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Literacy and Numeracy Proficiency in IALS, ALL and PIAAC

Marco Paccagnella

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Education Working Paper No. 142

By Marco Paccagnella

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

Marco Paccagnella, Analyst, Directorate for Education and Skills (Marco.Paccagnella@oecd.org)

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LITERACY AND NUMERACY PROFICIENCY IN IALS, ALL AND PIAAC

Abstract

This paper analyses proficiency in literacy and numeracy in the countries that have participated in the International Adult Literacy Survey (IALS, administered between 1994 and 1998), the Adult Literacy and Life Skills Survey (ALL, administered between 2003 and 2007) and the Survey of Adult Skills (PIAAC, administered in 2012). While many countries experienced small to modest changes in literacy proficiency between IALS and PIAAC, others saw sizeable variations, mostly on the negative side. In the shorter span that separated ALL and PIAAC, numeracy proficiency clearly declined (except in Italy), while literacy moved less on average (except for the large increase registered in Italy and the large decline experienced by Norway). Changes in the composition of the population have had little impact on observed changes in scores. Larger variations took place within different socio-demographic groups, but these tended to cancel each other out on aggregate. In particular, large variations are observed by age and levels of education. Older adults in PIAAC are generally more proficient than their IALS counterparts, probably due to the increase in educational attainments that took place over recent decades. On the contrary, tertiary-educated individuals appear to be on average less proficient than in the past, which may signal that the expansion of tertiary education has been accompanied by a decline in the average quality of university graduates (or of university instruction). There is also no evidence that the change in delivery mode, with a switch to a computer-based assessment in PIAAC, had any significant effect on performance. However, the OECD is unable to ascertain how differences in implementation and technical standards affect the comparability of the data, so that a certain degree of caution should always be exercised in interpreting these results. Amongst the countries that experienced larger changes in literacy proficiency between surveys, a close inspection of IALS data (in particular through an investigation of response patterns at the item level) highlights some anomalies in Italy and Poland (and, to a lesser extent, in England and Northern Ireland), suggesting that particular caution should be exercised in interpreting the evolution of proficiency in these countries.

Résumé

Ce document analyse les compétences en littératie et en numératie dans les pays qui ont participé à l'Enquête internationale sur l'alphabétisation des adultes (EIAA, administrée entre 1994 et 1998), à l'Enquête sur la littératie et les compétences des adultes (ELCA, administrée entre 2003 et 2007) et à l'Enquête sur les compétences des adultes (PIAAC, administrée en 2012). Alors que dans de nombreux pays le changement du niveau de littératie entre l'EIAA et PIAAC a été faible, d'autres ont enregistré des variations notables, pour la plupart négatives. Dans l'intervalle plus court qui sépare l'ELCA et PIAAC, les compétences en numératie ont clairement décliné (sauf en Italie), tandis que les niveaux de littératie ont en moyenne enregistré de moindres variations (excepté une importante augmentation enregistrée en Italie et un déclin notable constaté en Norvège). Les modifications dans la composition de la population semblent avoir peu d'impact sur le changement dans les résultats entre les différentes enquêtes. De plus grandes variations ont eu lieu au sein des différents groupes socio-démographiques, mais ceux-ci ont tendance à s'annuler les uns les autres dans l'ensemble. En particulier, de grandes variations sont observées selon l'âge et les niveaux d'éducation. Les adultes plus âgés dans PIAAC sont généralement plus compétents que leurs homologues de l'EIAA, probablement en raison de l'augmentation du niveau d'instruction qui s'est opérée au cours des dernières décennies. Au contraire, les individus ayant un niveau d'instruction de niveau tertiaire semblent en moyenne moins compétents que dans le passé, ce qui pourrait indiquer que l'expansion de l'enseignement supérieur a été accompagnée d'une baisse de la qualité des nouveaux entrants à l'université (ou de l'enseignement universitaire). Il n'a pas été prouvé que le changement dans le mode de livraison de l'enquête, avec un passage à l'évaluation sur ordinateur pour PIAAC ait eu un effet

significatif sur les performances. Toutefois, l'OCDE n’est pas en mesure de vérifier comment les différences dans la mise en œuvre et les normes techniques affectent la comparabilité des données, de sorte que ces résultats doivent toujours être interprétés avec une certaine prudence. L’examen attentif des données de l'EIAA (en particulier grâce à une analyse des profils de réponse au niveau de l’item) dans les pays ayant connu les plus grandes variations dans les compétences en littératie entre les enquêtes, met en évidence certaines anomalies en Italie et en Pologne (et, dans une moindre mesure, en Angleterre et en Irlande du Nord), ce qui suggère que des précautions particulières doivent être prises dans l'interprétation de l'évolution des compétences dans ces pays.

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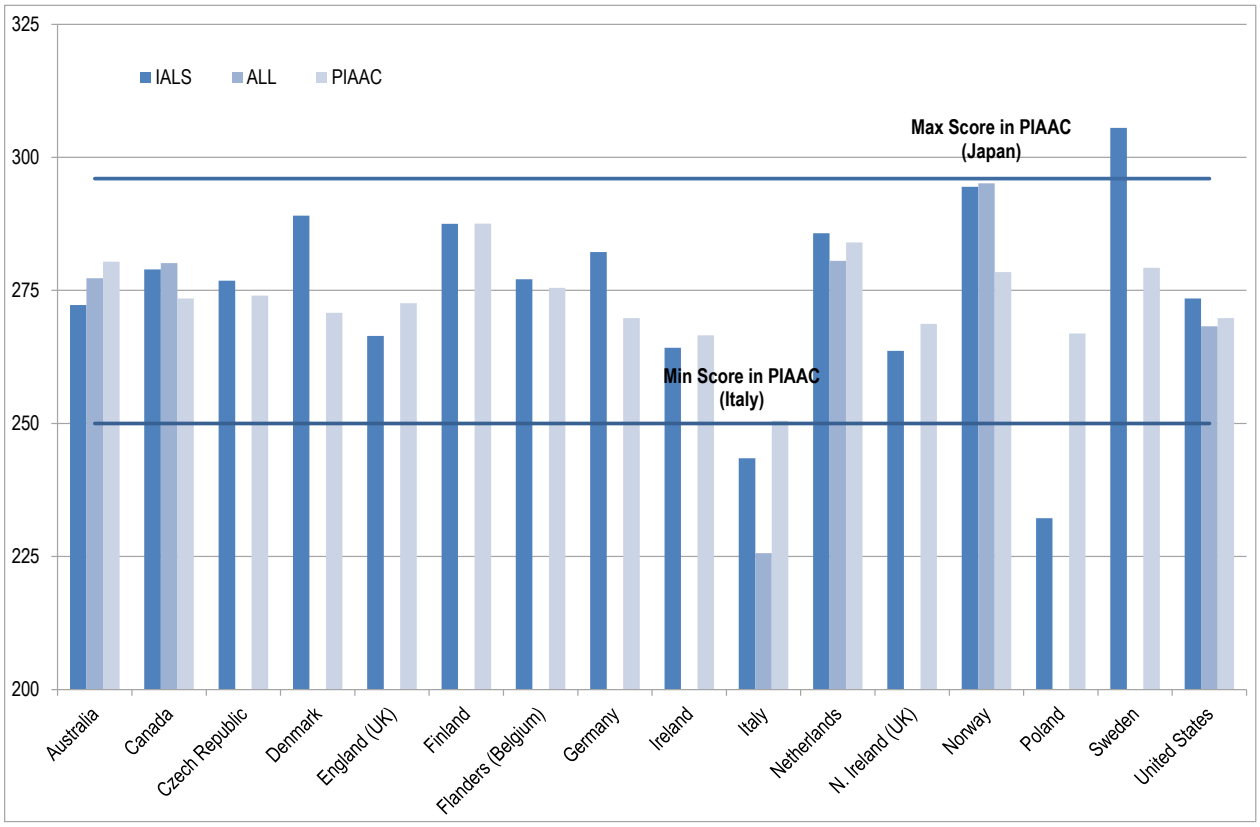
1. INTRODUCTION AND OVERVIEW OF MAIN FINDINGS

Prior to the Survey of Adult Skills (PIAAC), a number of OECD countries conducted two international assessments of adult skills: the International Adult Literacy Survey (IALS) between 1994 and 1998, and the Adult Literacy and Life Skills Survey (ALL) between 2003 and 2007. The Survey of Adult Skills was designed to be linked psychometrically with IALS and ALL in the domain of literacy, and with ALL in the domain of numeracy. The purpose of this paper is to briefly describe differences and similarities between the three surveys, focusing on the issues that have the potential to affect the comparability of results across surveys, and then to analyse, where comparable data are available, how measured proficiency changed between assessments.

This exercise is a first step in trying to understand how proficiency in information-processing skills evolves, both within single cohorts (age effects) and across generations (cohort effects). Understanding these effects is important for policymakers. Age effects are relevant in the context of the design of policies that aim to manage the impacts of age-related cognitive decline. Cohort effects are relevant in assessing change in the performance of the education and training systems.

Figure 1. Literacy proficiency in IALS, ALL and PIAAC



Source: International Adult Literacy Survey (IALS) (1994-1998), Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Figure 1 shows average scores in literacy for the countries that participated in the three surveys. To put numbers in perspective, two dashed lines report the minimum and the maximum literacy score measured in the Survey of Adult Skills, attained respectively by Italy (250 points) and Japan (296 points).

While the pattern varied between the countries that participated in PIAAC and one or both of IALS and ALL, the differences in literacy proficiency of the adult population between surveys were relatively small in scale in most cases. In seven countries (Flanders (Belgium), Canada, the Czech Republic, Finland, Ireland, the Netherlands and the United States) the change between IALS and PIAAC did not exceed ±5 score points, or around 10% of a standard deviation. However, some countries did experience quite large variations in average proficiency between IALS or ALL and PIAAC. Relatively large falls were seen in Denmark (-18 points from IALS to PIAAC), Germany (-12 score points from IALS to PIAAC), Norway (-17 points from ALL to PIAAC), and Sweden (-26 points from IALS to PIAAC). In Poland, average proficiency rose by 35 score points from IALS to PIAAC, which is equivalent to around 80% of a standard deviation. [1] Italy saw a large fall in average proficiency between IALS and ALL and an even larger rise between ALL and PIAAC.

Table 1. Literacy proficiency in IALS, ALL and PIAAC

National entities	IALS to ALL		ALL to PIAAC		IALS to PIAAC	
	Point change (standard error)	Standard deviation change	Point change (standard error)	Standard deviation change	Point change (standard error)	Standard deviation change
Australia	5.03	0.12	3.12	0.06	8.14	0.15
	(1.26)		*(1.14)*		*(1.40)*	
Canada	1.18	0.02	-6.63	-0.13	-5.45	-0.09
	(2.75)		*(0.89)*		*(2.73)*	
Czech Republic	-	-	-		-2.83	-0.07
					(1.43)	
Denmark	-	-	-		-18.25	-0.44
					(1.03)	
Finland	-	-	-		0.05	0.00
					(1.09)	
Germany	-	-	-		-12.39	-0.29
					(1.38)	
Ireland	-	-	-		2.33	0.04
					(3.37)	
Italy	-17.85	-0.31	24.86	0.43	7.01	0.12
	(2.53)		*(2.03)*		*(2.15)*	
Netherlands	-5.21	-0.12	3.47	0.08	-1.75	-0.04
	(1.31)		*(1.19)*		*(1.15)*	
Norway	0.64	0.01	-16.69	-0.39	-16.05	-0.36
	(1.39)		*(1.03)*		*(1.27)*	
Poland	-	-	-		34.71	0.59
					(1.26)	
Sweden	-	-	-		-26.31	-0.55
					(1.18)	
United States	-5.23	-0.09	1.56	0.03	-3.67	-0.06
	(1.95)		*(1.72)*		*(1.74)*	
Subnational entities						
Flanders (Belgium)	-	-	-		-1.61	-0.03
					(3.55)	
England (UK)	-	-	-		6.15	0.10
					(1.99)	
Northern Ireland (UK)	-	-	-		5.05	0.09
					(2.25)	

Source: International Adult Literacy Survey (IALS) (1994-1998), Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Table 1 reports the estimated changes (with their respective standard errors) across the different surveys, expressed both in terms of points and as standard deviation changes. We highlight in bolds variations that are statistically different from zero (at a 95% confidence level).

After a brief description of the three surveys, and a discussion of the comparability of results across them, the rest of the paper is structured in two Sections. The first is devoted to literacy proficiency as measured in IALS and PIAAC, and the second to proficiency in literacy and numeracy in ALL and PIAAC.

2. RELATIONSHIP OF THE SURVEY OF ADULT SKILLS WITH ITS PREDECESSORS[2]

Fifteen of the countries participating in the first round of the Survey of Adult Skills participated in IALS; six of them also participated in ALL (see Table 2). However, different countries participated in different surveys in different rounds, which makes comparisons over time and across countries more cumbersome.

Table 2. Participation of PIAAC countries in IALS and ALL

	IALS			ALL	
National entities	**1994**	**1996**	**1998**	**2003**	**2006-07**
Australia		X			X
Canada	X			X	
Czech Republic			X		
Denmark			X		
Finland			X		
Germany	X				
Ireland			X		
Italy			X	X	
Netherlands	X				X
Norway			X	X	
Poland	X				
Sweden	X				
United States	X			X	
Subnational entities					
Flanders (Belgium)		X			
England and Northern Ireland (UK)		X			

Source: International Adult Literacy Survey (IALS) (1994-1998), Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Constructs and instruments

It is possible to build links between different assessments in terms of the constructs measured and the content of the assessments instruments for Literacy, for which results can be compared across the three surveys, and Numeracy, for which only ALL and PIAAC can be compared. PIAAC conceived literacy more broadly than IALS and ALL, encompassing the domains of prose and document literacy (assessed separately in IALS and ALL); furthermore, in PIAAC literacy includes the reading of digital texts, in addition to the print-based used in the two previous surveys. Apart from these differences, there are many similarities in the definition of literacy, also in the light of the fact that 29 of the 52 literacy items included

in the computer-based version of the PIAAC literacy assessment (and 18 out of 24 in the paper-based version) were linking items, i.e. items that had been used for assessing prose and document literacy in IALS and/or ALL. The strongest link is between ALL and PIAAC: out of the 29 linking items, only 9 of them are in fact shared between IALS and PIAAC, and only 3 of them were administered to the entire sample of PIAAC respondents (i.e. in both the paper-based and the computer-based version of the assessment). The results for prose and document literacy from IALS and ALL have been combined and re-estimated, and only such re-scaled data can be compared with those from the Survey of Adult Skills.

The conceptualisation of numeracy in the Survey of Adult Skills is similar to that used in ALL, which replaced the quantitative literacy measured in IALS. Thirty of the 52 items included in the computer-based version of PIAAC were taken from ALL (19 out of 24 in the paper-based version). Also the numeracy results from ALL have been re-estimated and put on the same scale used in PIAAC.

Contrary to IALS and ALL, the Survey of Adult Skills was mainly designed as a computer-based assessment, with a pencil-and-paper option for respondents lacking sufficient computer skills. This difference in the delivery mode has the potential to negatively affect the comparability of results across surveys. Reassuringly, field tests conducted in 2010, which randomly assigned participants to either the computer-based or the paper-based version, failed to identify the presence of delivery-mode effects.

Comparability of background questions

In order to compare results for subgroups of the population, the definitions of the relevant subgroups must be consistent across surveys. This is generally the case when personal characteristics of the respondents are concerned, like language background, immigration status, labour force status, and so on. Where there are differences in response categories, appropriate derived variables were constructed.

Due to the revision of the International Standard Classification of Occupation (ISCO-08), adopted in 2007, comparisons between PIAAC and IALS and ALL can only be made at the one-digit level.

Comparability of implementation

Both the degree of standardisation of survey procedures and the effort put into monitoring compliance with these standards have been greater in the Survey of Adult Skills than was the case in either IALS or ALL. An external review of the implementation of the first round of IALS conducted in the second half of 1995 (Kalton, Lyberg and Rempp, 1998) concluded that, while there were no concerns regarding the development of instrumentation, “the variation in survey execution across countries is so large that we recommend that all comparative analyses across countries should be interpreted with due caution” (Kalton, Lyberg and Rempp, 1998, p. 4). In particular, while guidance on survey procedures was provided to the participating countries, the reviewers found that little was done to “enforce adherence to specific procedures” (Kalton, Lyberg and Rempp, 1998, p. 4). Quality-assurance procedures were subsequently improved for the second and third rounds of IALS (OECD/Statistics Canada, 2000, p. 129) and in ALL. The quality-assurance and quality control procedures put in place for PIAAC are among the most comprehensive and stringent ever implemented for an international household-based survey.

The extent of the differences between operational procedures and the extent to which compliance with these procedures was obtained in the different assessments is difficult to ascertain as is the effect, if any, on the results. A technical report covering the first wave of IALS was published in 1998 (Murray, Kirsch and Jenkins [eds], 1998). Some information on the implementation of the 2nd and 3rd rounds of IALS and the implementation of ALL is available in the methodological appendices of OECD/Statistics Canada (2000), OECD/Statistics Canada (2005), and OECD/Statistics Canada (2011). Technical reports covering the 2nd and 3rd rounds of IALS and the two rounds of ALL have not been released. The findings of a review of

IALS sponsored by the European Commission can be found in Bridgewood et al. (2000). Perhaps all that can be said is that, in line with the comments of the reviewers of the IALS data cited above, the possible variation in survey implementation between IALS, ALL and PIAAC mean that due caution should be exercised in interpreting observed differences in proficiency over time. By analysing the differences in literacy and numeracy proficiency as assessed in the three surveys, this paper also aims at providing indirect evidence about the likely robustness and reliability of such comparisons, hopefully contributing to a more informed analysis of such data by interested researchers in future studies.

3. FROM IALS TO PIAAC

Differences in the proficiency of the adult population at different points in time can be decomposed into changes in the proficiency of individuals with particular characteristics and changes in the relative size of different groups of individuals within the population. It is therefore useful to first look at the broad changes in the composition of the adult population observed between IALS and PIAAC, and then examine changes in proficiency within key population groups between IALS and PIAAC. Lastly, simple regression techniques allow the estimation of differences in proficiency between the two studies netting out the effect of changes in the composition of the population.

The changing composition of the underlying population

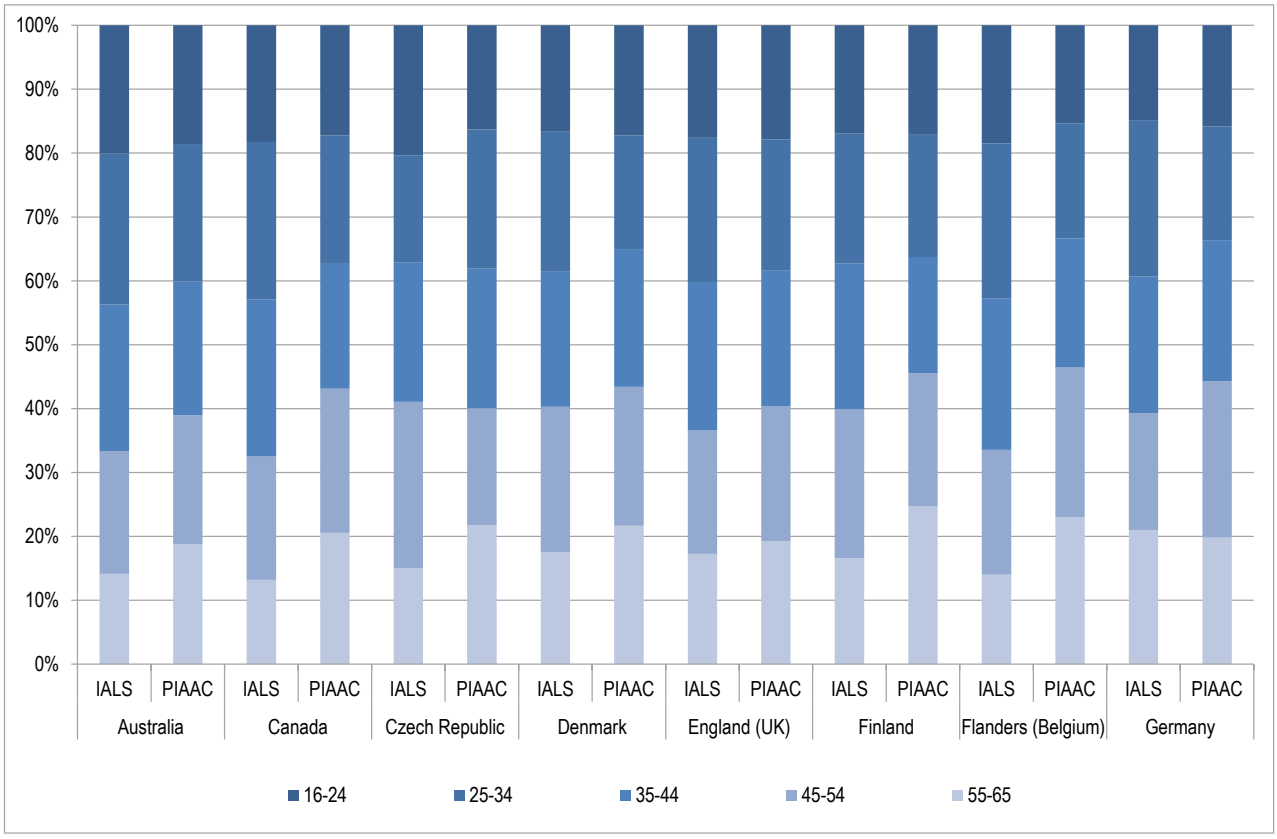
Literacy proficiency varies with socio-demographic characteristics such as age, immigration status and educational attainment. Changes in the composition of the population may therefore explain some of the changes in literacy proficiency observed over time in different countries. Population ageing and an increasing influx of immigrants into OECD countries, for instance, are potentially plausible explanations for the observed decreases in proficiency levels. On the other hand, higher levels of educational attainments (and, possibly, a higher quality of education) are likely to improve proficiency over time.

Population ageing

In the almost 20 years that passed between IALS and PIAAC, virtually all the countries under analysis experienced an increase in the age of their population. Figures 2 and 3 show the change in the distribution of the resident adult population across different age groups between the two surveys.

The share of individuals aged 55-65 years increased in all countries, with the exception of Germany. The share of individuals in the youngest age group, by contrast, decreased almost everywhere. An exception is the United States, where the share of 16-24 year olds increased, although by only 2 percentage points (from 16-18%). In Denmark, England, Finland, Flanders (Belgium), Germany, and Norway, the share of the youngest group remained rather stable. However, the share of individuals aged 25-34 years (the age group usually characterised by the highest levels of proficiency) increased only in the Czech Republic (by 5 percentage points), in Ireland (by less than 2 percentage points), and in Poland (by 1 point), and declined in all other countries (up to 7 percentage points in Flanders (Belgium), the Netherlands and Germany).

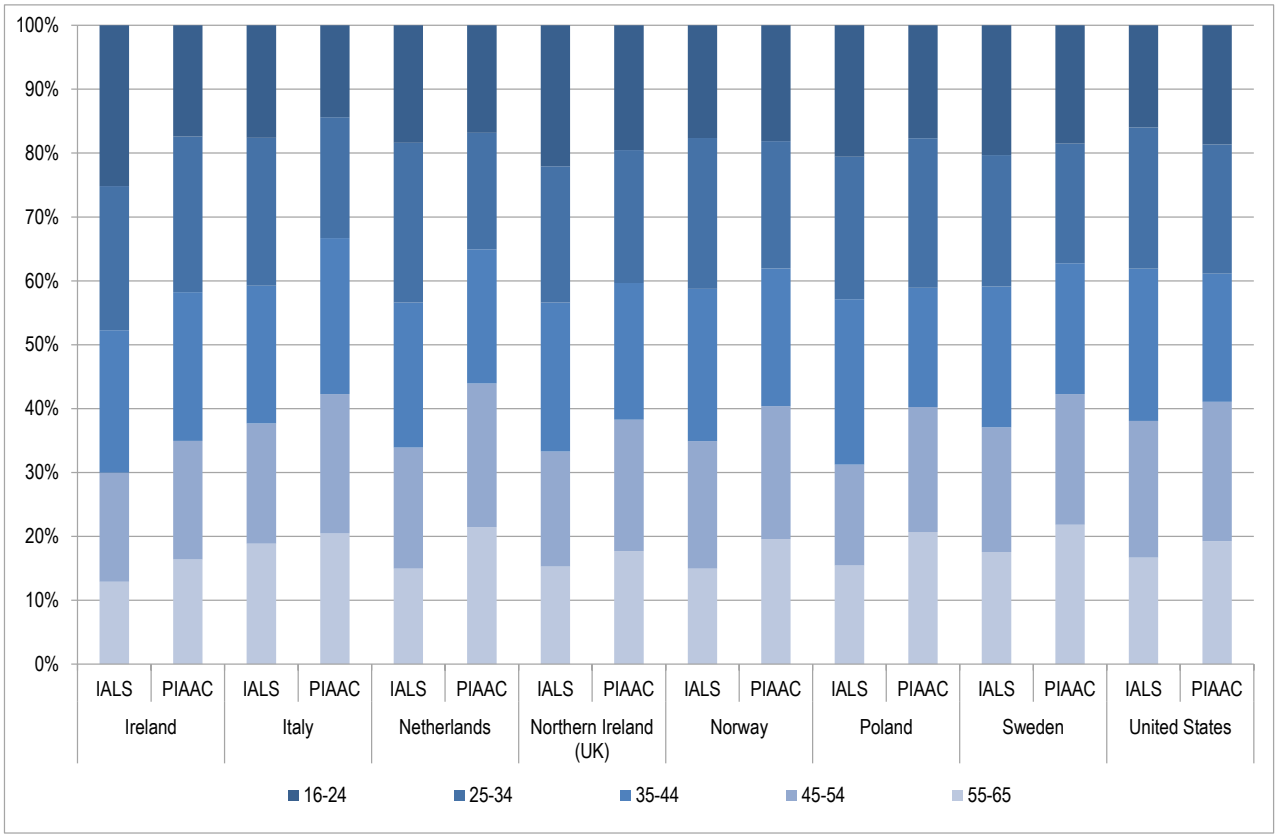
Figure 2. Age composition of the population in IALS and PIAAC (1)



Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Overall, the average age of the population increased in all countries; only in the United States the estimated change is not statistically different from zero. Aging was most pronounced in Canada (+2.5 years), Flanders (Belgium) (+3.5 years), the Netherlands (+2.8 years) and Poland (almost +2 years). However, it should be noted that, amongst the countries that participated in IALS, Poland was the one with the youngest population (37.9 years, on average, versus 40 years in Germany). In 2012 the Polish population was still relatively young, with an average age of 39.8 years. In a number of countries, the average age of the 16-65 year-old population was in excess of 41 years (Denmark, Finland, Flanders (Belgium), Germany and Italy).

Figure 3. Age composition of the population in IALS and PIAAC (2)

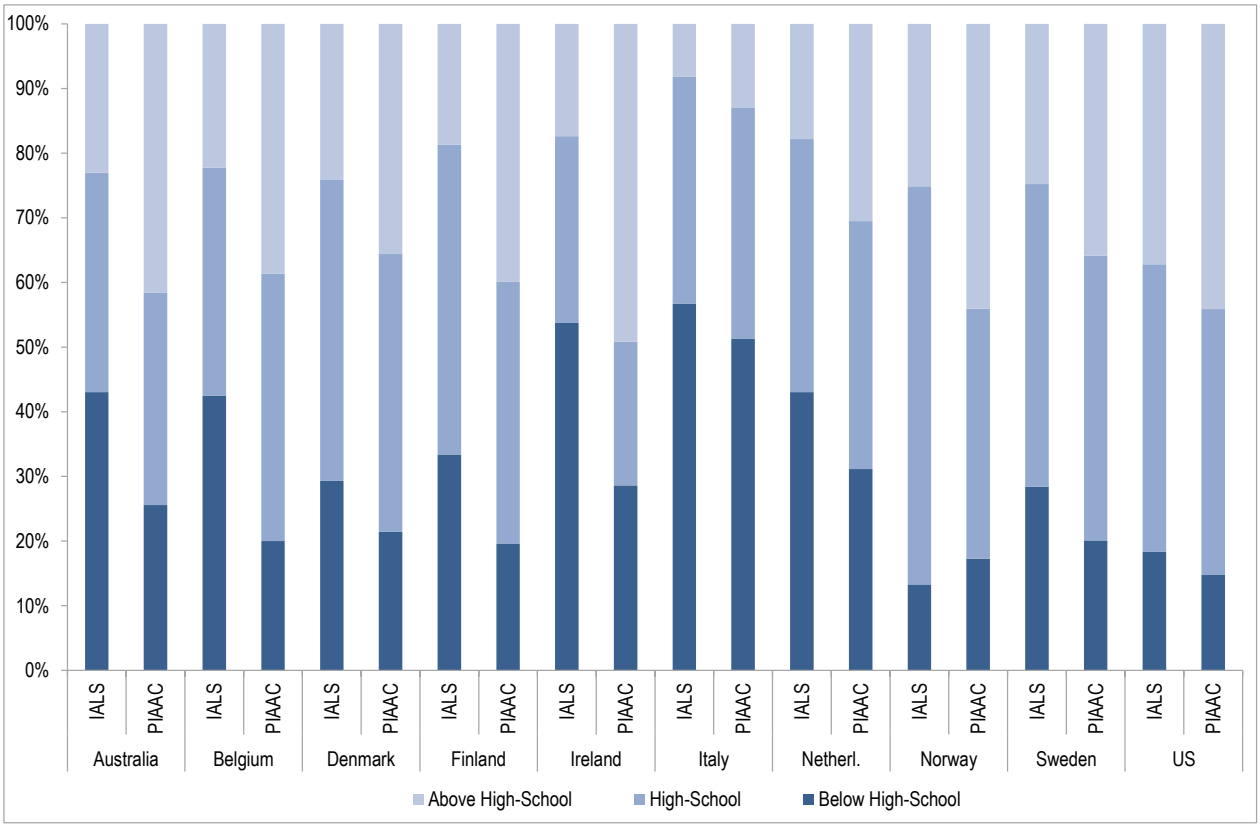


Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Educational attainment

As in the case of age, the level of educational attainment increased in most countries. The share of individuals with more than a tertiary qualification almost doubled, reaching 37% on average in 2012 (compared to 20% in 1994-98). Unfortunately, for four countries participating in IALS (the Czech Republic, Germany, Poland and the United Kingdom) information on the highest level of educational attainment in the IALS data base is unreliable (OECD 2013a; Gesthuizen et al., 2011). In particular, the share of individuals with less than a high-school degree is exceptionally high compared with other data sources. Figure 4 shows the distribution of the population by highest level of educational attainments, excluding these four countries.[3] As an alternative, it is possible to compare years of completed education which increased from 11.9 to 12.8, on average.[4] Denmark, Finland, Italy and the United States were the only countries in which completed years of education did not increase significantly. Large increases were recorded in Germany (2 years), Norway (2.3 years), Ireland (4 years) and Poland (1.5 years).

Figure 4. Composition of the population in IALS and PIAAC, by educational attainment



Source: International Adult Literacy Survey (IALS) (1994-1998) and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Foreign-born

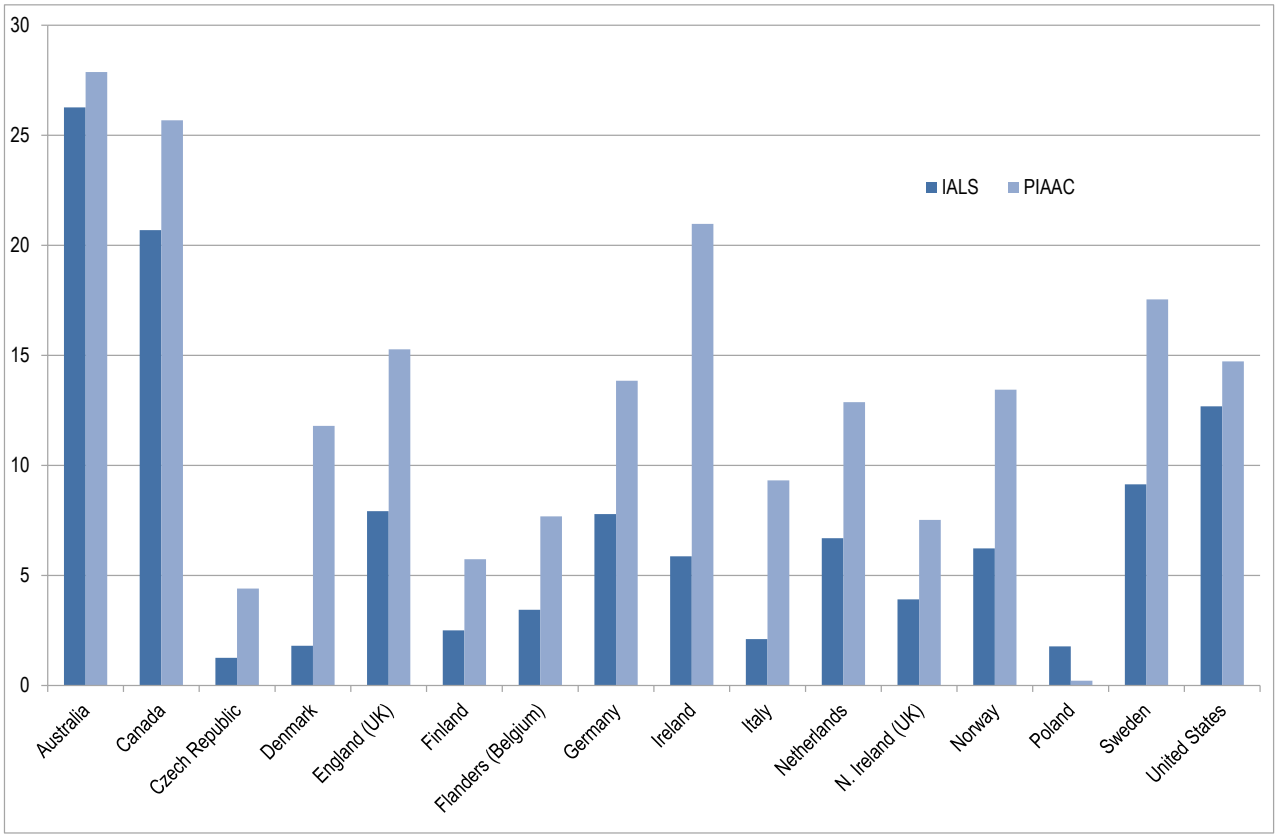
In recent decades, most OECD countries have experienced a large influx of migrants. As foreign-born adults often have lower proficiency in literacy than the native born (partly due to the simple fact that the language in which they took the test is not their mother-tongue), increases in the proportion of foreign-born adults are likely to influence negatively the average literacy proficiency of the population.

As shown in Figure 5, the share of foreign-born adults increased in all countries, with the exception of Poland (in Australia, the estimated change was not statistically different from zero). The magnitude of the increase was lowest in countries that had a large share of foreigners at the time of IALS (Australia and the United States, with Canada as a partial exception). A large increase in the share of foreigners was recorded in England, Italy, and Norway (7 percentage points in all of them), Denmark (10 percentage points), and Ireland (15 percentage points).

The increase in the immigrant population was also accompanied by changes in its composition. As far as age is concerned, there is no clear general pattern. Average age of foreign-born increased in Finland and in the Netherlands (by 6 years), as well as in Australia and Italy (by 3 years); it declined in Denmark (by 4 years), as well as in the Czech Republic and Poland (by 6 years). In terms of educational attainments, positive changes were recorded particularly in the Czech Republic, Ireland, Germany and Poland. In all countries (except Italy), the share of immigrants with a tertiary qualification increased substantially. Largest changes were recorded in Australia (37 percentage points), Canada (67 percentage points), and

Ireland (30 percentage points). However, Canada is also one of the few countries where also the share of immigrants without a secondary degree increased (by 10 percentage points). Italy and Norway stand out as the two countries that were least able to attract qualified migrants. Italy experienced both a decline in the share of tertiary-educated migrants (by 7 percentage points) and an increase in the share of individuals without a secondary degree (by 13 percentage points). In Norway, the first share increased by only 7 percentage points, while the latter increased by 6 percentage points. Years of education of immigrants increased also in the Czech Republic (+2.2), England (+0.7), Germany (+2.2), and Poland (+3.4); no significant change was instead recorded in Northern Ireland.

Figure 5. Share of foreign-born in IALS and PIAAC



Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

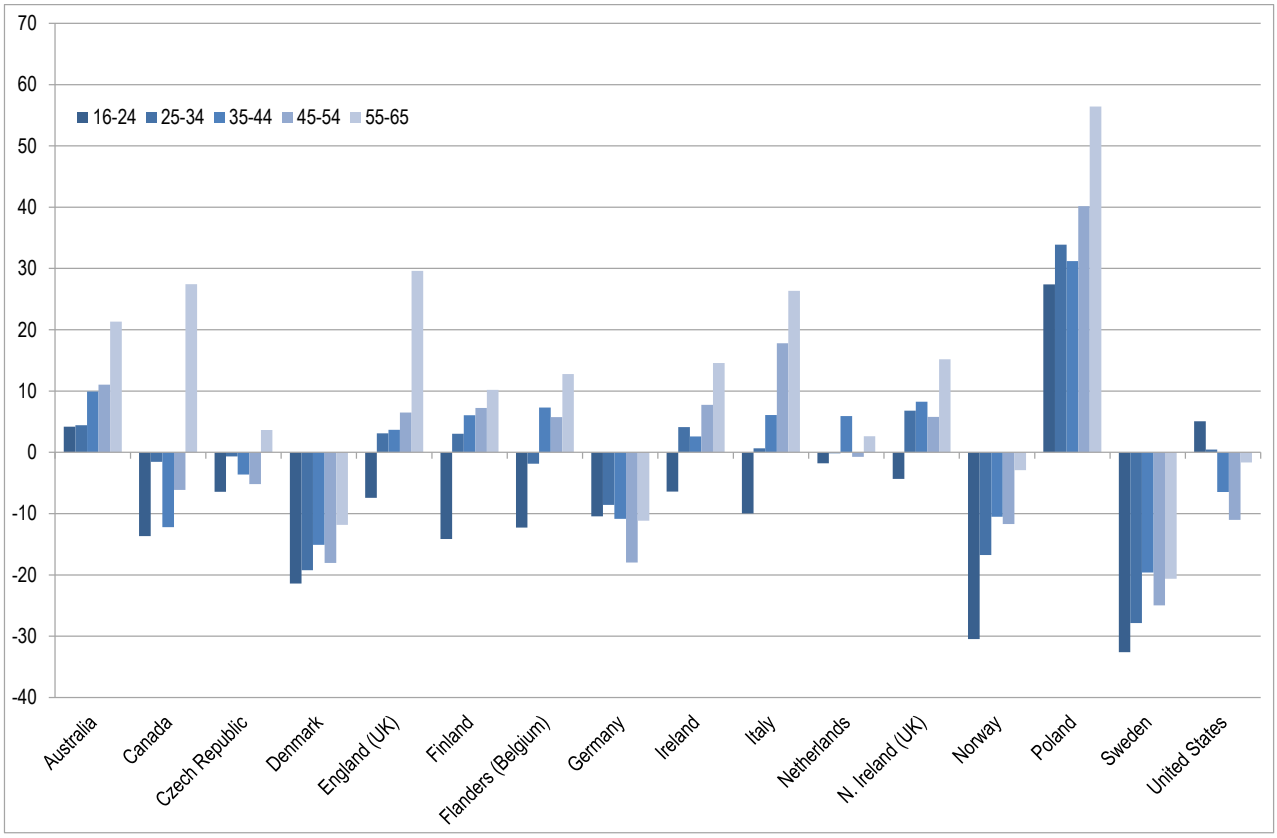
Within-group changes in proficiency

As noted above, country-level changes in proficiency are determined, other than by changes in the underlying population, by changes *within* the different subgroups in which the population can be partitioned. This section illustrates changes in proficiency observed between IALS and PIAAC by age, educational attainment and country of birth.

Figure 6 shows how literacy proficiency changed in different age groups. In most countries, the oldest age groups experienced the greatest gains (or the smallest losses) in proficiency, while the youngest groups experienced the smallest gains (or the largest declines). These patterns are consistent with the tapering off of the rate of increase in the levels of educational attainment over recent decades. The advantage in terms of completed years of education for adults assessed by PIAAC in 2011-12 over adults assessed in IALS between 1994 and 1998 is in fact greatest for the oldest age groups in all countries. In Norway, for

example, individuals aged 55-65 in 2012 have on average 3.5 years of schooling more than equally aged individuals in 1998, while the gain for the youngest age group amounted to less than one year. Other things being equal, proficiency growth is therefore expected to be higher (or the decline to be lower) among the older age groups, reflecting the greater improvement in their level of education relative to their counterparts in IALS.

Figure 6. Literacy proficiency in IALS and PIAAC, by age

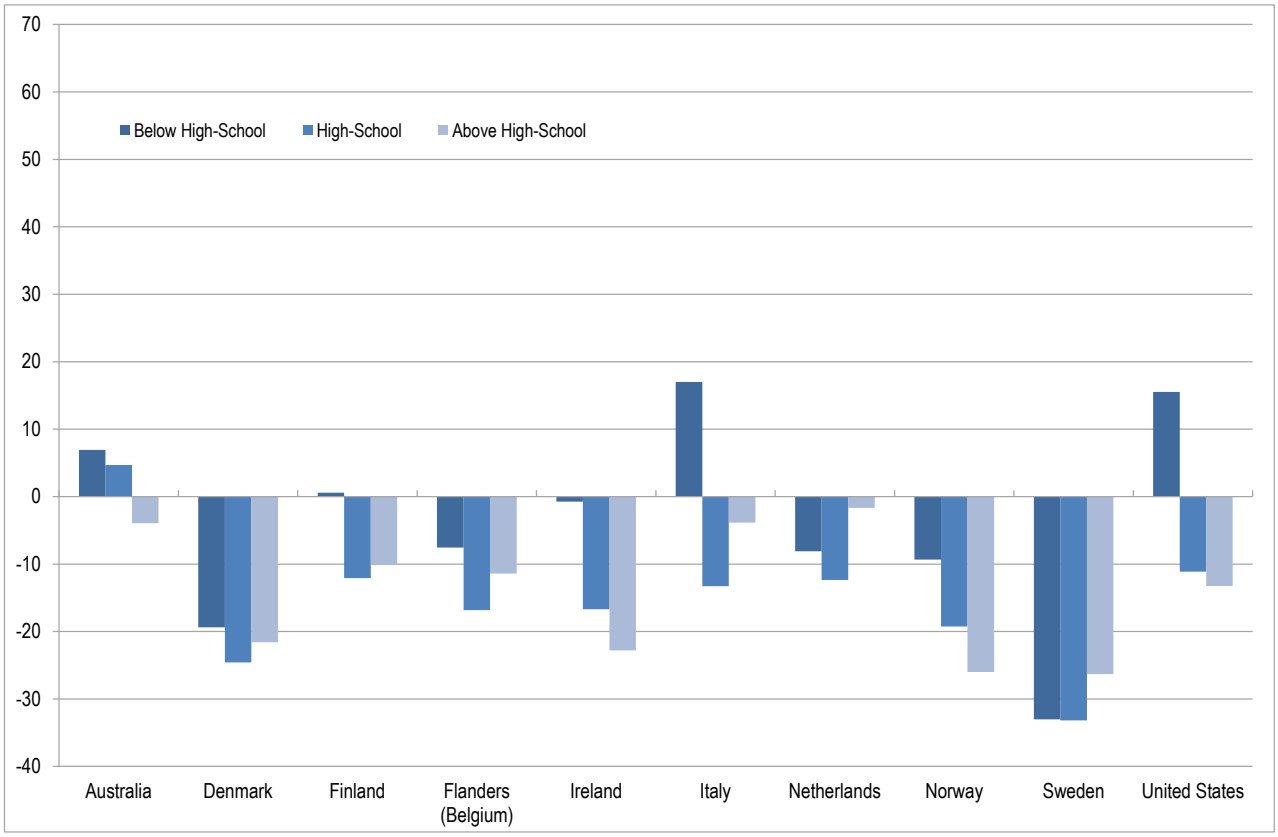


Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Figure 7 shows proficiency by levels of educational attainment (for the countries for which attainment data from IALS is reliable) in IALS and PIAAC. Individuals with an upper secondary or tertiary-level qualification performed worse in PIAAC than in IALS (with the exception of adults with upper secondary qualifications in Australia). The proficiency of adults with less than secondary level attainment increased or remained stable in 5 out of 10 countries. When it declined, it did so to a lesser extent than did the proficiency of adults with secondary qualifications (with Sweden being the exception).

These results could be interpreted in two ways. One interpretation could point towards an overall decline in the quality of formal education, i.e. in its ability to develop information-processing skills. On the other hand, it should be kept in mind that in the last decades average levels of education have increased considerably (in particular, the share of tertiary-educated individuals has grown, as displayed in Figure 4). This was probably accompanied by a widening in the ability range of individuals entering tertiary education, which could (partly) explain the decline in proficiency amongst the highly educated.

Figure 7. Literacy proficiency in IALS and PIAAC, by educational attainment



Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

A joint look at changes by age class and education offers an even more precise picture of the variation in proficiency over time. For this exercise, we restrict the sample to individuals above 25 (who are likely to have completed their education) and who are born in the country.[5]

Table 3 shows that in many countries the apparent decline in the literacy proficiency of tertiary-educated individuals between IALS and PIAAC is mainly concentrated among older individuals, while in the younger age classes more educated individuals performed better than individuals with lower levels of education. However, this is not the case in Finland, Sweden, and the United States, where the tertiary-educated performed worse along the entire age distribution.

When looking at the age dimension, the deterioration of proficiency of the youngest age classes appear to be concentrated primarily among the least educated (with the exception of Sweden and the United States, where only secondary-educated youngsters performed worse than older individuals).

An overall look at the analysis of changes in proficiency by age and education offers a rather gloomy picture. The strategy of increasing enrolment rates and the educational attainments of each generation of young people as a way of increasing human capital may be starting to display its limitations. While schooling continues to be a very strong predictor of literacy proficiency, there are signs that the ability of educational systems of improving proficiency is somehow deteriorating. The challenge ahead will therefore consist in improving the effectiveness of schools in transmitting literacy skills, and at the same time design institutions that can sustain proficiency along the entire life cycle of individuals.

Table 3. Literacy proficiency in IALS and PIAAC, by age and education (native born only)

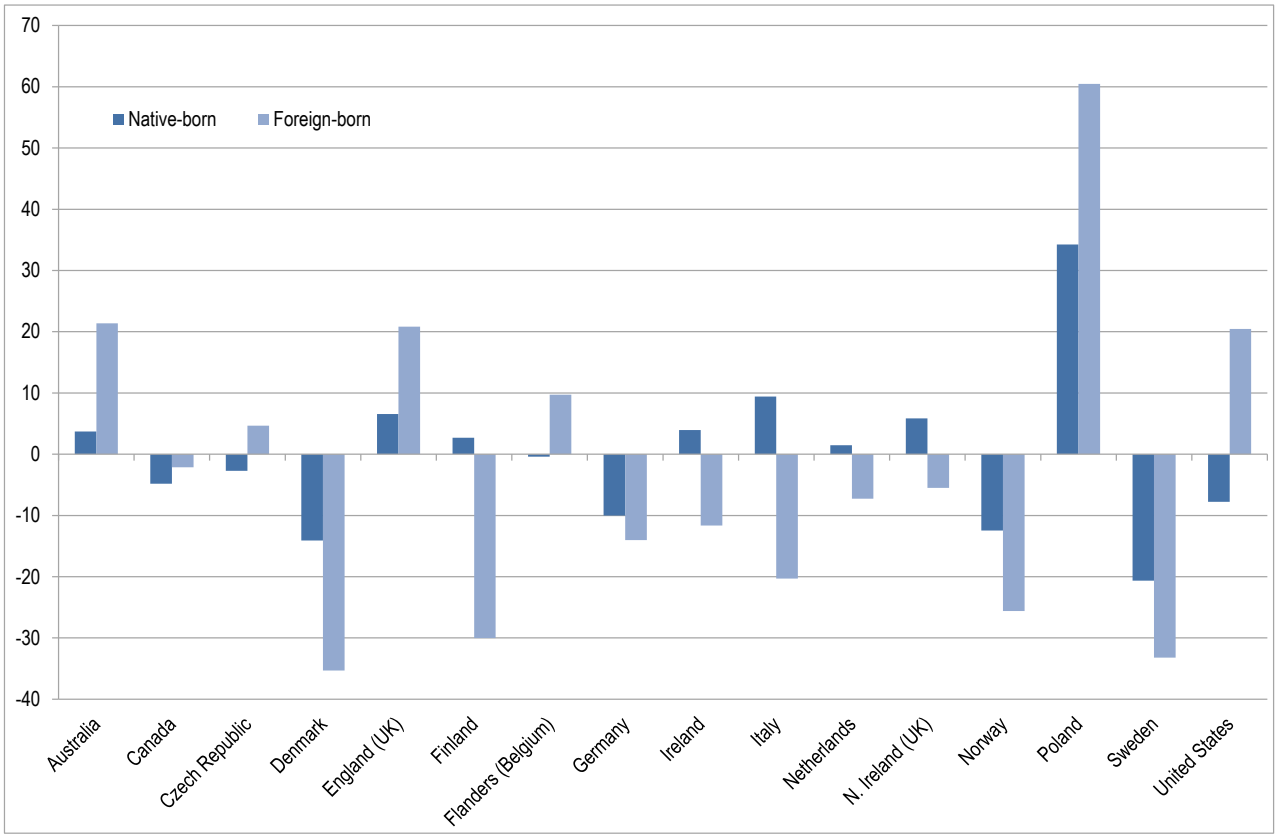
National entities	Age	Below High-School	High-School	Above High-School
Australia	25-34	-10.0	-6.2	-2.8
	35-44	-5.1	-7.6	-5.1
	45-54	-1.8	5.0	-8.2
	55-65	11.1	9.6	-8.4
Denmark	25-34	-18.0	-20.1	-14.1
	35-44	-32.1	-18.2	-12.4
	45-54	-14.5	-17.1	-20.4
	55-65	-13.8	-20.7	-20.9
Finland	25-34	5.4	-6.0	1.5
	35-44	10.6	-2.3	-3.0
	45-54	7.5	-8.1	-8.1
	55-65	8.7	-7.0	-14.5
Belgium	25-34	-19.1	-7.9	-9.4
	35-44	1.1	-11.5	-6.6
	45-54	-8.9	-13.9	-6.2
	55-65	8.0	-10.0	-6.4
Ireland	25-34	-7.6	-15.9	-5.1
	35-44	-13.5	-10.9	-25.8
	45-54	4.0	-13.4	-17.9
	55-65	15.4	-17.3	-33.2
Italy	25-34	2.6	-13.5	-3.8
	35-44	19.2	-5.0	-3.9
	45-54	24.1	-1.1	-2.3
	55-65	31.1	-2.7	-8.4
Netherlands	25-34	-8.5	-11.9	3.3
	35-44	-3.4	-5.4	7.6
	45-54	-2.9	-0.4	-4.6
	55-65	2.4	-9.6	-0.4
Norway	25-34	-19.8	-14.5	-15.2
	35-44	-19.2	-13.8	-14.5
	45-54	-4.5	-13.3	-19.4
	55-65	12.3	-12.6	-25.9
Sweden	25-34	-12.2	-28.7	-21.8
	35-44	-28.6	-19.6	-12.3
	45-54	-23.8	-26.5	-19.8
	55-65	-25.0	-24.5	-31.2
United States	25-34	11.0	-17.6	-11.4
	35-44	23.4	-16.6	-18.4
	45-54	9.3	-20.1	-18.6
	55-65	-1.8	-12.8	-16.8

Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

The pattern observed for natives largely reflects what is observed for the entire population (see Table 2). Figure 8 displays proficiency in IALS and PIAAC by place of birth. The picture is rather mixed. As a general pattern, the magnitude of the difference (positive or negative) in proficiency between IALS and PIAAC is larger for the foreign-born, undoubtedly reflecting a change in the composition of the

migrant population, for which the increases in migrant inflows are certainly responsible. However, the changes in proficiency of the foreign-born are estimated imprecisely. As a result of such uncertainty, estimated changes are not statistically different from zero in Canada, the Czech Republic, Flanders (Belgium), Ireland, the Netherlands and Northern Ireland. Foreign-born individuals were generally less proficient in 2012 than they were in the late nineties, but the opposite is true in Australia, England, Poland and the United States. The increase in proficiency of immigrants in such countries is likely driven by the fact that, as shown before, the level of education of foreign-born residents also increased between the two surveys. By the same token, the declines in proficiency observed in Denmark, Finland, Italy and Norway are consistent with the fact that years of education of the foreign-born declined (or at least did not improve) during the same period. However, in Canada, Germany and Ireland the increase in immigrants' levels of education did not translate into an increase in literacy proficiency.

Figure 8. Literacy proficiency in IALS and PIAAC, by place of birth



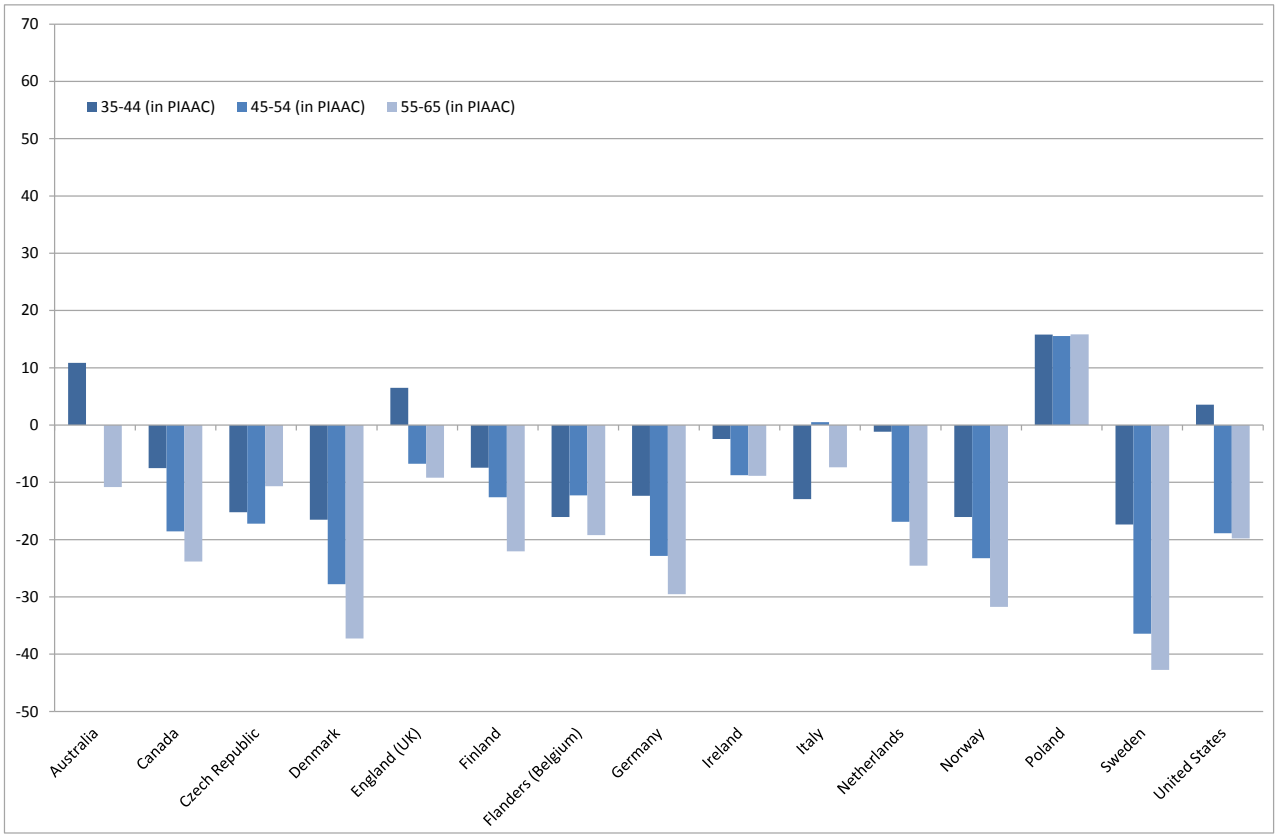
Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Analysing proficiency for different age cohorts allows for an investigation of how proficiency of the same group of individuals varied over time.[6] In particular, it is possible to select individuals in the three oldest age groups in PIAAC (35-44, 45-54 and 55-65 years of age), tracking them back to the age group they belonged to at the time IALS was administered (based on the year in which each country participated in IALS).

As a general pattern emerging from Figure 9, proficiency declined as the chosen cohorts aged, in particular for the two older cohorts. Poland is the exception. The observed decline is consistent with the hypothesis that cognitive skills are thought to peak in the late 20s, and then gradually decline (see

Desjardins and Warnke, 2012 for a comprehensive review of the literature on the evolution of cognitive skills over the lifecycle). This also helps to explain why changes for the younger cohort are very small: at the time of IALS, such individuals were still very young (between 17 and 30 years old), and presumably many of them were still on the upward-sloping segment of the age-proficiency curve.

Figure 9. Literacy proficiency in IALS and PIAAC, by cohort



Note: The data refer to native born only.

Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

The age-related variation in proficiency can also be decomposed by the highest level of educational attainment of respondents (Table 4). Among the oldest individuals (those that were aged between 55 and 65 years in PIAAC), the decline in proficiency was stronger the higher the level of education. The pattern is much more mixed when looking at younger individuals (aged 35 to 44 in PIAAC). For such age class, tertiary-educated individuals performed relatively better in Denmark, Flanders (Belgium), the Netherlands, Norway, Sweden and the United States, and relatively worse in Finland, Ireland and Italy.

Table 4. Literacy proficiency in IALS and PIAAC, by cohort and education (native born only)

National entities	Cohort (Age in PIAAC)	Below High-School	High-School	Above High-School
Australia	35-44	2.9	-3.0	-2.2
	45-54	-6.2	-2.5	-9.0
	55-65	-7.3	-15.3	-20.8
Denmark	35-44	-35.2	-28.3	-18.4
	45-54	-30.5	-34.4	-26.7
	55-65	-34.4	-37.7	-38.3
Finland	35-44	-6.8	-25.4	-13.0
	45-54	-13.9	-25.5	-16.9
	55-65	-16.6	-28.1	-35.1
Belgium	35-44	-29.9	-29.6	-15.4
	45-54	-20.6	-21.6	-20.0
	55-65	-17.2	-25.7	-24.3
Ireland	35-44	-9.3	-13.1	-16.5
	45-54	-10.1	-16.1	-29.1
	55-65	-2.8	-22.4	-31.3
Italy	35-44	3.0	-16.0	-11.7
	45-54	13.4	-8.5	-12.6
	55-65	6.4	-12.8	-22.0
Netherlands	35-44	-17.8	-13.4	0.1
	45-54	-19.1	-18.6	-15.5
	55-65	-23.7	-35.2	-21.6
Norway	35-44	-21.1	-23.9	-19.3
	45-54	-25.4	-29.1	-30.4
	55-65	-34.1	-31.2	-42.5
Sweden	35-44	-50.3	-29.7	-21.6
	45-54	-31.6	-43.5	-35.9
	55-65	-42.0	-43.1	-40.2
United States	35-44	-28.1	-11.1	-5.7
	45-54	2.5	-21.3	-25.9
	55-65	6.0	-20.3	-29.8

Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Netting out differences in the composition of the sample

A simple way to estimate changes in proficiency taking at the same time into account changes that occurred in the composition of the underlying population is to run an OLS regression of literacy proficiency on selected observable characteristics and on a dummy variable equal to one for scores measured in PIAAC (as opposed to IALS). To do so, IALS and the PIAAC datasets can be pooled in order to estimate, for each country, the following linear regression:

$$L_i = \alpha + \beta \text{PIAAC} + \gamma X_i + \varepsilon_i$$

where L_i is literacy proficiency of individual i, PIAAC is a dummy variable equal to 1 for scores measured in PIAAC, and X_i is a vector of individual characteristics including dummies for 10-years age groups, gender, place of birth (whether native or foreign-born), and two dummies for highest level of

educational attainment (less than high-school being the omitted category). For countries in which information on educational attainment in IALS is unavailable (Canada) or not reliable (the Czech Republic, England, Germany, Northern Ireland and Poland), years of education were used instead. The results for these two different specifications are presented in Table 5, under the headers "Model 1" and "Model 2", respectively.

Table 5. Literacy proficiency in IALS and PIAAC, net of compositional changes

National entities	Raw changes	Model 1		Model 2	
		PIAAC dummy	(standard errors)	PIAAC dummy	(standard errors)
Australia	8.14	2.13	(1.23)	-	
Canada	-5.45	-		-9.70	(2.54)
Czech Republic	-2.83	-		-6.04	(1.39)
Denmark	-18.25	-18.84	(1.10)	-13.27	(1.14)
Finland	0.05	-5.25	(1.17)	3.29	(1.14)
Germany	-12.39	-		-21.54	(1.51)
Ireland	2.33	-8.67	(2.72)	-26.92	(3.10)
Italy	7.01	7.30	(2.05)	9.07	(2.01)
Netherlands	-1.75	-3.45	(1.20)	0.30	(1.21)
Norway	-16.05	-16.49	(1.30)	-29.32	(1.37)
Poland	34.71	-		24.11	(1.26)
Sweden	-26.31	-25.85	(1.10)	-23.58	(1.17)
United States	-3.67	-7.93	(1.71)	-5.11	(1.67)
Subnational entities					
Flanders (Belgium)	-1.61	-7.72	(2.20)	0.65	(3.90)
England (UK)	6.15	-		4.82	(1.70)
Northern Ireland (UK)	5.05	-		8.36	(2.01)

Note: Model 1 conditions on dummies for highest levels of educational attainments. Model 2 conditions on years of education.

Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

The second column of Table 5 reports the raw differences (equivalent to the ones presented in Table 2). The following columns report the estimated coefficients of the PIAAC dummy (and the respective standard errors) for the two different specifications. The coefficient for the PIAAC dummy can be interpreted as the score point difference associated with participating in PIAAC as opposed to IALS, holding other relevant factors constant. For example, in Denmark, the score of an individual with a given set of observable characteristics was on average 18 score points lower than that of an individual with the same characteristics in IALS.

In most cases, the results suggest that changes in the composition of the population account for very little of the variation in proficiency of the adult population observed between IALS and PIAAC. In other words, although the composition of the population did change in terms of the age distribution, levels of educational attainment and the size of the foreign-born population in the countries, the effects partly cancel each other out (e.g. while population ageing would tend to depress proficiency, increasing levels of educational attainment has the opposite effect).

Particularly in the Czech Republic, England, Denmark, Italy, the Netherlands, Northern Ireland, Sweden, and the United States, controlling for changes in the characteristics of the population has very limited effects on the estimated changes in proficiency. In Australia, to the contrary, the observed increase in proficiency appears to be explained primarily by compositional changes. The same is true in Poland,

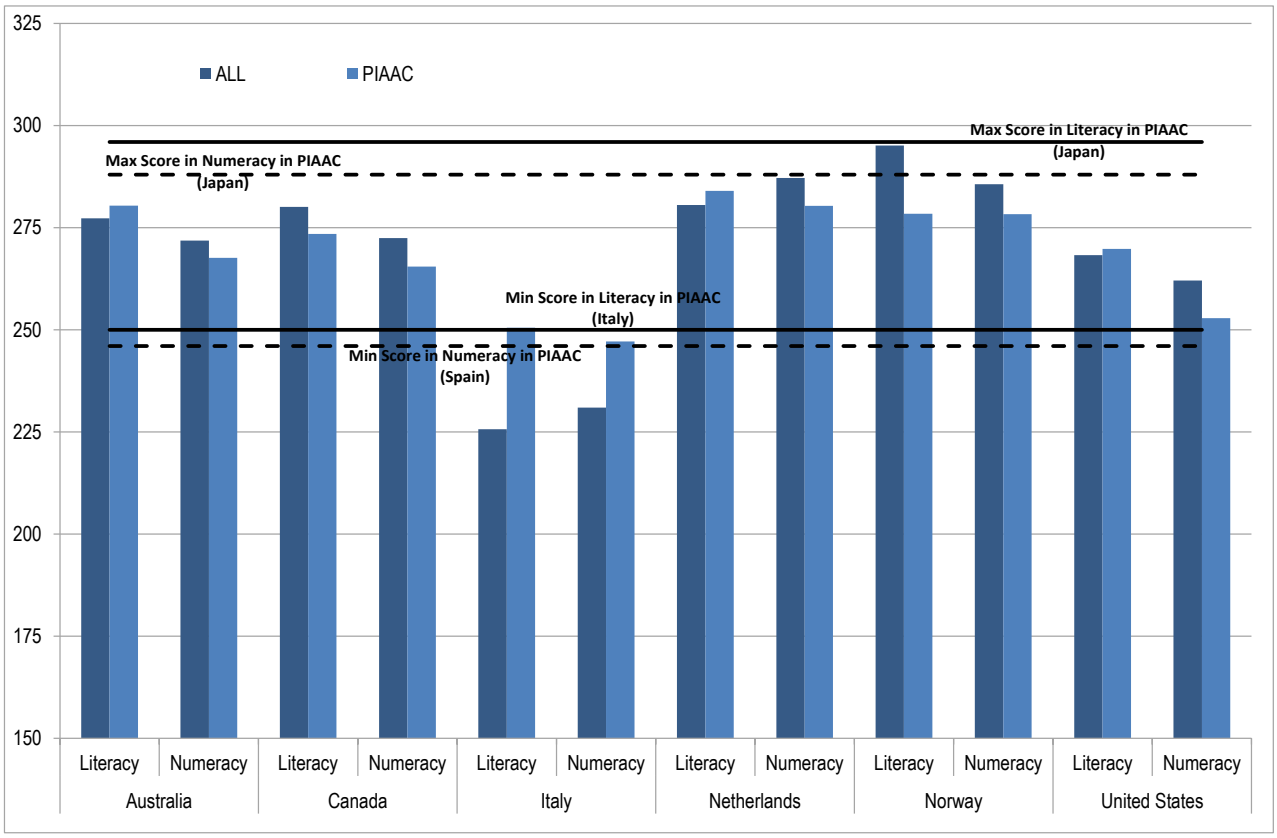
although to a much lesser extent. Similarly, in Canada and Germany positive changes in the composition of the population helped attenuate the decrease in proficiency. Finally, in Finland, Flanders (Belgium), Ireland and Norway the results are particularly sensitive to the choice of the empirical specification.

4. FROM ALL TO PIAAC

This section analyses the changes in literacy and numeracy proficiency that took place in the last decade, from ALL to PIAAC, mirroring the structure followed in the previous section.

Figure 10 and Table 6 summarise such changes, partly replicating the information presented in Table 2 and Figure 1.

Figure 10. Literacy and numeracy proficiency in ALL and PIAAC



Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Average proficiency in literacy among 16-65 year-old adults is higher in PIAAC than in ALL in four countries and lower in two. With the exception of Italy and Norway, the magnitude of change was relatively small. The average proficiency in numeracy is lower in PIAAC than in ALL in all countries other than Italy. In most cases the magnitude of the change in numeracy proficiency was greater than that

for literacy. Again, Italy and Norway are the exceptions. In Italy, the increase in numeracy proficiency was smaller than that observed in literacy and in Norway the decline in numeracy proficiency was significantly small than that for literacy. The scale of the fall in literacy proficiency in Canada, the Netherlands, Norway and the United States was reasonably large (between 13% and 18% of a standard deviation). In the Netherlands, it took place over only 6 years.

Table 6. Differences in literacy and numeracy proficiency from ALL to PIAAC

National entities	Literacy			Numeracy		
	Point change	*(standard errors)*	SD change	Point change	*(standard errors)*	SD change
Australia	3.12	*(1.14)*	0.06	-4.21	*(1.18)*	-0.08
Canada	-6.63	*(0.89)*	-0.13	-6.98	*(0.96)*	-0.13
Italy	24.86	*(2.03)*	0.43	16.16	*(1.88)*	0.31
Netherlands	3.47	*(1.19)*	0.08	-6.83	*(1.27)*	-0.15
Norway	-16.69	*(1.03)*	-0.39	-7.34	*(1.20)*	-0.18
United States	1.56	*(1.72)*	0.03	-9.25	*(1.86)*	-0.17

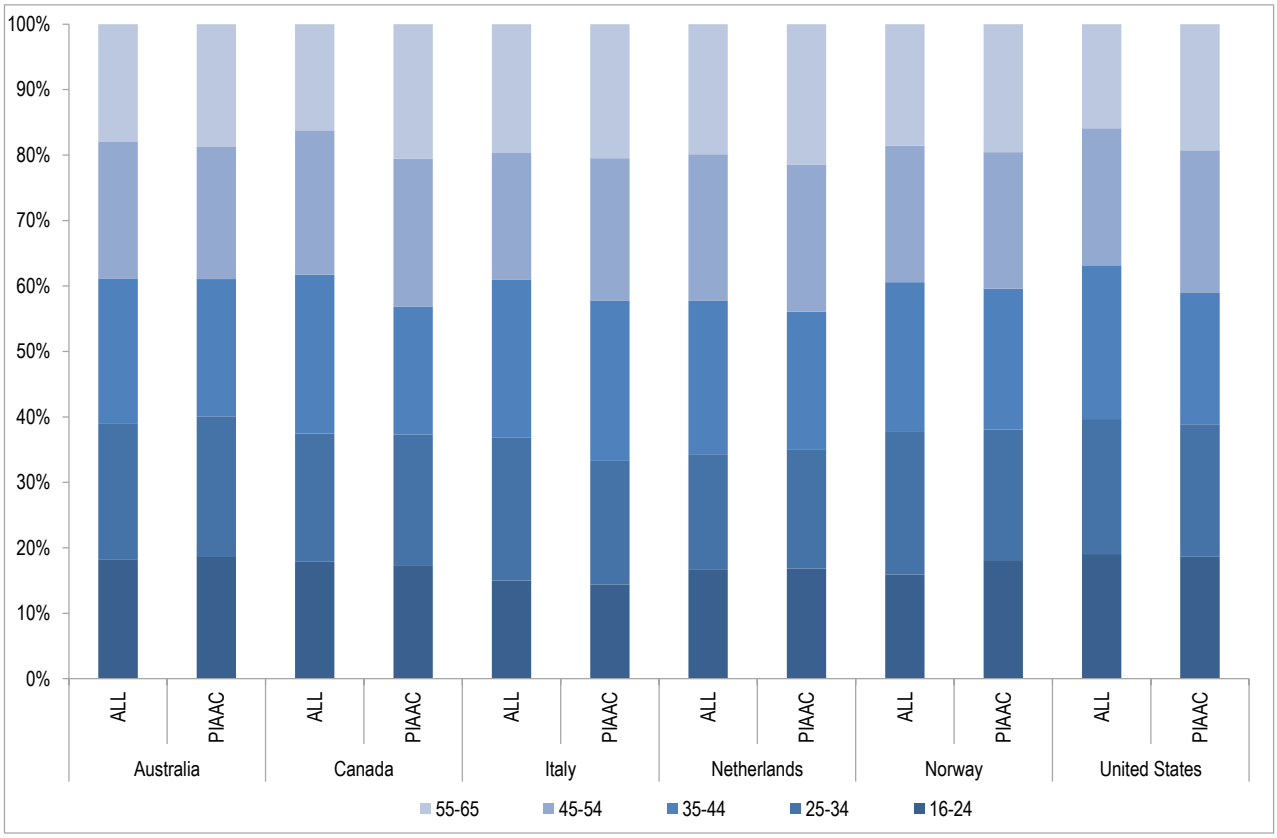
Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

The changing composition of the underlying population

Population ageing

The individuals that took the PIAAC assessment were older by around seven months on average than those who participated in ALL. Norway registered no significant variation, while in Canada the increase exceeded 14 months. Figure 11 shows that this was entirely due to an increase in the share of the population above 45 years, a pattern similar to the one observed in the United States. The share of individuals in the youngest age bracket did vary greatly , with the exception of Norway, where it increased by more than 2 percentage points (to 18%); at the same time, however, the share of individuals in the 25-34 bracket decreased by almost 2 percentage points, and the share of the oldest (55-65) increased from 18.6% to 19.6%.

Figure 11. Age composition of the population in ALL and PIAAC

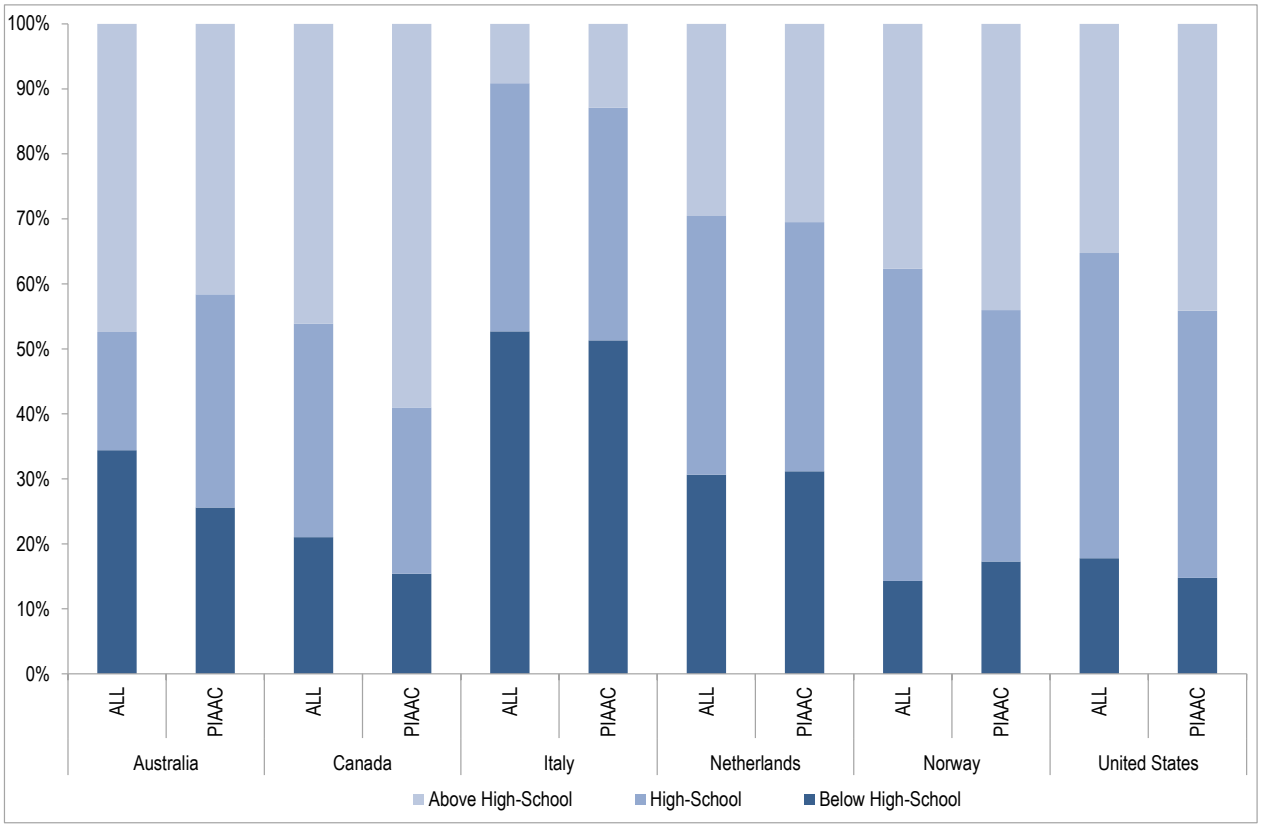


Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Educational attainment

The share of individuals with tertiary-level attainment increased between ALL and PIAAC in all countries other than Australia, where it declined from 47% to 41%; at the same time, however, Australia experienced a strong decline in the share of individuals without secondary education (from 34% to 25%). This share of the least educated group also decreased in Canada and in the United States (by a smaller amount) while it remained unchanged in Italy and the Netherlands, and increased from 14% to 17% in Norway.

Figure 12. Composition of the population in ALL and PIAAC, by educational attainment

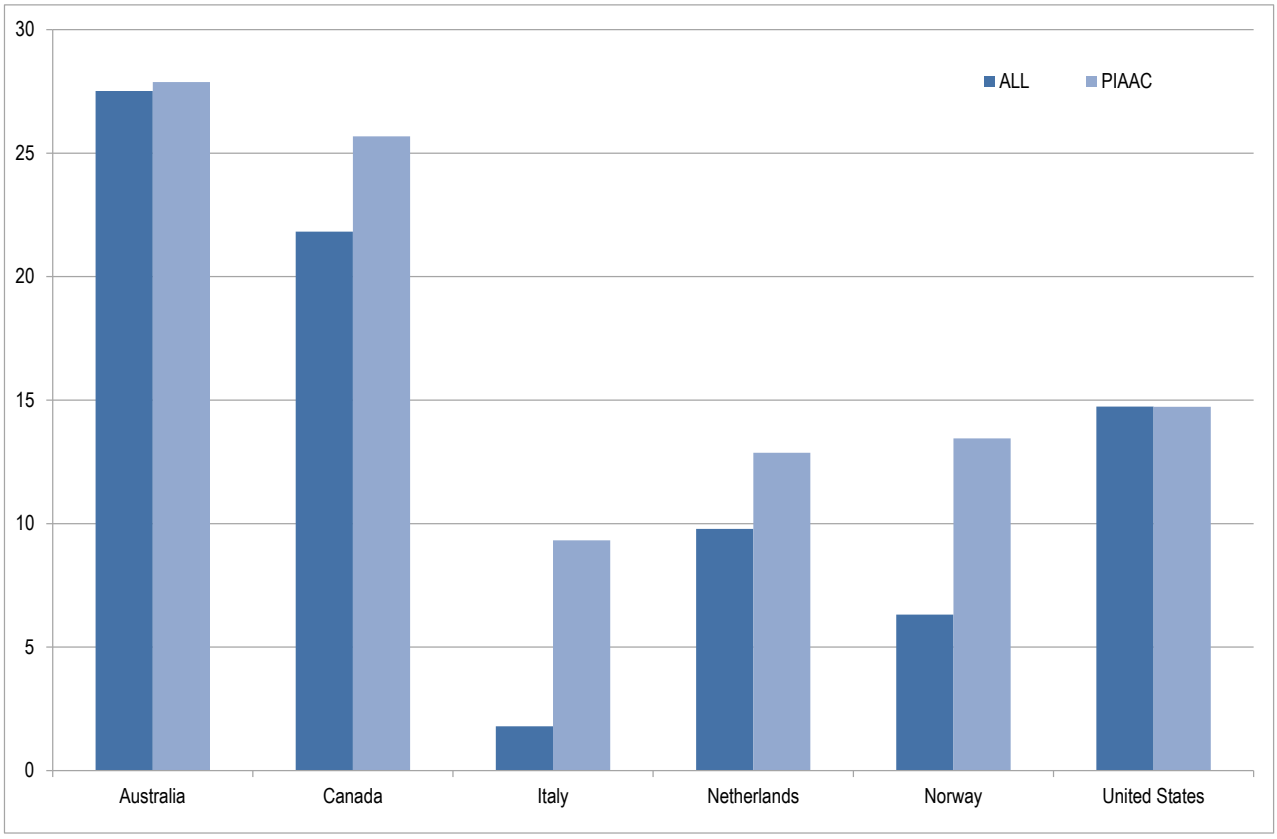


Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Foreign-born

Figure 13 displays the share of foreigners in the adult population in the two surveys. Comparing Figure 13 and Figure 5, it is evident that most of the increase in the share of foreign-born between IALS and PIAAC took place between IALS and ALL (with the partial exceptions of Italy and Norway). As a consequence, changes in the population in terms of language background are not expected to play a major role in explaining the evolution of proficiency between ALL and PIAAC. In both the Netherlands and Norway, however, the characteristics of the foreign-born population appeared to deteriorate, with an increase in the share of individuals without a secondary education close to 7 percentage points. The share of tertiary-educated immigrants did not display statistically significant changes.

Figure 13. Share of foreign-born in ALL and PIAAC

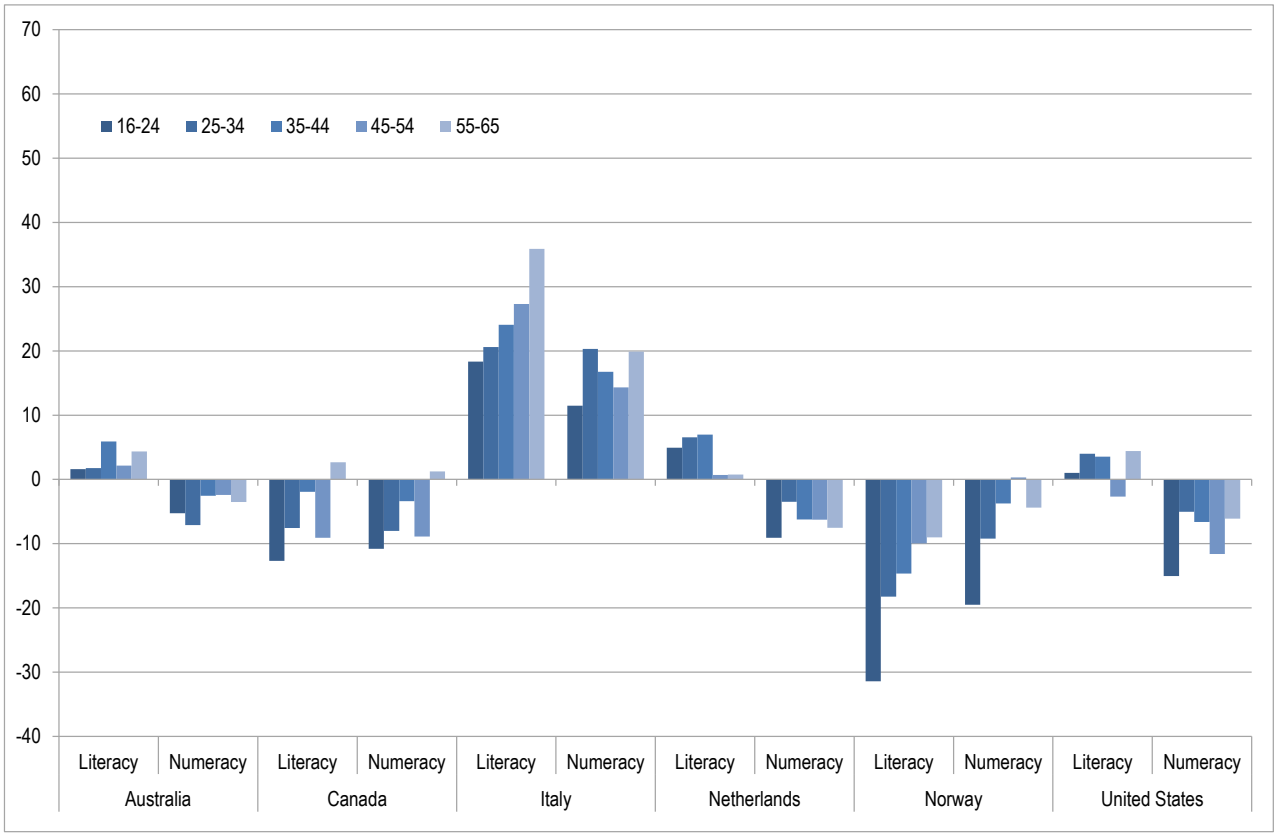


Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Within-group changes in proficiency

Changes in proficiency by age group are rarely significantly different from zero, with the exceptions of Italy, Norway, and (as far as numeracy is concerned), the United States. The pattern of changes observed is consistent with that seen between IALS and PIAAC for literacy (Figure 6) and is similar in both domains, with the greatest gains and smallest declines in proficiency being observed among older adults (Figure 14).

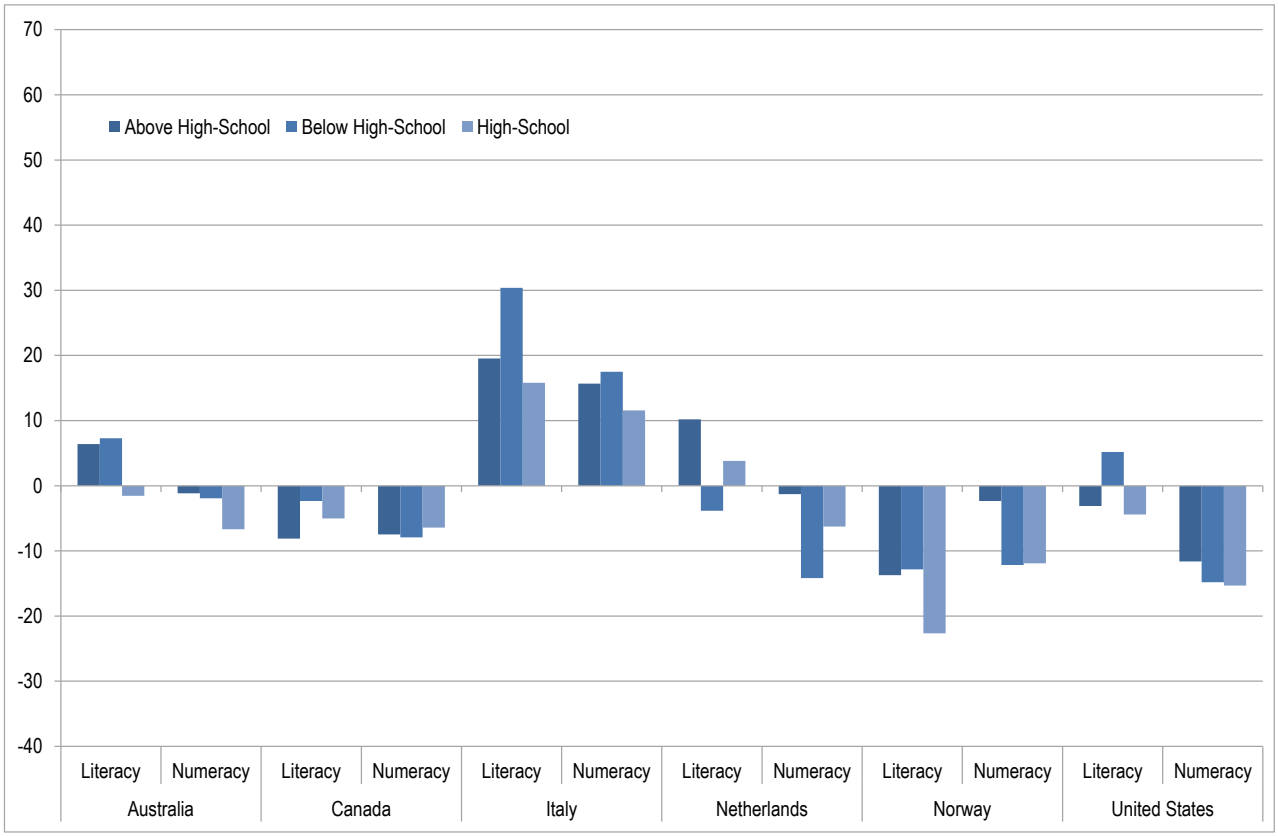
Figure 14. Literacy and numeracy proficiency in ALL and PIAAC, by age class



Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

The picture is very similar when looking at educational attainment (Figure 15). As in the case of the changes between IALS and PIAAC (Figure 7), individuals with higher levels of educational attainment in PIAAC perform worse relative to their peers in ALL than do adults with low levels of educational attainment. This is true for both literacy and numeracy.

Figure 15. Literacy and numeracy proficiency in ALL and PIAAC, by educational attainment



Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Table 7 jointly looks at changes in proficiency by age and education, restricting the analysis to the native-born population. The picture now is rather more mixed. Tertiary-educated individuals (particularly those in younger age classes) seem to perform relatively better in most countries, with the partial exception of Italy and (as far as literacy is concerned), the United States.

As in the case of the analysis of changes from IALS to PIAAC, the relatively worse performance of individuals in younger age classes is mostly attributable to those with low levels of education.

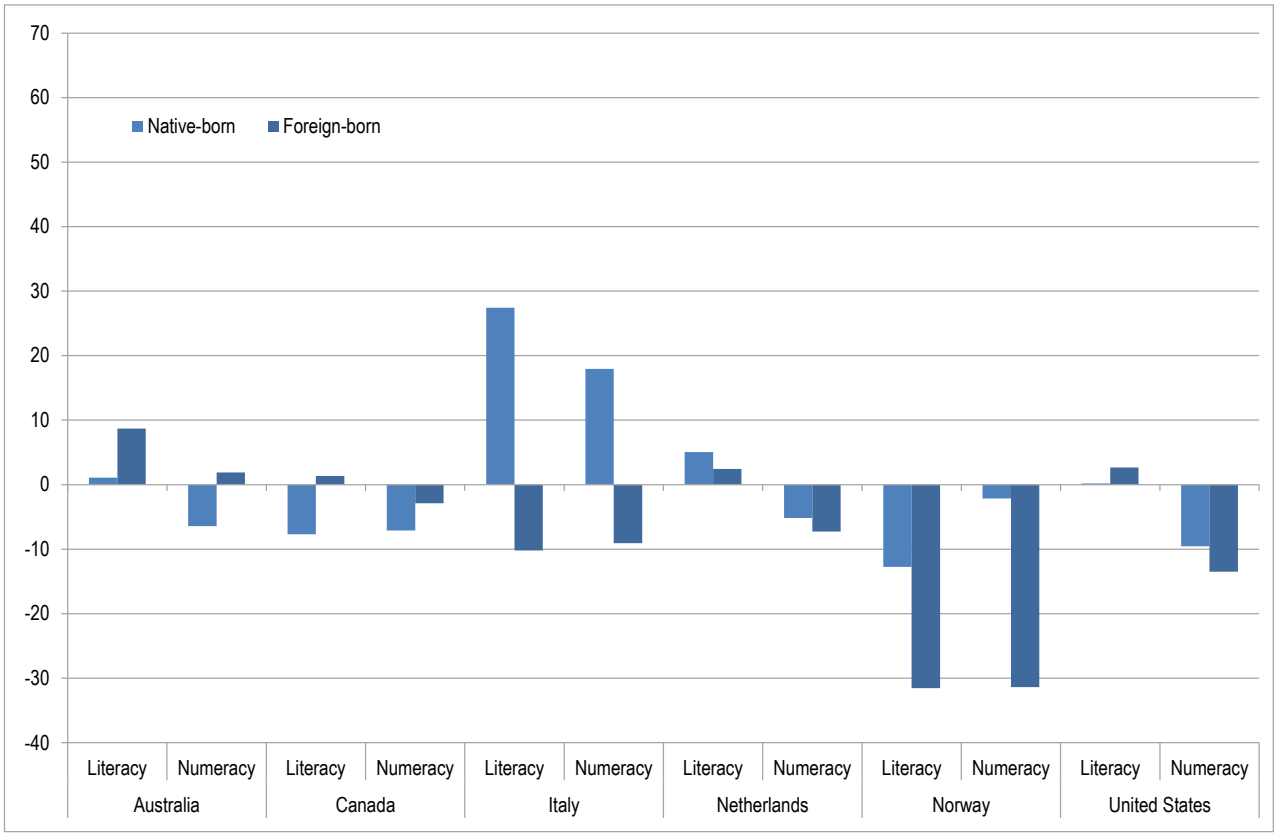
Table 7. Literacy and numeracy proficiency in ALL and PIAAC, by age and education (native born only)

National entities	Age	Literacy			Numeracy		
		Below HS	HS	Above HS	Below HS	HS	Above HS
Australia	25-34	-0.4	-9.4	10.8	-9.1	-15.8	-7.1
	35-44	-2.8	-8.2	8.6	-14.8	-14.9	-2.5
	45-54	-3.6	-14.7	3.7	-10.5	-16.0	-2.4
	55-65	7.4	-21.1	6.0	-2.9	-24.8	-3.5
Canada	25-34	-23.4	-8.6	-10.1	-25.3	-9.5	-8.0
	35-44	-8.7	-7.6	-9.3	-13.7	-10.5	-3.4
	45-54	-20.7	-14.1	-16.1	-28.0	-14.4	-8.9
	55-65	-4.2	-11.4	-11.7	-10.3	-11.6	1.2
Italy	25-34	22.3	14.0	25.7	18.3	16.1	20.3
	35-44	31.4	19.8	19.5	19.1	15.2	16.7
	45-54	31.2	29.4	14.4	13.2	20.0	14.3
	55-65	37.8	23.6	14.6	19.1	13.7	19.9
Netherlands	25-34	-6.7	1.1	14.1	-14.9	-8.1	-3.5
	35-44	-7.2	6.9	14.2	-20.0	-4.4	-6.2
	45-54	-3.2	6.5	7.3	-8.6	-0.1	-6.3
	55-65	0.2	-0.2	5.9	-7.6	-7.7	-7.5
Norway	25-34	-14.5	-13.3	-5.8	-8.3	-2.2	-9.2
	35-44	-22.3	-20.8	-3.9	-18.1	-7.6	-3.7
	45-54	-8.1	-14.7	-7.4	-3.6	-3.9	0.3
	55-65	-6.8	-15.2	-15.8	-10.0	-9.8	-4.4
United States	25-34	-2.0	-9.8	-4.5	-14.8	-18.7	-5.0
	35-44	7.7	-8.8	-0.3	-8.2	-21.2	-6.6
	45-54	16.2	-4.2	-8.0	-1.8	-11.7	-11.6
	55-65	-0.4	0.2	-5.3	-15.6	-9.7	-6.1

Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Figure 16 presents changes in proficiency by place of birth. In this case, the picture is more mixed than that observed between IALS and PIAAC. In some countries the magnitude of change is larger for the native-born population (Canada, Italy), while in others the reverse is true (Australia in literacy, Norway, the United States in numeracy). In Norway, the decline in proficiency is consistent with the observed decline in immigrants' level of educational attainment.

Figure 16. Literacy and numeracy proficiency in ALL and PIAAC, by place of birth

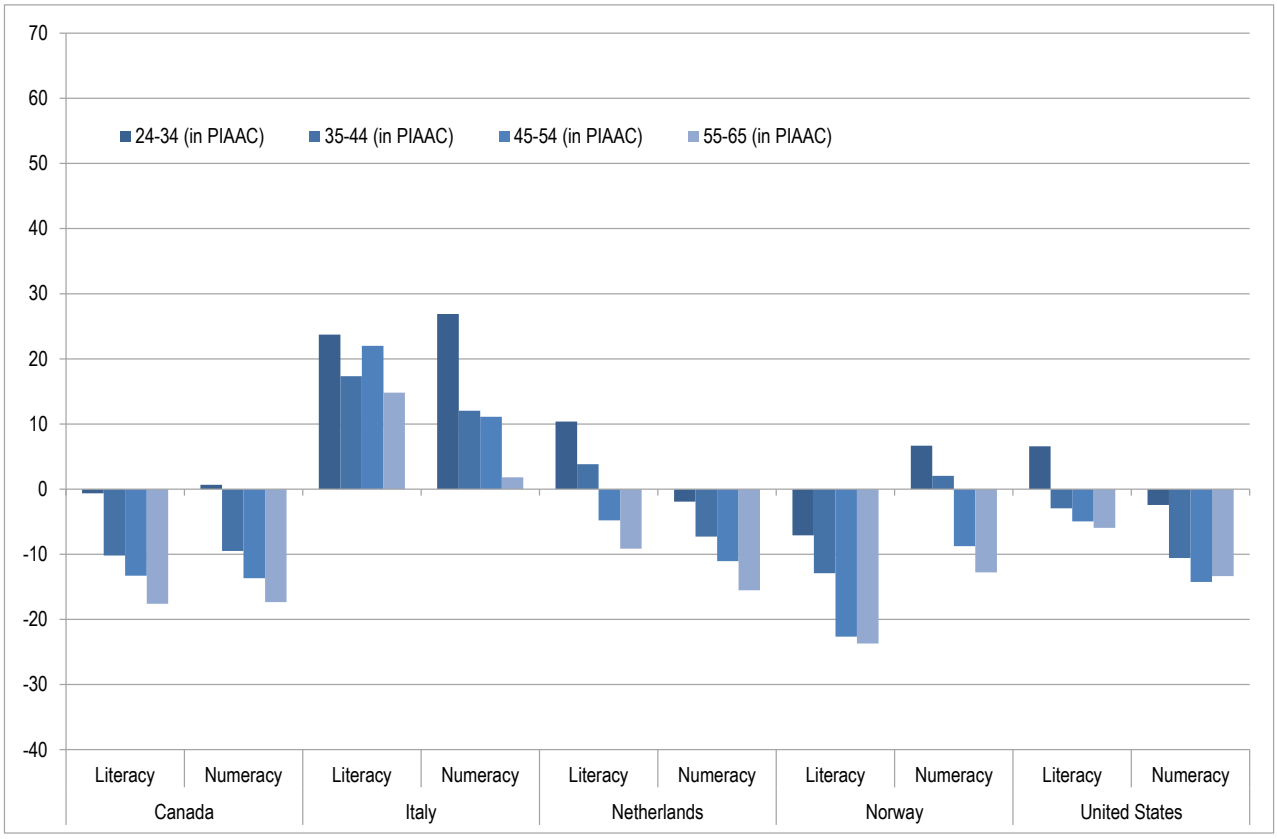


Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Figure 17 presents changes by birth cohort. As in the analysis of change between IALS and PIAAC (Figure 9), the results are consistent with the existence of age-related decline in cognitive ability.[7]

Table 8 presents age-related changes by level of educational attainment. In all countries, the relative performance of the youngest individual is positively correlated with their level of education. This result generally holds for older individuals as well, although with some exceptions (most notably Italy and the United States, but also Canada and Norway, as far as literacy is concerned).

Figure 17. Literacy and numeracy proficiency in ALL and PIAAC, by cohort



Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Table 8. Literacy and numeracy proficiency in ALL and PIAAC, by cohort and education (native born only)

National entities	Cohort (Age in PIAAC)	Literacy			Numeracy		
		Below HS	HS	Above HS	Below HS	HS	Above HS
Canada	24-34	-35.8	-17.7	-7.9	-37.2	-18.0	-3.3
	35-44	-28.1	-9.6	-14.9	-32.5	-10.4	-13.0
	45-54	-20.4	-17.3	-17.1	-27.0	-20.0	-15.4
	55-65	-14.9	-16.5	-25.1	-23.5	-17.3	-21.6
Italy	24-34	5.7	14.7	39.0	8.6	18.6	41.8
	35-44	23.3	16.7	16.4	14.2	15.8	10.1
	45-54	30.8	17.8	16.1	14.1	13.8	14.8
	55-65	20.5	20.7	-1.8	5.7	10.3	-3.2
Netherlands	24-34	-8.3	-1.1	20.4	-20.0	-11.3	3.8
	35-44	-9.3	3.8	10.9	-20.7	-6.6	-0.8
	45-54	-8.9	-1.0	0.8	-13.2	-6.5	-8.4
	55-65	-10.3	-7.9	-1.4	-16.6	-12.7	-9.0
Norway	24-34	-27.4	-21.8	0.4	-23.7	-7.7	14.3
	35-44	-17.7	-20.5	-9.3	-9.8	-7.5	8.6
	45-54	-26.7	-28.6	-17.4	-18.2	-15.2	-3.5
	55-65	-21.2	-26.8	-25.5	-17.5	-15.8	-12.6
United States	24-34	-21.8	-12.9	-11.9	-43.2	-22.3	-20.8
	35-44	-5.4	-12.3	-4.4	-21.0	-23.5	-8.7
	45-54	1.7	-8.6	-8.1	-14.8	-18.4	-16.3
	55-65	9.0	-5.7	-13.1	-6.5	-12.8	-20.4

Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Netting out differences in the composition of the sample

Table 9 reports the results of an OLS regression estimating changes in proficiency from ALL to PIAAC, controlling at the same time for changes in the underlying population. Due to data constraints,[8] a simple specification is adopted for all countries, including as regressors a gender dummy, a dummy that identifies native-born adults, and two sets of dummies for age class and the highest level of educational attainment. The coefficient associated with the PIAAC dummy can be read as the change in proficiency keeping other individual characteristics constant. For convenience, the raw changes are also reported.

Table 9. Literacy and numeracy proficiency in ALL and PIAAC, net of compositional changes

National entities	Literacy			Numeracy		
	Raw Change	PIAAC dummy	*(standard errors)*	Raw Change	PIAAC dummy	*(standard errors)*
Australia	3.12	3.67	*(1.12)*	-4.21	-3.63	*(1.08)*
Canada	-6.63	-8.64	*(0.88)*	-6.98	-9.22	*(1.06)*
Italy	24.86	25.86	*(1.98)*	16.16	16.60	*(1.87)*
Netherlands	3.47	4.70	*(1.07)*	-6.83	-5.81	*(1.10)*
Norway	-16.69	-15.09	*(0.96)*	-7.34	-5.45	*(1.17)*
United States	1.56	-2.55	*(1.62)*	-9.25	-13.91	*(1.78)*

Source: Adult Literacy and Life Skills Survey (ALL) (2003-2006), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

As expected, controlling for population changes does not have a large impact on the results of the analysis. PIAAC took place less than 10 years after ALL (even less in the case of Australia and the Netherlands), and there have been no dramatic changes in the characteristics of the underlying population over this period. In Canada and the United States changes in the characteristics of the population have been able to partly offset the decline of proficiency in numeracy; in Norway, on the other hand, a "worsening" in the characteristics of the population is partly responsible (although to a very small extent) for the observed decline in proficiency.

5. ASSESSING THE ROBUSTNESS OF THE RESULTS: AN ITEM-LEVEL ANALYSIS

IALS, ALL and PIAAC scores are estimated using Item Response Theory (IRT), which is the most appropriate methodology to combine multiple items from an assessment exercise to derive measures of an underlying unobservable psychometric trait, such as the proficiency of an individual (OECD, 2013a). IRT methodology allows having items with different difficulty levels, which are then taken into account in computing the final score. In fact, a wide distribution of items' difficulties makes the estimation of proficiency more precise. Furthermore, survey respondents were randomly administered different booklets, each of which included a given set of items. As a consequence, not all respondents answered the same questions. Such an assessment design makes obviously inappropriate simple scoring methods performed at the item level, such as computing the percentage of correct responses. Moreover, the computer-based version of PIAAC made also use of adaptive testing.

Despite these basic (and hard to dispute) considerations, a closer look at the item level can still be useful, particularly if one is interested in assessing the degree of comparability between two different surveys like IALS and PIAAC. This approach also allows taking advantage of the fact that IALS, ALL and PIAAC share a number of items, which makes it possible to compare results keeping constant the intrinsic difficulty of the item. In what follows, we will focus on the comparison between IALS and PIAAC, on the ground that only six countries participated in both ALL and PIAAC.[9]

While a total of 29 out of 52 PIAAC literacy items were linking items (i.e. items that had already been used in IALS and/or ALL), only nine of them were in common with IALS. Moreover, only three of these nine common items were taken by a representative sample of the entire population, because they were administered both in the paper-based and in the computer-based version of PIAAC; comparisons based on

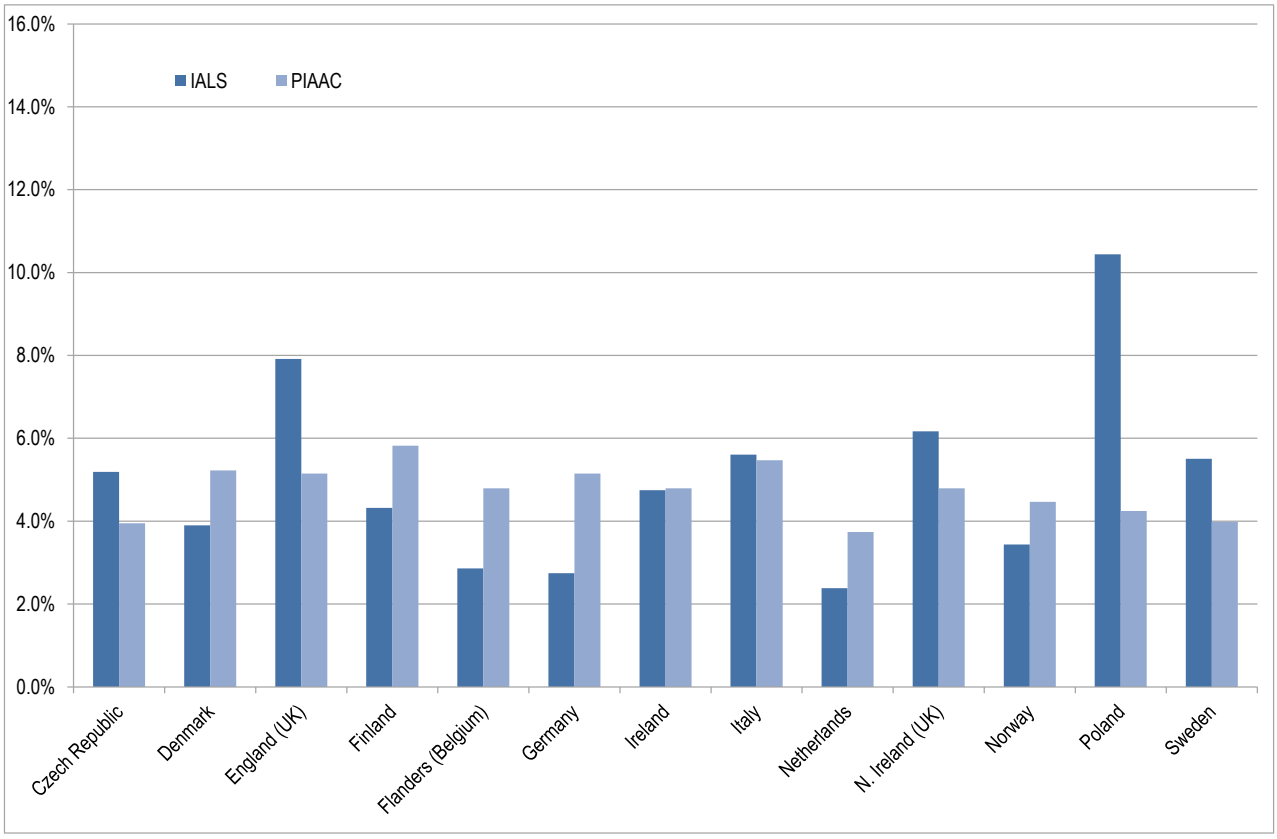
the remaining six common items will therefore suffer from a bias due to non-random selection of respondents into the paper-based or the computer-based version of PIAAC.

The analysis is conducted along two dimensions. First, it investigates the overall pattern of responses. In particular, differences in terms of the share of missing or not reached items, and the patterns of such answers within booklets, could signal differences in respondents' engagement, or in the way the tests were administered and scored. Second, by exploiting the common items between IALS and PIAAC, it examines differences in responses between surveys holding constant the intrinsic difficulty of the administered items.

Omitted answers could be a (very rough) measure of test-taking engagement. They also have an impact on overall scores, given that omitted answers were counted as wrong. However, it is not clear *a priori* if (and in which direction) a large share of missing answers is biasing overall results. Comparing the incidence of missing answers in IALS and PIAAC is also complicated by the fact that the two surveys have slightly different rules for coding an answer as omitted. In IALS, an item is coded as omitted if it is left blank and if it is followed by some items with a valid response (either right or wrong). If the item is followed only by other items with no valid answer (within a booklet), it is considered not reached (i.e. not administered), and does not contribute (neither positively nor negatively) to the final score. While the paper-based version of PIAAC follows exactly the same rules, the computer-based version takes instead advantage of the possibility of recording any interaction between the respondent and the computer. Nonresponses due to rapid omission were therefore differentiated from nonresponses after interaction with the stimuli, so that omitted responses were only treated as wrong if the respondent spent more than five seconds on the item. If the respondent spent less than five seconds, the item was considered not attempted, and treated as not reached/not administered (OECD, 2013c).

Figure 18 shows the share of items left blank in IALS and PIAAC. Two things emerge from the picture. First, the share of missing answers is generally quite small, in most countries at about 5%. Second, there is no clear pattern across the two surveys: missing answers decrease in the Czech Republic, England, Northern Ireland, Poland, and Sweden, and increase in Denmark, Finland, Flanders (Belgium), Germany, the Netherlands, and Norway. Perhaps more importantly, changes across surveys in the proportion of missing answers appear on average small (with the exception of Poland). In IALS, the incidence of missing answers was unusually high in Poland and, to a lesser extent, in England, Italy, and Northern Ireland.

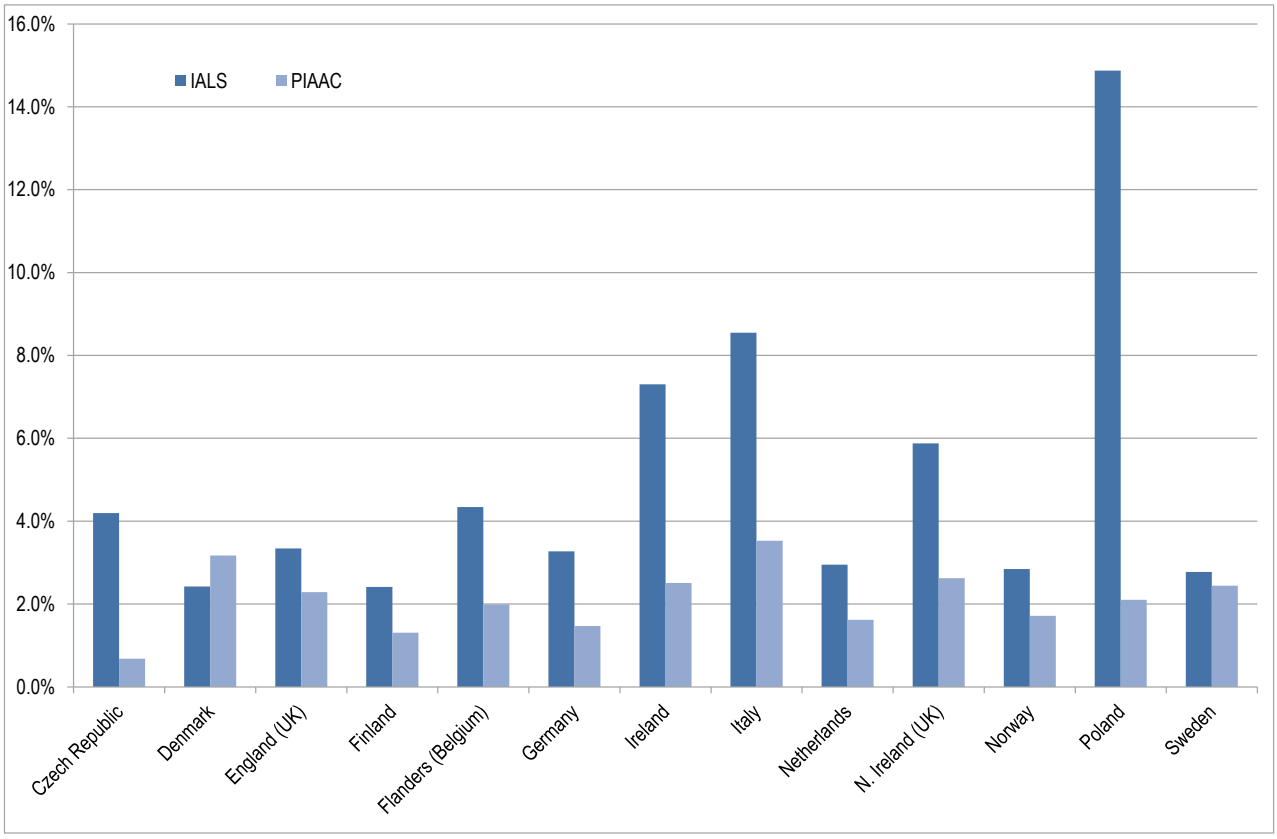
Figure 18. Share of missing answers in IALS and PIAAC literacy items



Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

Figure 19 displays the proportion of items that have not been reached by respondents. An item is classified as "not reached" if it was left blank and if all other following items were also left blank. While missing items were considered wrong answers, not reached items were discarded and did not contribute to the final score. As with missing items, the share of not reached items could be interpreted as a measure of test-taking engagement, although it is not possible to assess if and how not reached items are biasing overall results. With the only exception of Denmark, the share of not reached items in PIAAC strongly decreased with respect to IALS, probably thanks to the fact that PIAAC was delivered as a computer-based assessment (in both surveys, respondents were allowed to take as much time as they wished to complete the assessment). The strong decline in the share of not reached items is a further indication of the higher quality (and therefore of an overall higher reliability) of PIAAC over its predecessors.

Figure 19. Share of literacy items not reached in IALS and PIAAC

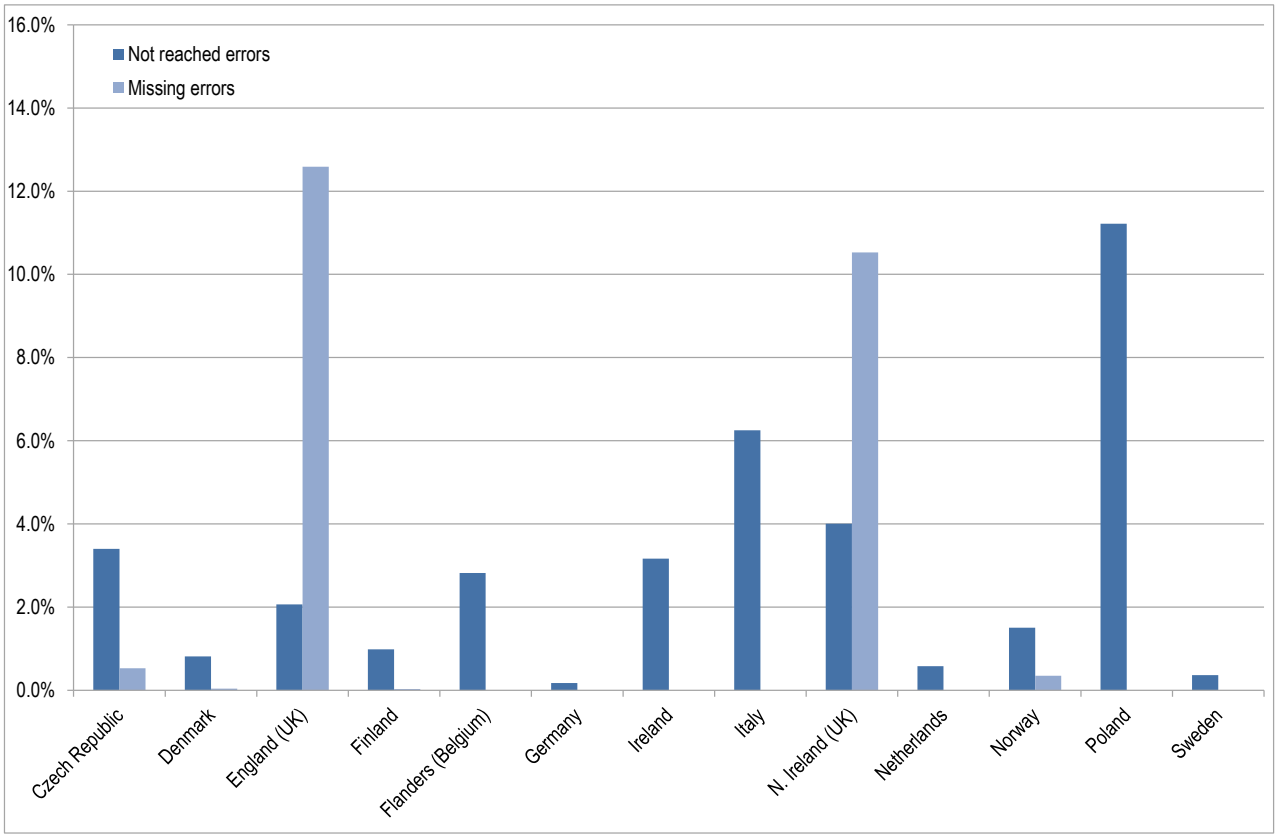


Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

The patterns shown in Figures 18 and 19 do not change significantly if the analysis is restricted to the nine common items, nor if it is performed on the sub-sample of native-born individuals.

Analysing the pattern of responses at the item level is also useful because it allows detecting "coding errors", most notably in IALS, given that in PIAAC the digital nature of the assessment brings the possibility of such errors to essentially zero. It is possible to identify two types of errors from inconsistencies in the pattern of coded responses. A first case of inconsistency occurs when an item is coded as "missing" but is then followed only by other missing: in such cases, in fact, the item should have been coded as "not reached". Given that missing answers are scored as wrong, this type of error introduces a downward bias in overall score. The second case of inconsistency occurs when an item is coded as "not reached" but is then followed by items coded as either "right" or "wrong": in such case, the item should have been coded as "missing". Given that not reached items do not contribute to the final score, this second type of error introduces an upward bias in overall performance.

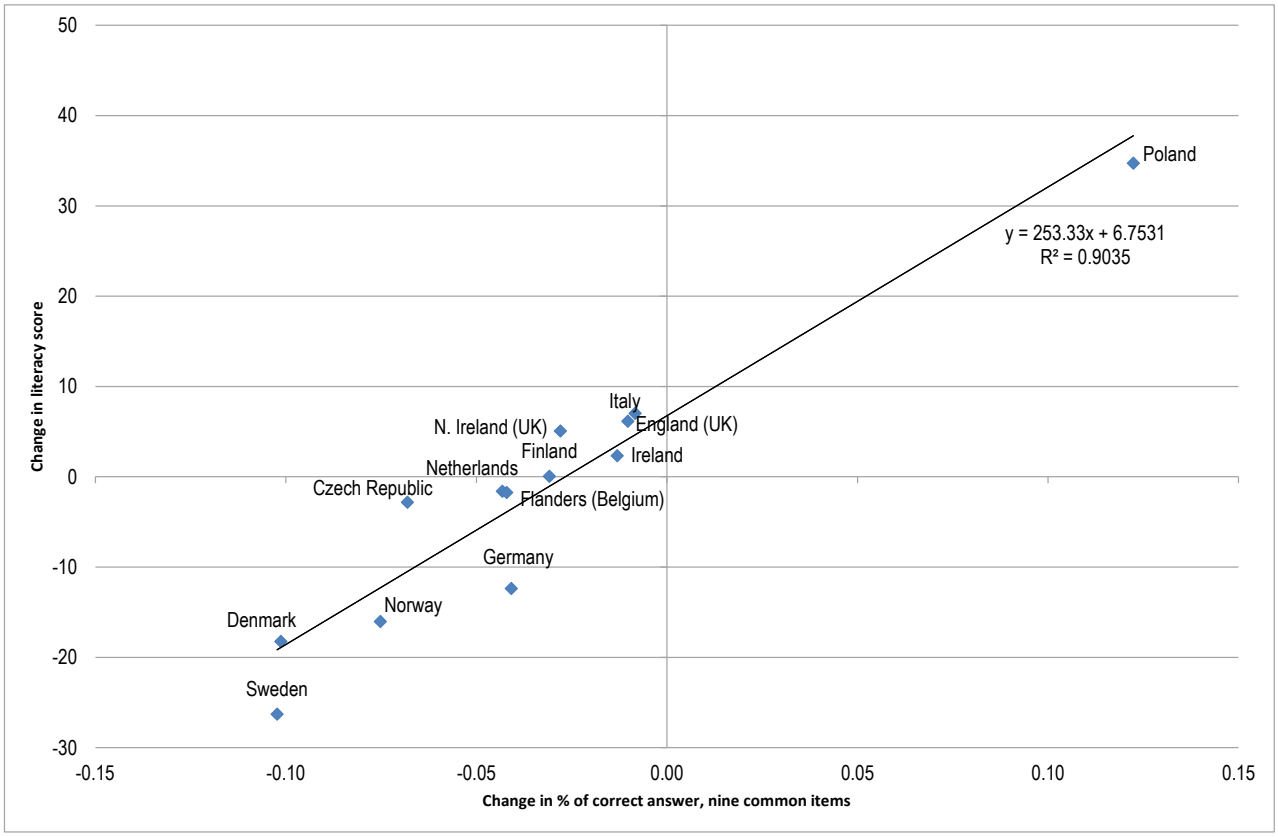
Figure 20. Coding inconsistencies in IALS booklets



Source: International Adult Literacy Survey (IALS) (1994-1998).

Figure 20 plots the percentage of IALS booklets that suffer from the two types of coding inconsistencies. While in the majority of countries coding inconsistencies are a negligible phenomenon, they appear to be a real concern in England, Italy, Northern Ireland and Poland. In England and Northern Ireland the large share of booklets in which items were incorrectly coded as "missing answers" has the potential to bias downward overall results, and could therefore partly explain why England and Northern Ireland are amongst the few countries to have recorded an improvement in performance from IALS to PIAAC. Italy and Poland, on the other hand, seems to be plagued more by the second type of error, which would imply that IALS results were upward biased; in such cases, the increase in performance across the two surveys (7 points in Italy, 34 points in Poland) would be even larger. However, other elements cast some doubts about the overall quality of Italian and Polish data, which prevent us from taking strong position about performance in IALS. Italy, for instance, had the lowest response rates in both IALS and ALL (at 35 and 44%, respectively; see Table 10 and OECD, 2013a). In Poland, on top of the inconsistencies shown in Figure 21, many booklets display what look like duplicate patterns of responses (i.e. many booklets share exactly the same sequence of answers).

Figure 21. Changes in literacy proficiency and in the nine common items



Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

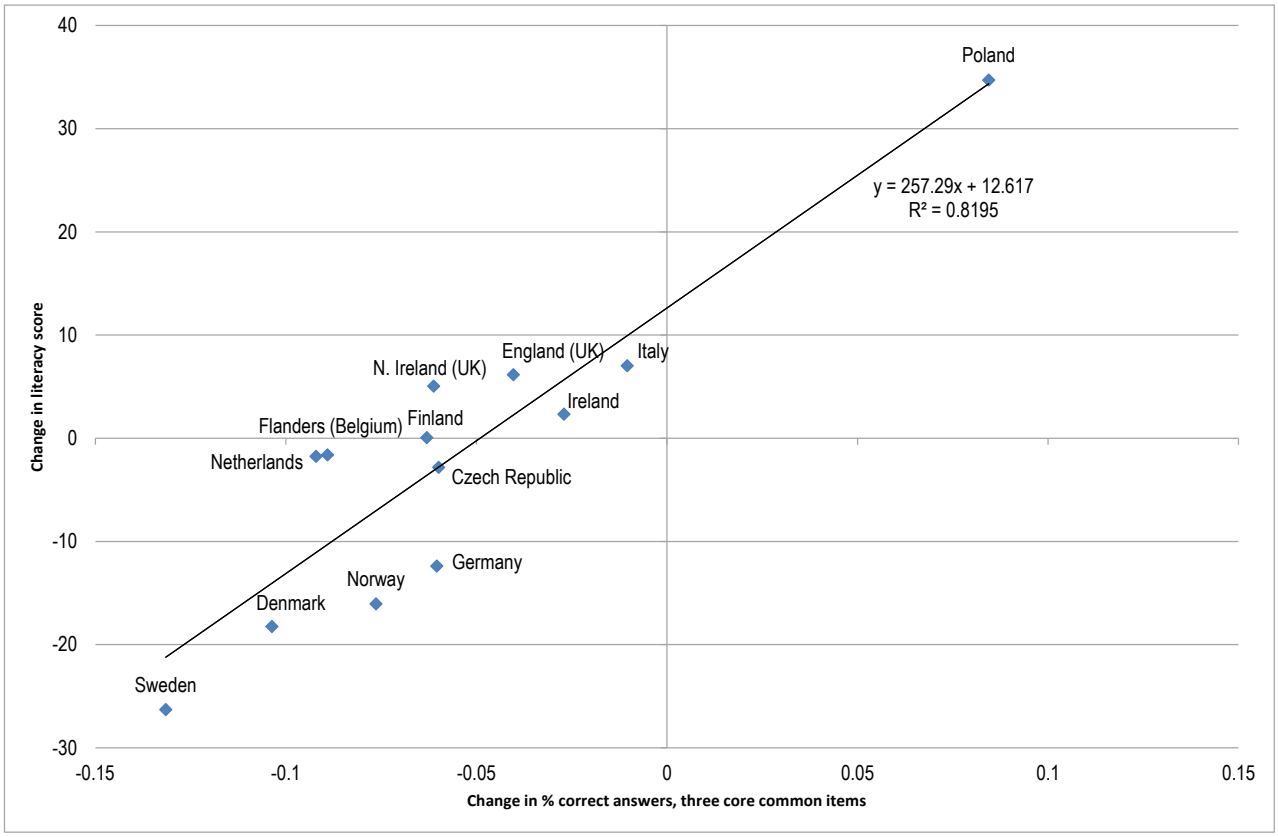
Table 10. Response rates in IALS, ALL and PIAAC

National entities	IALS	ALL	PIAAC
Australia	96	79	71
Canada	69	66	59
Czech Republic	61	-	66
Denmark	66	-	50
Finland	69	-	66
Germany	69	-	55
Ireland	60	-	72
Italy	35	44	56
Netherlands	45	47	51
Norway	61	56	62
Poland	75	-	56
Sweden	60	-	45
United States	60	66	70
Subnational entities			
Flanders (Belgium)	36	-	62
England (UK)	63	-	59
Northern Ireland (UK)	58	-	65

Source: OECD (2013a), *The Survey of Adult Skills: Reader's Companion*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264204027-en.

The final step of the item-level analysis zooms in on the nine items administered in both IALS and PIAAC. Figure 21 compares changes in literacy scores from IALS to PIAAC (on the vertical axis) with changes in the percentage of correct answers to the nine common items. The correlation between the two sets of data is very high, which is a clear indication that changes over time in overall performance was not driven by changes in the administered items. Results are very similar if we compare overall performance with performance in the three common items that were administered both in the paper-based and in the computer-based version of PIAAC (Figure 22).

Figure 22. Changes in literacy performance and in the three core common items



Source: International Adult Literacy Survey (IALS) (1994-1998), and Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

6. SOME COMMENTS ON COUNTRIES THAT EXPERIENCED "LARGE" CHANGES

Against a background of small to moderate variations in literacy proficiency over time, some countries stand out as having experienced quite large changes in literacy proficiency across different surveys. These include Germany, Italy, Poland, and the Scandinavian countries of Denmark, Norway and Sweden.

The observed evolution of the average literacy proficiency of the adult population in Italy is *prima facie* implausible. A large fall in literacy proficiency between IALS (1994) to ALL (2003) is followed by a large increase from ALL to PIAAC. The average literacy proficiency of the Italian population in ALL (225 score points) was the lowest recorded across all three surveys by a significant margin. In this case, it seems reasonable to conclude that ALL underestimated the literacy proficiency of adults in Italy. Furthermore, Italy had very low response rates in both IALS and ALL. An item-level analysis of IALS data also reveals a non-negligible incidence of inconsistencies in coding responses.

Poland is the only country in the sample that registered a large increase in average literacy proficiency between IALS (1994) and PIAAC. A relatively large component of the increase appears to be explained by compositional factors. In addition, given that the social and economic situation in Poland has changed dramatically over the period from 1994 to 2012, it is unsurprising that there is a largish increase in proficiency above and beyond that driven by compositional factors. However, there are grounds on which to doubt the quality of Polish data in IALS. The item-level analysis revealed an unusually large incidence of items left blank or not reached. Furthermore, more than 10% of all booklets were plagued by inconsistencies in coding responses. Of greater concern is the fact that a large number of booklets appear to have suspicious patterns of responses (i.e. many booklets display exactly the same pattern of answers). While the evidence does not allow to say whether IALS performance for Poland was over- or under-estimated (as it seems likely, given the exceptionally large improvement in performance), the analysis suggest that IALS data for Poland should be interpreted with caution.

Large declines in average literacy proficiency were observed in Denmark, Germany, Norway and Sweden between IALS and PIAAC. Two comments are in order. First, in all of these countries, the decline is from a high absolute level. For example, the average proficiency in literacy of Swedish adults was 305 in 1994 in IALS, by far the highest score recorded in literacy in all 3 surveys, some 11 score points higher than the mean score for Japanese adults in PIAAC. The average proficiency of Danish and Norwegian adults in IALS was similarly high. The average score of Norwegian adults in both IALS and ALL was virtually identical to that of Japanese adults in PIAAC. Danish adults had an average literacy score in IALS similar to that of Finnish adults in PIAAC (the second best performers in that survey). Second, the decline in literacy proficiency in Norway took place between ALL and PIAAC – an interval of only eight years. Unfortunately, as neither Denmark nor Sweden took part in ALL, it is impossible to know whether a similar pattern of decline occurred in these two countries. However, from a close inspection of the pattern of responses at the item level no suspicious pattern emerges that could cast doubts on the reliability of IALS data for these countries.

In numeracy, largish declines in numeracy were observed in four of the six countries that participated in both ALL and PIAAC. These occurred over periods ranging from eight years (Canada, Norway and the United States) to five years (the Netherlands). In the Netherlands and Norway the decline took place from a high absolute level. In both these countries the average numeracy scores in ALL were similar to that of the best performing country in PIAAC – Japan. Interestingly, the decline in numeracy proficiency was much smaller than that in literacy in Norway. In the Netherlands and the United States, the decline in numeracy was accompanied by an *increase* in average literacy scores. The case of Italy, where a large

increase in numeracy was observed between ALL and PIAAC deserves special comment. Given the relatively high correlation between literacy and numeracy proficiency, it seems likely, for the reasons discussed above that ALL underestimated the numeracy proficiency of Italian adults.

Lastly, as IALS and ALL were paper-based assessments and PIAAC was predominantly delivered in computer-based mode, it is possible that the different modes of delivery had some impact on the observed changes in proficiency between assessments, particularly if performance tended to differ between respondents taking the different modes. On average, one out of four respondents took the paper-based version of the assessment. The share is below 10% in countries such as the Netherlands, Norway and Sweden, and reaches 35% and more in Italy, Japan, Poland and the Slovak Republic.

Individuals who took the computer-based assessment scored generally much higher than individuals that took the paper-based assessment, as shown in Table 11. The gap in literacy scores ranges from 9 points in Estonia to 37 points in the Netherlands, while for numeracy it ranges from 22 points in Japan to 47 points in Sweden. These results are not surprising. It is mainly the low-skilled individuals (lacking the most basic computer skills) that were directed to the paper-based version. Given that the choice of the delivery mode is likely to be correlated with personal characteristics that are, in turn, likely to be correlated with proficiency, these differences should not be interpreted as the causal effect of delivery mode on test results. The fact that the gap is much higher for numeracy than for literacy is a further indication that some unobserved component of individual ability, correlated more with numeracy than with literacy proficiency, is driving the choice of the delivery mode.

During the field test of the Survey of Adult Skills, a proportion of respondents were randomly assigned to either the computer-based or the paper-based version of the test. Overall, the two groups did not display significant differences in performances, which constitutes the best possible evidence *against* the existence of a delivery-mode effect (OECD, 2013a; OECD, 2013c).

Table 11 reports, other than raw differences in performance between paper-based and computer-based, adjusted differences based on a regression that controls for a range of personal characteristics likely to be independently correlated with proficiency (age, immigrant and language background, gender, parental background, and educational attainment).

As expected, controlling for such characteristics strongly reduces the magnitude of the differences. In the case of literacy, the effect of delivery mode on proficiency becomes much smaller, in many cases not statistically different from zero, positive in some countries (Australia, Denmark, Sweden, the United States), negative in others (Estonia, France, Northern Ireland, Norway). In the case of numeracy, however, the estimated effect remains positive and statistically significant in all countries, although the magnitude is greatly reduced. This suggests the presence of some unobserved characteristic associated with both familiarity with computers and numeracy proficiency that is not being accounted for in the analysis

In summary, there is little evidence to suggest that the change from paper-based assessment to computer-based assessment have had a significant influence on the differences in literacy proficiency between IALS, ALL and PIAAC.

Table 11. Effect of taking the computer-based version of PIAAC

	Literacy			Numeracy		
National entities	**Raw difference**	**CBA coefficient**	***(standard error)***	**Raw difference**	**CBA coefficient**	***(standard error)***
Australia	22.9	6.3	*(2.3)*	35.2	19.1	*(2.4)*
Austria	23.6	2.6	*(1.8)*	35.3	17.0	*(1.9)*
Canada	20.0	2.5	*(1.6)*	36.4	19.9	*(1.6)*
Czech Republic	12.1	-3.5	*(2.4)*	27.4	13.1	*(2.2)*
Denmark	32.8	9.5	*(1.9)*	36.8	16.0	*(2.0)*
Estonia	8.6	-10.8	*(1.8)*	23.1	10.0	*(1.7)*
Finland	25.6	-6.1	*(2.1)*	35.9	11.2	*(2.4)*
France	14.5	-11.4	*(1.6)*	39.0	15.3	*(1.9)*
Germany	25.7	0.3	*(2.8)*	43.2	19.9	*(2.6)*
Ireland	13.2	-7.6	*(1.9)*	23.2	5.0	*(2.1)*
Italy	17.9	-0.3	*(2.3)*	30.1	15.1	*(2.2)*
Japan	17.2	1.7	*(1.5)*	22.1	8.9	*(1.7)*
Korea	24.3	-3.2	*(1.6)*	35.9	11.8	*(1.6)*
Netherlands	37.7	7.5	*(2.6)*	43.2	15.0	*(2.8)*
Norway	18.5	-5.7	*(2.5)*	32.1	8.0	*(2.5)*
Poland	19.8	-0.3	*(2.0)*	25.5	10.4	*(1.9)*
Slovak Republic	18.2	6.7	*(1.5)*	28.6	15.9	*(1.7)*
Spain	19.0	-4.6	*(1.6)*	31.4	10.3	*(1.6)*
Sweden	36.8	10.0	*(2.9)*	47.5	22.9	*(3.0)*
United States	30.8	8.8	*(3.1)*	42.7	20.0	*(3.7)*
Subnational entities						
Flanders (Belgium)	30.3	3.7	*(2.4)*	43.7	19.5	*(2.3)*
England (UK)	18.4	3.3	*(2.6)*	41.3	26.7	*(2.7)*
Northern Ireland (UK)	21.2	-5.4	*(2.4)*	40.5	14.8	*(2.6)*

Note: the CBA columns report the coefficients of a CBA dummy from a linear regression of proficiency scores. The regression also control for age, place of birth, native language, parental education, and educational attainment.

Source: Survey of Adult Skills (PIAAC) (2012), www.oecd.org/site/piaac/publicdataandanalysis.htm.

7. CONCLUSIONS

The objective of this paper was to examine the changes in literacy and numeracy proficiency observed between PIAAC and the two previous adult skills surveys, IALS and ALL. A particular focus was on disentangling the contribution of changes in the composition of the population and changes in proficiency across the population in the observed change in proficiency between surveys.

While many countries experienced small to modest changes in literacy proficiency between IALS and PIAAC, others saw sizeable variations, mostly on the negative side, and the paper pays special attention to these cases. In the shorter span that separated ALL and PIAAC, numeracy proficiency clearly declined (except in Italy), while literacy moved less on average (except for the large increase registered in Italy and the large decline experienced by Norway)

In broad terms, changes in the composition of the adult population appear to have had little impact on the observed changes in proficiency with the exception of Poland and, to a lesser extent Australia. Most of the variation over time can be attributed to changes in proficiency within groups between the different surveys. Quite large increases or declines in proficiency between surveys are observed by age group and by

level of educational attainment. In terms of age, the largest declines and the smallest increases in proficiency are observed amongst the youngest age groups and the smallest declines and largest increases amongst the oldest. This is likely to reflect the fact that the older age groups in PIAAC are much more educated than their counterparts that participated in previous surveys, while for the younger groups differences in educational attainment are less pronounced. Interestingly, in terms of educational attainment, the largest declines and smallest increases are generally found among the tertiary-educated rather than those with lower qualifications. This may reflect the fact that the expansion of tertiary-level education over recent decades has led to a decline in the average ability of individuals with tertiary education.

PIAAC differs from previous adult assessments in that it was delivered predominantly on computer whereas its predecessors were pencil-and-paper based. There is little evidence to suggest that the change in delivery mode is likely to have had an influence on the changes in proficiency observed over time.

As pointed out before, some countries experienced large changes in proficiency, especially in literacy between IALS and PIAAC. The large increase in literacy proficiency in Poland certainly reflects changes in the composition of the population and the effect of the marked social and political changes since the early 1990s. Poland has also experienced strong growth performance in the Programme for International Student Assessment (PISA) that is to some extent reflected in the increase in the literacy performance of the youngest age group in between IALS and PIAAC. However, there are reasons to exercise special caution in analysing and interpreting IALS data for Poland, especially in the light of the large number of inconsistencies found in scored booklets and because of the presence of suspicious patterns of responses. Anomalies were also detected in England, Italy and Northern Ireland. Additional elements contribute to raise concerns about the reliability of IALS and ALL data in Italy, most notably the very low response rates registered in IALS and ALL and the strange pattern of proficiency, with large declines from IALS to ALL followed by large increases from ALL to PIAAC (which hints to a possible underestimation of proficiency in ALL).

The average literacy proficiency of the adult population in Denmark, Germany and Sweden fell significantly from a very a high base between IALS and PIAAC and between ALL and PIAAC in the case of Norway. This was also true of the Netherlands and Norway in numeracy between ALL and PIAAC. The analysis, however, did not find any particular reason to question the accuracy and the validity of IALS and ALL data for these countries. Nevertheless, some caution is urged in interpreting the changes in proficiency observed in between IALS, ALL and PIAAC for all countries, due to the range of other factors, particularly relating to differences in survey implementation between countries and over time that may affect the comparability of the data from the different studies.

NOTES

[1] The reference point is the standard deviation of proficiency scores in IALS.

[2] This section draws heavily from the Reader's Companion to the Survey of Adult Skills (OECD, 2013a).

[3] Canada is also excluded, because the variable is missing in IALS.

[4] The information is missing for Australia in IALS.

[5] The restrictions of the sample in terms of age and place of birth make such results not directly comparable with Figures 6 and 7. Furthermore, the analysis is necessarily less precise, because of the reduction in the sample size of each age-education cell.

[6] There is no way to track exactly the same individuals, but we can track a random sample of individuals drawn from the same population. The analysis is carried out on native-born individuals only in order to net out the effect of immigration.

[7] The figure does not include Australia, for which the ALL dataset lacks the necessary information on age needed to identify the PIAAC cohort.

[8] The ALL dataset does not contain information on years of education and age for Australia.

[9] Unfortunately, item-level data are not available for Australia, Canada and the United States.

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