2→F5	-0.035	0.005	-6.808	0.000
AGE→F2→F5	0.017	0.003	5.194	0.000
FOR_BORN→F5	-0.021	0.003	-7.501	0.000
FOR_BORN→F1→F2→F5	-0.010	0.002	-4.149	0.000
FOR_BORN→F2→F5	0.000	0.002	-0.199	0.842
FOR_BORN→F4→F5	-0.011	0.002	-6.921	0.000

Model fit information: $\chi 2=3236.908$, $\chi 2/df=13.892$, n=70712,
RMSEA=.014, CFI=.977, TLI=.973, WRMR=2.296

*Reference category of gender (female) and for_born (native).

**→ indicates causal effects; ↔ covariance; and ← indicates observed item used to construct latent variable.

Source: PIAAC 2013, Own calculations.

The link between education and literacy was positive and significant (standardized coefficient .185 $p<.01$). In addition, it has both a very strong impact on skills use in daily life (standardized coefficient .562 $p<.01$) and on skills use in the workplace (standardized coefficient .553 $p<.01$). Education had a mediating effect on skills use in the workplace (standardized coefficient 0.06 $p<0.01$), and a slightly higher effect on those in daily life (standardized coefficient .066 $p<.01$). These results show that education is more relevant in explaining differentials in the use of skills in daily life and that these have an additive effect on literacy.

The practice of skills in the workplace and at home are very strongly correlated to each other (standardized coefficient .505 $p<.01$) and have a positive impact on literacy. This finding is in line with the literature, since both latent variables reflect the individual's daily life practices, albeit differentiating them by place of use. Home practice had a stronger impact on literacy (standardized coefficient .117 $p<.01$), which is similar to the impact of the use of skills in the workplace (standardized coefficient .108 $p<.01$).

Women tend to use fewer skills in the workplace than men, but this difference was non-significant for the daily use of skills. Women are likely to have an advantage (standardized coefficient .072 $p<.01$) in terms of education, but this is not reflected by skills use in the labour market (standardized coefficient -.015 $p<.01$). In addition, being foreign born has a negative effect on literacy (standardized coefficient -.226 $p<.01$) and on the use of skills in the labour market (standardized coefficient -.103 $p<.01$). Women and foreigners are likely to be employed in less skill-intensive occupations, performing jobs whose demands are below those of their actual level of qualification. The indirect effects of gender and being foreign born on education are significant, but have a moderate impact. These results demonstrate the unequal access to the labour market of women and foreign born individuals in the OECD area.

To sum up, education has an important mediating role in the configuration of adult skills. As a general predictor of these skills, it affects literacy directly, and it strongly influences the practice of skills. Furthermore, structural elements, such as family background, play an important role in shaping education, skills use in the workplace and, hence, labour market status. Moreover, a relevant residual influence of family background is associated with adult

skills, illustrating how unequal access among families to resources has a strong impact at later stages in life, having a marked impact on education and skill outcomes.

3.6. Conclusion

The mastery of certain key skills is deemed essential for social inclusion and participation in a constantly changing, knowledge-based economy. Skills are socially acquired in a wide variety of ways and the work of the individual is not simply another production factor, rather the ability to perform a job is conceived and constructed socially. A plurality of factors affects the acquisition and loss of skills and the interaction of these factors highlights the need for a complex analytical approach. Our paper has sought to recognise the importance of the interrelation of this array of factors in the configuration of adult skills in OECD countries. It has developed a hypothetical model of the acquisition of adult skills and accounted for the complex relationship between diverse constructs. Yet, this study has not considered the particularities of cross-country differences in adult skill levels and their dispersion; hence, caution should be exercised when interpreting the implications of these results as they do not provide specific evidence for individual countries in the PIAAC study.

However, our findings support the argument that there are structural elements of common configuration underpinning the acquisition of adult skills among the OECD members. Our results indicate that family background, age and education intervene strongly in the development of these skills. The importance of family background is persistent in the configuration of skills and the factor has both a direct and relevant influence on education and literacy, its impact being manifest in the shaping of social outcomes during later stages of life. The primary source of inequality in educational opportunities lies in the unequal access to a range of resources that exists between families of different backgrounds. As a general predictor of adult skills, education affects literacy directly and it strongly influences skills use. Education likewise plays an important role in mediating the effects of family origin on an individual's career and literacy. Even after controlling for all the other variables in the model, the use of skills at home and in the workplace still have notable effects on literacy. The evidence we

report, therefore, supports policies aimed at developing high quality, life-long learning programs that can promote the capacity for individual growth and experimentation.

References

Andrew, P. et al. (2014). OECD and Pisa tests are damaging education worldwide. *The Guardian*. London. Retrieved from http://www.theguardian.com/education/2014/may/06/oecd-pisa-tests-damaging-education-academics

Arrow, K. J. (1973). Higher education as a filter. *Journal of Public Economics*, *2*(3), 193–216. http://doi.org/10.1016/0047-2727(73)90013-3

Baron, J. N., & Bielby, W. T. (1980). Bringing the Firms Back in: Stratification, Segmentation, and the Organization of Work. *American Sociological Review*, *45*(5), 737–765.

Barone, C., & Van de Werfhorst, H. G. (2011). Education, cognitive skills and earnings in comparative perspective. *International Sociology*, *26*(4), 483–502.

Becker, G. (1964). *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. Chicago: University of Chicago.

Bedard, K., & Ferrall, C. (2003). Wage and test score dispersion: some international evidence. *Economics of Education Review*, *22*(1), 31–43.

Bell, D. (1973). *The Coming of Post-Industrial Society: A Venture in Social Forecasting*. (B. Books, Ed.) (1999 ed.). New York.

Black, S. E., Devereux, P. J., & Salvanes, K. G. (2005). Why the apple doesn't fall far: understanding intergenerational transmission of human capital. *The American Economic Review*, *95*(1), 437–449.

Blau, P. M., & Duncan, O. D. (1967). *The American occupational structure*. New York: Wiley Press.

Boudon, R. (1973). *L'inégalité des chances, La mobilité sociale dans les sociétés industrielles*. Paris: Colin.

Bourdieu, P., & Passeron, J.-C. (1964). *Les héritiers*. Paris: Minuit.

Bowles, S., Gintis, H., & Osborne, M. (2001). The Determinants of Earnings : A Behavioral Approach. *Journal of Economic Literature*, *39*, 1137–76.

Braga, M., Checchi, D., & Meschi, E. (2013). Educational policies in a long-run perspective. *Economic Policy*, *28*(73), 45–100.

Breen, R., & Karlson, K. B. (2014). Education and Social Mobility: New Analytical Approaches. *European Sociological Review*, *30*(1), 107–118.

Breen, R., Luijkx, R., Müller, W., & Pollak, R. (2009). Nonpersistent inequality in educational attainment: evidence from eight European countries. *American Jounal of Sociology*, *114*, 1475–1521.

Brown, P., Lauder, H., & Ashton, D. (2008). Education, globalisation and the future of the knowledge economy, *7*(2), 131–156.

Brown, P., Lauder, H., & Ashton, D. (2011). *The Global Auction: The Broken Promises of Education, Jobs, and Incomes*. Oxford: Oxford University Press.

Bukodi, E., & Goldthorpe, J. H. (2012). Decomposing "Social Origins": The Effects of Parents' Class, Status, and Education on the Educational Attainment of Their Children. *European Sociological Review*, *29*(5), 1024–1039.

Byrne, B. M. (2012). *Structural equation modeling with MPLUS. Basic concepts, applications and programming*. New York, London: Routledge.

Calero, J., Murillo Huertas, I., & Raymond Bara, J. L. (2016). *Education, age and skills: an analysis using the PIAAC survey* (Human Capital No. 3). Barcelona.

Carbonaro, W. (2007). The effects of education and cognitive skill on earnings: How much do occupations and jobs matter? *Research in Social Stratification and Mobility*, *25*(1), 57–71.

Chevalier, A., Harmon, C., O' Sullivan, V., & Walker, I. (2013). The impact of parental income and education on the schooling of their children. *IZA Journal of Labor Economics*, *2*(1), 8.

Coleman, J. (1966). Equality of Educational Opportunity. Retrieved December 23, 2015, from http://files.eric.ed.gov/fulltext/ED012275.pdf

Collins, H., & Evans, R. (2007). *Rethinking Expertise*. (T. U. of C. Press, Ed.). Chicago.

Collins, R. (1979). *The Credential Society: An Historical Sociology of Education and Stratification*. New York: Academic Press.

Cunha, F., & Heckman, J. (2007). The Technology of Skill Formation. *NBER Working Paper No. 12840*, (October 2003).

Cunha, F., Heckman, J., & Schennach, S. (2010). Estimating the Technology of Cognitive and Noncognitive Skill Formation. *NBER Working Papers*.

Damme, D. Van. (2013). How closely is the distribution of skills related to countries' overall level of social inequality and economic prosperity?, (105), 1–16.

Davis, K., & Moore, W. E. (1945). Some Principles of Stratification. *American Sociological Review*, *10*(2), 242–249.

Desjardins, R. (2003). Determinants of literacy proficiency: A lifelong-lifewide learning perspective. *International Journal of Educational Research*, *39*, 205–245. http://doi.org/10.1016/j.ijer.2004.04.004

Desjardins, R., & Warnke, A. J. (2012). *Ageing and skills. A Review and analysis of skill gain and skill loss over the lifespan and over time*.

Desrosières, A. (2002). *The Politics of Large Numbers*. Cambridge, Massachusetts: Harvard University Press.

Desrosières, A. (2008). La statistique, outil de gouvernement et outil de preuve. *L'argument Statistique I : Pour Une Sociologie Historique de La Quantification*, 7–20.

Dewey, J. (1916). *Democracy and Education: an introduction to the philosophy of education*. New York: Macmillan. http://doi.org/10.1086/591813

Dronkers, J., & Heus, M. de. (2013). Immigrants' children scientific performance in a double comparative design: the influence of origin, destination, and community. In *PISA, Power, and Policy: the emergence of global educational governance, edited by H.-D. Meyer & A. Benevot. Oxford: Symposium Books.* (pp. 247–265).

Dronkers, J., & Velden, R. Van Der. (2013). Integration and Inequality in Educational Institutions, 71–98.

Drucker, P. (1993). *Post-Capitalist Society*. Oxford: Butterworth-Heinemann.

Erikson, R., & Goldthorpe, J. H. (1992). *The constant flux: a study of class mobility in industrial societies*. London: Clarendon Press.

Espeland, W. N., & Stevens, M. L. (1998). Commensuration.pdf. *Annual Review of Sociology*, *24*, 313–343.

Espeland, W., & Sauder, M. (2007). Rankings and Reactivity. *American Journal of Sociology*.

EU high level group of experts on literacy. (2012). *Act now!* Luxembourg. Retrieved from http://ec.europa.eu/education/policy/school/doc/literacy-report_en.pdf

Flyvberg, B. (2001). *Making Social Science Matter. Why social inquiry fails and how it can succeed again*. Cambridge: Cambridge University Press.

Gal, I., & Tout, D. (2014). *Comparison of PIAAC and PISA Frameworks for Numeracy and Mathematical Literacy*. Paris.

Ganzeboom, H. B. G., de Graaf, P. M., & Treiman, D. J. (1992). A standard international socio-economic index of occupational status. *Social Science Research*, *21*, 1–56.

Gebhardt, E., & Adams, R. J. (2007). The influence of equating methodology on reported trends in PISA. *Journal of Applied Measurement*, *8*(3), 305–322.

Goldstein, H. (2004). International comparisons of student attainment: some issues arising from the PISA study. *Assessment in Education: Principles, Policy & Practice*, *11*(3), 319–330.

Grek, S. (2009). Governing by numbers: the PISA "effect" in Europe. *Journal of Education Policy*, *24*(September 2014), 23–37.

Grek, S. (2010). International Organisations and the Shared Construction of Policy "Problems": problematisation and change in education governance in Europe. *European Educational Research Journal*, *9*(3), 396.

Guile, D., & Okumoto, K. (2007). "We are trying to reproduce a crafts apprenticeship": from Government Blueprint to workplace generated apprenticeship in the knowledge economy. *Journal of Vocational Education & Training*, *59*(4), 551–574.

Haller, A. O., & Portes, A. (1973). Status Attainment Processes. *Sociology of Education*, *46*(1), 51–91.

Hanushek, E. A., & Kimko, D. (2000). Schooling, labor-force quality, and the growth of nations. *American Economic Review*, *90*(5), 1184–1208

Hanushek, E. A., Schwerdt, G., Wiederhold, S., & Woessmann, L. (2013). Returns to skills around the world: Evidence from PIAAC. *NBER, Working Papers*.

Hanushek, E. A., & Wößmann, L. (2008). The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature*, *46*(3), 607–668.

Harmon, C., Oosterbeek, H., & Walker, I. (2003). The Returns to Education: Microeconomics. *Journal of Economic Surveys*, *17*(2), 115–156.

Heckman, J. J. (1995). Lessons from the Bell Curve. *Journal of Political Economy*, *103*(5), 1091. http://doi.org/10.1086/262014

Herrnstein, R., & Murray, C. (1996). *Bell Curve: Intelligence and Class Structure in American Life*. New York: Free Press.

Hoskins, B., Janmaat, J. G., Han, C., & Muijs, D. (2014). Inequalities in the education system and the reproduction of socioeconomic disparities in voting in England, Denmark and Germany: the influence of country context, tracking and self-efficacy on voting intentions of students age 16–18. *Compare: A Journal of Comparative and International Education*, (June), 1–24.

ILO. (2011). *A Skilled Workforce for Strong, Sustainable and Balanced Growth: A G20 Training Strategy*. *Education And Training*. Geneva.

Jerrim, J., & Macmillan, L. (2015). Income Inequality, Intergenerational Mobility, and the Great Gatsby Curve: Is Education the Key? *Social Forces*, *00*(00), 1–29.

Kerckhoff, A. C. (2001). Education and Social Stratification Processes in Comparative Perspective. *Sociology of Education*, *74*, 3–18.

Kline, R. B. (2016). *Principles and practices of structural equation modelling*. *Methodology in the Social Sciences* (4th ed.). New York - London: The Guilford Press.

Krahn, H., & Lowe, G. S. (1998). *Literacy utilization in Canadian workplaces*. *International Adult Literacy Survey monograph series*. Ottawa.

Kuha, J., & Goldthorpe, J. H. (2007). Path analysis for discrete variables : Education as mediator of social mobility in Britain, (144), 1–37.

Lamont, M. (2012). Toward a Comparative Sociology of Valuation and Evaluation. *Annual Review of Sociology*, *38*, 201–221.

Marks, G. N. (2005). Accounting for immigrant non-immigrant differences in reading and mathematics in twenty countries. *Ethnic and Racial Studies*, *28*(March 2015), 925–946.

Meyer, H.-D., & Benavot, A. (2013). *PISA, Power, and Policy: the emergence of global educational governance*. Oxford: Symposium Books.

Muthén, B. O., & Muthén, L. K. (2015). MPLUS 7.4. Los Angeles.

OECD. (2000). Literacy in the information age. Retrieved December 22, 2015, from http://www.oecd.org/edu/skills-beyond-school/41529765.pdf

OECD. (2011). *PIAAC Conceptual Framework of the Background Questionnaire Main Survey Table of Contents*. Paris.

OECD. (2012). *Literacy, Numeracy and Problem Solving in Technology-Rich Environments: Framework for the OECD Survey of Adult Skills*. http://doi.org/http://dx.doi.org/10.1787/9789264128859-en

OECD. (2013a). *Better Skills Better Jobs Better Lives*. Paris: OECD Publishing.

OECD. (2013b). *Technical Report of the Survey of Adult Skills (PIAAC)*. Paris.

Oreopoulos, P., & Salvanes, K. G. (2011). Priceless: The Nonpecuniary Benefits of Schooling. *Journal of Economic Perspectives*, *25*(1), 159–184. http://doi.org/10.1257/jep.25.1.159

Porter, T. M. (1996). *Trust in numbers: The Pursuit of Objectivity in Science and Public Life*. New York, London: Princeton University Press.

Rammstedt, B., Ackermann, D., Helmschrott, S., Klaukien, A., & Maehler, D. B. (2012). PIAAC 2012 : Overview of the Main Results.

Reich, R. B. (1992). *The Work of Nations: Preparing Ourselves for 21st Century Capitalism*. Vintage.

Saris, W. E., Satorra, A., & van der Veld, W. M. (2009). Testing structural equation models or detection of misspecifications? *Structural Equation Modeling. Vol 16(4)*, *16*(October), 561–582.

Schleicher, A. (2008). PIAAC: a new strategy for assessing adult competencies. *International Review of Education*, *54*, 627–650.

Spence, M. (1973). Job Market Signaling. *The Quarterly Journal of Economics*, *87*(3), 355–374.

StataCorp. (2015). STATA 13.1. Texas.

Stoet, G., & Geary, D. C. (2015). Sex differences in academic achievement are not related to political, economic, or social equality. *Intelligence*, *48*, 137–151.

Svend, K. (2011). *Is the foundation under PISA solid? A critical look at the scaling model underlying international comparisons of student attainment*. Copenhagen.

Thurow, L. C. (1975). *Generating inequality*. New York: McMillan Press.

Wossmann, L. (2003). Specifying Human Capital. *Journal of Economic Surveys*, *17*(3), 239–270.

Chapter 4. How different education and training systems configure adult skills: A comparative analysis of five OECD countries using structural equation modelling

Abstract

Some studies report a relationship between family background and educational outcomes, others highlight cross-country variation in the distribution of educational attainment and skills outcomes, while identifying a range of distinct education and training systems. Drawing on this literature, our study contributes to the research on skills development by providing an integral analysis of skills in a cross-country perspective. We employ the broadly flexible statistical technique of structural equation modelling and examine direct measures of skills using PIAAC data. We focus on five countries: the United States, Japan, Germany, Denmark and Spain. Our results show that skills are configured in a highly complex manner and that significant differences emerge across the five countries, reflecting their historical and institutional characteristics. Intergenerational transmission of educational inequality is a crucial factor in shaping skills outcomes, although this factor varies considerably between countries. Moreover, the impacts of family background, educational attainment, and skills use in daily life on literacy respond to country specific equilibria, which are consistent with previous research findings.

Keywords: adult skills, education, PIAAC, models, structural equation.

4.1. Introduction

Contemporary societies are currently experiencing an upgrading in their skill levels, a process in which the individual is not simply one more factor in the production line, but the primary source of value added. In today's economy, a skilled workforce constitutes a critical component of a country's economic performance (Toner 2011). Over the last two decades, various attempts have been made to assess and compare not only educational attainment, but also educational outcomes in terms of skills. In so doing, large-scale, comparative assessments have been undertaken and used as a *benchmark* for the outputs of education and training. The recently implemented Programme for International Assessment of Adult Competencies (PIAAC) is one

such tool that promotes comparison across the OECD countries. This, and other tools, facilitates rich cross-country analyses and the examination of educational outputs and related social outcomes.

The comparative education literature shows how the institutional design of education and training has a variety of effects on the acquisition and distribution of educational achievements (Heisig & Solga 2015; Green et al. 2015; Dupriez et al. 2008; Mons 2007; Hanushek et al. 2011). These studies identify a range of different educational and training systems that are closely associated with a country's specific history and culture, which have in turn shaped the development of the respective nation-state (Green 2013; Mayer & Solga 2008; Iversen 2005). Within this framework, PIAAC should contribute to an exploration of as to whether different institutional equilibria result in distinct educational outputs, supporting the evidence with direct measures of adult competencies.

The development of competencies involves both the gain and loss of skills over the lifespan and the influence of a broad range of individual and social features (Desjardins & Warnke 2012). Skills acquisition is a multistage process that takes place in various contexts and which needs to be explored using a complex analytical framework. The aim of this study is to analyse the complexity of the configuration of adult skills and to evaluate the different channels via which skills are acquired. More specifically, the paper assesses whether there are internal and external, country-specific regularities in adult skills acquisition. Drawing on PIAAC data, we analyse differences in adult skills in the United States, Japan, Germany, Denmark and Spain by applying structural equation modelling. These countries can be considered to be representative of distinct education and training systems (Green 2006; Dupriez et al. 2008; Mons 2007).

The framework adopted understands skills acquisition as a social process; hence, we include in our analysis various social factors, including family background, educational attainment, and the use of skills at work and at home. Our approach contributes to the research on comparative education by examining adult skills in an integral way and by forging links with the comparative literature on education and training.

The rest of the paper is organized as follows. In Section 2, we present the research questions and their related hypotheses. In Section 3, we describe the main features of the education and

training systems of the countries selected, while in Section 4 we present the data and the model used to conduct the empirical analysis. In Sections 5 and 6 we report and discuss our results, while in Section 7 we state our conclusions.

4.2. Research questions

Skills are acquired in a variety of contexts. Where and how this process of acquisition occurs presents significant cross-country differences related to institutional and social equilibria. Our aim is to explore how adult skills are configured by taking an integral approach to their study. The main objective of this paper is to disentangle the impact of a range of social factors and to estimate the extent to which each of them contributes to skills development. The empirical foundation of the analysis draws on the seminal paper of Desjardins (2003) and the recent work of Scandurra & Calero (2016) where this framework is applied to the whole sample of PIAAC countries. The core of the model has been developed from the social mobility literature and the widely used social origin-education attainment-social destination triangle (Breen et al. 2009; Bukodi & Goldthorpe 2012; Breen & Karlson 2014). The main idea underpinning the model is that educational attainment mediates between family background and future social outcomes.

We specifically focus our explanation on the following factors associated with adult skills: a) the transmission of educational attainment attributable to family background (i.e., aspects of cultural capital and social inequality); b) the correspondence between education and skills acquisition (i.e., the "quality" in terms of the skills certified by education); c) the association between education and skills use in the labour market; and, d) the long-term differential in educational attainment (the effect of age on parental education).

We seek to determine whether and, if so, the extent to which, these elements of adult skills differ across countries by analysing the cases of the United States, Japan, Denmark, Germany and Spain. Many studies point to a divergence in the institutional designs of education and training systems (Braga et al. 2013; Allmendinger & Leibfried 2003; Green 2006; Bol & van de Werfhorst 2013) and this finding is upheld by recent research employing PIAAC data (Green et al. 2015; Heisig & Solga 2015; Scandurra 2015).

The five countries have quite distinct education and training systems in addition to quite different institutional and economic designs. Likewise, they have undergone quite distinct

historical processes in the expansion of their respective schooling systems. Some introduced compulsory education in the eighteenth century[17], others, such as Spain, did so at a later stage. Moreover, in recent decades, different trends emerge in terms of access to tertiary education if we compare young and older cohorts across the five countries. Thus, both the distribution of education certifications and their associated skills are highly unequal and at times polarized across the active population cohorts (Calero et al. 2016).

4.3. Brief description of the education and training systems of the selected countries

An extensive literature has shown how economic and social systems respond to the skill enhancements of post-industrial societies against the backdrop of globalization. There is considerable evidence indicating that the specific historical and institutional equilibria of the world's countries have an effect on their economic and social performances. Two main streams in the literature have sought to account for these differences. The "varieties of capitalism" approach (Hall & Soskice 2001) highlights the presence of economic, institutional and social complementarities, while that of "welfare regimes" (Esping-Andersen 1990; Esping-Andersen 1999) focuses on class struggle and the historical organization of systems of production. Research in comparative education has also shown that education and training systems form part of these complex designs, which are closely linked to state formation and the basic idea of citizenship. As such, these elements shape divergent educational and social outcomes (Green 2013; Dupriez et al. 2008; Brown 2013; Jerrim & Macmillan 2015; Dupriez & Dumay 2006). The institutional characteristics of education and training, moreover, respond to social and economic processes and, to some extent, condition their evolution in the long run.

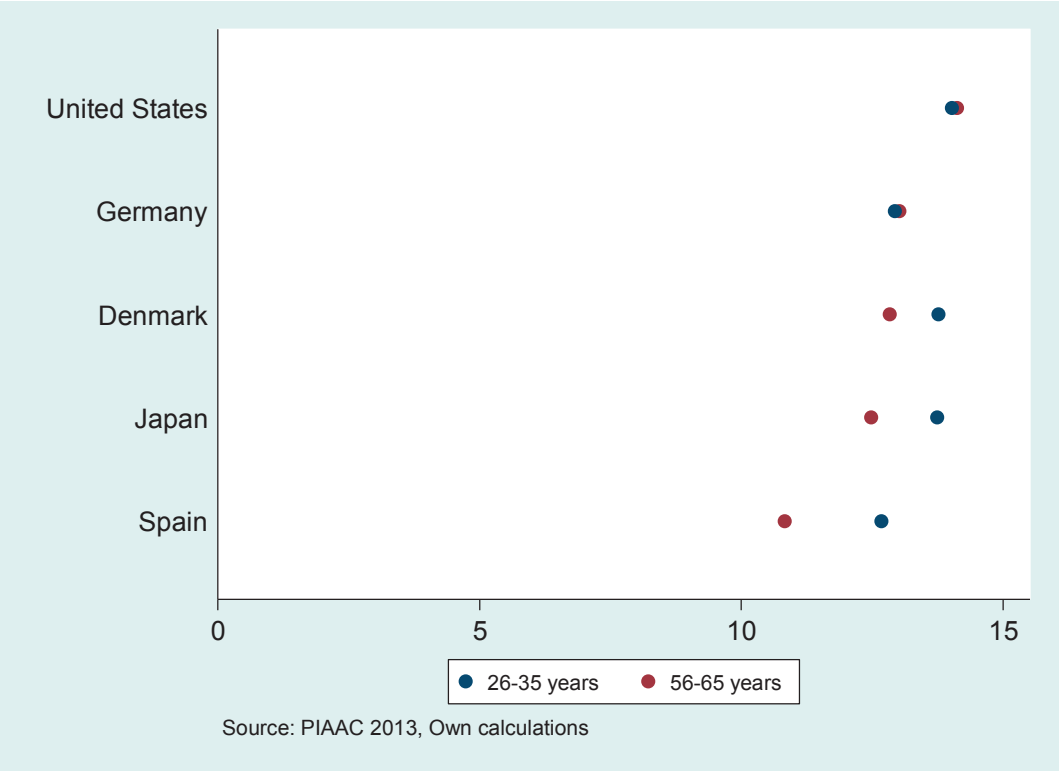
Five models of education and training can be identified: a) the Anglo-Saxon, Liberal model, an incomplete and highly marketed, comprehensive model with a clear emphasis on school choice; b) the East Asian model, a comprehensive, competitive model with a very highly reputed public schooling system; c) the German, dual model, a tracked education and training model centred on the provision of specific skills; d) the Nordic, Social Democratic model, with

[17] The case of the German-speaking countries: Frederick II introduced the first mandatory education in Prussia in 1783, while Queen Maria Theresa would do the same ten years later in Austria.

a full comprehensive education system and universal and inclusive social programs and e) the Southern European model, with its incomplete comprehensive schooling and welfare systems. Initially, the East Asian model did not form part of this classification, as the comparison was centred primarily on European and Anglo-Saxon countries. In recent decades, there has been a growing interest in analysing East Asian countries, in part due to their outstanding performances on large scale educational assessment instruments. Some authors, drawing on previously established typologies and recent evidence, conclude that these countries are characterised by certain inner traits, which constitute a distinct model (Aizawa 2016). Taki (2010) divided the educational systems of the OECD countries into five categories after refining ideas from Mons (2007) and Dupriez et al. (2008), and defined Japan as a *competitive examination model*.

In this section, we describe the main characteristics of the education and training systems of the selected countries. In so doing, we draw largely on the literature on comparative education and we provide a brief selection of key indicators in **Table VIII.**

Figure 5. Mean number of years of schooling for young and older adults in OECD countries



Source: PIAAC 2013, Own calculations

4.3.1. United States

The United States operates a comprehensive education and training system. The route into higher secondary education is fairly linear. Following elementary school, students move from middle school to junior and then senior high school, which terminates after grade 12 and gives access to post-secondary education. There is no formal tracking, but there is a strong ability-based sorting of pupils. The education system is highly decentralized and subject to local regulation in nearly all states. Local school boards have considerable control over educational content and financial resources are derived primarily from local property taxes and distributed among local school districts. Curriculum regulation is largely unstandardized across the system and the disparity in teaching quality is high (Merry 2013). The level of education has, historically, been among the best in the world, although this advantage has been reduced in

relative terms if we consider the change in the average number years of schooling among the older and the youngest cohorts (**Table VIII**).

The US social welfare model is one of relative statelessness with a central state apparatus and a budget that are markedly smaller than those of their European counterparts. Social insurance benefits and services are modest and means tested. Generally, benefits target low-income members of the working class. The entitlement rule is very strict and social rights are only partially recognized. The United States has very high income inequality and a high proportion of the population lives in poverty, and has poor access to health care. The country has a moderate unemployment rate and a very high proportion of the active population has a skilled occupation. The economy is very open and concentrated above all in intensive, high value-added sectors.

Table VIII. Education and labour market system indicators of the examined countries

	Completion after N years	Completion after N+2 years	Years of schooling, pop. 26-35	Years of schooling, pop. 56-65	Difference years of schooling between over 55 and under 34	Skilled occupations, all pop, %	Employed, all pop, %	Vocational specificity (dual system)	Length of tracked curriculum (2002)	Age at first selection (2003)	Numbers of tracks at 15 years old (2003)
Denmark	60.18	72.93	13.77	12.83	0.94	52.79	76.97	47.7	0.25	16	1
Germany	M	m	12.93	13.02	-0.09	41.09	79.36	45	0.69	10	4
Japan	93.83	m	13.74	12.48	1.26	37.39	76.09	0	0.25	15	2
Spain	60.43	83.16	12.67	10.83	1.84	35.72	62.55	2.8	0.33	16	1
United States	85.47	88.2	14.02	14.12	-0.1	51.45	76.62	0	0	16	1
	OECD, 2014		PIAAC 2012			PIAAC, 2012		OECD, 2005	UNESCO		

Source: Own calculations

4.3.2. Japan

At the end of World War II, Japan introduced a comprehensive school system similar to that operated in the United States, comprising six years of primary education (from the age of 6), three years of lower secondary education, three years of upper secondary, and tertiary education. Japan has experienced a rapid expansion of its education system in tandem with marked economic growth during a period of late industrialization[18] (Hanushek & Woessmann 2016). During this period, public secondary schools were founded, a process that was accompanied by a sharp increase in demand for manual and non-manual workers (Kariya 2013). Indeed, national secondary schools are generally held in higher prestigious than private schools.

The academic vs. vocational tracking takes place in senior high schools by means of selective, entrance examinations and about a quarter of students opt for vocational training. A highly selective system is operated in upper secondary education based on entrance examinations (Hanushek & Wößmann 2006). Vocational track graduates occasionally enrol in tertiary education.

Central and local authorities are the main decision-making bodies and the schooling system has one of the highest levels of autonomy among all OECD countries as regards curriculum and student assessment policies. Access to the teaching profession is highly regulated. Moreover, Japan has a very low degree of socioeconomic segregation in its schooling system. Overall investment in education is high and is mainly private. Around 55% of total expenditure on early childhood institutions comes from private sources, which are primarily households. Tertiary students face high tuition fees.

Japan has a highly educated population with a low dropout rate and a high rate of access to tertiary education (Grossman 2006). For the oldest cohort of the active population, the average number of years of education was slightly below that of the most advanced economies, but in recent decades education has expanded markedly because of the exceptional increase in tertiary access, which is now among the highest in OECD countries.

[18] During the Meiji Era, Japan imported Western technology and between 1890 and 1910 achieved a complete and local industrialization through the active adaptation of Western technology to Japanese needs and social traditions.

Japan's welfare model is not fully developed and is employment-centred. Its conservative system is generally considered as being similar to that of Germany, based on a male breadwinner model, although it retains certain differential features. The country has a very low rate of unemployment and only a small proportion of its active population, compared to the rest of the OECD, has a skilled occupation. There is also quite a marked gender disparity and a tertiary-educated woman earns, on average, just 48% of what a similarly educated man earns, this being the lowest figure among all countries for which data are available. Traditionally, Japan is not a migration destination, having one of the lowest migration rates in the OECD area.

4.3.3. Germany

Germany has a highly decentralized education system, with responsibilities being shared between administrative authorities. Although the *Landers* (the federal states) have strong powers in this jurisdiction, a high degree of standardization guarantees coordination through a standing conference of educational decision-makers.

The system is one of the most important examples of a tracked and vocationally oriented education and training model. Students are sorted into one of four clearly hierarchical secondary school types at the age of 10. The *Gymnasium* prepares pupils for post-secondary education and finishes with the final examination (*Abitur*). The *Hauptschule* prepares pupils for subsequent vocational education in the form of apprenticeships. The *Realschule* lies in between these two types and is most often followed by attendance at higher vocational schools. The *Gesamtschule* combines all three types of education.

The apprenticeship system, or the dual system model (as it is known internationally), developed out of the guilds of arts and professions of the Middle Ages. The system is coordinated by various social actors, including the chambers of commerce and the unions, which actively participate in its governance. Vocational training lasts between two and three years and 70% of these activities are carried out in the workplace. The costs of apprenticeship are shared between the private and the public sector and the apprentices have formal working contracts and fair job conditions controlled by the local authorities.

Germany was one of the first countries to introduce compulsory education (at the time of the Prussian Empire) and the average number of years of education is historically one of the highest

in the OECD. More than half the population aged between 25 and 65 has an upper secondary education certificate, which is almost a third higher than the OECD area as a whole. However, over the last two decades, access to tertiary education has not followed a comparable rate of growth to that experienced in the OECD area.

The labour market is extremely stable with a very high rate of employment and approximately a quarter of the active population is in a skilled job. Germany was a pioneer of social insurance, as promoted by the conservative reformers of Bismarck and von Taaffe during the nineteenth century. The welfare model is largely dependent on the contributions of the workers and is based on the historical male breadwinner model. This gives rise to a fairly consistent gender wage gap, where women earn 74% of their male counterparts.

4.3.4. Denmark

The Danish *Folkeskole* is a basic, comprehensive schooling system, comprising primary and lower secondary education that finishes at the age of 16. Since 1967, the upper secondary level has constituted a traditional three-year, academically oriented *Gymnasium* or a two-year preparatory course for higher education (HF). Both options provide a general education and a route to post-secondary education. The vocational and training system has deep historical roots and resembles the German dual system, although the percentage of young people choosing the vocational track is lower in Denmark. Unlike the other Nordic countries, Denmark has retained a selective system with two separate tracks: a general educational program leading to higher education, and a dual vocational program directed towards the labour market (Jørgensen 2008). The Danish vocational education and training (VET) system has a very clear work-based component of learning and training and relies on the participation of social partners through the principle of occupational self-governance. VET provides young people with an effective transition from education to the workplace (Müller 2005).

The financing of education is centrally controlled in the main and curricular guidelines, which are relatively specific for upper secondary schools, are issued by the National Ministry of Education. Some degree of local self-governance is allowed on educational matters.

Historically, the country's education system expanded moderately in line with systems in other post-industrial economies. In recent decades, both the average number of schooling years

and the rate of access to tertiary education have increased if we compare younger and older cohorts of the active population. This is, in part, related to the high access rate to tertiary institutions.

The Danish system is one of the most widely recognized of the Nordic universal welfare models, where all citizens are entitled to receive social security benefits and services, regardless of their relationship with the labour market. Social security is financed through general taxation and active social measures are promoted with a high degree of local decentralisation of social responsibilities. Moreover, Denmark is a migration destination with a quarter of its population being foreign born, mostly from non-Western countries, making Danish society highly heterogeneous.

4.3.5. Spain

The Spanish education and training system is comprehensive and partially decentralized at the regional level. Over the last few years, the governance of education has been devolved to the regions, with a limited amount of space for individual school autonomy. Full-time education is compulsory until the age of 16, although recent legislation seeks to lower this to 15. Spanish secondary education is four years long, with students at the end of the third year being able to choose between either *Bachillerato* (Baccalaureate equivalent) or *Ciclo de Grado Formativo*, the latter being geared towards vocational training. Indeed, there are two programs of vocational training, a shorter and a longer program, lasting three and five years, respectively. All students successfully completing secondary education can access university after passing a general entry examination organized by each public university.

Spain has one of the highest retention rates for secondary education and an extremely high school leaving rate. There is a high private and government-dependent private provision of primary and secondary schools, due in part to the rapid expansion of education demands after the dictatorship that could not be met by the public sector.

In terms of years of schooling, Spain still lags behind its OECD partners. This is in part due to a highly unequal distribution of education across the age cohorts. The population aged 56- 65 has the second lowest average number of years of schooling (after Italy) of the 24 countries sampled in PIAAC. However, over the last four decades, access to university increased until the mid-

nineties, stagnating thereafter until the outbreak of the economic crisis, since when it has increased to account for almost 45% of the young adult cohorts.

Spain operates a family welfare system based primarily on the male breadwinner model, although, until the effects of the economic crisis were felt, there were signs of change, especially as regards the increasing access of women to paid employment. It is a country of recent immigration, above all from Spanish-speaking countries. The labour market has traditionally suffered from a very high unemployment rate, but this was gradually reduced in the 20-year period up to 2009. Youth unemployment is especially high and the transition between education and the first job is especially precarious. Moreover, the active population in Spain has one of the lowest rates of employment in skilled occupations and the mean value added over the last few decades is one of the lowest in the OECD.

4.4. Data and Methods

We draw on the first wave of the PIAAC survey conducted between 2011 and 2012. This survey provides rich information about the individual social environment of the adult population, together with direct skills measures. PIAAC collected information from adults aged between 16 and 65 in 24 countries, most of which are OECD members. The program assesses three skill domains: literacy, numeracy and problem solving. This last skill domain, however, was not implemented for all countries and, for this reason, we consider literacy as our outcome variable and we use numeracy to perform our sensitivity analyses.

According to the PIAAC framework, literacy can be defined as "understanding, evaluating, using and engaging with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential" (OECD 2011). In PIAAC, a proxy of literacy and numeracy is collected using 56 items divided across three task characteristics: medium, context and aspect. For the reading component, interviewers timed respondents and this information is taken into account when measuring their response efficiency (OECD 2013b). The underlying assumption of the framework is that the domains assessed represent a range of core skills that both enable the introduction of higher order skills and retraining within a changing economy. In our analysis, we exclude the interviewees that are unemployed or who are not part of the labour market when the survey was conducted. In order to obtain the best estimate of the skill

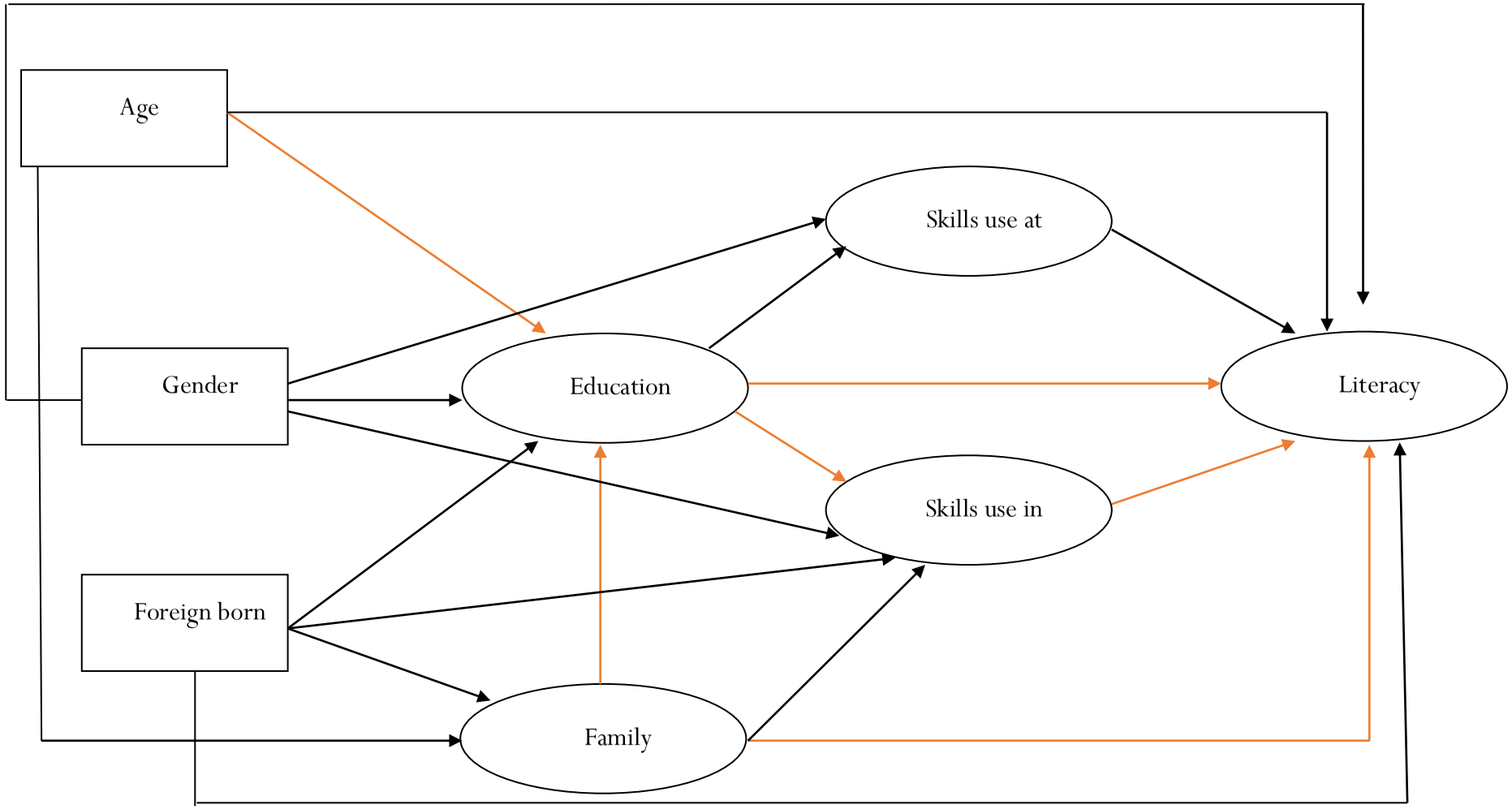
structure of the active population, we restrict the sample to workers between 25 and 55 years of age. Our analysis is based on an integral model of skills development and we disentangle the impact of diverse social factors on skills, while at the same time accounting for their interacting effects. For a fuller theoretical and methodological explanation of the model see our more recent paper (Scandurra & Calero 2016).

To test the hypothesized relationships between the constructs and to evaluate the theoretical model, we used a structural equation model (SEM). This is a set of statistical techniques that allows the representation of the constructs of interest and the measurement of the extent to which the data are consistent with a proposed theoretical model. The advantages of SEM over multivariate regression analysis are basically four: a) it explicitly models the measurement error; b) it allows us to handle different types of variables, allowing for a mix of categorical, continuous and unordered variables; c) it provides statistics on the reliability of the model; and d), as in path analysis, researchers can rely on estimates of both direct and indirect effects.

Employing the model introduced above, we proceed to the estimation process as follows. First, we test a unique model (i.e., the same for all five countries selected) in which all the parameters are equal for all groups. Hence, we apply the J-Rule, following the methodology proposed by Saris et al. (2009) when seeking to identify any misspecification in the structural parameters[19]. The estimator selected was robust weighted least squares (WLSMV), which is a modification of the weighted least squares (WLS) estimator, created to deal specifically with a combination of ordinal, discrete and continuous data and a small to medium sample size. All the results were estimated using Mplus 7.4 (Muthén & Muthén 2015).

[19] We use the software program developed by Daniel Oberski which can be consulted at his personal webpage https://zenodo.org/record/10657#.VpNwE_nhBD8

Figure 6. Path diagram, visual representation of the model



*Circles represent the latent variables and rectangles the observed variables.

4.5. Results

The results are shown in **Tables IX and X**, following SEM notation, and they are graphically represented in **Figure 6**. The model yields relevant results and the structural parameters are important in shaping skills. Family background is a key determinant in the model, affecting all factors directly and indirectly. Additionally, both the effects of education on skills use and on skills differ markedly between countries. The estimates are presented for the five countries analysed: the United States, Japan, Germany, Denmark and Spain. In the following subsections, we offer a theoretical interpretation of the coefficients and discuss the results. In the discussion, for the sake of clarity, references to "effects" can be interpreted as causality claims. However, we do not seek to provide any causal explanation owing to the limitations of the data and the methodology (Bollen & Pearl 2013; Pearl 1998).

4.5.1. Intergenerational transmission of education and skills inequalities

In this subsection, we interpret the paths that originate from the family background construct and which affect: a) education (in our notation F2 on F1); b) skills (F5 on F1); c) skills use in the workplace (F4 on F1)[20].

The association between family background and individual education is indicative of the extent of the transmission of education and of the importance of family origin in shaping educational outcomes. In the OECD, this effect is highly relevant across all countries. Spain has the strongest correspondence between family background and individual education (standardized coefficient .85 $p<0.01$). The effect of intergenerational transmission of education inequality is also strong in the United States, Japan and Germany (standardized coefficient of around .7 $p<0.01$). However, these outcomes are low compared to that reported for Spain for, at least, 10 per cent of a standard deviation. Denmark is the country with the lowest intergeneration transmission of education inequality (standardized coefficient .589 $p<0.01$) among the five countries considered, but the effect is still substantial.

[20] In the framework of SEM notation, F2 on F1 means that F1 is regressed onto F2. We retain this notation for a matter of clarity.

The relevance of family background for skills can be associated with a critical period in the lifespan of the individual. Moreover, these results highlight the extent to which family background is directly associated with individual skills at a later stage in their life. In our model, this effect is strong in the United States (standardized coefficient .365 $p<0.01$), while in Spain, Denmark and Germany, it is moderate (standardized coefficient between .214 and .137 approx. $p<0.01$). Only in the case of Japan is this effect nonsignificant.

The correlation between an individual's family background and their use of skills in the workplace is a measure of the influence of individual origin upon labour market outcomes. Indeed, it might be considered as the influence on the level of occupation, since the use of skills could be considered as a proxy of the actual tasks performed by the individual in their job. Hence, it represents a similar measure to what, in the social mobility literature, is referred to as the effect of social origin on labour market destination. In our model, the correlation is not significant for the United States, Spain or Japan, but it is positive for Germany (standardized coefficient .116 $p<0.01$). In the case of Denmark, it is negative (standardized coefficient -.087 $p<0.01$). The model indicates that these differences are produced mainly through educational attainment, but in Germany the effect on the unequal use of skills in the workplace is increasing, while for Denmark it is falling slightly.

The unequal distribution of education between age cohorts consistently affects the education level and has an indirect effect via family background. We analyse this in greater depth below.

4.5.2. The link between education and skills

An individual's education is critical in terms of its effect on their labour market outcomes and skills. As expected, this path (F2 on F5) is relevant in all the countries considered, since a greater intake of education provides individuals with skills and favours their formation. However, differences emerge between the countries selected, the effects being especially strong for Japan and Germany (standardized coefficient .376 and .356 $p<0.01$). This reveals a strong and positive association between education and skills. In contrast, a comparatively moderate relation is found in the case of the United States, Spain and Denmark (standardized coefficient between .231 and .186 $p<0.01$).

The correspondence between an individual's education and their skills use in the workplace (F2 on F4) reflects the effect of the level of education on the daily use of skills in the labour market. Additionally, the intensive use of job specific skills could be interpreted as skills that are employed in a higher level job. For Spain this effect is strong, i.e., having a higher level of education matches well with the use of skills in the workplace (standardized coefficient .739 $p<0.01$). For the United States, Germany and Denmark the effect is moderate (standardized coefficient of around .5 $p<0.01$). In Japan, the effect is comparatively low (standardized coefficient .389 $p<0.01$).

Inequality in educational achievement is consistent between gender and country origin. Ceteris paribus, women are more likely to have a higher education than are men, although the effect is moderate for the cases of the United States, Denmark and Spain. In Germany, women present an education disadvantage and in the case of Japan the relation is nonsignificant.

Being born in a foreign country has a moderate effect on the individual's education level in the case of Spain (standardized coefficient -.175 $p<0.01$). In Germany, Denmark and the United States, however, these differences are very weak and indicate that foreigners are likely to have higher intakes of education. The effect is nonsignificant in the case of Japan, given that less than 1% of interviewees had been born in a foreign country.

4.5.3. The effects of age on skills

Both individual life cycle factors and over-time variations affect skills. On the one hand, skills are likely to increase in an individual's early years when the highest level of education is being attained or upon entering the labour market. Skill losses might also occur during employment: specific applied sets of competencies are more likely to be used in the workplace, for example, than other skill sets that are likely to become obsolete. On the other hand, a range of other factors might impact skill levels. Specifically, two different effects of ageing might be relevant: first, the ageing process and its associated biological causes may result in the deterioration of individual cognitive abilities; and second, the asymmetry in access to education at different points over time may affect skill levels. Generally, younger OECD cohorts experience longer periods in the education system than their older counterparts. The evidence indicates that the

progressive expansion of education across younger cohorts has had a positive impact on skill levels, partially offsetting the negative effect of the biological processes (Calero et al. 2016).

A negative and direct effect of age on skills is shown in the cases of Denmark, Germany and Japan, which present very similar estimates (standardized coefficient around -.1 $p<0.01$). For Spain and United States, the effect is nonsignificant. However, there is a general and relevant effect of age on family background, indicating that older parents are likely to have a poorer education. This effect is strong for Japan (standardized coefficient -.388 $p<0.01$), moderate for Spain and Denmark (standardized coefficient -.27 and -.29 respectively $p<0.01$) and weak for the United States and Germany (standardized coefficient -.17 and -.08 respectively $p<0.01$), which historically both present very high rates of education access. The differences between age groups in terms of education are very marked in the case of Japan and Spain, and only moderately so in the United States and Denmark. In Germany, the differences are smaller and negative, indicating a very stable level of education across cohorts. Furthermore, Spain has a very high indirect effect on education through age (standardized coefficient -.232 $p<0.01$), showing the country's delayed expansion of education and its unequal distribution.

4.5.4. Skills use in daily life

Skills use at home has a positive and very similar impact on competencies in all five countries (standardized coefficient between .16 and .24 $p<0.01$). Moreover, skills use in the workplace has a positive effect on literacy only in the case of Denmark (standardized coefficient .136 $p<0.01$), while the effect is nonsignificant in the other four countries.

Women are likely to present a lower use of skills in the workplace than are men, the difference being most notable in Japan (standardized coefficient -.299 $p<0.01$). For the rest of the countries, the gender difference in skills use in the workplace is small (ranging between standardized coefficient -.185 for Spain -.104 and for Germany $p<0.01$), indicating a smaller gender gap in terms of skills use in the labour market.

Table IX. Model Direct effects

	United States			Japan			Spain			Germany			Denmark		
	Estimate	S.E.	P-Value	Estimate	S.E.	P-Value	Estimate	S.E.	P-Value	Estimate	S.E.	P-Value	Estimate	S.E.	P-Value
F5 on F1	0.365	0.054	0.000	0.042	0.051	0.407	0.214	0.099	0.030	0.137	0.050	0.006	0.178	0.036	0.000
F5 on F4	0.020	0.034	0.544	0.032	0.028	0.252	0.042	0.037	0.259	0.022	0.033	0.500	0.136	0.025	0.000
F5 on F2	0.231	0.051	0.000	0.376	0.039	0.000	0.221	0.093	0.017	0.356	0.044	0.000	0.186	0.032	0.000
F5 on F3	0.194	0.030	0.000	0.159	0.026	0.000	0.240	0.029	0.000	0.228	0.028	0.000	0.228	0.023	0.000
F2 on F1	0.714	0.037	0.000	0.689	0.032	0.000	0.850	0.037	0.000	0.697	0.031	0.000	0.589	0.034	0.000
F4 on F2	0.533	0.046	0.000	0.389	0.032	0.000	0.739	0.063	0.000	0.516	0.047	0.000	0.561	0.033	0.000
F4 on F1	0.030	0.056	0.591	0.004	0.039	0.907	-0.106	0.071	0.137	0.116	0.057	0.043	-0.087	0.039	0.025
F3 on F2	0.551	0.021	0.000	0.357	0.022	0.000	0.567	0.018	0.000	0.526	0.021	0.000	0.498	0.020	0.000
F1 on age	-0.179	0.034	0.000	-0.388	0.027	0.000	-0.272	0.035	0.000	-0.086	0.032	0.008	-0.294	0.028	0.000
F1 on for born	-0.255	0.030	0.000	-0.011	0.026	0.676	0.101	0.037	0.006	-0.263	0.029	0.000	0.049	0.021	0.022
F5 on age	0.015	0.021	0.452	-0.119	0.026	0.000	-0.023	0.027	0.401	-0.101	0.017	0.000	-0.094	0.017	0.000
F5 on gender	-0.021	0.018	0.247	-0.024	0.021	0.234	-0.069	0.021	0.001	0.024	0.016	0.147	0.012	0.017	0.491
F5 on for born	-0.165	0.017	0.000	-0.078	0.013	0.000	-0.211	0.024	0.000	-0.153	0.015	0.000	-0.301	0.011	0.000
F2 on age	0.084	0.032	0.008	0.236	0.031	0.000	0.152	0.034	0.000	-0.053	0.027	0.048	0.088	0.029	0.002
F2 on for born	0.005	0.026	0.854	-0.032	0.012	0.009	-0.175	0.035	0.000	-0.053	0.024	0.031	-0.059	0.017	0.000
F2 on gender	0.091	0.025	0.000	-0.038	0.023	0.102	0.112	0.022	0.000	-0.046	0.022	0.041	0.164	0.021	0.000
F4 on gender	-0.110	0.023	0.000	-0.299	0.020	0.000	-0.185	0.020	0.000	-0.104	0.020	0.000	-0.175	0.021	0.000
F4 on for born	-0.093	0.020	0.000	-0.025	0.020	0.211	-0.110	0.024	0.000	-0.087	0.019	0.000	-0.153	0.014	0.000
F3 on gender	-0.003	0.023	0.897	0.069	0.022	0.002	-0.124	0.021	0.000	-0.053	0.022	0.016	-0.156	0.021	0.000
F3 with F4	0.499	0.026	0.000	0.465	0.022	0.000	0.491	0.026	0.000	0.536	0.025	0.000	0.492	0.022	0.000

Source: PIAAC 2013, Own calculation.

Table X. Indirect effects

	United States			Japan			Spain			Germany			Denmark		
	Estimate	S.E.	P-Value	Estimate	S.E.	P-Value	Estimate	S.E.	P-Value	Estimate	S.E.	P-Value	Estimate	S.E.	P-Value
gender→F5	0.018	0.009	0.048	-0.042	0.042	0.324	-0.013	0.016	0.412	-0.031	0.009	0.001	-0.029	0.010	0.005
gender→F3→F5	-0.001	0.004	0.897	0.035	0.013	0.006	-0.030	0.006	0.000	-0.012	0.005	0.020	-0.036	0.006	0.000
gender→F4→F5	-0.002	0.004	0.550	-0.031	0.027	0.253	-0.008	0.007	0.265	-0.002	0.003	0.501	-0.024	0.005	0.000
gender→F2→F5	0.021	0.007	0.005	-0.046	0.029	0.109	0.025	0.012	0.032	-0.016	0.008	0.048	0.031	0.007	0.000
F2→F5	0.118	0.016	0.000	0.052	0.008	0.000	0.167	0.023	0.000	0.132	0.015	0.000	0.190	0.014	0.000
F2→F3→F5	0.107	0.017	0.000	0.043	0.007	0.000	0.136	0.017	0.000	0.120	0.015	0.000	0.114	0.012	0.000
F2→F4→F5	0.011	0.018	0.551	0.010	0.008	0.250	0.031	0.028	0.266	0.012	0.017	0.504	0.077	0.015	0.000
F1→F5	0.250	0.031	0.000	0.450	0.045	0.000	0.325	0.070	0.000	0.343	0.030	0.000	0.210	0.019	0.000
F1→F2→F3→F5	0.001	0.001	0.613	0.000	0.002	0.908	-0.004	0.005	0.401	0.003	0.004	0.498	-0.012	0.006	0.045
F1→F2→F5	0.008	0.013	0.550	0.013	0.011	0.252	0.026	0.024	0.267	0.008	0.012	0.504	0.045	0.009	0.000
F1→F2→F4→F5	0.076	0.013	0.000	0.057	0.010	0.000	0.116	0.015	0.000	0.084	0.011	0.000	0.067	0.008	0.000
F1→F4→F5	0.165	0.034	0.000	0.380	0.045	0.000	0.188	0.078	0.016	0.248	0.032	0.000	0.110	0.019	0.000
age→F5	-0.010	0.007	0.147	-0.011	0.009	0.218	-0.018	0.009	0.054	-0.040	0.010	0.000	-0.016	0.006	0.004
age→F1→F2→F5	-0.030	0.009	0.001	-0.098	0.014	0.000	-0.051	0.022	0.021	-0.021	0.008	0.011	-0.032	0.006	0.000
age→F2→F5	0.019	0.008	0.020	0.087	0.015	0.000	0.034	0.016	0.031	-0.019	0.010	0.058	0.016	0.006	0.005
for born→F5	-0.043	0.011	0.000	-0.387	0.183	0.035	-0.024	0.009	0.008	-0.086	0.013	0.000	-0.026	0.005	0.000
forborn→F1→F2→F5	-0.042	0.010	0.000	-0.069	0.166	0.677	0.019	0.010	0.069	-0.065	0.011	0.000	0.005	0.002	0.031
for born→F2→F5	-0.002	0.003	0.557	-0.020	0.023	0.400	-0.005	0.004	0.265	-0.002	0.003	0.513	-0.021	0.004	0.000
for born→F4→F5	0.001	0.006	0.853	-0.298	0.118	0.012	-0.039	0.018	0.029	-0.019	0.009	0.040	-0.011	0.004	0.002
gender→F4	0.048	0.014	0.001	-0.052	0.032	0.109	0.083	0.018	0.000	-0.024	0.012	0.045	0.092	0.013	0.000
gender→F2→F4	0.048	0.014	0.001	-0.052	0.032	0.109	0.083	0.018	0.000	-0.024	0.012	0.045	0.092	0.013	0.000
for born→F4	0.003	0.014	0.854	-0.336	0.133	0.012	-0.130	0.029	0.000	-0.027	0.013	0.034	-0.033	0.010	0.001
for born→F2→F4	0.003	0.014	0.854	-0.336	0.133	0.012	-0.130	0.029	0.000	-0.027	0.013	0.034	-0.033	0.010	0.001
F1→F4	0.381	0.039	0.000	0.429	0.050	0.000	0.628	0.065	0.000	0.360	0.034	0.000	0.331	0.030	0.000
F1→F2→F4	0.381	0.039	0.000	0.429	0.050	0.000	0.628	0.065	0.000	0.360	0.034	0.000	0.331	0.030	0.000
gender→F3	0.050	0.014	0.000	-0.039	0.024	0.107	0.063	0.013	0.000	-0.024	0.012	0.043	0.082	0.011	0.000
gender→F2→F3	0.050	0.014	0.000	-0.039	0.024	0.107	0.063	0.013	0.000	-0.024	0.012	0.043	0.082	0.011	0.000
age→F2	-0.128	0.026	0.000	-0.345	0.032	0.000	-0.232	0.033	0.000	-0.060	0.023	0.008	-0.173	0.020	0.000
age→F1→F2	-0.128	0.026	0.000	-0.345	0.032	0.000	-0.232	0.033	0.000	-0.060	0.023	0.008	-0.173	0.020	0.000
for born→F2	-0.182	0.024	0.000	-0.244	0.584	0.677	0.086	0.032	0.007	-0.184	0.023	0.000	0.029	0.013	0.024
for born→F1→F2	-0.182	0.024	0.000	-0.244	0.584	0.677	0.086	0.032	0.007	-0.184	0.023	0.000	0.029	0.013	0.024

Source: PIAAC 2013, Own calculation.

4.6. Complementarities of education and training systems

The model yields results that point to historical rifts and markedly distinct processes in the education and social systems of the countries selected. Of particular note is the variation in intergenerational transmission of inequality both in education and skills. Additionally, the relation between education and skills use in the workplace and competencies varies substantially across the five countries. Overall, the level of historical access to education is especially relevant in explaining the structure of skills acquisition. The main results of the analysis can be summarised on this basis and in conjunction with the education and social systems of each of the five countries. We should stress that the countries were selected on the basis of the external typology of their respective education and training systems, which in turn are closely connected to their welfare systems. The typology employed emerges from an extensive literature on comparative education which highlights this institutional differentiation (Janmaat et al. 2013; Green 2006; Estevez-Abe et al. 2001; Mons 2007; Dupriez et al. 2008).

The United States is a highly unequal country in terms of educational achievement, and family background is a key determinant of educational qualifications and skills. Moreover, the link between education, competencies and skills use in the workplace is only moderate. In the United States, educational attainment is more homogeneous across the age groups examined, reflecting the very early expansion of education. Despite the country's historical tradition of migration and the development of education, foreigners suffer disadvantages in terms of both education and skills.

Japan operates a quite distinct model of education and welfare, one that has often been excluded from European comparative analyses as its educational system is quite different from those in the developed West (Hanushek & Wößmann 2006). Japan has the most highly educated labour force in the OECD, with a high rate of access to higher education and, thus, comparatively low differences in education access across cohorts. The level of education in the country has increased monotonically over the last five decades and Japan shows signs of a more homogeneous distribution of skills and a stronger association between the level of education and skills. The level of correspondence between education and skills use in the workplace is also lower, which is probably due to an overall use of skills that is higher yet more equal than in the

other four countries. Yet, family background is still relevant in explaining educational attainment, but the overall intergenerational transmission is lower compared to that of the other countries. Japan has a particularly homogeneous population with one of the lowest percentages of foreign-born population.

Germany, together with the United States, has the highest historical level of educational attainment. It also has a moderate intergenerational transmission of educational achievement and shows signs of social differentiation in the use of skills in the workplace and in the labour market system. The effect of education on skills is very strong and this is partially due to the unequal access to highly qualified occupations on the basis of an individual's social origin. Germany has a tracked education system with a very early and clear differentiation in educational pathways. Historically, it has experienced a moderate level of tertiary education access, maintaining instead a very high enrolment in secondary vocational education and training. Moreover, the welfare state is prominently based on employment conditions. This is highlighted by the unequal labour market conditions between sexes and foreigners. Indeed, the latter still face moderate disadvantages in terms of educational achievement compared to those faced by their counterparts in the rest of the countries examined.

Denmark shows both the lowest intergenerational inequality in education and the lowest residual effect of family background on skills. Furthermore, there is a moderate correspondence between education and use of skills in the workplace. This is accompanied by a lower match between education and skills. This country has a historically high level of education and one of the highest percentages of access to tertiary education. A quarter of its population is foreign born, which makes it highly heterogeneous. Denmark operates a universal model of welfare with a high recognition of social rights and with highly developed active and inclusive intervention policies. These features are again reflected in very low disparities between the native and foreign born population and the very narrow gender gap.

Spain has the highest intergenerational transmission of inequality in education among the countries compared, which is further reinforced by a very high correspondence between education and skills use in the workplace. This reveals how life chances are shaped basically by an individual's social origin. Besides, there is a strong residual effect of parental education on

skills. The match between education certification and skills is moderate, pointing also to a relatively unequal education system. In common with other Southern European countries, the expansion of education in Spain came late, but, between the seventies and mid-nineties, it rapidly caught up with the rest of the OECD by expanding access greatly to tertiary education. The expansion of education has led to a polarization of educational attainment, accompanied by a very high early school leaving rate. The social and economic expansion of the past decades has only partially met the challenges of reducing social origin inequality. Spain is a country that attracts low educated immigrants, but the education level of this group is not very different from the average level of the native population. Women are likely to have a slightly higher education level which is not reflected in their respective labour market conditions. Being foreign born is a disadvantage in terms of skills in the workplace.

4.7. Conclusion

In this study, we have analysed how adult skills are acquired using an integral model that considers many social factors, including family background, educational attainment, and the use of skills at work and at home. The analysis is based on direct measures of adult skills extracted from PIAAC and we have focused our study on five OECD members: the United States, Japan, Germany, Denmark and Spain, given that the comparative education literature identifies these countries as operating quite specific models of education and training. A structural equation model was applied in order to account for the complexities of the plurality of relationships.

Our results show that differences in family cultural and social capital are relevant in explaining education and skills in the long run. Differences emerge in the ways in which countries deal with the unequal life chances of individuals, connected to their education and welfare arrangements and to their historical and institutional evolution. Moreover, the impact of education in the configuration of adult skills varies greatly across countries and it has both a direct and indirect effect on skills outcomes.

The findings support a lower intergenerational transmission of education in Denmark and Japan. Japan also presents the highest level of correspondence between educational attainment and adult skills. In recent decades, both countries have experienced a greater expansion of education than have the other countries. In Spain, Germany and the United States, family

background has greater relevance in the overall model. Spain is the country in which family background has the greatest impact on the overall process of skills acquisition. Additionally, Spain also presents the most unequal distribution of educational attainment across age cohorts. Germany and the United States historically enjoyed high access to education, although this does not seem to have had an impact in terms of reducing the effect of family origin on adult skills compared to the situation in the rest of the countries analysed here.

These findings illustrate the need for an in-depth understanding of the configuration of adult skills, at the same time as they highlight the complexity of the process and the cross-country differences in the shaping of skills outcomes. Studies in comparative education have provided considerable evidence of the fact that the countries analysed here exemplify diverse models of education and training. However, this body of literature has not specifically focused on the analysis of direct measures of adult skills. While our findings cannot be used as evidence that these groups constitute different models of adult skills acquisition, they do suggest that the configuration of skills in the United States, Japan, Germany, Denmark and Spain do follow different paths, which in turn are complementary to their welfare arrangements. Specific education and training systems emerge through micro and macro interactions and these equilibria of the social and educational structures form the space in which interactions and changes occur. The complementarities between social and educational institutions are critical to understand the social origins of educational systems and the processes of educational change. If educational systems and their related achievements are interwoven with the characteristics of welfare regimes, it seems relevant to strengthen these underlying connections. Hence, when considering a policy that seeks to enhance skills, it is essential to refer to the broader social system and to consider how groups of individuals might be affected.

References

Aizawa, S., 2016. A Comparative Sociological Study of Japanese and Taiwanese Upper Secondary Education. *Educational studies in Japan: International Yearbook*, 10, pp.33–48.

Allmendinger, J. & Leibfried, S., 2003. Education and the welfare state: the four worlds of competence production. *Journal of European Social Policy*, 13(1), pp.63–81.

Bol, T. & van de Werfhorst, H.G., 2013. Educational Systems and the Trade-Off between Labor Market Allocation and Equality of Educational Opportunity. *Comparative Education Review*, 57(2), pp.285–308.

Bollen, K. a & Pearl, J., 2013. Eight Myths About Causality and Structural Equation Models. In S. L. Morgan, ed. *Handbook of Causal Analysis for Social Research*. Springer, pp. 301–328.

Braga, M., Checchi, D. & Meschi, E., 2013. Educational policies in a long-run perspective. *Economic Policy*, 28(73), pp.45–100.

Breen, R. et al., 2009. Nonpersistent inequality in educational attainment: evidence from eight European countries. *American Jounal of Sociology*, 114, pp.1475–1521.

Breen, R. & Karlson, K.B., 2014. Education and Social Mobility: New Analytical Approaches. *European Sociological Review*, 30(1), pp.107–118.

Brown, P., 2013. Education, opportunity and the prospects for social mobility. *British Journal of Sociology of Education*, 34(5-06), pp.678–700.

Bukodi, E. & Goldthorpe, J.H., 2012. Decomposing "Social Origins": The Effects of Parents' Class, Status, and Education on the Educational Attainment of Their Children. *European Sociological Review*, 29(5), pp.1024–1039.

Calero, J., Murillo Huertas, I. & Raymond Bara, J.L., 2016. *Education, age and skills: an analysis using the PIAAC survey*, Barcelona.

Desjardins, R., 2003. Determinants of literacy proficiency: A lifelong-lifewide learning perspective. *International Journal of Educational Research*, 39, pp.205–245.

Desjardins, R. & Warnke, A.J., 2012. *Ageing and Skills. A Review and analysis of skill gain and skill loss over the lifespan and over time.*, Paris.

Dupriez, V. & Dumay, X., 2006. Inequalities in school systems: effect of school structure or of society structure? *Comparative Education*, 42(2), pp.243–260.

Dupriez, V., Dumay, X. & Vause, A., 2008. How do school systems manage pupils' heterogeneity. *Comparative Education Review*, 52(2), pp.245–266.

Esping-Andersen, G., 1999. *Social Foundations of Postindustrial Economies*, Oxford: Oxford University Press.

Esping-Andersen, G., 1990. *The Three Worlds of Welfare Capitalism*, Princeton: Princeton University Press.

Estevez-Abe, M., Iversen, T. & Soskice, D., 2001. Social protection and the formation of skills: a reinterpretation of the welfare state. *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*, pp.145–183.

Green, A., 2013. *Education and state formation* third., London: Palgrave Macmillan.

Green, A., 2006. Models of Lifelong Learning and the "knowledge society." *Compare: A Journal of Comparative and International Education*, 36(3), pp.307–325.

Green, A., Green, F. & Pensiero, N., 2015. Cross-country variation in adult skills inequality: Why are skill levels and opportunities so unequal in anglophone countries? *Comparative Education Review*, 59(4), pp.595–618.

Grossman, M., 2006. Education and Nonmarket Outcomes. In E. . Hanushek & F. Welch, eds. *Handbook of the Economics of Education*. Amsterdam, pp. 577–633.

Hall, P. & Soskice, D., 2001. *Varities of Capitalism*, New York: Oxford University Press.

Hanushek, E.A. & Woessmann, L., 2016. Knowledge capital, growth, and the East Asian miracle. *Science*, 351(6271).

Hanushek, E.A., Woessmann, L. & Zhang, L., 2011. General Education, Vocational Education, and Labor-Market Outcomes Over the Life-Cycle. *National Bureau of Economic Research*, pp.1–51.

Hanushek, E.A. & Wößmann, L., 2006. Does Educational Tracking Affect Performance and Inequality? Differences- in-Differences Evidence Across Countries. *The Economic Journal*, 116(510), pp.C63–C76.

Heisig, J.P. & Solga, H., 2015. Secondary Education Systems and the General Skills of Less- and Intermediate-educated Adults: A Comparison of 18 Countries. *Sociology of Education*, 88(3), pp.202–225.

Iversen, T., 2005. *Capitalism, Democracy, and welfare*, Cambridge University Press.

Janmaat, J.G. et al., 2013. *The dynamics and social outcomes of education systems*, London: Palgrave Macmillan.

Jerrim, J. & Macmillan, L., 2015. Income Inequality, Intergenerational Mobility, and the Great Gatsby Curve: Is Education the Key? *Social Forces*, 94(2), pp.1–29.

Jørgensen, C.H., 2008. School and Workplace as Learning Environments in Vocational Education and Training. In C. H. Jørgensen & V. Aarkrog, eds. *Divergence and Convergence in Education and Work*. Bern: Peter Lang, pp. 171–196.

Kariya, T., 2013. *Education Reform and Social Class in Japan. The emerging incentive divide*, New York: Routledge.

Mayer, K.U. & Solga, H., 2008. *Skill Formation Interdisciplinary and Cross-National Perspectives*, Cambridge: Cambridge University Press.

Merry, J.J., 2013. Tracing the U.S. Deficit in PISA Reading Skills to Early Childhood: Evidence from the United States and Canada. *Sociology of Education*, 86(3), pp.234–252.

Mons, N., 2007. *Les nouvelles politiques éducatives: La France fait-elle les bons choix?*, Paris: Presses Universitaires de France.

Müller, W., 2005. Education and Youth Integration into European Labour Markets. *International Journal of Comparative Sociology*, 46(5), pp.461–485.

Muthén, B.O. & Muthén, L.K., 2015. MPLUS 7.4.

OECD, 2011. *PIAAC Conceptual Framework of the Background Questionnaire Main Survey Table of Contents*, Paris.

Pearl, J., 1998. Graphs, Causality, and Structural Equation Models. *Sociological Methods & Research*, 27(2), pp.226–284.

Saris, W.E., Satorra, A. & van der Veld, W.M., 2009. Testing structural equation models or detection of misspecifications? *Structural Equation Modeling. Vol 16(4)*, 16(October), pp.561–582.

Scandurra, R., 2015. *An analysis of inequality of skills achievement among adults using PIAAC 2012*, Madrid. Available at: http://repec.economicsofeducation.com/2015madrid/10-00.pdf.

Scandurra, R. & Calero, J., 2016. *An integral model of adult skills in OECD countries*, Barcelona.

Toner, P., 2011. *Workforce Skills and Innovation: An Overview of the major themes in the Literature*, Paris.

Chapter 5. Conclusions

In contemporary societies, education and training systems are being subjected to various reforming attempts which aim at increasing the skill level of the population. The justification for this broad focus has been based mainly on the economic value of skills, from both a macro and individual perspective. Since the introduction of large comparative assessments, the analysis of adult skills is becoming very relevant from both the analytical and practical points of view. This topic is very central in the social sciences and is positioned at the intersection of diverse disciplines ranging from economics, sociology, psychology and political science. This interdisciplinary interest arises from theoretical aspects, connected to the way and the context in which skills are developed, and from a more practical desire to seek evidence for policy interventions. Constructing and analysing a measure of adult skills might be considered as a proxy for human capital. This is intriguing in a knowledge-based economy, where it is contended that economic competiveness is mainly produced by new ideas, knowledge and skills rather than material capital accumulation.

However, it is necessary to consider the complexity of skills acquisition. On the one hand, a proxy of skills requires a categorization of what, as a society, we believe to be necessary for an individual to fully develop his or her aspirations. On the other hand, from an analytical perspective we need to acknowledge that skills are not an individual result, but rather a complex outcome of a process which is inherently socially produced and influenced by macro, meso and micro relations. For these reasons, it is necessary to look at skills acquisition as a complementary process, which is not fixed or exogenously produced. Consequently, an integral approach is needed to assess skills configuration. Additionally, the recognition of the complexity of social relationships might help to design, implement and specifically target some policy interventions and to ascertain who benefits from them and how.

The objective of this thesis was to contribute to the characterization of adult skills from an analytical perspective, by deepening the examination and considering diverse channels in their acquisition. The inclusion of a plurality of social factors contributed to a better understanding of

the underlying relationships between the social factors and their influence in the formation of skills. The overall work is based mainly on data extracted from PIAAC, a program coordinated by the OECD. The proxies of skills measured by PIAAC relate to some core dimensions that an individual has to master to "participate in contemporary society" (OECD 2013). The following sections summarize the main findings and conclusions of the three empirical papers which form the body of the thesis. They also offer some suggestions about possible developments of this research in the near future.

Chapter 2 provides an overview of the configuration of adult skills across 24 participating countries in the PIAAC study. The research asks whether it is possible to identify similarities or divergences between OECD countries and how life course factors contribute to the configuration of diverging models of education and training. In order to answer this question, I pursue an analysis of adult skills for all countries by employing the Shapley variance decomposition which has some advantages over other methods, particularly when there is high collinearity between the explanatory variables. A comparative analysis is provided about the association between adult skills and age, gender, education attainment, home background, position in the labour market, formal training, and skills use in the workplace. This process leads to a comparative assessment of where the sources of inequality in skills acquisition lie. On the base of these results, a cluster analysis was performed to examine whether there were internal and external regularities in the configuration of adult skills.

Findings show a certain pattern of clustering between the examined countries which reflect these countries' production and welfare arrangements. The way countries are grouped together supports previous institutional comparative literature on educational and training systems (Soskice et al. 2001; Green 2006; Janmaat et al. 2013). The results show that Northern European (Denmark, Norway and Sweden) and Central European (Austria, Estonia and Germany) countries have an occupation-centred model of skills formation, although Central European countries have more relevant inequality associated with individual home background (Bol & van de Werfhorst 2013). Contrarily, the Czech Republic, Northern Ireland, Japan, Korea and Finland have a more egalitarian model of structuring differences in adult skills. In these countries, skills are not very much associated with individual background, nor with educational attainment.

A residual group of countries are clustered together and within it, two subgroups emerge. Anglo-Saxon countries (Canada, England and the United States) and the Slovak Republic form a group where both home background and education attainment play a fundamental role in skills formation. In these countries, the balance of these two factors demonstrates the relationship between education credentials and skills, but also the strong link between individual home background and education attainment. Spain and Italy have a common model of skills acquisition which is very specific, with differences in skills being more a result of the combination (for some individuals) of a poor home background and a lower degree of educational attainment. Furthermore, in these countries, the position in the labour market has a very weak impact on skills compared to the other countries. In Spain and Italy, to some extent, the position in the labour market does not respond to skills, but to external factors. This finding was reinforced by the fact that skills use in the workplace has a higher impact on skills.

Overall the evidence supports a correlation between education and training system outcomes and countries' welfare production equilibria based on a common heritage, which may affect the evolution in these countries' education and welfare arrangements. These findings contend that the production and welfare regimes are relevant in the configuration of adult skills if we consider them a result of a broad process which is not exclusively based on country-specific education and training systems. For this reason, when we consider adult skills, we need to acknowledge the importance of macro and complex historical and institutional equilibria. This point should be regarded when, as a society, we aim at designing policy measures to improve skills outcomes. This objective cannot be achieved without referring to a broader social system and its inner social relationships.

Chapter 3 proposes a hypothetical model of adult skills acquisition common for all the PIAAC participating countries. It conceives of adult skills as a social process embedded in the context where it is produced, by assessing its association with diverse life course factors. A complex model was applied for untangling the acquisition of adult skills. We consider education attainment as a central factor in life course chances and as a relevant key component in the configuration of adult skills. Together with education attainment, we assess a diverse set of social factors such as family background, skills use in the workplace and skills use in daily-life. We complement this analysis accounting also for age, gender and whether the individual is

native or is foreign born. In order to test this hypothetical model of skills acquisition, we use structural equation modelling. This set of statistical methods allows us to combine many observed variables, although they have different measurements, into latent constructs. Moreover, SEM provides overall fit statistics in order to assess the reliability of the model. We pool together all the OECD countries in the PIAAC and use all the information available.

The results show the plausibility of the hypothetical model which fits well for the overall sample and for each separate country assessed in the PIAAC study. In the overall model, family background is very relevant in shaping education attainment and it has a residual influence on adult skills. This shows how unequal access to resources by the family has strong impacts at later stages in life and it strongly affects individual outcomes in various other aspects. However, skills practice both at home and at work have a relevant and positive effect on literacy. Even though structural elements, such as family background and education, are crucial in the life course chances of an individual, there is still space to increase adult skills through daily practice and effective lifelong learning policies.

In **Chapter 4**, using the theoretical and empirical model presented in **Chapter 3**, we analyse how adult skills are acquired through an integral approach by comparing five OECD countries: the United States, Japan, Germany, Denmark and Spain. In this chapter, we assess whether skills acquisition in these countries differ. Comparative education literature has identified different groups of countries with specific characteristics in their education and training systems (Green 2006; Janmaat et al. 2013; Dupriez et al. 2008). We select five countries that are representative of these models of education and training. The divergences in the configuration of adult skills between these countries were also supported by the results of the analysis presented in **Chapter 2**. By analysing 24 OECD countries, this previous research shows internal specificities and external differences between them. **Chapter 4** uses direct measures and extends comparative education research taking into consideration these diverging ways of configuration of educational outcomes. In fact, prior research has concentrated on mandatory education because of reduced availability of cross-country comparable data on the adult population. To account for the complexities of the overall relationships, we used structural equation modelling, as in **Chapter 3**.

The analysis points out that key elements of the model, such as family background and education, are relevant in explaining education and skills in the long run. Differences emerge in the ways in which countries deal with the unequal life chances of the individuals, which are connected to their education and welfare designs and to their historical and institutional evolution. Specifically, Denmark and Japan have both a more egalitarian access to education and adult skills that are less affected by family background. These two countries have expanded their education in the last decades. Nevertheless, important gender differences are still persistent in skills use, for example in Japan. Additionally, in Denmark, the use of skills in daily life directly affects adult skills, showing that lifelong learning programs in this country still have a positive effect even after accounting for all the other factors.

The United States, Germany and Spain are characterized by a strong persistence of intergenerational transmission of education inequality. Spain is the most extreme case, where this is also accompanied by a very strong impact of education on skills use in the workplace. Moreover, the association between education and skills is moderate compared to the rest of the countries. Additionally, Spain also has the most unequal distribution of education attainment across age cohorts. Germany and the United States had historically high access to education, although this seems not to have an impact in reducing the impact of family origin on adult skills when compared to the rest of the analysed countries. However, the impact of family origin persists in education access and, in the case of the United States, there is a very persistent residual effect of family background on skills.

This shows the importance of the environment in early life stages in configuring long term social outcomes in this country. Additionally, the impact of education on the configuration of adult skills varies largely across countries, affecting skills outcomes directly and indirectly although this relationship is far from perfect. These findings reinforce the need to delve deeper into the consideration of the complexity of skills acquisition. It points out the internal specificity of the countries in the formation of skills outcomes. These specific equilibria emerge through intertwined relationships and for this reason, the complementarities between various contexts of skills acquisition have to be considered.

Social and education institutions are key points for understanding this complementary process and informing country specific evolution. It is necessary to explore the underlying connection between fundamental social institutions in order to better understand their links and target any policy interventions. Whenever considering a public policy that aims at improving skills, it seems sensible to refer to the broader social system and examine the way groups of individuals could be affected.

These three pieces of research are closely connected and, in aggregate terms, they provide an overall picture of the research objective. There are mainly four points of connections which were also outlined in the introduction. First, the analysis is based on core adult skills as they were measured in the PIAAC study. Second, the analysis comparatively focuses on a specific group of countries which represent the most advanced or richest economies in monetary terms. There is a close examination of intergenerational inequality transmission and this effect is considered along with a plurality of dimensions. There is an organic development across the three pieces of research. In fact in **Chapter 2**, there is an identification of the internal consistencies and external divergences in the configuration of adult skills between countries. These findings pointed out some of the macro explanations of the level and distribution of adult skills across OECD countries, which were first explored in aggregate terms in **Chapter 3** and then closely examined in **Chapter 4**.

The implications of this research are two-fold. First, it illustrates with different statistical techniques the configuration of adult skills by using a newly implemented dataset. This gives robustness to the analysis and additionally it provides a comprehensive picture of the relationship analysed. Second, it proposes an integral theoretical model of adult skills acquisition, providing evidence on the impact of diverse life course factors and their practical underpinnings.

Many research questions derive from this analysis of adult skills. One concerns the inequality in adult skills and its relevance for a plurality of social outcomes. Globalization and technology upgrades have led to an increasing differentiation between jobs. This has meant that there is an increasing supply of jobs related to ICT skills, while manual jobs diminished drastically in part due to manufacturing delocalization to developing countries. This leads to an increasing polarization of life chances and social inequality. The distribution of skills within and between

countries could affect a diverse set of individual outcomes which are not exclusively connected to labour market access. One of my future research interests will be to comparatively evaluate whether and how inequality in the access to adult skills is creating inequalities in health, social and political participation. While there is some literature which suggests that the level and distribution of skills is affecting the wage premium, the proposed research might contribute to the debate enriching the analysis with a plurality of measure of non-monetary outcomes of skills inequality.

Another more theoretically driven interest highlighted by this research is the use (and misuse) of the word skill in the social sciences. Throughout my research, I delve into the technicalities of the construction of skills measures and the way they are interpreted. There is an extensive literature about 'sociology of quantification', which originated from the intersection of different fields of studies, and has focused on the development of measures and their underpinnings. The construction and diffusion of new measures of skills has a history that still has to be tracked from both theoretical and practical aspects. For this purpose, it would be very fruitful to identify the origin of the word and its interpretative practical and political consequences through discourse analysis.

Finally, one possible development of this research will be to analyse institutional mechanisms of education and training systems and the way they affect adult skills. The average level of schooling and skills varies widely between countries and over time, possibly in response to specific institutional settings in which education systems operate. Tracked educational systems are known to increase inequality of educational opportunity while improving labour market entry. On the other hand, different features of the educational system can moderate the advantage of students of high socioeconomic level, reducing educational inequality. Other systems can reinforce inequality by separating the students in different groups using various mechanisms of "sorting" people (Dupriez, Dumay, Vause, 2008; Hanushek and Wossmann, 2006). Therefore, I would like to analyse the effects of education characteristics at a secondary level and its impact on the skills of young adult .

In capitalist societies, merit is defined as the ability to be productive. People who are not productive, are considered as "social parasites" and for this reason are condemned to poverty

(Arrow et al., 2000). In a knowledge-based society, where value-adding seems to entail competition, ideas and skills, the individual "human capital" is officially presented as the main meritocratic mechanism through which individuals can climb up the social ladder. However, skills acquisition is neither fixed nor exogenously produced, but is rather an inherently social process. For this reason, public policy should aim at enabling the individual within his/her particular circumstances and do so from an integral perspective. In this way, the capacity for individual growth and experimentation will be promoted (Dewey 1916).

References

Bol, T. & van de Werfhorst, H.G., 2013. Educational Systems and the Trade-Off between Labor Market Allocation and Equality of Educational Opportunity. Comparative Education Review, 57(2), pp.285–308.

Dewey, J., 1916. Democracy and Education: an introduction to the philosophy of education, New York: Macmillan.

Dupriez, V., Dumay, X. & Vause, A., 2008. How do school systems manage pupils' heterogeneity. Comparative Education Review, 52(2), pp.245–266.

Green, A., 2006. Models of Lifelong Learning and the "knowledge society." Compare: A Journal of Comparative and International Education, 36(3), pp.307–325.

Janmaat, J.G. et al., 2013. The dynamics and social outcomes of education systems, London: Palgrave Macmillan.

OECD, 2013. The Programme for the International Assessment of Adult Competencies. What is PIAAC?, Paris.

Soskice, D., Estevez-Abe, M. & Iversen, T., 2001. Social protection and the formation of skills: a reinterpretation of the welfare state. Varieties of Capitalism: the Institutional Foundations of Comparative Advantage., pp.145–183.

Annex Chapter 2

Table A21 Descriptive statistics of literacy

Country	Mean	Standard deviation	Differences. between percentile 5 and 95	Percentage of population with level 4 or above	Percentage of population with level 1 or below	% of population with level 2, 3
Austria	267.86	43.97	141.94	8.02	16.25	75.73
Canada (English)	274.46	51.60	166.26	15.02	16.46	68.52
Canada (French)	267.01	50.33	163.78	11.23	20.12	68.65
Czech Republic	272.75	40.90	132.92	8.15	12.44	79.41
Denmark	269.71	48.77	156.61	10.04	16.68	73.28
England (UK)	274.40	49.19	158.61	14.50	15.90	69.60
Estonia	273.43	44.85	146.99	10.88	14.29	74.83
Finland	285.67	51.87	165.23	21.73	11.63	66.64
Flanders (Belgium)	273.79	47.80	154.67	12.80	15.75	71.45
France	259.46	49.82	163.48	7.31	23.56	69.13
Germany	268.14	47.71	156.38	10.20	18.61	71.19
Ireland	265.76	48.30	159.17	8.77	18.45	72.78
Italy	248.74	44.67	146.57	3.15	29.25	67.60
Japan	295.70	40.39	131.00	22.84	5.30	71.86
Korea	268.53	42.01	137.24	6.94	14.88	78.18
Netherlands	281.84	49.44	161.67	18.05	13.37	68.58
Northern Ireland (UK)	267.77	46.30	151.86	9.91	18.42	71.67
Norway	279.18	47.76	154.73	14.86	12.47	72.67
Poland	263.79	48.67	160.34	9.00	20.69	70.31
Slovak Republic	273.40	40.15	131.87	7.38	11.86	80.76
Spain	250.21	49.62	163.77	4.80	29.13	66.07
Sweden	278.46	51.55	167.05	16.38	14.11	69.51
United States	269.47	50.47	166.71	12.49	19.12	68.39

Source: PIAAC 2013, Own calculation.

Table A22. Descriptive statistics of correlates

	Gender (female)	Age Groups		Non-native speakers	Foreign Born	Parental Tertiary Education	Tertiary Education	Employed	Skilled	Work Experience ys		On The Job Training	Writing at Work		Numeracy at Work	
Country	%	mean	sd	%	%	%	%	%	%	mean	sd	%	mean	sd	mean	sd
Austria	0.5	3.52	2.21	14.28	17.43	18.18	19.36	75.77	41.94	22.47	11.53	37.334	2.13	1.84	2.37	1.83
Canada (English)	0.5	3.55	2.27	27.73	31.43	36.82	53.48	79.4	55.49	22.21	11.59	47.34	2.51	1.83	2.73	1.74
Canada (French)	0.5	3.67	2.28	12.30	13.49	25.45	49.31	75.81	54.02	22.22	11.47	38.3	2.28	1.85	2.32	1.76
Czech Republic	0.5	3.5	2.33	3.46	5.41	13.17	20.24	72.34	36.41	21.9	12.08	41.5	2.41	1.69	2.75	1.53
Denmark	0.5	3.68	2.26	11.97	12.32	28.09	40.61	76.97	48.63	24.23	12.35	53.66	2.3	1.71	2.72	1.76
England (UK)	0.5	3.47	2.27	14.5	15.34	24.09	39.76	75.15	41.23	22.29	12.03	45.33	2.4	1.91	2.5	1.79
Estonia	0.53	3.47	2.31	4.34	16.45	31.67	42.06	77.76	44.23	21.53	11.98	41.23	1.66	1.59	2.39	1.81
Finland	0.5	3.75	2.34	4.23	6.54	15.73	43.12	76.04	42.84	21.87	12.56	52.323	2.35	1.72	2.75	1.75
Flanders (Belgium)	0.49	3.75	2.24	7.13	8.43	21.96	39.16	77.11	48.63	22.4	11.67	39.43	2.26	1.83	2.29	1.78
France	0.51	3.62	2.28	13.2	14.34	15.48	29.28	70.35	40.55	21.35	12.47	29.54	1.8	1.72	2	1.73
Germany	0.49	3.6	2.18	12.43	15.43	33.65	34.39	79.45	39.23	21.49	12.12	43.23	2.27	1.79	2.57	1.83
Ireland	0.51	3.17	2.23	11.34	21.21	18.29	34.64	65.89	37.58	19.02	11.4	38.21	1.96	1.93	2.08	1.83
Italy	0.51	3.55	2.23	12.3	9.21	4.89	13.72	61.79	31.43	19.13	12.05	19.17	1.24	1.62	1.46	1.7
Japan	0.5	3.68	2.32	0	0	29.22	45.51	76.08	36.59	20.59	12.07	34.28	2.47	1.88	2.43	1.81
Korea	0.5	3.38	2.15	1.14	1.11	13.76	40.17	74.62	29.27	14.61	10.49	37.27	2.05	1.99	2.27	1.87
Netherlands	0.5	3.65	2.25	11.32	14.12	21.37	34.96	78.05	55.86	21.41	11.47	51.37	2.43	1.8	2.56	1.77
Northern Ireland (UK)	0.51	3.37	2.26	4.65	7.32	13.44	33.02	70.09	37.16	21.12	11.64	39.36	2.09	1.92	2.21	1.84
Norway	0.49	3.51	2.26	14.65	14.32	30.24	41.04	82.91	51.18	21.57	11.74	56.29	2.66	1.68	3.01	1.66
OECD	0.51	3.48	2.25	12.45	15.54	21.59	37.08	73.61	44.67	20.75	11.71	42.9	2.19	1.8	2.38	1.76
Poland	0.51	3.4	2.37	1.32	0	11.75	28.63	67.05	38.09	18.86	11.9	28.29	1.56	1.75	1.8	1.77
Slovak Republic	0.5	3.36	2.31	7.42	3.57	10.48	21.18	68.12	41.07	20.67	11.87	28.38	1.75	1.82	1.85	1.74
Spain	0.5	3.42	2.2	8.32	13.32	11.38	31.68	62.58	30.36	18.44	11.83	33.31	1.63	1.85	1.74	1.82
Sweden	0.5	3.65	2.31	18.45	18.23	31.72	33.11	80.71	47.74	22.45	12.65	51.2	2.22	1.59	2.83	1.67
United States	0.52	3.48	2.28	15.65	16.616	35.67	40.4	76.63	48.81	22.47	12.16	47.12	2.4	1.93	2.67	1.83

Source: PIAAC 2013, Own calculation.

Table A23. Variance decomposition results

			Shapley values						Shapley values in percentage of total R squared explained					
	Variance literacy	Total R squared	Demographic	Social Background	Education	Labour Market	Training at work	Skill use at work	Demographic	Social Background	Education	Labour Market	Training at work	Skill use at work
Austria	2663	0.37	2.42	12.31	6.84	8.77	1.41	5.37	6.52	33.16	18.43	23.62	3.80	14.47
Canada (English)	2534	0.36	0.59	11.07	10.98	6.70	2.07	4.32	1.65	30.98	30.72	18.75	5.79	12.10
Canada (French)	1673	0.43	2.89	10.79	14.08	7.57	2.37	4.99	6.77	25.28	32.98	17.74	5.55	11.68
Czech Republic	2379	0.25	2.25	4.39	7.88	6.85	0.15	3.81	8.87	17.34	31.12	27.04	0.58	15.04
Denmark	2011	0.41	1.66	14.69	8.10	8.78	1.91	5.38	4.09	36.25	20.00	21.67	4.72	13.28
England (UK)	2691	0.37	0.81	11.66	9.72	7.91	2.00	4.41	2.21	31.95	26.63	21.67	5.48	12.07
Estonia	2482	0.21	1.56	6.20	4.79	5.17	0.70	2.89	7.30	29.09	22.47	24.26	3.31	13.56
Finland	2277	0.40	6.73	8.14	7.70	11.31	1.41	4.29	17.00	20.56	19.46	28.57	3.56	10.84
Flanders (Belgium)	2333	0.42	3.21	10.42	12.73	8.85	1.55	5.09	7.67	24.89	30.42	21.16	3.71	12.15
France	1995	0.40	2.59	11.82	12.76	7.27	1.50	4.20	6.44	29.45	31.80	18.11	3.74	10.47
Germany	1631	0.37	3.00	11.74	7.44	8.71	1.98	4.56	8.01	31.36	19.89	23.27	5.29	12.17
Ireland	1934	0.32	1.00	8.62	11.99	4.72	1.24	3.97	3.16	27.34	38.02	14.96	3.95	12.59
Italy	1765	0.28	1.59	8.61	7.40	4.00	1.55	4.89	5.66	30.71	26.41	14.26	5.53	17.43
Japan	2444	0.29	5.62	6.39	8.54	6.07	0.62	1.49	19.57	22.25	29.73	21.11	2.14	5.20
Korea	2281	0.37	7.28	7.50	12.98	5.01	1.54	3.11	19.45	20.04	34.69	13.40	4.12	8.31
Netherlands	2369	0.41	3.79	11.07	11.16	8.27	1.27	5.45	9.24	27.00	27.21	20.18	3.09	13.28
Northern Ireland (UK)	1612	0.35	1.41	6.27	12.17	8.74	1.55	5.35	3.97	17.67	34.30	24.63	4.36	15.07
Norway	2462	0.38	3.05	14.75	5.94	10.11	0.30	4.14	7.97	38.51	15.52	26.39	0.79	10.82
Poland	2658	0.29	1.98	7.00	9.12	6.16	1.29	3.46	6.82	24.14	31.43	21.22	4.46	11.93
Slovak Republic	2548	0.27	0.75	9.41	8.68	4.47	1.52	2.57	2.73	34.34	31.67	16.31	5.56	9.39
Spain	2420	0.39	2.46	11.65	10.98	6.40	1.57	5.67	6.36	30.08	28.34	16.52	4.07	14.63
Sweden	2144	0.47	1.78	20.25	7.77	10.22	1.81	5.58	3.75	42.71	16.39	21.56	3.81	11.78
United States	2285	0.41	0.57	13.90	13.77	6.94	1.60	4.04	1.39	34.06	33.73	17.00	3.93	9.89

Source: PIAAC 2013, Own calculation.

Annex Chapter 3

Table A31. Descriptive statistics with missing values included

Age Recoded 5-Year Groups	%
26-30	14.79
31-34	15.76
35-40	16.88
41-44	17.76
45-50	18.11
51-54	16.71
Missing	0.00
Background - Born In Country	
No	88.03
Yes	11.93
Missing	0.04
Female	
Male	50.37
Female	49.63
Missing	0.00
Parental Higher Education In 3 Categories	
Isced 1, 2, and 3C Short	38.04
Isced 3 (Excluding 3C Short) and 4	37.91
Isced 5 and 6	20.20
Missing	3.86
Education - Highest Qualification - Age Of Completion, Categorised	
Aged 15 or Younger	4.59
Aged 16-19	33.02
Aged 20-24	32.70
Aged 25-29	16.24
Aged 30-34	5.81
Aged 35 or Older	6.66
Missing	0.98
Index Of Use Of Reading Skills At Work (Prose And Document Texts), Categorised	
All Zero Response	4.58
Lowest to 20%	13.99
More than 20% to 40%	17.37
More than 40% to 60%	20.14
More than 60% to 80%	21.54
More than 80%	22.24
Missing	0.13
Index Of Use Of Numeracy Skills At Work (Basic And Advanced), Categorised	
All Zero Response	16.62
Lowest to 20%	14.42
More than 20% to 40%	15.50
More than 40% to 60%	16.34
More than 60% to 80%	18.05
More than 80%	18.93
Missing	0.13
Index Of Use Of Writing Skills At Work, Categorised	
All Zero Response	11.63
Lowest to 20%	13.58
More than 20% to 40%	16.72
More than 40% to 60%	18.35
More than 60% to 80%	20.27
More than 80%	19.32
Missing	0.13

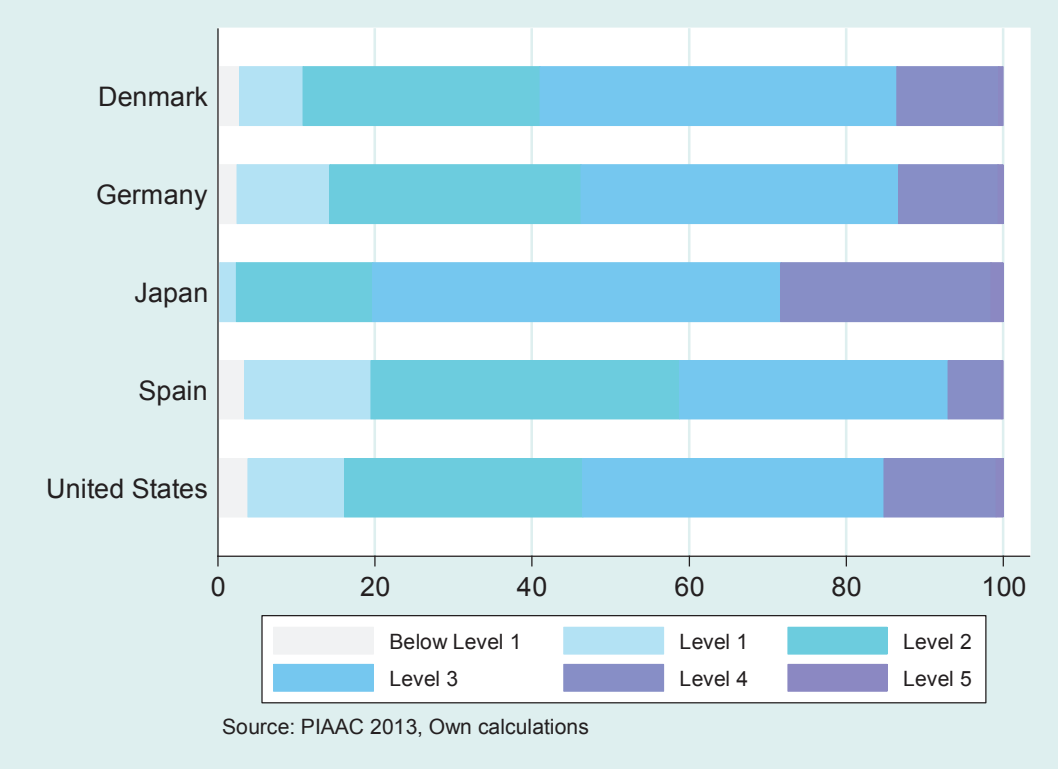
Table A31. Descriptive statistics with missing values included (continued)

Index Of Use Of Influencing Skills At Work, Categorised	%
All Zero Response	8.28
Lowest to 20%	15.76
More than 20% to 40%	16.86
More than 40% to 60%	18.19
More than 60% to 80%	19.61
More than 80%	21.16
Missing	0.13
Index Of Use Of Reading Skills At Home (Prose And Document Texts), Categorised	
All Zero Response	0.77
Lowest to 20%	14.01
More than 20% to 40%	19.69
More than 40% to 60%	22.53
More than 60% to 80%	22.52
More than 80%	20.45
Missing	0.04
Index Of Use Of Numeracy Skills At Home (Basic And Advanced), Categorised	
All Zero Response	8.11
Lowest To 20%	17.13
More than 20% to 40%	18.81
More than 40% to 60%	19.91
More than 60% to 80%	20.71
More than 80%	15.30
Missing	0.04
Index Of Use Of Writing Skills At Home, Categorised	
All Zero Response	7.87
Lowest to 20%	22.62
More than 20% to 40%	12.86
More than 40% to 60%	24.60
More than 60% to 80%	16.36
More than 80%	15.66
Missing	0.04
Index Of Use Of ICT Skills At Home, Categorised	
All Zero Response	0.61
Lowest to 20%	15.12
More than 20% to 40%	18.22
More than 40% to 60%	18.78
More than 60% to 80%	18.29
More than 80%	16.52
Missing	12.46
Education - Highest Qualification - Years of education	
(mean) Highest Level Of Education Obtained Imputed Into Years Of Education	13.61
(sd) Highest Level Of Education Obtained Imputed Into Years Of Education	2.82
(p50) Highest Level Of Education Obtained Imputed Into Years Of Education	14.00

Source: PIAAC 2013, Own calculation.

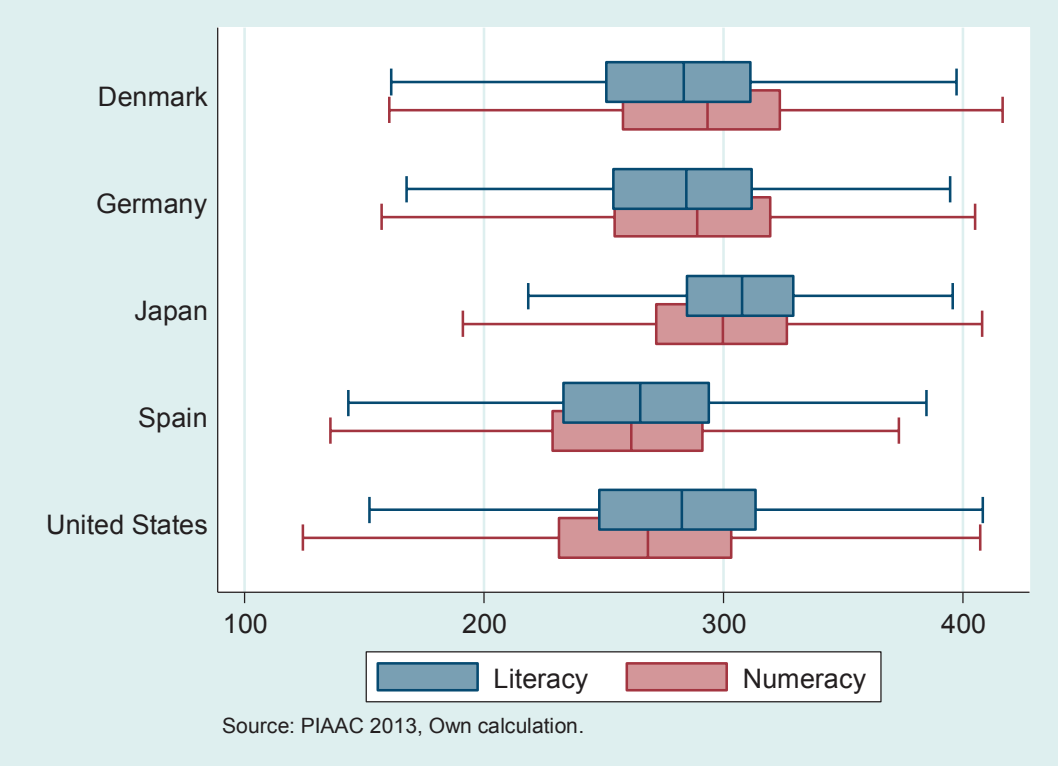
Annex Chapter 4

Figure A41. Distribution of skills, %



Source: PIAAC 2013, Own calculation.

Figure A42. Skills competences distribution



Source: PIAAC 2013, Own calculation.

Table A41. Measurement model

		United States			Japan			Spain			Germany			Denmark		
		Estimate	S.E.	P-Value	Estimate	S.E.	P-Value	Estimate	S.E.	P-Value	Estimate	S.E.	P-Value	Estimate	S.E.	P-Value
F1	Fated	0.725	0.004	0.000	0.735	0.004	0.000	0.723	0.004	0.000	0.721	0.003	0.000	0.724	0.003	0.000
F2	Yrsqual	0.995	0.015	0.000	0.909	0.011	0.000	0.933	0.011	0.000	0.973	0.012	0.000	0.951	0.016	0.000
	B_Q01c1_C	0.682	0.015	0.000	0.906	0.013	0.000	0.760	0.013	0.000	0.695	0.014	0.000	0.636	0.016	0.000
F3	Readh_C	0.800	0.014	0.000	0.818	0.016	0.000	0.830	0.013	0.000	0.787	0.015	0.000	0.776	0.014	0.000
	Numh_C	0.718	0.017	0.000	0.707	0.018	0.000	0.655	0.017	0.000	0.718	0.018	0.000	0.702	0.015	0.000
	Writh_C	0.836	0.014	0.000	0.623	0.018	0.000	0.796	0.014	0.000	0.652	0.017	0.000	0.761	0.013	0.000
	Icth_C	0.733	0.017	0.000	0.683	0.020	0.000	0.716	0.018	0.000	0.687	0.019	0.000	0.752	0.015	0.000
F4	Readw_C	0.872	0.014	0.000	0.866	0.013	0.000	0.911	0.010	0.000	0.870	0.011	0.000	0.858	0.013	0.000
	Numw_C	0.688	0.019	0.000	0.716	0.016	0.000	0.708	0.016	0.000	0.753	0.015	0.000	0.712	0.016	0.000
	Writw_C	0.804	0.014	0.000	0.725	0.015	0.000	0.797	0.013	0.000	0.683	0.016	0.000	0.640	0.016	0.000
	Inflw_C	0.608	0.020	0.000	0.642	0.017	0.000	0.687	0.016	0.000	0.721	0.015	0.000	0.641	0.017	0.000
F5	Pvlit1	0.952	0.003	0.000	0.888	0.005	0.000	0.949	0.003	0.000	0.939	0.003	0.000	0.938	0.003	0.000
	Pvlit2	0.947	0.004	0.000	0.894	0.004	0.000	0.939	0.004	0.000	0.938	0.004	0.000	0.938	0.003	0.000
	Pvlit3	0.947	0.004	0.000	0.894	0.004	0.000	0.943	0.003	0.000	0.938	0.003	0.000	0.940	0.003	0.000
	Pvlit4	0.959	0.003	0.000	0.905	0.004	0.000	0.934	0.004	0.000	0.938	0.003	0.000	0.933	0.003	0.000
	Pvlit5	0.951	0.004	0.000	0.893	0.004	0.000	0.946	0.003	0.000	0.932	0.004	0.000	0.939	0.003	0.000
	Pvlit6	0.941	0.004	0.000	0.900	0.004	0.000	0.943	0.003	0.000	0.938	0.003	0.000	0.934	0.003	0.000
	Pvlit7	0.948	0.004	0.000	0.899	0.004	0.000	0.935	0.004	0.000	0.940	0.003	0.000	0.936	0.003	0.000
	Pvlit8	0.948	0.004	0.000	0.900	0.004	0.000	0.942	0.003	0.000	0.942	0.003	0.000	0.940	0.003	0.000
	Pvlit9	0.956	0.003	0.000	0.904	0.004	0.000	0.937	0.003	0.000	0.943	0.003	0.000	0.934	0.003	0.000
	Pvlit10	0.942	0.004	0.000	0.897	0.005	0.000	0.942	0.003	0.000	0.945	0.003	0.000	0.936	0.003	0.000

Source: PIAAC 2013, Own calculation.

Table A42. Goodness of fit measures

	χ2	χ2/df	df	n	RMSEA	90% C.I. RMSEA	CFI	TLI	WRMR
United States	874.081	3.2	273	2421	0.034	0.031-0.036	0.965	0.959	1.102
Japan	828.144	3.03	273	2633	0.031	0.029-0.033	0.973	0.969	1.202
Spain	508.566	1.86	273	2695	0.021	0.018-0.023	0.989	0.987	0.79
Germany	1000.218	3.66	273	2871	0.034	0.032-0.036	0.969	0.964	1.204
Denmark	1125.514	4.12	273	3205	0.035	0.033-0.037	0.968	0.962	1.252

Source: PIAAC 2013, Own calculation.

Table A43. Descriptive statistics

	Denmark	Germany	Japan	Spain	United States
Age Recoded 5 Years Groups					
26-30	10.38	13.58	12.88	13.10	17.42
31-34	14.59	14.28	15.38	16.99	16.43
35-40	16.18	12.95	20.17	18.78	15.81
41-44	20.07	19.43	18.04	19.11	15.85
45-50	20.76	21.07	17.62	18.00	16.68
51-54	18.02	18.70	15.91	14.03	17.80
missing	0.00	0.00	0.00	0.00	0.00
Background - Born In Country					
Yes	75.72	88.27	99.66	86.42	84.43
No	24.19	11.70	0.34	13.58	15.52
missing	0.09	0.03	0.00	0.00	0.04
Father Higher Education In 3 Categories					
Isced 1, 2, And 3C Short	35.79	9.99	27.27	72.58	21.10
Isced 3 (Excluding 3C Short) And 4	36.63	52.54	42.84	14.25	44.55
Isced 5 And 6	26.56	32.45	26.02	11.39	31.54
missing	1.03	5.01	3.87	1.78	2.81
Gender					
Men	50.56	50.87	52.91	53.32	49.26
Women	49.44	49.13	47.09	46.68	50.74
missing	0.00	0.00	0.00	0.00	0.00
Education - Highest Qualification					
Aged 15 Or Younger	2.37	2.30	3.30	20.56	3.43
Aged 16-19	13.97	29.42	37.22	30.46	27.58
Aged 20-24	32.67	35.06	53.82	29.17	34.97
Aged 25-29	28.96	20.93	3.76	11.80	16.85
Aged 30-34	10.35	7.94	1.14	3.15	8.42
Aged 35 Or Older	11.16	3.83	0.65	3.23	7.93
missing	0.53	0.52	0.11	1.63	0.83
Index Of Use Of Reading Skills At Work					
All Zero Response	2.49	3.90	3.76	13.95	3.39
Lowest To 20%	10.10	12.64	12.53	19.89	10.94
More Than 20% To 40%	14.15	14.73	19.37	17.59	17.51
More Than 40% To 60%	22.63	19.25	19.83	15.40	19.12
More Than 60% To 80%	25.31	24.03	19.83	13.65	21.47
More Than 80%	25.16	25.42	24.42	19.15	27.46
missing	0.16	0.03	0.27	0.37	0.12

Table A43. Descriptive statistics (continued)

	Denmark	Germany	Japan	Spain	United States
Index Of Use Of Numeracy Skills At Work					
All Zero Response	15.68	15.11	9.57	26.90	12.96
Lowest To 20%	16.52	16.64	15.00	12.88	10.90
More Than 20% To 40%	15.71	15.32	25.29	14.99	12.14
More Than 40% To 60%	17.49	15.29	18.91	12.84	17.34
More Than 60% To 80%	17.58	16.64	15.65	15.47	21.76
More Than 80%	16.86	20.96	15.31	16.55	24.86
missing	0.16	0.03	0.27	0.37	0.04
Index Of Use Of Writing Skills At Work					
All Zero Response	7.11	9.16	6.84	23.12	11.60
Lowest To 20%	12.38	12.05	10.03	13.58	12.68
More Than 20% To 40%	21.66	18.04	14.28	15.44	13.34
More Than 40% To 60%	22.85	21.48	18.31	13.58	15.57
More Than 60% To 80%	19.92	20.89	24.08	16.18	21.02
More Than 80%	15.93	18.35	26.21	17.74	25.76
missing	0.16	0.03	0.27	0.37	0.04
Index Of Use Of Influencing Skills At Work					
All Zero Response	4.99	9.26	7.14	16.47	4.75
Lowest To 20%	11.10	16.43	20.17	23.45	12.14
More Than 20% To 40%	15.74	19.67	22.71	16.03	15.98
More Than 40% To 60%	19.76	22.11	19.03	15.40	16.02
More Than 60% To 80%	24.41	19.78	17.28	13.58	20.89
More Than 80%	23.85	12.67	13.41	14.73	30.10
missing	0.16	0.07	0.27	0.33	0.12
Index Of Use Of Reading Skills At Home					
All Zero Response	0.31	0.14	0.46	1.45	1.07
Lowest To 20%	7.98	8.81	16.45	23.86	8.88
More Than 20% To 40%	19.64	15.11	27.23	21.82	13.83
More Than 40% To 60%	27.65	21.41	24.57	18.22	19.61
More Than 60% To 80%	24.84	26.50	18.88	15.66	22.67
More Than 80%	19.45	28.03	12.42	18.96	33.94
missing	0.12	0.00	0.00	0.04	0.00
Index Of Use Of Numeracy Skills At Home					
All Zero Response	5.14	5.57	15.99	14.69	4.42
Lowest To 20%	16.74	16.09	29.70	22.52	10.03
More Than 20% To 40%	19.45	17.69	24.69	18.70	13.91
More Than 40% To 60%	22.04	20.89	15.38	14.69	20.23
More Than 60% To 80%	21.51	23.96	9.68	16.03	25.93
More Than 80%	15.02	15.81	4.56	13.36	25.47
missing	0.09	0.00	0.00	0.00	0.00

Table A43. Descriptive statistics (continued)

	Denmark	Germany	Japan	Spain	United States
Index Of Use Of Writing Skills At Home					
All Zero Response	3.40	2.44	7.25	15.81	9.29
Lowest To 20%	21.23	16.99	22.71	28.57	18.37
More Than 20% To 40%	14.15	10.13	21.08	15.66	10.86
More Than 40% To 60%	26.47	31.86	24.31	20.15	20.15
More Than 60% To 80%	18.98	22.08	14.09	9.24	18.04
More Than 80%	15.65	16.50	10.56	10.58	23.29
missing	0.12	0.00	0.00	0.00	0.00
Index Of Use Of Ict Skills At Home					
All Zero Response	0.25	0.63	1.79	0.71	0.58
Lowest To 20%	10.44	15.46	32.66	16.03	10.57
More Than 20% To 40%	14.59	17.37	24.84	16.33	15.52
More Than 40% To 60%	21.73	19.95	14.01	14.55	17.51
More Than 60% To 80%	24.41	20.72	6.80	13.36	18.79
More Than 80%	24.75	16.33	3.91	13.21	20.85
missing	3.83	9.54	15.99	25.83	16.18
(mean) Highest Level Of Education (years)	13.65	14.44	13.75	12.34	14.24
(sd) Highest Level Of Education (years)	2.63	2.72	2.26	3.48	2.92
(n) Highest Level Of Education (years)	3,206	2,871	2,632	2,694	2,133

Source: PIAAC 2013, Own calculation.