U.S. PIAAC

Commissioned Paper
November 2019

Revisiting the Determinants of Literacy Proficiency: A Lifelong-Lifewide Learning Perspective

Author:
Richard Desjardins

Suggested Citation: Desjardins, R. (2019). *Revisiting the Determinants of Literacy Proficiency: A Lifelong-Lifewide Learning Perspective*. Retrieved [insert date] from PIAAC Gateway website: [insert link]. Washington, DC.

This project has been funded by the American Institutes for Research through a contract with the National Center for Education Statistics (NCES) of the U.S. Department of Education. This report is based on 1994-1998 IALS data and 2012/2014 PIAAC data. The views expressed in this paper do not necessarily reflect the views or policies of the American Institutes for Research, National Center for Education Statistics, or the U.S. Department of Education, nor does mention of trade names, commercial products, or organizations imply endorsement of same by the U.S. Government.

AIR-PIAAC Contact:

Jaleh Soroui (AIR-PIAAC Director)
Saida Mamedova (Senior Research Analyst)
PIAACgateway.com
piaac@air.org

Author Contact:

University of California, Los Angeles
Richard Desjardins at desjardins@ucla.edu

Revisiting the determinants of literacy proficiency: a lifelong-lifewide learning perspective

Richard Desjardins, UCLA

Introduction

Emphasis on the acquisition and maintenance of literacy skills has grown due to mounting evidence of their importance to quality of life and overall societal productivity and social cohesion. This is one of the underlying motivations for the OECD's Programme for the Assessment of Adult Competencies (PIAAC). Important goals of the PIAAC study are to provide an accurate overview of the extent and distribution of literacy proficiency and other core competencies among and within countries in a comparable manner, and to study the antecedents as well as individual and societal outcomes associated with such competencies. Foremost, an important goal is to provide data to conduct analyses which can suggest ways in which policymakers might work to augment adult literacy competencies in the society in which they live and work. To do so, it is important to understand the determinants of literacy proficiency, how they may be implicated in the development of literacy from an individual lifecycle perspective, as well as how they may be implicated in development of national profiles of literacy proficiency as countries' socio-demographic make-up, socio-cultural practices and economies change over time. As part of the PIAAC study, direct links were established with the International Adult Literacy Survey (IALS) conducted in the 1990s, which together now provide measures of literacy proficiency and a range of antecedents that are comparable over time and across countries[1]. First results of the PIAAC study were reported in OECD (2013a) which included some analysis of the determinants of literacy proficiency. Similarly, Desjardins (2003) summarized results from an extensive analysis of the determinants of literacy on the basis of the IALS data. The purpose of this paper is to revisit research examining the determinants of literacy proficiency and specifically to examine further the underlying structure of the determinants from a lifecycle perspective as well as the trends in this structure at the macro level for countries that participated in both the PIAAC and IALS studies.

The paper is organized as follows. First, changes to cross-national profiles of literacy between IALS (1994 and 1998) and PIAAC (2012 and 2016) are shown to motivate the research questions and method of analysis. Second, there is a discussion of the factors that can be implicated in the development of literacy proficiency on the basis of theoretical reasoning and previous research. Third, three different micro-level models predicting literacy proficiency are

[1] The literacy proficiency scale in IALS was rescaled to ensure comparability with the PIAAC literacy scale. For example, to ensure strong links in literacy with IALS and ALL, approximately 60% of the assessment items in the literacy domain in PIAAC were drawn from these previous surveys (OECD 2013b).

estimated, discussed and compared. Fourth, a macro level analysis of the relationship between changes to national literacy profiles and country level changes to the determinants included in the microlevel analysis is presented in order to ascertain how well the micro-level results aggregate to country level results. Finally, the results are summarized and implications are discussed.

Cross-national profiles of literacy proficiency

PIAAC and IALS studies

IALS was a large-scale co-operative effort undertaken by governments, national statistics agencies, research institutions and multi-lateral agencies in the period between 1994 and 1998 (for more details see OECD and Statistics Canada, 2000). PIAAC is a follow up study that targeted the same population (aged 16 to 65) with the same objectives, namely to provide direct measures of the extent and distribution of literacy proficiency among and within countries in a comparable manner, and to study the antecedents as well as individual and societal outcomes associated with literary and other competencies; and, for the most part implemented near identical survey and measurement instruments that are comparable in nature (for more details see OECD 2013a; 2013c). PIAAC currently provides data for countries that participated in different rounds between 2012 and 2016. Both IALS and PIAAC are cross-sectional studies based on a unique combination of household survey methodologies (as in the case of Labor Force Surveys) and direct skill assessment methods. Both studies were primarily designed as international comparative assessments of literacy proficiency, which were administered to nationally representative samples of adults aged 16 to 65 (large sample sizes ranging between 2,000 to 5,000 cases per country). In this paper, only adult populations aged 26 to 65 are considered. This is because most youth continue to experience substantial cognitive development into their early 20s and the majority in most countries are still in their first cycle of studies which are themselves major determinants of proficiency. For this reason, it is advisable to conduct a separate analysis of the determinants of proficiency for youths aged 16 to 25 and so this is left for further study.

Thirteen countries from PIAAC and IALS are included in the analysis, namely: Belgium (Flanders), Czech Republic, Denmark, Finland, Germany, Ireland, Italy, Netherlands, Norway, Poland, Sweden, UK (England and Northern Ireland), and USA. A small number of other countries participated in both studies but due to restricted data access these countries are excluded from the analysis (e.g. Australia and Canada). Table 1 lists the countries included in the determinants analysis along with sample sizes.

Table 1. Countries included in analysis, target population and sample sizes

	IALS sample size (age 26-65)	PIAAC sample size (age 26-65)
Belgium (Flanders) (BE)	1511	3978
Czech Republic (CZ)	2628	4467
Denmark (DK)	2434	6130
Finland (FI)	2320	4480
Germany (DE)	1723	4232
Ireland (IE)	1806	5110
Italy (IT)	2451	4004
Netherlands (NL)	2436	4122
Norway (NO)	2586	3897
Poland (PL)	2326	4246
Sweden (SE)	2069	3554
UK (England and Northern Ireland)	3262	7450
United States (US)	2432	3986

Changes to cross-national profiles of literacy proficiency

PIAAC and IALS provide comparable measures of literacy proficiency on the basis of two scales, which are the main dependent variables considered in the analysis. The first scale provides an ordinal and continuous measure of literacy proficiency on a scale from 0 to 500 points, and the second scale provides an ordinal and categorical measure according to five levels of proficiency.

The first scale is useful for most types of statistical analysis (i.e. linear regression). However, it is important to note that the meaning of the scale is not based on constant intervals which makes it difficult to interpret score differences since interpretation depends on which range of scores is made to be relevant. As an example, a 10-point difference in the middle of the scale, say around 275 points, is not equivalent to a 10-point difference, say around the 100 or 400-point marks on the scale. Differences of 25 to 50 points around the 275 to 326-point range can point to substantial differences in terms of what people can actually do with their literacy skills whereas it is not readily clear what the same point differences mean around the 100 or 400 points marks other than marginal increases in probability of achieving similar tasks. For this reason, it is important to interpret results carefully and not attribute too much weight to a given analysis making use of only the 0 to 500-point scale.

Figure 1 summarizes the national profiles of literacy on this first scale for 13 countries who participated in both IALS and PIAAC. Overall, results show small differences going either way along the entire distribution with little consistency across countries. Perhaps most remarkably, very few countries seem to have experienced substantial improvements to their overall profile despite the fact that educational qualifications among adult populations have continued to

increase in nearly all countries over the approximate interim 20-year period (discussed below, see Table A7). One exception is the literacy profile for Poland which has significantly improved at nearly all points along the distribution. However, Poland also had the lowest scores at each point on the distribution in the 1990s and has experienced substantial structural change since the 1990s. Otherwise, a few countries show similar or somewhat better literacy profiles such as Finland, the Netherlands, Belgium (Flanders), UK (England and Northern Ireland), Czech Republic, Ireland and Italy. A couple countries show somewhat worse literacy profiles, but significantly so, such as Denmark and Germany. A few other countries show substantially and significantly worse literacy profiles including Norway, Sweden and the US. For Norway and Sweden, the decline in literacy is more or less uniform across the distribution but for the US the pattern is mixed with some to little change at the lower end of the distribution but significant declines in scores in the middle to upper end of the distribution.

As mentioned, the second scale provides an ordinal and categorical measure according to five levels of proficiency which correspond to the following ranges of scores on the first scale as follows: Level 1 (0-225 points); Level 2 (226-275 points); Level 3 (276-325 points); Level 4 (326-375 points); and, Level 5 (376-500 points). Due to the broad range of scores at Level 1 and the comparatively large proportion of populations at this level in many countries, an effort was made in PIAAC to distinguish between 'Below Level 1' (0-175 points) and 'Level 1' (176-225 points), but this was not done in IALS – thus the label 'Level 1 or below' in this analysis. This second scale is more meaningful in terms of what people can actually do and in this way helps to compensate for the shortcomings of the first scale. The 2013 Skills Outlook (OECD, 2013a) defines the distinction between the levels of proficiency in detail. In short, people who score at Level 2 (226-275 points) are literate by demonstrating an ability to integrate two or more pieces of information or to compare and contrast easily identifiable information when responding to text-based stimuli but are more likely (than at Level 3 or higher) to make errors when there are several distractors or when plausible but incorrect pieces of information are present, or when more complex inferences are required. While people at Level 2 are thus literate and can function in many everyday situations requiring literacy, they are more likely to make errors of interpretation when presented with more complex everyday literacy related situations that require comparisons, assessment of facts and inferences. Adults at Level 1 or below are by definition even more likely to encounter difficulties with literacy related situations. Scoring at Level 2 or below may thus be insufficient in dynamic, modern, market-based and democratic societies, for example, in terms of discretionary decision making in the context of literacy rich environments.

While the issue of what constitutes an adequate level of literacy proficiency to foster dynamic and well-functioning market-based democracies is for further research, in this analysis, Level 2 vs 3 is interpreted as an important breakpoint in the proficiency scales. The breakpoint is somewhat arbitrary but what is clear is that people who score at Level 2 or below have substantively lower

levels of literacy proficiency than those who score at Level 3 of higher. Moreover, the latter are more likely to cope with more complex and demanding literacy related situations, which are increasingly the norm in many advanced industrial economies and societies who are experiencing the widespread use of information communications technologies in nearly every aspect of daily living. On this basis, a key policy relevant question is whether there is a greater proportion of adults who score at Level 2 or below in the 2012-2016 period compared to the 1990s?

Figure 2 summarizes the national profiles of literacy on the second scale. The left of the axis shows the proportion of adult populations who scored at Level 2 or below and the right of the axis shows those who scored at Level 3 or higher. As can be seen, Poland experienced a decrease of adults who scored at Level 2 or below of 23 percentage points which is consistent with the pattern observed in Figure 1 where substantial improvements can be seen at every point along the distribution. Also consistent with Figure 1, Finland, Ireland and the Netherlands experienced small and insignificant declines in the proportions of adults who score Level 2 or below. Belgium (Flanders), UK (England and Northern Ireland), and the Czech Republic also experienced declines in the proportions of adults who score Level 2 or below, but these are somewhat larger and significant. In Italy, despite improvements to the median, 25th and 10th percentiles (from Figure 1), and particularly the reduction in the proportion of adults who score at Level 1 or below (from Figure 2), this country nevertheless experienced a growth in the overall proportion of adults who score at Level 2 or below. Otherwise, Germany's adults who scored at Level 1 or below increased by 4 percentage points. Norway and Sweden experienced increases to the proportion of adults who score at both Level 2 or Level 1 or below which were large, approximately 8 and 14 percentage points, respectively. Lastly, the US experienced a large and significant increase in the proportion of adults scoring at Level 2, approximately 9 percentage points.

In summary, the pattern of changes to national literacy profiles is mixed with only one country showing substantial improvement, a few experiencing marginal improvements and a few others experiencing declines in proficiency at different points of the distribution. Notably, at least three countries including the US experienced substantial increases in the proportion of adults who scored at Level 2 or below. A key question is why might this be the case? To address this question, it is important to understand the determinants of literacy proficiency, how they may be implicated in the development of literacy from an individual lifecycle perspective, as well as how they may be implicated in development of national profiles of literacy proficiency as countries' socio-demographic make-up, socio-cultural practices and economies change over time. This question can be addressed at least partly with the data made available by PIAAC and IALS by helping to draw out which factors are most associated with literacy proficiency on the basis of multivariate analysis, how these factors vary by country, and how they are changing over time across countries.

Figure 1. Distribution of literacy in PIAAC and IALS on 0 to 500-point proficiency scale, adults aged 26-65

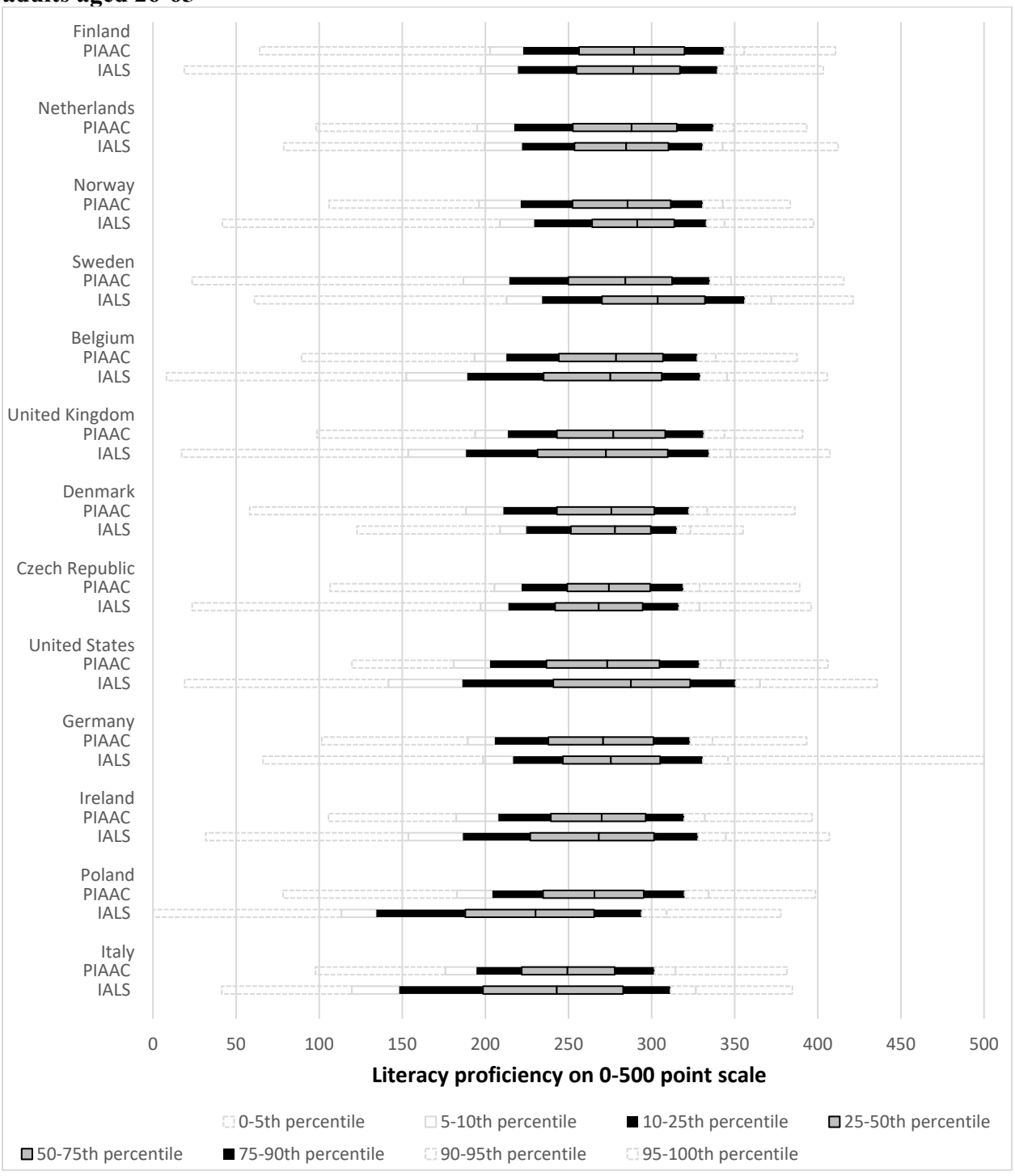
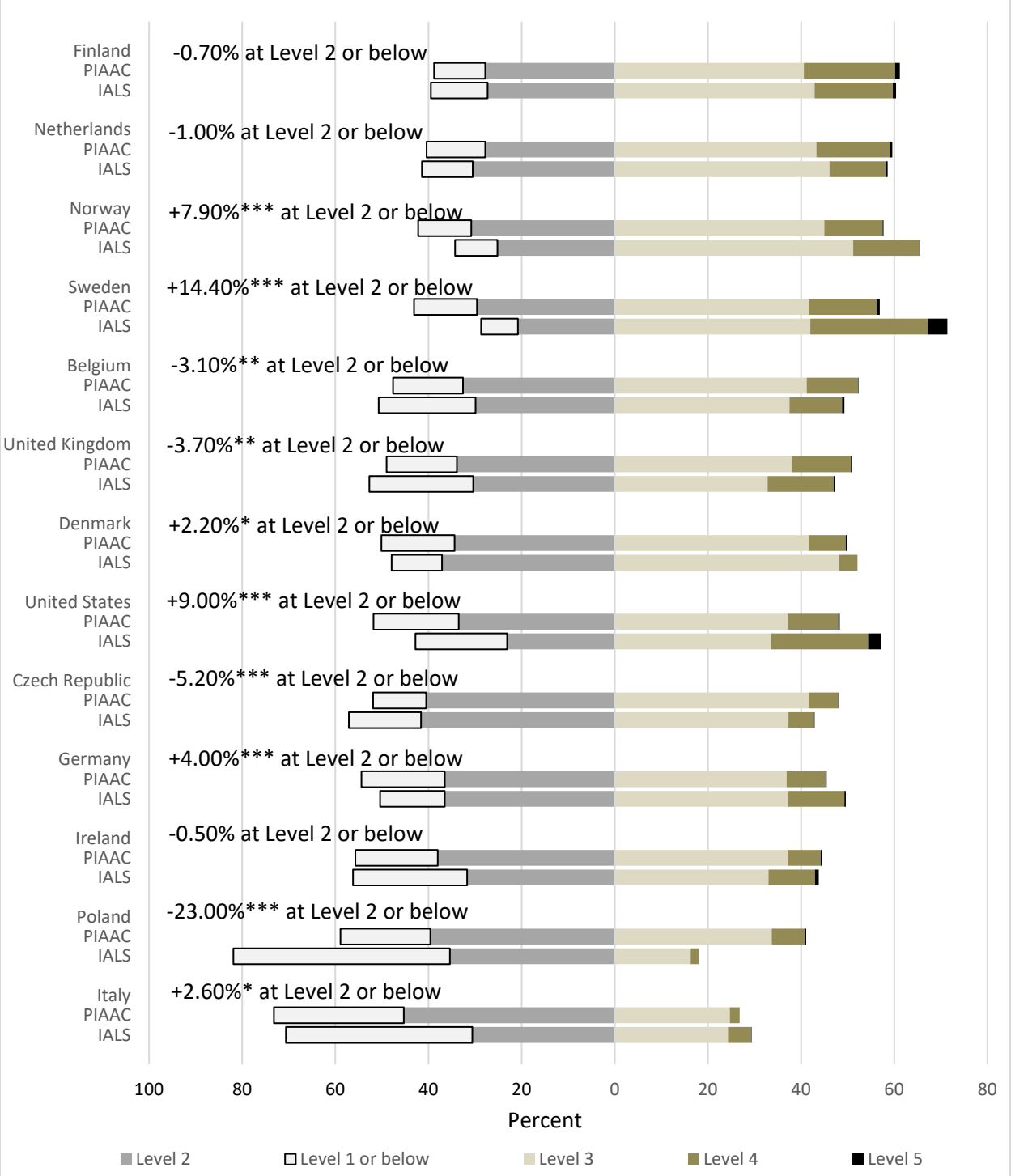


Figure 2. Distribution of literacy in PIAAC and IALS by level of proficiency, adults aged 26-65



Note: * p < .1, ** p < .05, *** p < .01

Research questions

The subsequent analysis will focus on the following two research questions:

1. What factors influence literacy proficiency at the individual (micro) level?
    a. How do socio-demographic factors relate to literacy proficiency?
    b. How do practice-oriented factors relate to proficiency?
2. How does observed change in national literacy profiles relate to structural change in selected country (macro) level factors?
    a. How do changes in socio-demographic make-up of populations relate to changes in literacy proficiency?
    b. How do structural changes affecting opportunities to practice literacy relate to changes in literacy proficiency?

Socio-demographic and practice-oriented factors related to literacy proficiency

There are several factors that can be implicated in the development of literacy proficiency which are made available in a comparable manner over time and across countries by IALS and PIAAC. This section discusses these on the basis of theoretical reasoning and prior research. A distinction is made between two different types of factors related to literacy proficiency, namely socio-demographic and practice-oriented factors. These are introduced by focusing on how the different factors can be implicated in the development of proficiency at an individual (or micro) level from a lifecycle perspective.

Socio-demographic factors related to proficiency

Socio-demographic characteristics of all kinds are potentially important factors that relate to the development and maintenance of literacy proficiency over the lifecycle, primarily by being related in some way to the opportunity of adults to practice and develop literacy proficiency. The way in which a factor may be related however is complex and is not always clear from available data. Often socio-demographic factors are simply markers of social status that can be associated with advantaged or disadvantaged access to contexts, opportunities or other experiences, which in this case can affect the development and maintenance of literacy proficiency. They can also however, be a marker for different types of preferences for certain behaviors, lifestyles and outcomes, and thus by extension choices by individuals for choosing to engage in certain contexts instead of others. These two types of markers have different meanings and implications, for example for policy purposes, but rarely can these be disentangled in real life since human and social behavior should be understood as a product of the interaction of the existence of contexts, the structural conditions (of authority, power, norms etc.…) affecting access to those contexts as well as individual choices to engage in those contexts (Coleman, 1991; Giddens, 1984; Harper, 2015; Lin, 2017). Furthermore, it is even more difficult to be able to distinguish among the alternatives mentioned on the basis of data made available by large scale datasets, and thus

appropriately interpret the meaning of statistical results. To complicate things further, literacy proficiency is itself a characteristic that affects individual behaviors and choices, as well as access to contexts and opportunities that can further develop or maintain literacy proficiency.

Despite these difficulties, social research typically strives to take account of a handful of core socio-demographic factors, namely gender, socio-economic status, immigration, language and/or other minority status, and age. Whether a strong or weak relation to the outcome is interpreted as a consequence of disadvantaged/advantaged access, individual preferences or choices, often depends on the nature of the factor itself in relation to historical, social, cultural and political circumstances but also the framing and emphasis of the analysis. The following briefly discusses a set of core socio-demographic characteristics in relation to literacy proficiency which are made available by IALS and PIAAC and can be implicated in the development of literacy proficiency from a lifecycle perspective.

Gender

There are no strong theoretical expectations regarding the direct effect of gender on literacy proficiency. However, preferences for engaging in reading related behaviors may play a role, particularly at younger ages. Some research suggests that girls tend to read more at an earlier age and this translates into better literacy proficiency than boys of the same age (Tsai, Smith, & Hauser, in print; Borgonovi, Pokropek, Keslair, Gauly, & Paccagnella, 2017; Loveless, 2015; Halldórsson & Ólafsson, 2009). But research also suggests that the gap narrows considerably in adulthood (Martin, 2018; Borgonovi et al., 2017; Solheim & Lundetræ, 2016). The latter may reflect indirect effects that arise as a consequence of differential access to contexts and/or preferences for engaging in certain contexts that develop literacy proficiency (e.g. types of majors and careers). Historically women have had unfavorable access to contexts in which literacy can be developed such as formal educational contexts or work-related contexts in which cognitive demands are higher such as professional and leadership positions. Much progress has been made in this regard in many advanced industrialized countries, for example in terms of educational attainment and labor force participation, but it is not uniform and can vary substantially by country or even by regions within countries. Separately, some research suggests that men and women have different occupational preferences (Barbulescu & Bidwell, 2013; World Bank, 2012; Hakim, 2006). This may indirectly affect the development and maintenance of literacy proficiency from a lifecycle perspective. Gender therefore may have an indirect effect on literacy proficiency via educational attainment and/or type of occupation, particularly more so in some countries where gender differences remain in either of those pathways (Shoham, Shoham, & Malul, 2011).

Parents' education (socio-economic origins, class)

Class, or socioeconomic status (SES), differences in access to gainful opportunities is a classical research topic. Typically, the emphasis is on the social status of different classes in terms of power and resources, particular regarding advantage or disadvantage in access to contexts, opportunities or other experiences, to develop further and/or maintain power and resources. For our purposes, this is limited to opportunities to develop and maintain literacy proficiency, which is widely believed to be a crucial resource for individuals to acquire further resources and capacities to realize what it is that matters to them (Crocker, & Robeyns, 2009; Lynch, 2009; Sen, 1992; Sen, 1993; Shore, Sabatini, Lentini, & Holtzman, 2013). Broad access to quality education for all is believed to alleviate many of the disadvantages associated with lower SES which is an important basis for maintaining universal and compulsory public education up to a minimum age of at least 15 in most advanced industrialized countries, and even higher in many others such as the US. But in most countries, although to varying degrees, SES remains associated with achievement such as literacy proficiency (OECD, 2015; Schmidt, Burroughs, Zoido, & Houang, 2015; Shore, Sabatini, Lentini, & Holtzman, 2013; Willms, 2010; Brozo, Shiel & Topping, 2007), as well as further educational attainment and learning over the life course which further enhances literacy proficiency (Martin, 2018; Barnes, Brown, & Warhurst, 2017; Willms, & Murray, 2007). Therefore, SES may have direct effects on literacy proficiency as a consequence of the educative impact of the home background for which schools are unable to compensate (Coleman, 1966; Downey, & Condron, 2016; Reder, 2015), as well as indirect effects as a consequence of impacts on the quality and quantity of education and access to other educative and nurturing contexts over the lifespan.

Given that socioeconomic background is a difficult concept to measure requiring data on income, wealth and occupation of parents when adults were growing up, it is often necessary to use proxies. The only data in IALS and PIAAC that is relevant to class or socioeconomic origins of the respondents is parents' education. Parents' education is a good proxy since education is an important predictor of income, wealth and occupation. It is also indicative of the educative environment of the home as adults were growing up which may have had direct effects on the development of literacy proficiency at a younger age. The use of parents' education has been used as a proxy for SES in the research literature (e.g. Bradbury et al., 2015) While emphasis is placed on the actual measure in the empirical analysis, the discussion and interpretation of results makes reference to SES since it is used a proxy for this concept. In defining the variable, the education of both parents is considered as follows: at least one parent attained higher than upper secondary education, at least one parent attained at least upper secondary education, and neither parent attained upper secondary education.

Earnings

As discussed, parents' education is used to control for socioeconomic origins, but to account for the current socioeconomic status of adults it is more relevant to use current earnings (in the year preceding the survey). Those who earn more are more likely to have resources at their disposal and thus considerable advantage in access to contexts, opportunities or other experiences, to develop further and/or maintain literacy proficiency. In the analysis, the variable is defined according to quintiles plus an additional no earnings category.

Immigration, language and other minority status

Birth place and first language(s) used while growing up can be markers of social advantage or disadvantage vis-à-vis access to opportunities to develop literacy in the majority (or native) language(s). In terms of immigrants, the disadvantage may be reduced to the length of time one has been exposed to the local language as well as the local context. Otherwise, being native-born and/or a native-speaker may provide advantaged access to opportunities which are often conditioned by the local and majority cultures who typically have more power to regulate norms and laws. Disadvantages may arise due to deficiencies in the local and majority language which is the case for many immigrants who are not native-speakers. This can typically be addressed with initiatives and additional resources, although systemic discrimination and social exclusion of 'others or foreigners' may well persist. Further, it may also be the case for native-born adults who are part of a local minority culture that is not related to immigration and speak a language that may not be officially recognized or was different than the language in which the literacy assessment was administered (e.g. Swedish-speaking Finns in Finland, Native Americans in the US). Finally, in other cases some native-born and native-speakers carry minority status as a consequence of other markers such as ethnicity. In the US, for example, race is a crucial marker of minority status for historical reasons and is associated with deep structural differences related to educational attainment and achievement (Arora, 2018; Rothstein, 2015; Kao & Thompson, 2003).

The meaning of the relationship is thus highly context dependent, which is a challenge in an international and comparative study such as IALS and PIAAC. It is nevertheless crucial since literacy proficiency is assessed by language and depending on the country this is only done in one or two of the country's official languages. Given the complexities and to preserve the comparative nature of the analysis, we will focus only on whether adults are native-born or not and whether they are native-speakers (in the language of the assessment) or not. Specifically, in defining the variable, four categories are considered as follows: native-born and native speaker (test language same as at least one of the languages learned as a child); native-born and foreign-speaker (test language different language(s) learned as a child); foreign-born (immigrant) and native-speaker; and foreign-born and foreign-speaker. For a number of countries, the number of immigrants who are non-native speakers has grown substantially since the 1990s, which is an important factor that may explain changes to national literacy profiles. In the discussion, the

analysis will directly consider the native-language of immigrants as well as level of proficiency to distinguish between high-skill and low-skill migrants.

Age

Older age groups tend to be associated with lower average levels of literacy proficiency than younger adults (OECD, 2013; Statistics Canada, 2000; Steen-Baker, Ng, Payne, Anderson, Federmeier, & Stine-Morrow, 2017). There are several alternative explanations for this observation. Similar to gender, age can be a marker of dispositions or preferences in terms of choice of contexts in which to engage in, and/or discrimination in terms of access to opportunities to develop proficiency. For example, some research suggests that younger adults have a greater disposition to engage in intellectually challenging contexts than older adults, possibly associated with risk taking behaviors, which can influence the development or decline of proficiency (Reder, & Bynner, 2008; Grotlüschen, Mallows, Reder, & Sabatini, 2016). Other research suggests that employers are more likely to adopt new technologies or processes with younger workers than older ones (Hämäläinen, De Wever, Malin, & Cincinnato, 2015; Charness, Boot, & Czaja, 2015; Morris, & Venkatesh, 2000) which may negatively affect the opportunity for older workers to develop or maintain their proficiency. Age may thus directly affect proficiency on the basis of such alternatives.

However, age carries special properties in the context of a lifespan analysis in at least two ways which may relate to a range of indirect effects on proficiency. First, age is a marker of cumulative experience, specifically a marker of practice, exposure and familiarity (or lack thereof) with different situations such as literacy related ones. In other words, not all older adults necessarily show lower levels of proficiency. Those who have engaged in diverse literacy related situations frequently their whole lives, perhaps as a consequence of the type of job they hold, may well have continued to develop or at least maintain their literacy proficiency into older age. In contrast, those who have engaged in few literacy related situations and less frequently so, may have experienced substantial declines in proficiency as they aged. In this regard, the average result at the country level, may reflect the relative number of adults who have the opportunity to practice their literacy skills, and want to, over their lifespan (Boeren, 2016; Desjardins and Warnke, 2012; Reder, 2015). Second, because IALS and PIAAC are cross-sectional studies, age is also a marker for cohort effects. As an example, a large number of older adults may have had less exposure to formal educational contexts simply because fewer opportunities existed when they were younger. Similarly, fewer older adults, at least compared to younger cohorts, have had less opportunity to obtain skilled work at earlier ages because of the growth of knowledge economies and the introduction of information communications technologies over time (Desjardins and Warnke, 2012). Accordingly, in defining the variable, age groups that correspond roughly to distinct stages of career are considered as follows: 26-40, 41-55, 56-65.

Practice-oriented factors over the lifespan related to proficiency

As alluded to in the above discussion, the opportunity to engage in literacy related situations is a crucial element linking socio-demographic factors to literacy proficiency. In this section, the emphasis is on a range of factors available in IALS and PIAAC which are proximally closer to the opportunity to engage and ultimately the actual engagement in literacy related situations in terms of frequency and variety. The idea that exposure to literacy related situations, the opportunity to engage in literacy situations, and ultimately the actual practice of literacy, is directly related to literacy proficiency is often referred to as practice engagement theory. This theory contends that literacy proficiency and engagement in literacy practices reinforce each other over time (Barton, 2017; Smith, 2009; Reder, 2017; Reder, 1994). The following briefly discusses a set of core practice-oriented factors in relation to literacy proficiency which are made available by IALS and PIAAC and can be implicated in the development of literacy proficiency from a lifecycle perspective.

Education

Formal education that leads to qualifications plays a dual role in terms of being a practice-oriented factor as well as a socio-demographic factor relevant to the development of literacy proficiency. As a practice-oriented factor, it is easy to see how schooling can enhance literacy proficiency, since this is one of its core purposes, to produce a population that able to read and write. In most countries, a principal goal of primary schools is to teach basic literacy skills, and then for secondary schools to practice the use of these skills for learning specific content. Tertiary schools extend this into specialized areas. As literacy skills are practiced through educational contexts, proficiency increases. Reder (1998) terms this effect of education on literacy as the "literacy development effect". As a socio-demographic factor, educational qualifications can provide or limit access to opportunities to develop proficiency. For example, qualifications can affect the type of occupation one may be able to secure, or alternatively the frequency and variety of different types of opportunities to practice literacy in work-related contexts. It can also affect preferences for particular occupations and more generally engagement in literacy related practices. In the analysis, the variable is defined according to three categories: completed less than upper secondary; completed upper secondary; completed more than upper secondary.

Other types of educational opportunities such as formal and non-formal types of adult education can also lead to the development and maintenance of literacy proficiency, but given the highly variable nature of such opportunities, it is not always clear to what extent they may or may not be proximal to literacy. To the extent that adult education involves certain types and intensity of text-based instruction and learning, then it may be directly implicated in the development and maintenance of literacy (Belzer, 2017; Crossley, Skalicky, Dascalu, McNamara, & Kyle, 2017; Purcell-Gates, Degener, Jacobson, & Soler, 2002).

Unfortunately, in PIAAC there is insufficient information about the nature of adult education opportunities undertaken by respondents. For example, there is insufficient information to ascertain whether the activity was undertaken to improve basic skills such as literacy, or whether it was related to the development of manual skills or advanced professional development. Moreover, at a population level, there is a confounding relationship between adult education and literacy proficiency. Research shows that highly proficient adults are more likely to participate in adult education of various kinds, for example, including further professional development (Grotlüschen et al., 2016). This suggests a positive mutually reinforcing relationship, namely that proficiency may induce participation which may further improve proficiency. However, low proficiency adults may also be more likely to participate in adult education but of specific kinds including those specifically designed to improve proficiency, although this would depend on the available opportunities which varies greatly by country. This suggests a negative relationship, namely those who undertake adult education for basic skills do so because they have low proficiency. In other words, without information on the type of adult education and for what reason, there is a highly confounding relationship between adult education and literacy proficiency. For this reason, adult education is not included in the micro-level analysis although its growth as well as its possible role in the development of national literacy profiles is acknowledged in the discussion and interpretation of results.

Occupation

Similar to education, occupation can play a dual role in terms of being a practice-oriented factor as well as a socio-demographic factor relevant to the development of literacy proficiency. As a socio-demographic factor, occupational status may improve or limit access to opportunities to develop proficiency outside the work context such as access to specific types of professional networks that involve extensive engagement in literacy (Boeren, 2016; Grotlüschen et al., 2016; Reder, 2017). However, one's occupation is also a marker for the types of practices that one may or may be engaged in on a recurring basis over their career, and in this sense, is a proximal factor reflecting engagement in literacy related situations. For example, certain occupations are much more likely to involve engagement in a diverse and challenging set of literacy related situations than others. In the analysis, the variable is defined according to four categories: skilled workers (ISCO 1, 2 and 3: managers, professionals and associate professionals); semi-skilled white-collar workers (ISCO 4, 5 and 6): clerks and service, shop and sales workers); semi-skilled blue-collar workers (ISCO 7, 8: craft and trades, plant and machine operators, assemblers); and, elementary workers (ISCO 9).

Literacy practice at work

Both PIAAC and IALS contained data on actual engagement in specific literacy related situations in terms of frequency and variety. According to practice engagement theory discussed above, more literacy-related practice should translate into greater proficiency. Importantly, however, it is not only the frequency of practice that should matter but also the variety (Smith,

1996). Accordingly, three items related to the literacy practice at work which followed a Likert frequency scale (at least once a week, less than once a week and rarely or never) were used to construct a sum scale which was in turn used to generate two categories as follows: at least two types of reading at work weekly or several others less than once a week; and, little to no reading at work. The three items collected in both IALS and PIAAC in a comparable manner are as follows: as part of job… read or use letters, memos or emails; as part of job… read reports, articles, magazines, or journals; and, as part of job… read manuals or reference books. While there are comparable items related to literacy practice both at work and outside work, the analysis only considers those related to work due to the high correlation between the two and the fact that there is less variation for practices outside work, as well as to keep the analysis more parsimonious.

Micro-level models predicting literacy proficiency

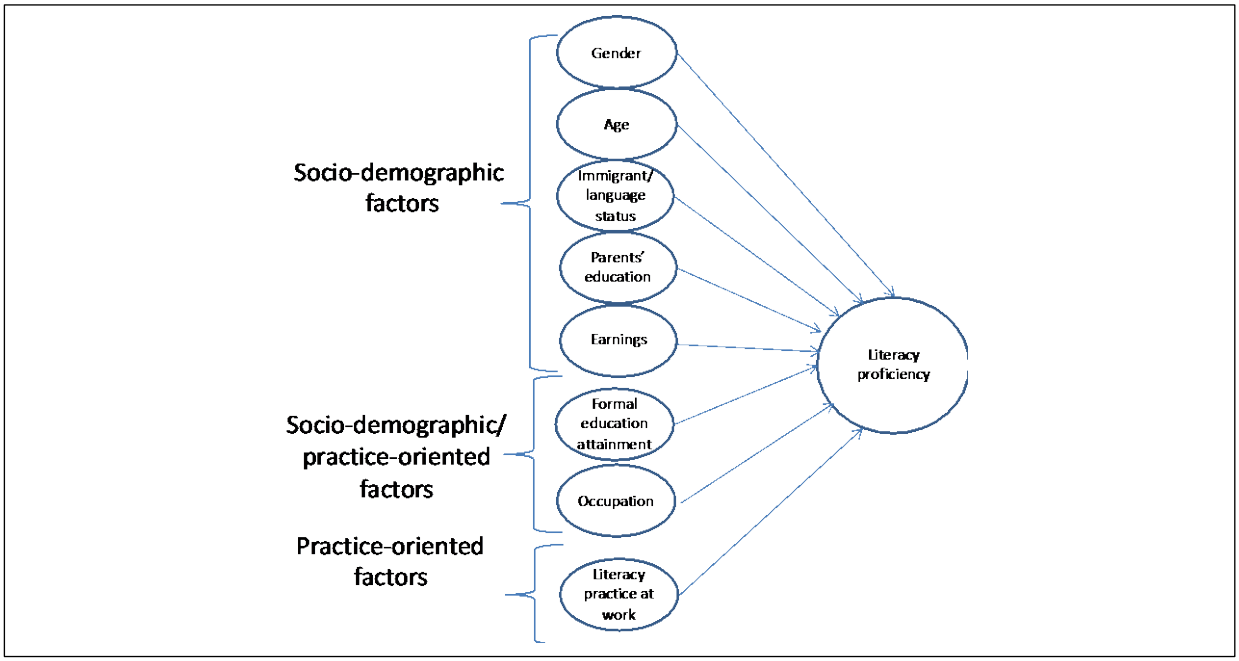
This section constructs and estimates multivariate models, which presume a causal structure that may underlay literacy proficiency. A variety of techniques are used to estimate and compare results so as to establish stability in the underlying structure of the determinants of literacy. The purpose of the models is to disentangle the influences of various factors and to estimate the relative importance of different factors, which may contribute to the development of literacy proficiency. In so doing, causal directions among the factors are hypothesized. These are merely hypotheses advanced on the basis of theoretical reasoning and previous research which were discussed above. The findings do not in themselves prove or disprove the hypotheses but provide reasonable support for or against the potential role of different factors. Causality is therefore not established empirically and constitutes an important limitation to the results presented. Note that all results discussed are statistically significant at the 5% level of significance unless otherwise indicated.

Conceptual models

Figure 3 summarizes a simplified conceptual model that is operationalized and estimated using logistic regression and linear regression (results reported in sections entitled logistic regression model and linear regression model). It includes each of the factors discussed above and their hypothesized relationship to literacy proficiency. Although the structure of determinants of literacy proficiency are complex as alluded to above, with multiple direct and indirect pathways among the independent and dependent variables, it is useful to focus on simplified multivariate models which estimate only direct effects for at least four reasons. First, it allows for the disentanglement of direct influences of various factors and by extension to estimate the relative importance of different factors on the basis of their direct effects on literacy proficiency. Second, it allows for the comparison of results across the two different scales of literacy proficiency discussed above using suitable techniques. For example, when using the continuous scale ranging from 0 to 500, linear regression is more appropriate, whereas when using the discrete scale defined as a binary (i.e., Level 2 or below vs Level 3 or above), logistic regression is more

appropriate. Third, it allows for a specification of many of the key independent variables in a manner that reflect data in terms of specific categories as they were collected from respondents, and by extension non-linear modelling which allows for a more precise fit of models to the data. For example, discrete variables with more than two categories and without clear ordinality can be more appropriately specified using linear or logistic regression models compared to a structural model. Fourth, it facilitates the estimation of design based standard errors to reinforce the quality of inferences that can be drawn from the analysis (i.e. special macros designed to handle the complex sampling and data architecture of the PIAAC dataset can be used for the logistic regression and linear regression functions).

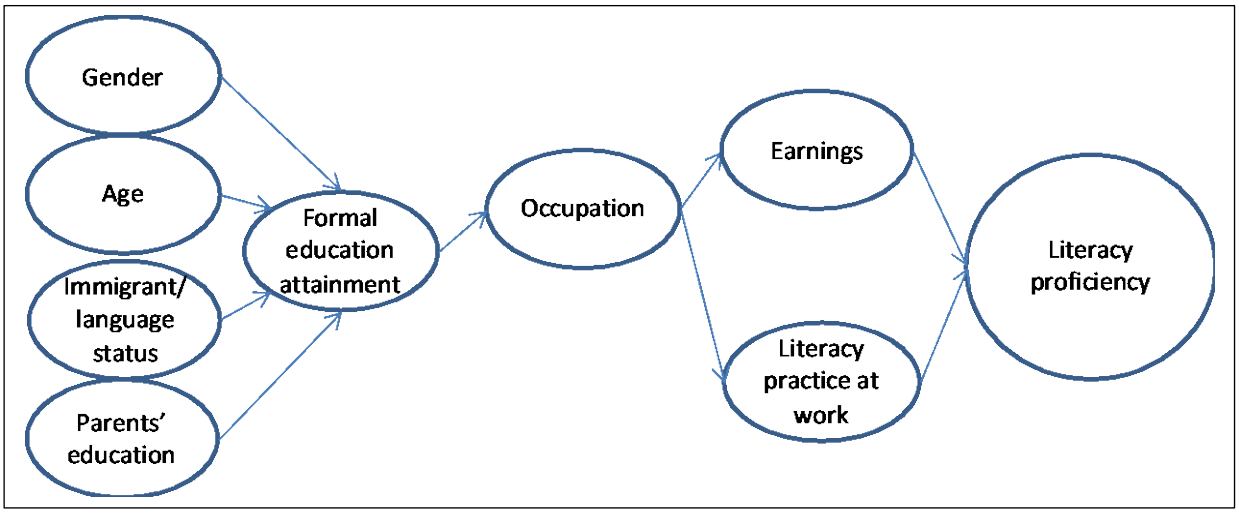
Figure 3. Multivariate model depicting socio-demographic and practice-oriented factors hypothesized relationship to literacy proficiency



In contrast, Figure 4 summarizes a simplified path model which is advanced on the basis of theory and previous research discussed above which is operationalized and estimated using structural equation modelling (SEM) (results reported in section entitled structural model). This includes the estimation of direct effects as well as indirect effects of factors that operate via other factors due to their structural relationship. Such a model makes sense among the factors discussed above and in the context of literacy proficiency from a lifecycle perspective because there is a temporal order among some of the factors. As a starting point, the model first considers (fixed) socio-demographic factors that cannot be easily influenced or changed such as gender, age, immigrant and language status, parents' education, whereby these factors can significantly affect educational attainment and other learning experiences, attitudes, behaviors, opportunities,

and choices over the lifespan which can affect literacy proficiency. A set of practice-oriented factors are considered including educational attainment and occupational status which can in turn affect later earnings and proficiency. Not least, one's type of occupation can affect the extent and variety of literacy practice at work and in turn proficiency. Importantly, literacy practice at work differs distinctly from the (fixed) socio-demographic factors. Literacy practice related behaviors are potentially recurrent over the lifespan of individuals as they can occur on a daily, weekly or monthly basis, or not at all. It is important to note, however, that because PIAAC is a cross-sectional survey, some of the inherent reciprocal and dynamic relationships among the factors cannot be considered. For example, the cumulative effect of continued learning in adulthood on proficiency cannot be accounted for, perhaps leading to an underestimation of the relative effect of the job and other literacy related factors occurring in adulthood.

Figure 4. Simplified path model depicting socio-demographic and practice-oriented factors hypothesized relationship to literacy proficiency



Nevertheless, the temporal and structural nature of the determinants considered can make it problematic to rely too heavily on estimation techniques that focus on direct effects only. For example, SES origins can have an effect on proficiency but operate primarily via educational attainment since it is well known that SES origins influences educational attainment (Shore, Sabatini, Lentini, Holtzman, 2013) and other factors over the lifespan such as occupational status. To illustrate, if SES effects on educational attainment are very strong in a particular country, then a linear or logistic regression may suggest that SES has no effect on proficiency when in fact it does, but it primarily operates indirectly via its effect on educational attainment. This indirect effect however is suppressed in non-structural models because the multiple determinants are by assumption deemed independent and modelled as such. Often, the interpretation of non-structural statistical results overlooks the underlying structural relationship

among determinants. Thus, SEM is useful for estimating the underlying structure of determinants including the direct, indirect and total effects of determinants. There are however at least two disadvantages associated with SEM. First, SEM requires the transformation of most factors into linear measures such as on a continuous interval-based scale, which can deviate substantially from the manner in which data was collected from respondents or the actual scale-related properties of a particular variable. For example, the ordinality and interval-based nature of a variable like occupation can be problematic. This requires several assumptions that do not always do justice to the actual distribution and/or meaning of the data, and thus are not always ideal for interpreting the results. Second, the estimation of standard errors according to the design of complex studies such as PIAAC are not readily measurable when using SEM.

For the above reasons, the analysis gives priority to simpler estimates on the basis of logistic and linear regression. These are constructed to generate results on comparable scales across the variables, namely predicted probability and predicted scores, which are easy to interpret and compare. The SEM analysis is used only to gain insight into the underlying structure of literacy proficiency from a lifecycle perspective, which is important for interpreting the overall results. Specifically, the focus of the SEM analysis is primarily on key structural pathways to assess the total effect of key variables (e.g. total effect of SES including direct effects as well as indirect effects via the following pathway and associated variants: SES → Education → Occupation → Literacy). In the case of the SES, this is important because if social inequality at the country level grows over time, the SES effect on literacy may also be growing, which is a highly policy relevant development. As discussed, the latter however can be easily overlooked when relying exclusively on direct effects which ignore the underlying structure among the determinants. Our objectives therefore are to use estimates of the structure of core determinants to interpret results associated with the determinants from the simpler regression in a more thorough manner. Specifically, the total effects are estimated on the basis of the SEM method for a range of key variables of interest, namely gender, age, immigrant and language status, parents' education, educational attainment and occupation, and compared across countries and over time. This helps to provide a more accurate overview of the factors that are most associated with literacy proficiency, how these factors vary by country, and how they are changing over time across countries.

Descriptives

Annex Table A1 summarizes the percentage distribution of each variable included in the models for both IALS and PIAAC. Changes to the distribution over time of each variable are discussed further when macro level changes are considered in a later section of the paper.

Logistic regression model

Results of the logistic regression applied to the PIAAC and IALS datasets are presented in Annex Tables A2 and A3, respectively. The tables include odds ratios along with their design-

based p-values. The odds ratios along with the unadjusted (or observed) probabilities are used to estimate adjusted probabilities which are easier to interpret and facilitate comparisons across all variables as well as over time. Unadjusted probabilities are defined as those resulting from bivariate distributions without statistically controlling for other variables. The formula used to estimate probabilities associated with odds ratios is as follows: [(p/(1-p)*odds ratio]/[1+(p/(1-p)*odds ratio)], where p is the unadjusted probability (see Liberman, 2005).

The dependent variable is a dichotomous measure of literacy proficiency based on the ordinal and categorical measure of literacy proficiency discussed above, namely low proficiency (Level 2 of below) vs medium to high proficiency (Level 3 or above). This allows for insight on the basis of a multivariate analysis into some of the factors that may be involved in the increase or decrease of adults who scored at Level 2 or below in the 2012-2016 period compared to the 1990s. Predictors of proficiency included in the model are defined as categorical as follows (reference categories are underlined): age (26-40, 41-55, 56-65), gender (men, women), immigrant and language status (native-born, native-language; native-born, foreign-language; foreign-born, native-language; foreign-born, foreign-language), parents' highest level of education (at least one parent completed post-secondary, at least one parent completed upper secondary, both parents did not complete upper secondary), respondent's highest level of educational attainment (completed higher than upper secondary, completed upper secondary, did not complete upper secondary), employment status (employed, unemployed, other), occupation (skilled; semi-skilled, white-collar; semi-skilled, blue-collar; elementary; no work for at least five years) , literacy practice at work (at least two types of reading at work weekly or several others less than once a week, little to no reading) and earnings (highest quintile, next to highest quintile, middle quintile, next to lowest quintile, lowest quintile, no earnings). In nearly all cases, the reference category chosen displays the most advantaged vis-à-vis literacy proficiency.

Tables 1A and 1B summarize the results in terms of effects sizes measured as the difference between adjusted probabilities of two selected contrast categories. As mentioned, this is done by converting odds ratios from the binary logistic model into adjusted probabilities which are deemed to be simpler to interpret and compare across the variables. Then effect sizes are calculated as the difference in adjusted probabilities between two contrast categories associated with a variable (e.g. difference in adjusted probabilities between men and women is an effect size). Typically, contrast categories include the most advantaged (this is usually the reference category by design) vs the most pertinent disadvantaged category that applies across the majority of countries (e.g. native-born and native-language vs foreign-born and foreign-language are chosen as contrast categories since the other two categories are not applicable in all countries but nevertheless may reveal greater disadvantage in some countries). Summarizing the results in terms of effects sizes, makes it easier to distinguish the relative importance of different

predictors and thus produces an easy to interpret rank order and comparison of the most important predictors across countries and over time. Substantial effects are defined as those that are statistically significant at the .05 level and are near to at least .10 probability points or higher.

It can be seen from Tables 1A and 1B that one of the most important predictors of scoring at Level 2 or below vs Level 3 or higher in the majority of countries considered is educational attainment. It ranks first as the most substantial predictor in 9 of the 13 countries, ranks second in two countries and third in the remaining two countries. In PIAAC, the average effect size associated with educational attainment across countries is .65 adjusted probability points, which means that adults who attained less than upper secondary have a .65 greater probability of scoring at Level 2 or lower than an adult who attained more than upper secondary. Across countries, the higher the probability for an adult with low educational attainment to score at Level 2 or lower implies that low educated adults have fewer chances to develop and practice literacy over their lifespan. For example, there may be fewer second chances for educational opportunities or adult education in those countries. In PIAAC, education has the strongest effect in the Czech Republic (.76), the Netherlands (.76), Belgium (.74), Sweden (.71), Germany (.70) and the US (.66). It has the lowest effect in Ireland (.54) and Norway (.56). The estimates suggest that over the last two decades, the magnitude of the effect associated with low vs high education has declined substantially exceeding a change in probability points of .1 in six countries, namely Denmark (from .78 to .63), Finland (.84 to .65), Ireland (.76 to .54), Italy (.66 to .55), and Norway (.84 to .56). As can be seen from Tables 1A and 1B, the decline in five of the six countries is not due to an improvement in the chances of low educated to score higher, instead it appears to be because the most educated are increasingly likely to score at lower levels of proficiency. This is also the case in the US where the more educated have a higher probability (+.09 probability points) in PIAAC of scoring at Level 2 or below than in the 1990s in IALS. In contrast, the probability in the US of scoring at Level 2 or lower for adults without upper secondary remained unchanged at .99 between IALS and PIAAC.

From Tables 1A and 1B, it can be seen the second most important predictor on average of scoring at low levels of proficiency is parents' level of education, an indicator of SES, with an average probability difference between low and high educated parents of .51. Taken as an indicator of SES, parent's education has the strongest effect in Belgium (.68), the Czech Republic (.68), and the US (.63) followed by the UK (.56) and Germany (.54). The lowest effect of SES origins on proficiency is in Sweden (.36), Denmark (.41), Ireland (.45), the Netherlands (.45), Norway (.46) and Finland (.47). The relative importance of SES increased substantially in five countries, namely Belgium (from .32 to .68), the Czech Republic (.46 to .68), Germany (.35 to .54), Ireland (.14 to .45) and the US (.50 to .63). It decreased substantially in Denmark (from .51 to .41), but not due to improvement of the chances of adult with low SES origins but instead due to an increase in the probability of adults with high SES origins to score at lower levels of proficiency.

In the US, the change is driven by a large increase in the probability of adults with low SES origins to score at lower levels (from .75 to .94) but this was somewhat offset by the increased probability of adults with high SES origins to also score at lower levels (from .25 to .32).

The remaining rank order of the most important predictors in order is as follows: occupation (.48 probability difference between blue-collar and skilled workers), earnings (.47 probability difference between lowest and highest earners), immigrant and language status (.38 probability difference between native-born native-speakers and foreign-born foreign-speakers), age (.4 probability difference between older and younger adults), literacy practice at work (.26 probability difference between workers who read frequently vs rarely) and gender (.04 probability difference between women and men).

From Tables 1A and 1B, it can be seen that the relative importance of occupation increased substantially in the Czech Republic (from .27 to .43), Poland (.35 to .54), Sweden (.35 to .46) but decreased substantially in the UK (.54 to .42). The relative significance of occupation also declined in the US, decreasing from .66 to .57. For the Czech Republic and Sweden, the increase in relative significance of occupation appears to be primarily driven by an increased probability of blue-collar workers to score at lower levels. In the UK, the decline is because blue-collar workers show an increased probability of scoring at higher levels, whereas in the US the decline is due to the increased probability of skilled workers of scoring at lower levels (from .19 to .32).

In Tables 1A and 1B, it can be seen that earnings increased substantially in relative importance in Belgium (from .35 to .54), Finland (.14 to .39), Germany (.12 to .53), Italy (.11 to .32), the Netherlands (.30 to .48), Norway (.04 to .59), Poland (.24 to .46), and Sweden (.12 to .39). In most of these countries, this was driven by large increases in the probability of low earners to score at lower levels. The only exception is Poland where the change is driven primarily by sharp drop in the probability of high earners of scoring at low levels. The earnings effect on proficiency was among the highest in the US in 1990s but a small decline in relative significance is estimated (from .60 to .54), which appears to be primarily because the probability of high earners of scoring at lower levels increased from .16 to .23.

The relative significance of native-born native-speakers vs foreign-born foreign-speakers only changed in a handful of countries. In Ireland where immigrants had an advantage in the 1990s but now have a .28 probability of scoring at low levels (remains at a very low difference in comparison to other countries), and in the US where the effect size declined from .59 to .44. The decline in relative importance in the US is primarily due to the increased probability of native-born and native-speakers scoring at lower levels (from .38 in IALS to .48 in PIAAC).

Age substantially declined in relative importance as a predictor in the Czech Republic (from .45 to .31) and the UK (.40 to .16) but increased in the US from an effect size of .17 to .28. The increase in the importance of age in the US is primarily driven from an increased probability of older adults aged 56 to 65 of scoring at Level 2 or lower (.59 to .71).

The relative importance of literacy practice at work substantially decreased in Denmark (.35 to .24), Finland (.42 to .17), Ireland (.39 to .22), the Netherlands (.41 to .25), the UK (.7 to .23) and the US (.48 to .24), but increased in Germany (.21 to .33), Poland (.25 to .37). In most countries, this is because the probability of workers who read little (as part of job… letters, memos or emails, reports, articles, magazines, journals, manuals or reference book) show a reduced probability of scoring at Level 2 or lower. In Poland, those who read frequently as part of their job show a much lower probability of scoring at low levels compared to the 1990s. In contrast, for the US, adult who read frequently as part of their job are in PIAAC more likely to score at lower levels by wide margin (.29 vs .40).

Gender has a low relative significance in the majority of countries. In PIAAC, the effect size is only substantial in Belgium (.11) and the Netherlands (.13), in both cases revealing that women have a higher probability of scoring at Level 2 or below. While the effect sizes for Gender appear to be marginal, it is important to note substantial changes in the relative size of the effects from IALS to PIAAC in a few countries, namely Denmark (-.1 to .07), Finland (-.17 to -.04). Ireland (-.03 to .09), the Netherlands (-.12 to .13), Norway (-.16 to .05), Sweden (-.05 to .05).

Table 1A. Summary of differences in adjusted probability points (effect sizes) of scoring at Level 2 or below in PIAAC between most advantaged (reference category) and selected disadvantaged categories associated with each determinant

	BE		CZ		DK		FI		DE		IE		IT		NL		NO		PL		SE		UK		US		Average
Older (56-65)	0.81		0.69		0.87		0.90		0.89		0.74		0.89		0.84		0.86		0.78		0.84		0.59		0.71		
Younger (26-40)	0.34		0.37		0.40		0.21		0.45		0.48		0.63		0.29		0.30		0.51		0.32		0.43		0.43		
Difference (effect size)	0.47	***	0.31	***	0.47	***	0.69	***	0.43	***	0.26	***	0.27	***	0.55	***	0.56	***	0.27	***	0.53	***	0.16		0.28	***	0.40
Women	0.55		0.51		0.57		0.37		0.55		0.62		0.74		0.51		0.46		0.58		0.48		0.50		0.52		
Men	0.45		0.48		0.50		0.41		0.51		0.54		0.70		0.38		0.41		0.61		0.42		0.47		0.52		
Difference (effect size)	0.11	***	0.03		0.07	***	-0.04		0.04		0.09		0.04		0.13	**	0.05		-0.03		0.05		0.03		0.00		0.04
Immigrant	0.97		0.51		0.93		0.93		0.94		0.83	***	0.96		0.90		0.88		0.61		0.93		0.84		0.92		
Native	0.46		0.48		0.48		0.37		0.49		0.56		0.70		0.37		0.39		0.59		0.37		0.46		0.48		
Difference (effect size)	0.52	***	0.02		0.45	***	0.56	***	0.45	***	0.28		0.26	***	0.52	***	0.49	***	0.02		0.55	***	0.37	***	0.44	***	0.38
Low SES	0.90		0.88		0.74		0.67		0.90		0.79		0.88		0.67		0.72		0.83		0.64		0.84		0.94		
High SES	0.22		0.20		0.33		0.20		0.36		0.34		0.40		0.22		0.26		0.34		0.28		0.28		0.32		
Difference (effect size)	0.68	***	0.68	***	0.41	***	0.47	***	0.54	***	0.45	***	0.47	***	0.45	***	0.46	***	0.49	***	0.36	***	0.56	***	0.63	***	0.51
Low Ed	0.96		0.96		0.94		0.88		0.98		0.95		0.96		0.94		0.84		0.96		0.94		0.92		0.99		
High Ed	0.22		0.20		0.31		0.24		0.29		0.41		0.41		0.18		0.28		0.33		0.24		0.30		0.33		
Difference (effect size)	0.74	***	0.76	***	0.63	***	0.65	***	0.70	***	0.54	***	0.55	***	0.76	***	0.56	***	0.63	***	0.71	***	0.62	***	0.66	***	0.65
Blue-collar	0.78		0.73		0.84		0.67		0.80		0.74		0.87		0.75		0.77		0.88		0.70		0.70		0.88		
Skilled	0.27		0.30		0.32		0.21		0.30		0.36		0.49		0.25		0.24		0.33		0.25		0.28		0.32		
Difference (effect size)	0.51	***	0.43	***	0.52	***	0.46	***	0.51	***	0.38	***	0.38	***	0.50	***	0.53	***	0.54	***	0.46	***	0.42	***	0.57	***	0.48
Low practice	0.57		0.57		0.63		0.43		0.70		0.63		0.81		0.52		0.55		0.72		0.54		0.59		0.64		
High practice	0.30		0.36		0.39		0.27		0.36		0.41		0.48		0.27		0.32		0.35		0.31		0.36		0.40		
Difference (effect size)	0.27		0.22		0.24	*	0.17		0.33	**	0.22		0.33	***	0.25		0.23	*	0.37	***	0.22		0.23	*	0.24		0.26
Low earnings	0.78		0.63		0.75		0.59		0.78		0.80		0.83		0.66		0.79		0.80		0.59		0.72		0.77		
High earnings	0.24		0.31		0.24		0.19		0.25		0.26		0.52		0.18		0.21		0.34		0.20		0.21		0.23		
Difference (effect size)	0.54	**	0.32	**	0.51	***	0.39	***	0.53	***	0.55	***	0.32	***	0.48	***	0.59	***	0.46	***	0.39	***	0.52	***	0.54	***	0.47

Notes: For complete results see Table A2.
* p < .1, ** p < .05, *** p < .01

Table 1B. Summary of differences in adjusted probability points (effect sizes) of scoring at Level 2 or below in IALS between most advantaged (reference category) and selected disadvantaged categories associated with each determinant

	BE		CZ		DK		FI		DE		IE		IT		NL		NO		PL		SE		UK		US		Average
Older (56-65)	0.92		0.89		0.87		0.93		0.80		0.80		0.96		0.88		0.88		0.95		0.70		0.86		0.59		
Younger (26-40)	0.39		0.44		0.37		0.24		0.44		0.48		0.59		0.29		0.24		0.75		0.21		0.46		0.42		
Difference (effect size)	0.54	***	0.45	***	0.50	***	0.69	***	0.37	***	0.33	***	0.37	***	0.59	***	0.63	***	0.20	***	0.49	***	0.40	***	0.17		0.44
Women	0.52		0.57		0.39		0.28		0.50		0.52		0.65		0.31		0.22		0.83		0.25		0.51		0.26		
Men	0.48		0.56		0.49		0.45		0.50		0.55		0.69		0.44		0.38		0.81		0.31		0.51		0.49		
Difference (effect size)	0.04		0.01		-0.10	***	-0.18	***	0.01		-0.03		-0.04	**	-0.13	***	-0.16	***	0.02		-0.05		0.00		-0.23	***	-0.06
Immigrant	0.99		0.89		0.89		0.91		0.88		0.37		0.99		0.89		0.81		u.e		0.82		0.97		0.97		
Native	0.50		0.56		0.48		0.41		0.49		0.56		0.69		0.42		0.35		0.80		0.27		0.51		0.38		
Difference (effect size)	0.49	***	0.33		0.41	**	0.50	***	0.39	***	-0.19		0.30	***	0.47	***	0.46	***	–		0.55	***	0.45	***	0.59	***	0.40
Low SES	0.58		0.76		0.75		0.66		0.64		0.51		0.77		0.57		0.64		0.90		0.47		0.75		0.75		
High SES	0.26		0.30		0.24		0.17		0.29		0.37		0.38		0.21		0.18		0.51		0.14		0.20		0.25		
Difference (effect size)	0.32		0.46	***	0.51	***	0.50	***	0.35	*	0.14		0.40		0.36		0.46	***	0.39	**	0.33	**	0.55	***	0.50	***	0.40
Low Ed	0.97		0.95		0.96		0.96		0.81		0.95		0.98		0.94		0.95		0.99		0.85		0.90		0.99		
High Ed	0.16		0.23		0.18		0.12		0.21		0.19		0.32		0.14		0.11		0.49		0.10		0.19		0.24		
Difference (effect size)	0.81	***	0.72	***	0.78	***	0.84	***	0.60	***	0.76	***	0.66	***	0.81	***	0.84	***	0.50	***	0.75	***	0.71	***	0.75	***	0.73
Blue-collar	0.80		0.64		0.83		0.72		0.76		0.69		0.84		0.72		0.65		0.92		0.51		0.82		0.85		
Skilled	0.31		0.37		0.24		0.20		0.26		0.26		0.38		0.23		0.17		0.57		0.17		0.27		0.19		
Difference (effect size)	0.49	**	0.27		0.59	***	0.52	***	0.50	***	0.43	**	0.46		0.49	***	0.48	***	0.35	*	0.35	***	0.54	***	0.66	***	0.47
Low practice	0.64		–		0.71		0.68		0.63		0.72		0.83		0.68		0.56		0.87		0.51		0.74		0.77		
High practice	0.30		–		0.36		0.26		0.42		0.33		0.49		0.26		0.26		0.62		0.20		0.37		0.29		
Difference (effect size)	0.34		–		0.35	***	0.42	***	0.21	***	0.39	**	0.34	***	0.41	***	0.31	**	0.25		0.31	***	0.37	***	0.48	***	0.35
Low earnings	0.64		0.65		0.41		0.38		0.45		0.88		0.69		0.52		0.28		0.91		0.30		0.79		0.75		
High earnings	0.29		0.40		0.30		0.24		0.33		0.23		0.54		0.22		0.24		0.67		0.18		0.25		0.16		
Difference (effect size)	0.35		0.24		0.11		0.14		0.12		0.65	***	0.15		0.30		0.04		0.24		0.12		0.54	***	0.60	***	0.28

Notes: For complete results see Table A3.
* p < .1, ** p < .05, *** p < .01

Linear regression model

In a similar way to the preceding section, the following summarizes results of a linear regression model of the determinants of literacy proficiency that was applied to the IALS and PIAAC datasets. As above, results showing coefficients, design-based p-values and fit statistics are presented in Annex Tables A4 and A5.

The dependent variable is the ordinal and continuous measure of literacy proficiency that ranges on a scale from 0 to 500 points as discussed above. This allows for insight on the basis of a multivariate analysis into some of the factors that may be involved in the increase or decrease of proficiency along the entire continuum of literacy between 2012-2016 period and the 1990s. Predictors of proficiency included in the model are the same as those in the logistic regression model above including the choice of reference categories.

Tables 2A and 2B summarize the results in terms of effects sizes measured as the difference between predicted scores of two selected contrast categories, namely the reference category (usually the most advantaged) and another category reflecting the most pertinent disadvantaged category for that factor which applies across the majority of countries. Again, this produces an easy to interpret rank order and comparison of the most important predictors across countries and over time. Substantial effects are defined as those that are statistically significant at the .05 level and are near to at least 10 score points or higher.

It can be seen from Table 2A and 2B that the most important predictors of proficiency on the continuous scales ranging from 0 to 500 points are not necessarily the same as in the analysis presented in Tables 1A and 1B on the basis of the categorical scale defined as low (Level 2 or below) vs medium to high proficiency (Level 3 or above). Nevertheless, educational attainment remains one of the most substantial predictors in the majority of countries. It ranks first in 7 of the 13 countries, second in four countries and third (Finland) and fourth (Norway) in the remaining two countries. In PIAAC, the average effect size associated with educational attainment across countries is 34 points (ranges from 28 in Italy to 42 in the US), which means that adults who attained less than upper secondary score 34 points lower on average than adults who attained higher than upper secondary. Over time, the relative importance of education as a predictor of proficiency substantially declined in Belgium (effect size changed from 62 to 40 points), Finland (39 to 26), Ireland (44 to 33), Italy (62 to 28), Norway (44 to 19), Poland (58 to 38) and the US (66 to 42). In most countries, this is due to a substantial increase in the average score of the lowest educated. For the US this improvement is only marginal, but there is also a substantial drop in the average score of those who completed higher than upper secondary, which in turn substantially reduces the effect size associated with education. It should be noted however that the effect size for education in the US was among the highest in IALS and remains the highest of all the countries despite the substantial reduction.

The second most important predictor of proficiency on the continuous scale is immigration and language status. It is associated with an average effect size of 30 points across the countries if the Czech Republic and Poland are included but if the latter two countries are excluded due to having too few immigrants and thus unreliable estimates for immigrants, the average is closer to 38 points which is higher than the average effect size for educational attainment. In fact, immigration and language status ranks as the most important predictor in six countries including Belgium (effect size = 49 points), Denmark (42), Finland (51), Norway (40), Sweden (50) and the UK (33), which are all countries with significant and growing immigrant populations. Over time, the relative importance of immigrant and language status declined substantially in Belgium (74 to 49), the UK (68 to 33) and the US (67 to 29). This is due to substantial increases to the average proficiency score of foreign-born and foreign-speaking adults in each of those countries.

On average, SES origins (as measured by parents' education) ranks third in its relative effect on proficiency in PIAAC but this varies widely by country. The effect size is high in the US (26 points) followed by the UK (24 points), otherwise in other countries it is closer to the average of an effect size of 16 points. Over time the effect size has grown in Belgium (+8 points), Germany (+9 points), Ireland (+16 points), Italy (+6 points), Norway (+9 points) and the US (+7 points).

Age and occupation follow SES origins closely in the majority of countries and rank third and fourth on average as the most important predictors followed by earnings. Age is associated with an average score difference between the oldest and youngest adults of about 15 points. For occupation the score difference between those who are skilled and blue-collar workers is about 14 points on average. Similarly, the average score difference between low and high earners is about 12 points. Over time, age has become less important in Belgium (26 to 17 points), Ireland (16 to 6), Italy (32 to 13), Poland (38 to 6) and the UK (11 to 2) but more important in the US (from 2 to 7 points). Effect sizes associated with occupation remain similar for most countries over time. For earnings, the effect sizes increased substantially for Denmark (from -1 to 17 points), the Netherlands (x to 15 points), Norway (-3 to 15), Sweden (-2 to 10), but declined substantially in the UK (25 to 15) and the US (24 to 13 points). The latter results for the UK and the US appear to be driven by the relative decline in the average scores of the highest earners. Results for literacy practice at work and gender more or less mirror the results seen in Tables 1A and 1B.

Table 2A. Summary of differences in score points (effect sizes) in PIAAC between most advantaged (reference category) and selected disadvantaged categories associated with each determinant

	BE		CZ		DK		FI		DE		IE		IT		NL		NO		PL		SE		UK		US		Average
Older (56-65)	308		307		307		313		301		312		284		314		308		309		317		325		316		
Younger (26-40)(reference)	326		318		326		346		324		319		298		336		329		315		334		327		323		
Difference (effect size)	-18	***	-11	***	-19	***	-33	***	-23	***	-7	***	-14	***	-22	***	-21	***	-6	***	-17	***	-3	*	-7	***	-15
Women	322		318		325		348		325		317		299		335		327		318		332		328		324		
Men (reference)	326		318		326		346		324		319		298		336		329		315		334		327		323		
Difference (effect size)	-3	**	0		-1		2		1		-2		1		-1		-2		3	**	-2	*	0		1		0
Immigrant	277		314		284		295		297		289		271		299		289		341		284		294		294		
Native (reference)	326		318		326		346		324		319		298		336		329		315		334		327		323		
Difference (effect size)	-49	***	-5		-42	***	-51	***	-27	***	-29	***	-27	***	-38	***	-40	***	26		-50	***	-33	***	-29	***	-30
Low SES	313		309		311		329		310		300		284		324		312		300		321		303		297		
High SES (reference)	326		318		326		346		324		319		298		336		329		315		334		327		323		
Difference (effect size)	-13	***	-10	***	-15	***	-17	***	-14	***	-18	***	-14	***	-12	***	-17	***	-15	***	-13	***	-24	***	-26	***	-16
Low Ed	286		281		296		320		281		285		270		298		309		277		298		296		281		
High Ed (reference)	326		318		326		346		324		319		298		336		329		315		334		327		323		
Difference (effect size)	-40	***	-38	***	-30	***	-26	***	-43	***	-33	***	-28	***	-38	***	-20	***	-38	***	-36	***	-32	***	-42	***	-34
Blue-collar	314		307		308		332		309		310		288		324		309		297		323		315		307		
Skilled (reference)	326		318		326		346		324		319		298		336		329		315		334		327		323		
Difference (effect size)	-12	***	-12	***	-18	***	-14	***	-15	***	-9	***	-10	***	-13	***	-20	***	-18	***	-12	***	-12	***	-16	***	-14
Low practice	324		315		322		344		321		315		290		333		325		307		330		324		321		
High practice (reference)	326		318		326		346		324		319		298		336		329		315		334		327		323		
Difference (effect size)	-2		-4	***	-4	***	-2		-3	**	-4	**	-8	***	-3	**	-4	***	-8	***	-4	***	-3	**	-2		-4
Low earnings	313		311		309		333		312		300		290		321		314		305		325		312		310		
High earnings (rererence)	326		318		326		346		324		319		298		336		329		315		334		327		323		
Difference (effect size)	-13	***	-7	***	-17	***	-13	***	-11	***	-19	***	-8	***	-15	***	-15	***	-10	***	-10	***	-15	***	-13	***	-13

Notes: For complete results see Table A4.
* p < .1, ** p < .05, *** p < .01

Table 2B. Summary of differences in score points (effect sizes) in IALS between most advantaged (reference category) and selected disadvantaged categories associated with each determinant

	BE		CZ		DK		FI		DE		IE		IT		NL		NO		PL		SE		UK		US		Average
Older (56-65)	286		296		298		313		314		310		278		309		300		260		336		333		339		
Younger (26-40)(reference)	312		313		315		340		333		326		310		328		325		298		354		344		341		
Difference (effect size)	-26	***	-17	***	-17	***	-28	***	-19	***	-16	***	-32	***	-20	***	-25	***	-38	***	-18	***	-11	***	-2		-21
Women	312		315		319		350		336		335		315		339		334		293		355		355		355		
Men (reference)	312		313		315		340		333		326		310		328		325		298		354		344		341		
Difference (effect size)	1		2		4	***	10	***	3		9	***	5	*	10	***	9	***	-5	*	1		11	***	13	***	6
Immigrant	238		297		294		284		297		330		275		282		289		296		306		276		274		
Native (reference)	312		313		315		340		333		326		310		328		325		298		354		344		341		
Difference (effect size)	-74	***	-16	*	-21	***	-56	***	-35	***	4		-35	***	-47	***	-36	***	-2		-48	***	-68	***	-67	***	-39
Low SES	307		301		303		320		327		324		303		327		317		288		337		324		323		
High SES (reference)	312		313		315		340		333		326		310		328		325		298		354		344		341		
Difference (effect size)	-5		-12	***	-12	***	-20	***	-5		-2		-8		-2		-8	***	-10	**	-17	***	-20	***	-19	***	-11
Low Ed	257		272		281		301		303		282		249		326		281		240		316		304		276		
High Ed (reference)	312		313		315		340		333		326		310		328		325		298		354		344		341		
Difference (effect size)	-55	***	-41	***	-33	***	-39	***	-30	***	-44	***	-62	***	-2		-44	***	-58	***	-38	***	-40	***	-66	***	-42
Blue-collar	304		311		302		327		313		311		305		326		312		295		341		326		320		
Skilled (reference)	312		313		315		340		333		326		310		328		325		298		354		344		341		
Difference (effect size)	-8		-2		-13	***	-14	***	-20	***	-15	***	-5		-2		-13	***	-3		-13	***	-17	***	-22	***	-11
Low practice	303		313		308		332		329		312		295		325		319		290		346		334		327		
High practice (reference)	312		313		315		340		333		326		310		328		325		298		354		344		341		
Difference (effect size)	-9	***	0		-6	***	-9	***	-3		-14	***	-15	***	-3		-6	***	-8		-8		-10	***	-15	***	-8
Low earnings	312		312		316		335		336		300		317		326		328		297		356		319		318		
High earnings (rererence)	312		313		315		340		333		326		310		328		325		298		354		344		341		
Difference (effect size)	0		-1		1		-5		3		-26	***	7		-3		3		-1		2		-25	***	-24	***	-5

Notes: For complete results see Table A5.
* p < .1, ** p < .05, *** p < .01

Structural model

Annex Table A6 summarizes the results of a structural model fitted to the datasets using maximum likelihood estimation along with a path analysis approach. Specifically, a Structural Equation Modelling (SEM) method of analysis, using the LISREL software was used to estimate the hypothesized structural models. For a full derivation of the LISREL model see Jöreskog (1969). Additionally, for a summary of the theory guiding the application of LISREL see Jöreskog and Sörbom (1990) as well as Tuijnman and Keeves (1997) who elaborate on the path analysis approach. In brief, Figure 4 depicted a simplified recursive path model on the basis of theoretical reasoning and previous research, but the standard procedure when fitting models is to initially allow all paths to be estimated. As a recursive model, causation is inferred in one direction only. Paths that are found to be insignificant at the .05 level are constrained in an iterative manner starting with the left most factors and proceeding to other factors in the order that are sequenced in the structure of the model. All final estimates are statistically significant at the .05 level. As with the logistic and linear models, sampling weights were applied when estimating the parameters.

Fit statistics suggest that the general structure of the hypothesized model fits all 13 countries for both the PIAAC and IALS datasets relatively well. Model fit is assessed in relation to criteria where the Goodness of Fit (GFI), and preferably the Adjusted Goodness of Fit (AGFI) index exceeds .9, the Root Mean Square Residual (RMR) is below .05, and the Root Mean Square Error of Approximation (RMSEA) is preferably below .08 but does not exceed .1 (see for example, Hoyle and Panter, 1995; Tuijnman and Keeves, 1997). Table A6 shows that the fit statistics meet standard criterion of fit for all countries or are very close which suggests that the hypothesized structural model is reasonable relative to alternative specifications. Moreover, while some of the specific paths differ from country to country and over time, the general hypothesized relationships among the major factors included are relatively consistent across all countries for both datasets.

All models were estimated using the same variables included in the logistic and linear regressions but with some adaptations to fit linear modelling requirements. Exceptions are as follows. A continuous version of education measured in years of schooling was used (Variable ‘a7’ for IALS and ‘yrsqual’ for PIAAC) instead of the categorical version. Similarly, a continuous version of reading at work was used which was the reading at work index included in both databases. For the Czech Republic, data on reading at work was not available in IALS. The strictly dependent variable is literacy proficiency on the continuous scale ranging from 0 to 500 (i.e. PVLIT1). All missing values were imputed using the multiple imputation procedure in SPSS. However, a missing value indicator was inserted into the structure to account for the

values missing by design, namely persons who were out of the labor force and had no information for the occupation, reading at work and earnings variables.

For this paper, only the standardized solution for the total, direct and indirect effects are presented in Table A6 which facilitates comparisons across variables and over time.

As can be seen from the results, educational attainment is the most substantial predictor on average. It ranks as the most important predictor in terms of its total effects in 9 of the 13 countries in PIAAC and in 11 out of 13 countries in IALS. On average, educational attainment has an effect size of .386 in PIAAC and .401 in IALS. This can be interpreted to imply that an educational attainment that is one standard deviation above the average can be expected to translate into a proficiency score that is approximately .4 of a standard deviation above the average. On average, about 60% of the total effect can be attributed to a direct effect on proficiency. Otherwise about 40% occurs via labor force participation and particularly occupational status. Over time, the effect sizes associated with educational attainment can be seen to be relatively stable in most countries although there are substantial changes in a few countries. In this analysis, the effect size is approximately .4 for the US in both PIAAC and IALS. This is in contrast to the logistic regression analysis which suggests a decline in predictive capacity because higher educated Americans have a higher probability to score at lower proficiencies in PIAAC than in IALS.

The second most important predictor on average is parents' education, and indicator of SES, but this varies across countries. It ranks as the first or second most important in 7 out of 13 countries in IALS but in 9 out of 13 in PIAAC. Otherwise, it ranks third in most other countries, and this is typically because immigrant and language status have a stronger relationship to proficiency in those countries. On average, only about 28% of the total effect of SES in IALS and 40% in PIAAC can be attributed to a direct effect of SES on proficiency. Otherwise, the effect of SES plays out through educational and occupational attainment. The sharp rise in the direct effect of SES from IALS to PIAAC is perhaps an indication that as educational systems are expanding access, they are having difficulties redressing socioeconomic inequalities emanating from the home background. This is apparent in the US, where the direct effect as a proportion of the total effect grew from about 36% in IALS to about 46% in PIAAC. Moreover, the total effect associated with parents' education increased for the US, from about .38 to .45, which is an indication that the predictive capacity of parents' education is increasing in the US. This is consistent with results from the logistic regression analysis probably because of the increased importance of the direct effect of SES. Otherwise, a primary motive to supplement the determinants analysis with structural estimates was to uncover patterns related to indirect effects.

For the remainder of the factors, there is an observed shift in their relative importance in many countries when comparing results from IALS and PIAAC. In IALS, occupation ranks as the third most important factor on average, but this shifted to the fourth most important factor in PIAAC. This is primarily because 'immigration and language status' is a relatively more important predictor in PIAAC for several European countries. In Sweden, for example, this is now the most important predictor and it ranks second or third for another 9 countries. It is the opposite for the US where immigration and language status are relatively less important as predictors in PIAAC compared to IALS. As can be seen from Tables A2-A5, this is primarily because immigrants have increased their probability of scoring at higher proficiencies relative to native-born and native-speaking Americans.

The importance of age as a predictor has declined somewhat from IALS to PIAAC, shifting from the fourth most important factor, on average, to the fifth most important. The average effect size also declined from about -.2 to -.14. In contrast, earnings increased in relative importance but on average this is a weaker predictor. The sharp increase for Sweden is notable but for some countries the effect size declined. For example, it declined in the US from about .15 to .10. This is primarily because higher earners in the US are more likely to score at lower proficiencies in PIAAC than in IALS (see Tables A2-A5).

Surprisingly, reading at work declined in average relative importance shifting from the seventh most important factor to the eight across countries. For example, for the US this factor ranked as the fifth most important in IALS, but its total effect declined from about .16 in IALS to .02 in PIAAC. According to the data (see Tables A2-A5), this is primarily because frequent readers at work in the US are now more likely to score at lower levels of proficiency and conversely less frequent readers are more likely to score at higher levels of proficiency.

Summary of results

The results across the different models are relatively stable and consistent in terms of overall patterns. However, specific findings vary, for example, in terms of the relative importance of predictors, but this is mostly as expected given the variations in measures and specifications across the models.

Not surprisingly, education stands out as being consistently one of the most important predictors across countries, over time and across models. In a few countries, immigrants whose native-language is different than the language of the test administered in IALS and PIAAC is substantially stronger. This is particularly, the case in countries that experienced rapid growth in immigrants in the interim period between IALS and PIAAC such as in Denmark, Norway and Sweden.

With some variation across countries and models, the other most important predictors are immigration, SES and occupation, and although the relative importance of age appears to be declining over time in most countries, it is still a substantial predictor in several countries (e.g., Belgium, Czech Republic, Germany, Denmark, Finland, the Netherlands and Norway).

On average, immigration comes out as a stronger predictor when the continuous scale ranging from 0 to 500 points is modelled as the dependent as compared to when a binary scale (Level 2 or below vs Level 3 or higher) is used. This is mostly because immigrants whose native-language is different than the language of the test administered tend to score on average across countries close to the lower end of Level 3 (i.e., just above 275 points) whereas native speakers tend to score on average across countries close to the upper end of Level 3 (i.e., just below 325 points). In other words, while many immigrants score at Level 2 or below, many also score near the lower threshold of Level 3, which reduces the probability of immigrants scoring at Level 2 or below. Nevertheless, the average score of immigrants is substantially lower than native speakers. Thus, in the predicted probability analysis (i.e. binary logistic regression), the effect size is not as large as in the predicted score analysis (i.e. linear regression).

Perhaps the most important nuance that emerges in comparing results across the different types of models, is the relative importance of parents' education, an indicator of SES, specifically for a few countries. In the predicted score analysis, immigration displays a greater effect size than SES in several countries, but this ignores the indirect effects of SES on proficiency. When the indirect effects of SES are considered as in the SEM analysis, SES becomes substantially more important in Ireland, Italy, the UK and the US. This is because the effect of SES on educational and occupational attainment, and in turn, proficiency, is rather substantial in those countries but suppressed by assumption in the predicted score analysis. In fact, according to the SEM analysis and when total effects are considered, SES becomes the most important predictor in both the UK and the US, although only marginally higher and not statistically significantly different than educational attainment. Moreover, the patterns reveal that the total effects associated with SES for Ireland, Italy and the US increased from IALS to PIAAC, and that this was driven by an increase in the direct effect of SES. The results are consistent with the predicted probability analysis, which also shows that the direct effect of SES increased substantially and significantly over time for Ireland and the US. Specifically, the difference in probability points of scoring at Level 2 or below between low and high SES adults increased from .14 to .45 in Ireland (+.31), from .39 to .47 (+.08) in Italy and from .49 to .63 (+.13) in the US.

Another worthwhile point to summarize is the apparent relative decline over time in the importance of occupation and reading at work but a slight corresponding increase in the relative importance of earnings. This is likely a reflection of the changing structure of the economy and corresponding work-related practices associated with different types of occupations. In other

words, the variation in literacy-related behaviors and proficiency within occupational and reading at work categories appears to have increased over time. This is not surprising for occupation since the categories, for example skilled vs blue-collar workers, are very broad and crude, and thus do not capture very well actual changes in specific work tasks or skills needed to perform those tasks. However, a puzzling finding for the US is that, workers who engage less frequently in reading at work are scoring significantly better in PIAAC vs IALS, while workers who engage more frequently in reading at work are scoring significantly worse in PIAAC vs IALS. Similarly, skilled workers in the US are scoring significantly worse in PIAAC vs IALS while blue collar workers are doing about the same.

Lastly, in both IALS and PIAAC, the weakest predictor across countries, over time and across the models is gender.

Macro-level analysis of relationship between structural changes and national literacy profiles

The analysis so far has focused on variations and results within countries at a micro level but in a comparative manner across countries which helps to contextualize results for a given country and enables insights into the underlying structure of determinants of literacy proficiency from a life cycle perspective. This section discusses changes to many of the determinants considered in the above analysis but at the country (or macro) level. The selection of variables follows from the determinants analysis at the micro level, which as discussed are thought to be some of the main factors that can have an impact on the development and maintenance of literacy. Thus, the purpose in this section is to analyze the relationship between national changes in literacy proficiency over time, and changes to national proportions of high skill jobs, proportions of educational qualifications, proportions of high and low skill immigrants, average levels of engagement in literacy practices at work, as well as proportions participating in adult education. This is helpful for ascertaining some of the underlying macro level reasons for observed changes to national skill profiles. Annex Table A7 summarizes the percent distribution of, and change in, socio-demographic and practice-oriented factors related to literacy proficiency over time between the PIAAC and IALS surveys.

As can be seen from Table A7, there were substantial increases to the proportion of higher level qualifications across all countries. For example, in Poland an additional 17.8% of the adult population aged 26-65 had attained a post-secondary qualification in PIAAC compared to IALS, and an additional 32.4% had attained secondary qualifications, which translates into a total increase in qualifications of 50.2 percentage points. For the US, the comparable increase was 9.3 percentage points. Similarly, there were substantial increases to the proportion of higher level qualifications among parents across all countries. For the US, the proportion of adults who at least one parent who had attained an upper secondary or post-secondary qualification increased by 8.7 percentage points while those who had neither parent who had attained an upper

secondary decreased by a corresponding 8.7 percentage points. Participation rates in adult education also increased substantially in most of the countries. For example, in the US, proportion of adults who reported that they participated at least once in an activity considered to be adult education in the 12 months preceding the survey increased by 16.9 percentage points.

In terms of the occupational structure of economies, all countries experienced an increase in the proportion of skilled workers except Sweden which declined by 3.3 percentage points. In the US, the increase was 13.9 percentage points. Interestingly, however, reading at work declined in 9 out of 12 countries, increasing only in Ireland, the Netherlands and Poland. For the US, persons who reported engaging in at least two types of reading activities at work per week declined by 4.7 percentage points. According to the data, a comparable figure was decrease as high as 10 percentage points in Finland.

The table also summarizes changes to the immigration and language profile of countries over time. According to the IALS and PIAAC datasets, there was an increase in the proportion of foreign-speaking adults in all countries except the Czech Republic. For the US, the corresponding increase was 1.5 percentage points which is less than half of the 3.7 percentage points increase in all immigrants. Nevertheless, for the US there was a 2.5 percentage point increase in the proportion of immigrants who scored at Level 2 or below. All other countries except Poland had increases to the proportion of immigrants who scored at Level 2 or below.

Figures 5 to 10 show the results of correlation analyses conducted between each of the macro level changes and the changes the proportion of adults who score at Level 3 or higher. Measurement error and the associated attenuation bias which biases correlations toward zero is not accounted for. Furthermore, a multivariate analysis does not produce any meaningful results due to the low sample size (i.e. n=13) as well as the high variation in the bivariate relationships for each of the variables which is driven by outliers as can be seen from each of the figures below.

It can be seen from Figure 5 that the correlation between higher qualifications and an improvement in national literacy profiles is strong at .65. This is expected from the micro level analysis which confirmed that qualifications are one of the most important predictors of literacy proficiency. However, while all countries experienced substantial increases to the proportion of adults with higher level qualifications, this did not translate into higher proportions of adults who score at Level 3 or higher in all countries. In particular, Denmark, Italy, Norway, Sweden and the US, all boosted their qualifications but experienced declines in the proportion of adults who scored at Level 3 or higher. In fact, only a few countries are driving the correlation at the macro level, particularly the Czech Republic and Poland who invested heavily in higher education. Thus, the micro level results for the education and proficiency relationship do not aggregate well, which is an indication that qualifications per se do not always contribute to literacy proficiency

as would be expected. This is perhaps related to educational quality, or alternatively skill loss for adults who attained higher qualifications but are not engaged in practices on a recurring basis over their lifespan to maintain or develop their literacy proficiency.

In a similar fashion, Figure 6 shows a high correlation between higher levels of qualifications among parents and an improvement in national literacy profiles (r = .48), which follows from the micro level analysis, but this does not translate into higher proportions of adults who score at Level 3 or higher in all countries. This is particularly the case in the Denmark, Norway, Sweden and the US. Again, this is perhaps an indication of educational quality or skill loss as above, but also perhaps a reflection of the relative nature of socioeconomic positionality in a given society. In other words, as the proportion of higher qualifications continue to increase, the relationship between qualifications and access to advantaged contexts to practice and further develop literacy may become weaker and other markers of positional competition may strengthen such as the type and quality of education or alternatively the extent and quality of networks.

As shown in Figure 7, the relationship between adult education and changes to national literacy profiles is weaker (r = .31). This is not surprising since adult education has a confounding relationship with literacy proficiency. Namely, adults with weak proficiency stand to benefit from participating such as in basic skills programs, but also those with stronger proficiency are much more likely to participate in adult education on a recurring basis. Accordingly, as countries boost initiatives and programs to target the low skilled, the relationship may become flatter but in theory this should still help to boost overall national literacy profiles. An alternative explanation is that the nature and content of much of adult education activity may have a weak relationship to literacy related practices.

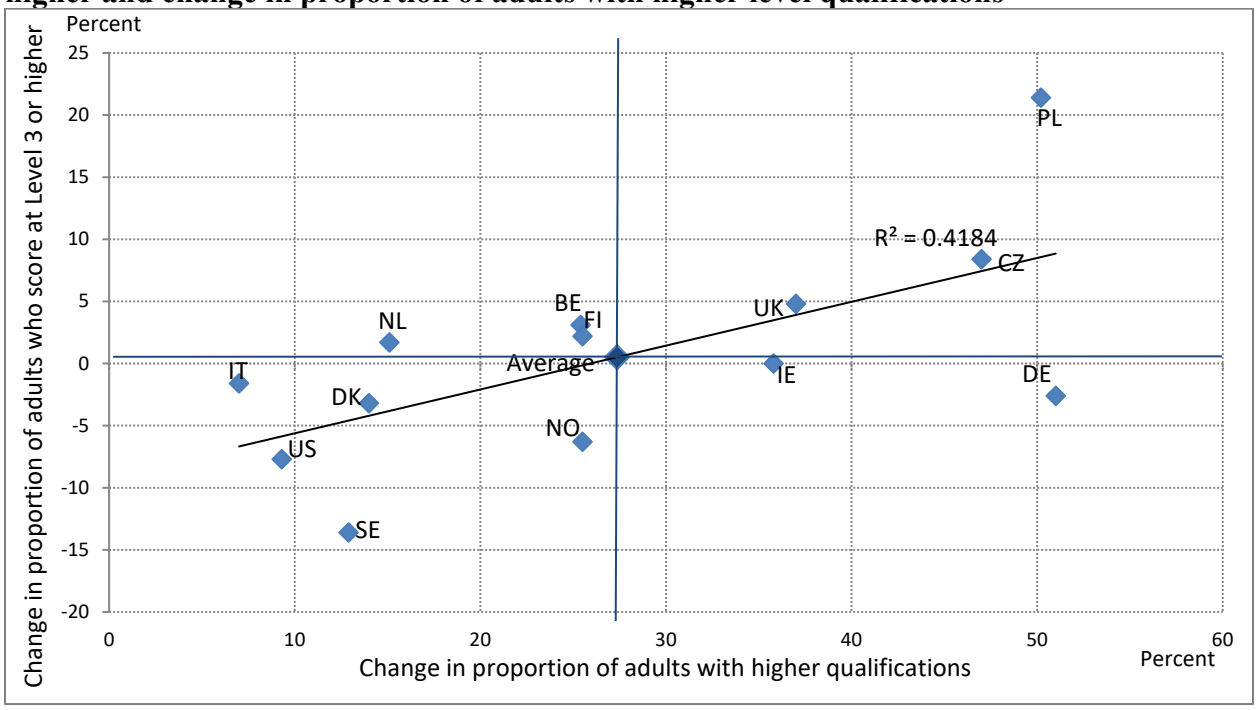
Not surprisingly, Figure 8 shows a strong negative relationship between increases in the proportion of foreign speakers and increases in the proportion of adults who score at Level 3 or higher (r = .63). Nevertheless, a few countries who experienced a relatively substantial increase in the proportion of foreign speakers did not experience any decline in the proportion of adults who score at Level 3 or higher, namely Ireland, the Netherlands and the UK. In the case of the US, while the increase in foreign speakers is consistent with a decline in the proportion of adults who score at higher levels of proficiency, the increase in foreign speakers is significantly lower than the increase of adults who score at lower levels of proficiency.

Figure 9 shows a weak relationship between the strong growth of skilled occupations such as managers, professionals, and associated professionals and the proportion of adults who score at Level 3 or higher (r = .19). This is consistent with the micro level results which showed a decline in the predictive capacity of occupation but in a similar fashion is puzzling since a growth in

these kinds of jobs should lead to an increase in opportunities for adults to maintain and continue to develop their proficiency over the life cycle.

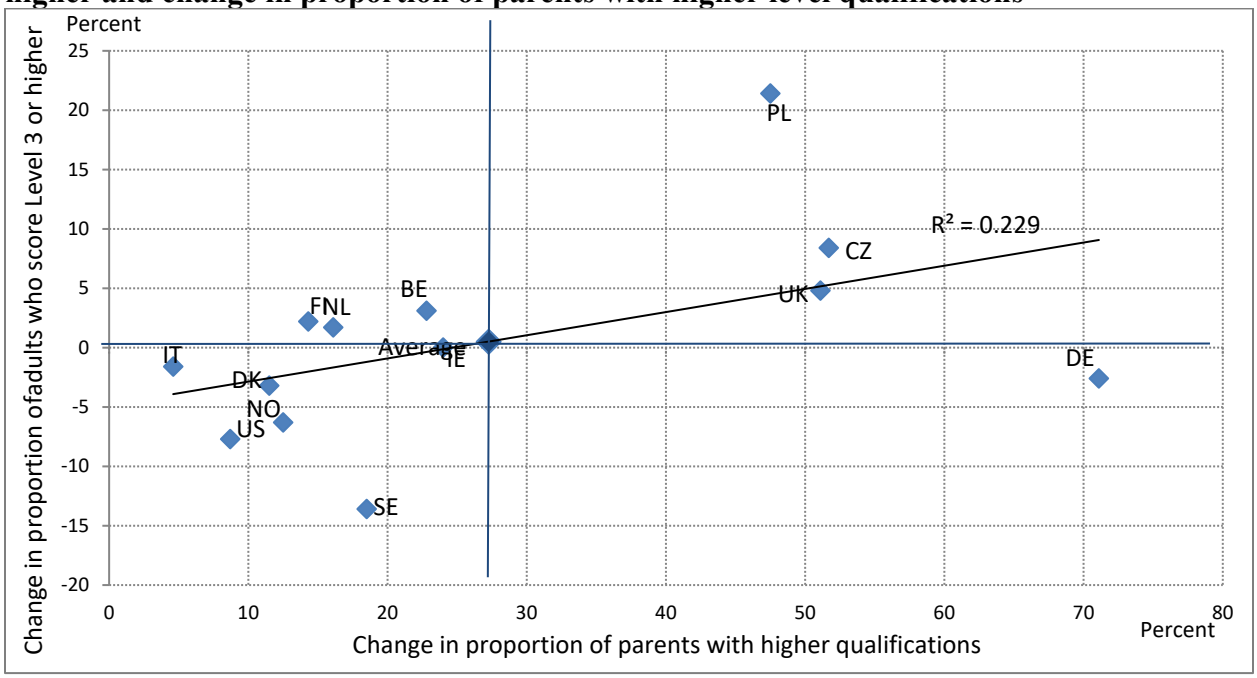
Lastly, Figure 10 shows a positive relationship between changes in reading practices and the national literacy profile ($r = .5$), however, this is primarily driven by Poland. Otherwise, most other countries experienced a decline in reading at work, and despite this some experienced increases to the proportion of adults with higher proficiencies (e.g. Finland).

Figure 5. Correlation between change in proportion of adults who score at Level 3 or higher and change in proportion of adults with higher level qualifications



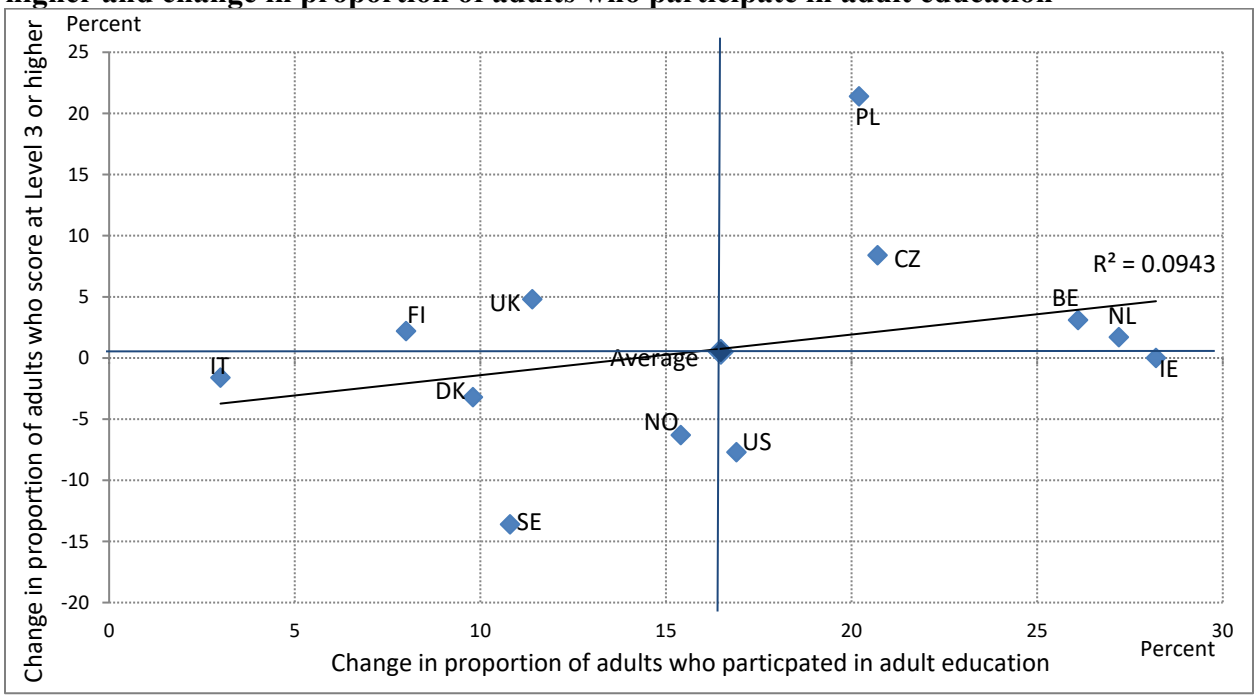
Notes: Correlation = .65.

Figure 6. Correlation between change in proportion of adults who score at Level 3 or higher and change in proportion of parents with higher level qualifications



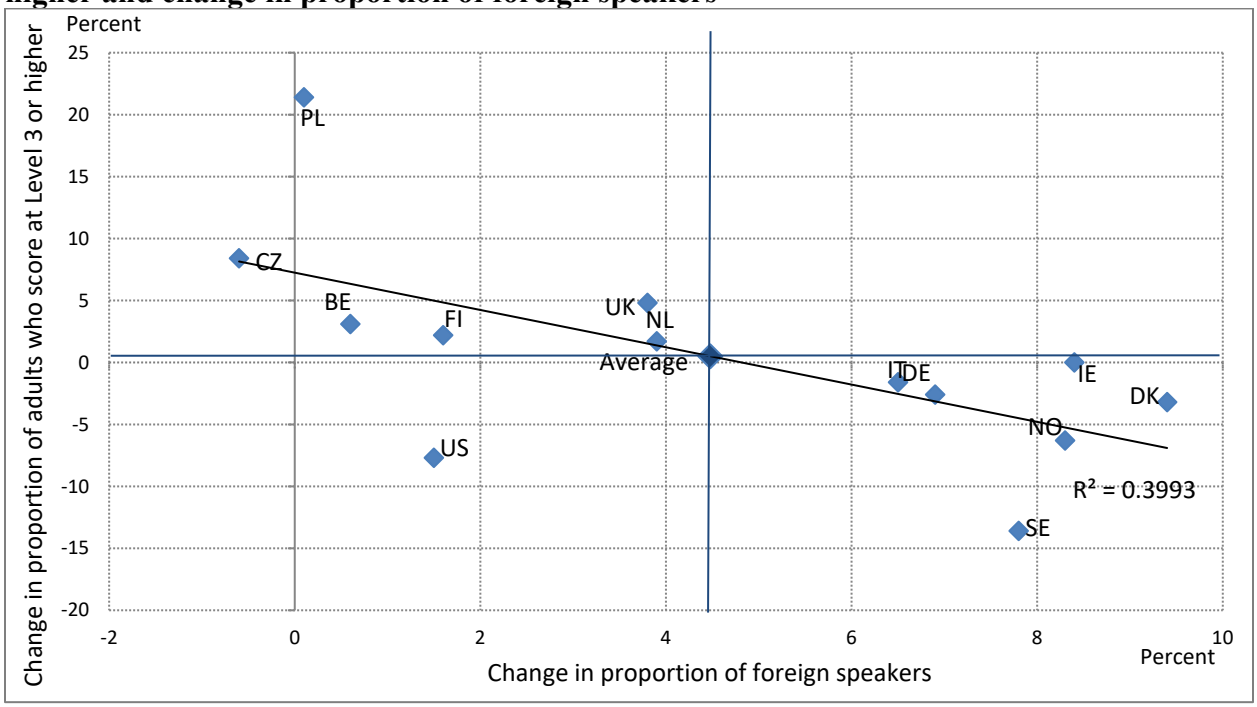
Notes: Correlation = .48.

Figure 7. Correlation between change in proportion of adults who score at Level 3 or higher and change in proportion of adults who participate in adult education



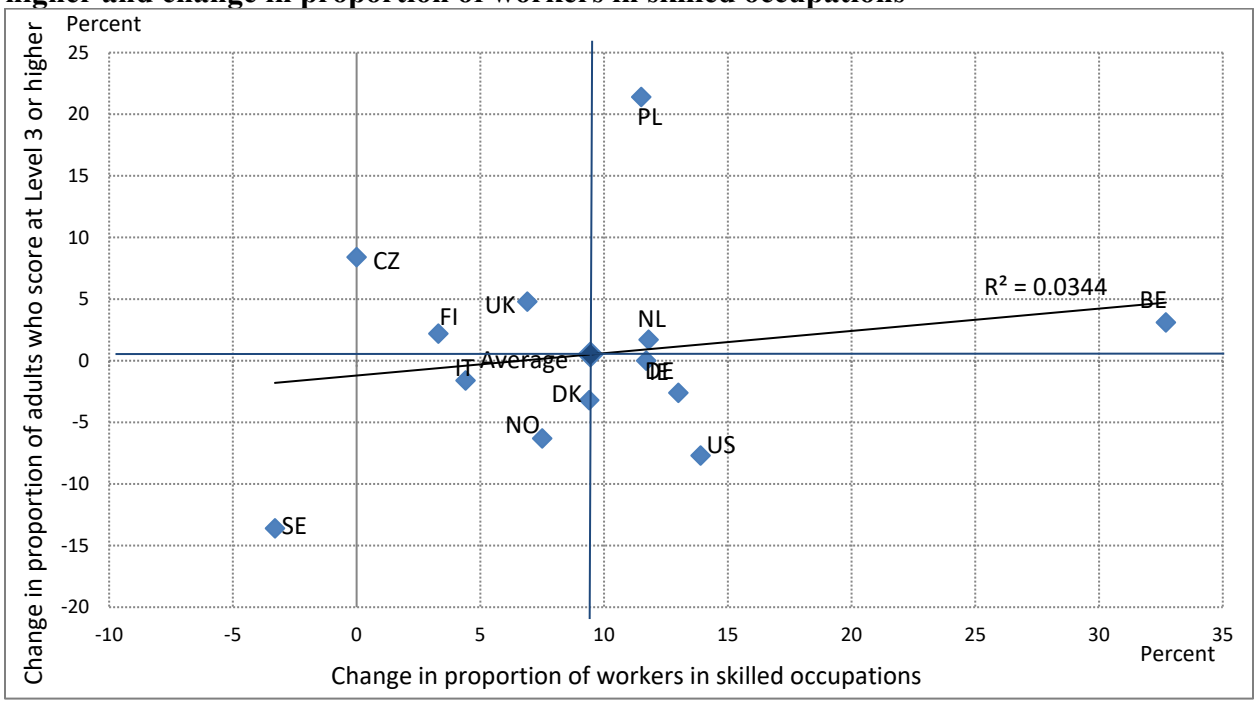
Notes: Correlation = .31.

Figure 8. Correlation between change in proportion of adults who score at Level 3 or higher and change in proportion of foreign speakers



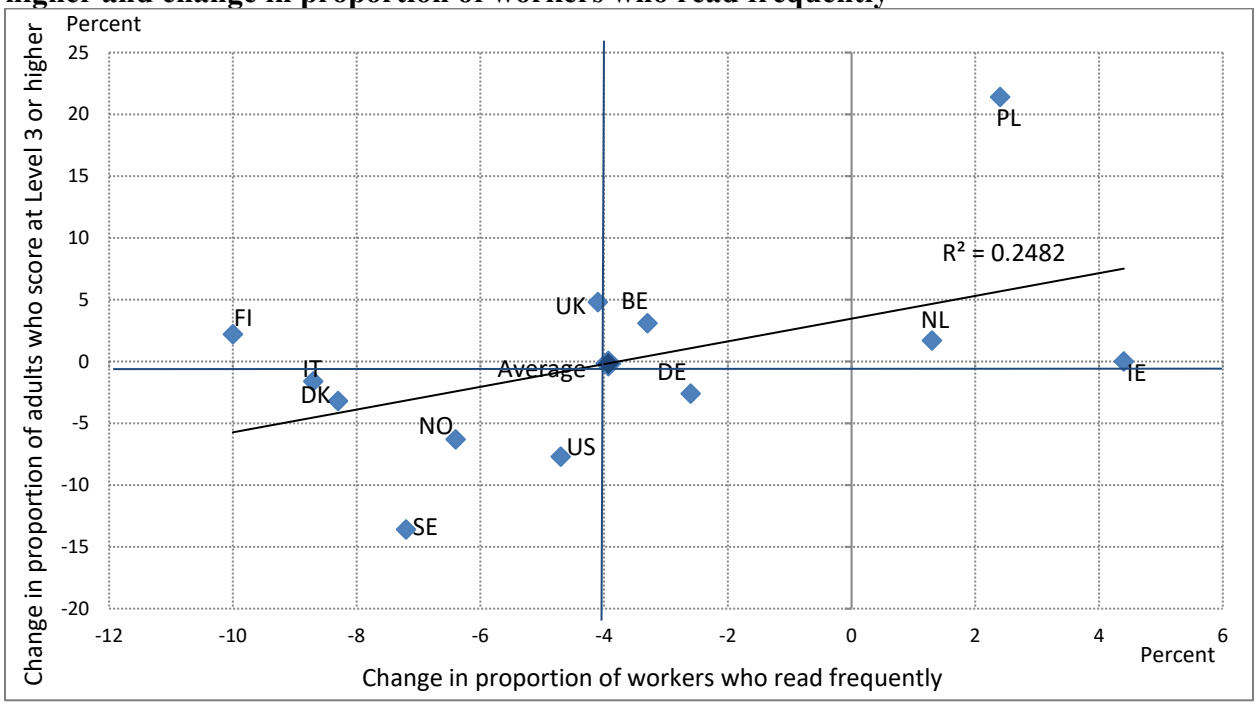
Notes: Correlation = .63.

Figure 9. Correlation between change in proportion of adults who score at Level 3 or higher and change in proportion of workers in skilled occupations



Notes: Correlation = .19.

Figure 10. Correlation between change in proportion of adults who score at Level 3 or higher and change in proportion of workers who read frequently



Notes: Correlation = .5 (.28 without Poland).

Discussion and implications

This paper has sought to revisit the determinants of literacy proficiency conducted in Desjardins (2003) from different perspectives and on the basis of different techniques. There are two underlying motivations for doing this. First, is to make use of data made available by PIAAC and IALS and to establish a comparative overview of the 13 countries that participated in both studies, and for which their data was made available. Second, is to consider why national literacy profiles have stagnated or failed to improve in a number of countries despite the substantial growth in qualifications and skilled occupations in those same countries. The latter are some of the most significant determinants of literacy proficiency at the micro level. Accordingly, a reasonable expectation from a policy and practice perspective is that investment in education and growth in the economy in favor of occupations requiring higher level of cognitive skills, would improve the overall national profile. However, the findings and analysis presented in this paper do not support this expectation suggesting on the basis of evidence that micro-level relationships and results do not necessarily aggregate into macro-level relationships and results. This is an indication of the importance of carefully assessing micro-level statistical results, no matter how rigorous they may be, within a macro level framework of analysis incorporating logical and structural forms of comparison.

While structural changes to the immigration and language profile of countries help to account for this contradiction between micro and macro level results, the evidence suggests that such changes are not sufficient to explain the stagnation and decline of literacy proficiency at a macro level. This is particularly the case for countries that experienced significantly worse literacy profiles in PIAAC vs IALS (see Figure 2), namely Norway, Sweden and the US. As was seen in Figure 2, Norway and Sweden experienced substantial declines in a uniform manner across the distribution. Declines at the lower end are consistent with the substantial increase of immigrants in those countries who are typically disadvantaged in terms of literacy proficiency in the local language but declines in the middle and upper end appear to be related to declines in proficiency among advantaged categories such as those with higher levels education, higher levels of SES, and who are in skilled occupations. Patterns for the US are similar but there is less change to the lower end of the distribution. This is partly because the US had substantially fewer immigrants who score at lower levels of proficiency than in Norway and particularly Sweden (see Table A7). Instead, the sharp drop in proportion of adults who score at Level 3 or higher in the US (-9%) appears to be driven as in Norway and Sweden by declines in proficiency among advantaged categories. Additionally, however, the declines are accompanied by fall in some of the disadvantaged categories, in some cases exacerbating inequalities. This is apparent for Norway and Sweden in the case of immigrants but in the US, this appears to be concentrated among lower SES categories. Specifically, the decline in average scores of adults for whom neither parent completed upper secondary, an indicator of lower SES, is sharper than the decline of those

for whom at least parent had completed post-secondary education, an indicator of higher SES, leading to a net increase in the impact of SES in the US. A similar pattern can be seen for Sweden and to some extent Norway, but this is more attenuated.

The results suggest that educational and occupational quality may be an issue which could partly explain why micro-level results do not necessarily translate into macro level results. In other words, there is increasing variation in proficiency among advantaged categories such as higher-level qualifications and skilled occupations, particularly as these become more prevalent or saturated. Moreover, this increased variation may be related to SES whereby advantaged SES plays an increased role in the positional competition for quality education and quality jobs. For the US, the overall increase in the predicative capacity of parents' education, an indicator of SES, combined with the rise in the direct effect of SES from IALS to PIAAC is an indication that as educational systems are expanding access, they are having difficulties redressing socioeconomic inequalities emanating from the home background. In other words, educational systems are becoming more stratified according to socio-economic background. The decline in the indirect effect of SES via occupation may suggest a similar phenomenon in relation to skilled occupations.

In relation to the occupational structure of the economy, however, the results suggest other possibilities such as changes to the literacy related practices involved among skilled occupations. This is consistent with the overall decline in the predictive capacity of occupation in a number of countries. However, a puzzling finding is that direct measure of literacy related practices is also associated with a decline in predictive capacity in most countries. One interpretation is the possible deskilling of many occupations previously considered to be skilled. This brings into question the rejection of Braverman's deskilling hypothesis. In a book entitled *Monopoly and Labor Capital: The Degradation of Work in the 20th Century* (1974), Braverman questioned the notion that upskilling goes hand in hand with technological progress. Instead, he suggested that it will lead to deskilling. He noted the division of work tasks, stronger control by the employers through scientific management resulting in de-qualification, and the use of computer technologies to routinize and mechanize non-manual work. Despite intense debates among scholars, evidence regarding tendencies for deskilling or upskilling remains ambiguous. This is partly due to varying understandings of skills and considerable variation in the way the demand for skill has been assessed. While there is little evidence of widespread deskilling as postulated by Braverman, deskilling cannot be ruled out. It is likely that some deskilling is occurring as technological change affects production and work processes. It may even be happening just enough to offset otherwise expected improvements over time in literacy skill profiles at the country level.

An alternative interpretation of this result is that the measures of literacy related practices made available in PIAAC and IALS are insufficient for predicting proficiency. For example, the measures of literacy practices in PIAAC and IALS can only detect frequency and variety, but not intensity and criticality. The latter are likely to become more important for interpreting variations in proficiency in the future, particularly as the high-skill sector continues to increase in several advanced industrial countries. A recommendation is therefore to encourage the development of more reliable and complex measures of literacy related behaviors as part of future rounds of PIAAC. Arguably, the same attention should go into producing such measures and scales as the measure of literacy proficiency, particularly if there are deskilling processes that are emerging in different economies.

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