Migrant–Native Skill Gaps in Europe: Evidence from two Cycles of PIAAC Surveys

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1 Objectives and research questions

Cognitive skills play a crucial role in shaping immigrants' integration pathways in the destination labour markets and societies. Literacy, numeracy and problem-solving skills are foundational as they enable the participation in the society and the successful integration into the current and future labour markets (Batalova & Fix, 2015). We investigate whether the skills gap between immigrants and natives persists, diminishes or widens over time and across migrant generations. The relationship between immigrants' cognitive skills and their socio-demographic characteristics already widely discussed in the existing literature. OECD's analyses of the first and second PIAAC cycles show that migrants generally have lower literacy, numeracy and problem-solving skills than natives, but the native-migrant skill gaps dimmish if age, gender, educational attainment and other SES are controlled for (OECD 2016, OECD 2020). These analyses, however, provide cross-sectional snapshots but do not focus on the temporal evolution of migrant's skill outcomes and native-migrant skills gaps in Europe. In our analysis we jointly assess two cycles of PIAAC data, in order to look at the temporal trends and the evolution of migrant skills gaps. Are the trends converging or diverging? Are the skills gaps persistent, are they narrowing or widening? And for whom? This comparative across-time and countries analysis is important because international migrant trends have been shifting over the past more than a decade. Substantial flows of immigrants from other EU countries, who move freely within the Schengen system, have been replaced in many countries by increases in immigrant from the rest of the world. Evidence on skill composition of migration flows is, however, limited. We assume, however, that these compositional changes in immigrant stock – be it by place of origin, gender, age or educational attainment – will be reflected in PIAAC data. Another important temporal trend to capture is the growing population of the so called second generation – descendants of immigrant parents. The number of persons with migrant background has been increasing and is sizeable mainly in traditional immigration countries, such as France, Germany or Belgium. A cross-national analysis is needed also because European countries differ in immigration and integration policies (OECD, 2018). This can help identify the shades of the skills gap determined by the characteristics of migrant subgroups and define more solid evidence of its existence. Evaluating the skills of immigrants and how they differ from those of natives and across migrant generations is crucial to properly recognise their skills, reduce prejudice and discrimination and support their integration into the receiving labour market. This would enable immigrants to fully benefit from their new lives and opportunities in the destination country while allowing the host country to maximise the contributions of immigrants to its labour force. Our analysis aims to contribute to address the missing pieces of the complex puzzle of migration analysis, which are crucial for effectively managing this phenomenon and maximising its benefits for both immigrant and host populations.

This work addresses four main research questions, spanning from broader to narrower perspectives. First, it starts from analysing whether a gap in immigrants' and natives' skills exists or not. These skills we analyse are restricted to functional literacy and numeracy.

RQ1: "What is the skills gap between immigrants and natives starting from literacy and numeracy skills in European destination countries?"
RQ2: "How has this gap evolved over time, specifically from Cycle 1 to Cycle 2?",
RQ3: "Is there a difference in pattern when we distinguish between first-generation immigrants and second-generation migrants?"
RQ4: "What are the variables that most affect the migrant-native literacy and numeracy skill gap? And how?"

The purpose is to examine whether the skills gap decreases or increases as immigrants settle in the receiving country and whether it varies between first-generation immigrants and second-generation migrants. To do so and, therefore, to answer the first three research questions, a descriptive analysis will be implemented, by covering the demographic composition of both immigrant and native subpopulations and the temporal distribution of their skills – expressed in literacy and numeracy scores and levels. To answer to these three questions we perform regression analysis to investigate the existence and the magnitude of the skill gaps and their temporal trends.
Finally, the fourth question will also be addressed by applying regression methods to investigate the effect of specific independent variables on the migrant-native skills gap. In other words, multiple models will be attempted to explore the socio-economic and demographic variables that influence migrant-native gap and the direction and magnitude of their effects.

Note that this first draft will be enriched by a comprehensive literature review after the submission. We will also perform analyses with additional survey from Austria, as we have recently acquired scientific use files which have variables not included in microdata files provided by the OECD.

2 Data and Methods

2.1 Data

We use microdata from the OECD's Programme for the International Assessment of Adult Competencies (PIAAC), which provides the Survey of Adult Skills. PIAAC is a large-scale household survey designed to measure adults' proficiency in literacy, numeracy, and problem solving, complemented by extensive information on migration background, education, labour-market participation, language use, and family characteristics. The survey employs stratified multistage probability sampling and is administered face-to-face using computer-assisted interviewing. Respondents complete an extensive background questionnaire before undertaking a cognitive assessment. Adults with very low literacy skills or insufficient command of the test

language may instead complete a reading components test, and in Cycle 2 a short "doorstep interview" was introduced to encourage participation among individuals unable to complete the full assessment.

We draw on publicly available data from PIAAC Cycle 1 (2011–12) and Cycle 2 (2022–23). Our analytic sample includes respondents aged 16–65 from eight European countries that participated in both cycles and have sizeable immigrant-origin populations: Belgium (Flanders), Finland, France, Germany, Ireland, Italy, Spain, and the United Kingdom (England). These countries differ considerably in their migration histories, education systems, skill-recognition regimes, and institutional approaches to integration, offering a rich comparative setting for studying variation in adult cognitive skills.

Cycle 2 introduced methodological innovations to mitigate non-response among adults with limited test-language proficiency, most notably the doorstep interview. To ensure comparability across time, we exclude respondents who completed only the doorstep interview, as these individuals did not complete the full cognitive assessment and therefore cannot be meaningfully compared with respondents in Cycle 1. This exclusion reduces sample sizes—particularly among first-generation migrants—but avoids mixing fundamentally different assessment modes. Appendix A provides country-specific sample sizes, response rates, and details on survey design features and weighting.

While PIAAC aims for cross-national harmonisation, replication methods and variable availability are not fully consistent across countries. France uses a replication technique incompatible with the Fay-adjusted design employed elsewhere, and Germany's public-use file lacks harmonised parental education information necessary for pooled analysis. As a result, France and Germany are excluded from pooled regression models; separate robustness checks for these countries are reported in Appendix B.

1.2 Measures

Our main outcomes are literacy and numeracy proficiency scores[1], each measured on a 0–500 scale. These reflect latent traits estimated using item response theory. PIAAC provides ten plausible values per domain to capture uncertainty in the estimation of individual proficiency. Following OECD standards, all descriptive and regression analyses incorporate each plausible value separately, with estimates combined using Rubin's rules. Because the two domains are scaled independently, results are interpreted within each domain rather than across them. For descriptive purposes, we also group scores into standard PIAAC proficiency levels (Below Level 1 and Levels 1–5).

Migrant background is defined following the OECD convention. Natives are respondents born in the survey country to two native-born parents. First-generation immigrants (G1) are respondents born abroad, irrespective of parental origin. Second-generation immigrants (G2) are respondents born in the survey country with at least one foreign-born parent. These classifications are harmonised across cycles using respondents' country of birth and parental-origin variables. Because public-use files lack information on age at arrival, the "1.5 generation" cannot be separately identified.

[1] We exclude problem-solving because its measurement changed substantially between cycles, making the domain unsuitable for cross-cycle comparisons.

We adjust for a set of demographic and socioeconomic characteristics known to correlate with skills and migration. These include age, gender, highest attained education, and parental education, with mother's and father's education harmonised into low, medium, and high categories following ISCED mapping. We further account for employment status (employed, unemployed, in education, inactive), a language-background indicator distinguishing respondents born in a country where the test language is not dominant, and the country in which the respondent obtained their highest qualification (OECD vs. non-OECD). In addition, we incorporate harmonised world-region-of-birth categories and include country of interview as destination-country fixed effects. Detailed variable definitions, value categories, and harmonisation procedures for variables that differ across countries or cycles are provided in Appendix C.

1.3 Analytical strategy

The analysis proceeds in two stages, combining descriptive and regression-based approaches.

First, we provide a descriptive overview of the composition of native, first-generation, and second-generation immigrant populations across cycles. We examine differences in age structure, educational attainment, and migrant-generation composition, as these shape the distribution of cognitive skills. We then compare mean literacy and numeracy proficiency and the distribution of proficiency levels across groups and survey cycles. All descriptive analyses use final sampling weights and Fay-adjusted replicate weights.

Second, we estimate survey-weighted linear regression models to assess whether migrant–native skill gaps persist after accounting for compositional differences. Following OECD guidelines, we run separate models for each plausible value (ten per domain and cycle) and pool coefficients and standard errors using Rubin's rules. Models are estimated using svyglm, applying final sampling weights and replicate weights.

For each domain and cycle, we estimate two main specifications. The baseline model includes only migrant status (or migrant generation):

$\text{score}_\text{i} = \alpha + \beta\text{Migrant}_i + \varepsilon_i.$

The fully adjusted model incorporates migrant background, demographic and socioeconomic covariates, and country fixed effects:

$\text{score}_\text{i} = \alpha + \beta\text{Migrant}_i + \text{X}_\text{i}\Gamma + \delta_{c(i)} + \varepsilon_i,$

where X_i represents the full set of individual-level covariates and $\delta_{c(i)}$ denotes fixed effects for the respondent's country of interview. This structure isolates within-country differences and nets out cross-national differences in mean proficiency levels.

In the regression analysis, multiple models were implemented separating by survey cycle and cognitive skill domain – literacy and numeracy. a linear model was applied with the proficiency score as dependent variable. We have followed OECD's recommendation to implement 10 different linear models for each plausible value, and subsequently we combine them all. This increases the accuracy of skill proficiency distribution, given the estimation of plausible values from respondents' answers to both tasks and background questionnaire. The

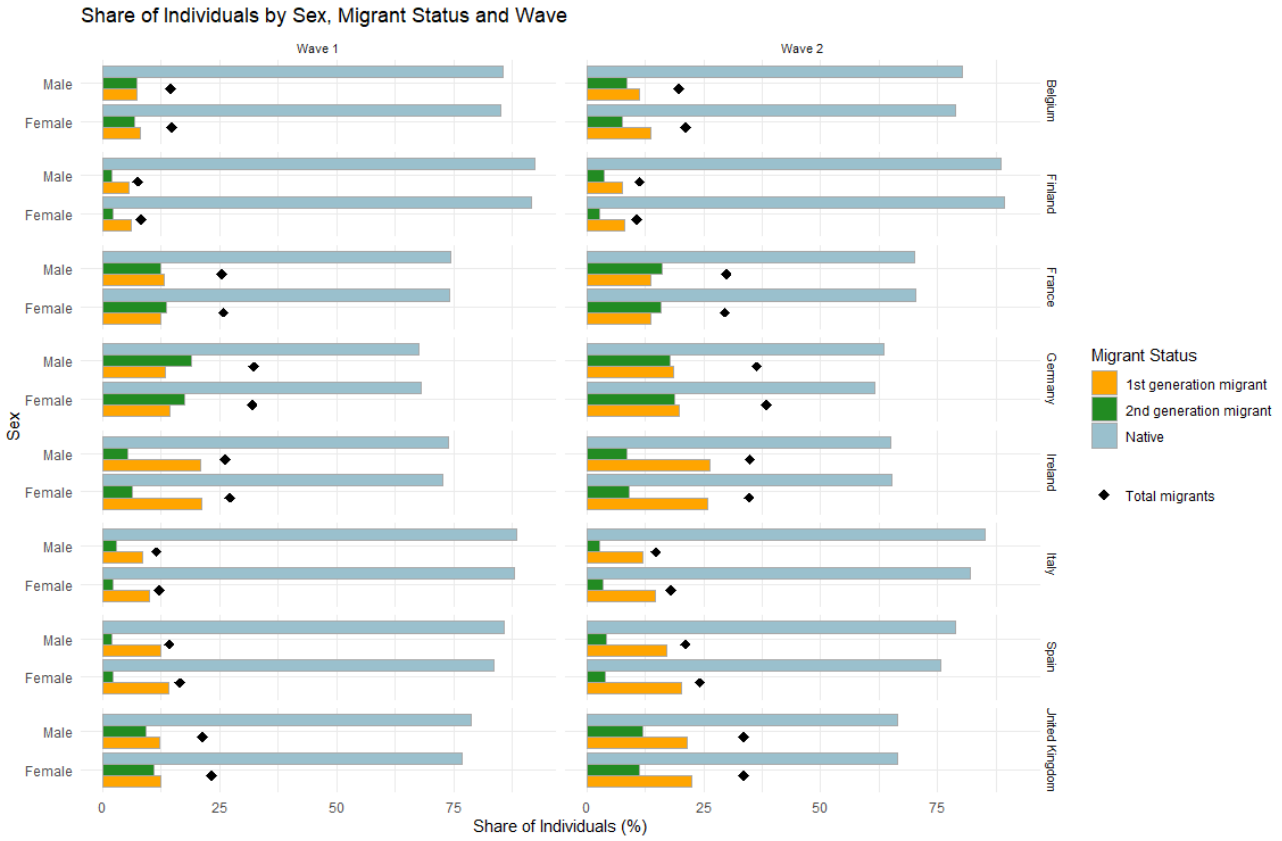
final output provides an estimation and explanation of the effect of relevant variables and interaction terms on the skills gap.

As robustness checks, we additionally estimate models with interactions between migrant background and key predictors (education, language background, employment status) to explore potential heterogeneity in gaps. These interaction effects are generally imprecise and are therefore not discussed in the main text.

The regression was implemented using the *mitools* package in R which allows to perform the linear models on each of the 10 datasets corresponding to each plausible value. The *lapply* function enables the application of the model to all ten different values and respective datasets simultaneously. The models were pooled following Rubin's Rules and using the *MIcombine* function from the *mitools* package

1.4 Analytical sample

The composition of the analysed samples by country and wave (cycle) is presented in Figure 1.



The distribution of immigrants across age groups is right skewed with a majority of younger individuals, regardless the generation. Concerning first-generation immigrants, all countries have maintained similar distributions across gender and age groups. In cycle 1, both women and men were mainly concentrated in the groups 25-45 across countries with the exception of 16-45 in Belgium, 25-65 in Germany and 45-65 in France. On the other hand, in cycle 2, both genders confirmed the significant concentration in 25-45 and expended toward older ages in Belgium for both and France for women. An overall increasing predominance of women in older age groups in Belgium, Italy, Spain and UK is apparent when comparing across cycles and age. Men dominate

the 16-25 age group in Belgium, Italy and UK. Ireland shows men prevailing in 45-65 conversely to average trends. The G2 resembles agender composition of natives.

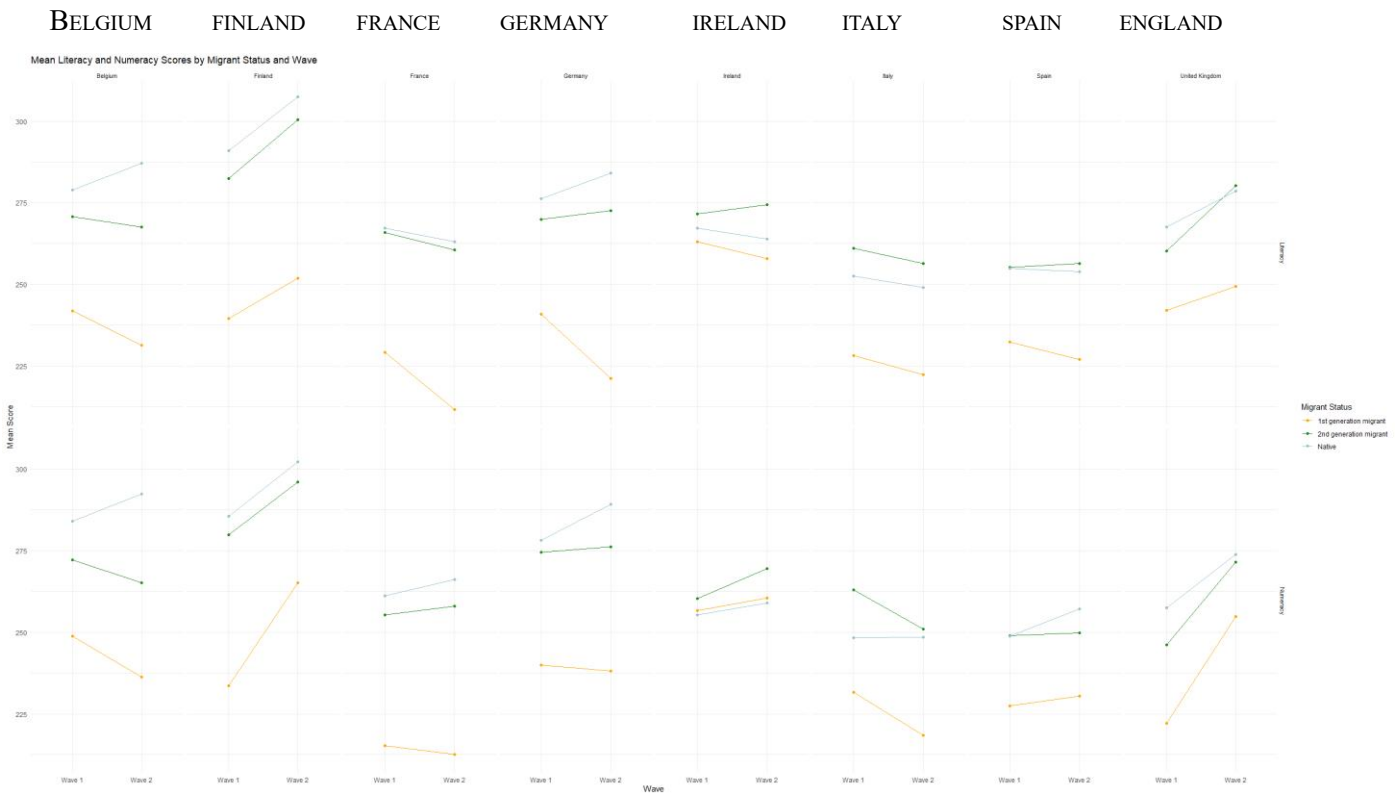
3. Descriptive results

In terms of demographic gap, immigrants are mainly women, low educated and young individuals, aged 25-34. The educational gap between natives and immigrants explains partially the literacy and numeracy skills gap. In fact, the charts clearly highlight the concentration of immigrants in lower levels. Regardless the educational disaggregation and the performance discrepancy, the trends in literacy and numeracy scores reveal that immigrants and natives tend to follow the same increasing or decreasing pattern between the two cycles, with the exception of Belgium and Germany. In some countries such as Finland and England, immigrants' trend is steeper than natives' suggesting a potential ability to improve or an increasing selectivity towards high-educated immigrants as a consequence of the migration policies of the receiving country. In accordance with the progressing educational expansion, younger immigrants report higher education level suggesting an improvement in access to education. This can also be seen in the cross-cycle detail. Worth noting and critical point of this work is the generational gap among immigrants. Not only is a purpose of it to highlight the skill discrepancy between first- and second-generation immigrants but also how differently the skills of these two generations are in comparison to natives. Overall, first-generation immigrants are the most disadvantaged group. On the other hand, second-generation migrants and natives follow mostly the same pattern, although the migration background still and often provoke disparity. Having been raised in a different country from the new residency one or by parents with migration background are the key to discrimination, stereotypes and, consequently, deprivation of the rights that natives daily experience. However, second-generation migrants, included in the second criteria, are integrated into local schools, culture and society explaining the similarity in the trends. Furthermore, the sample of countries allows the identification of the trend across Europe, between northern and southern Eurpoean countries. The former shows a greater performance as a consequence of greater education conversely to the latter whose performance is more stable.

When plotted by generation, as shown in Figure 2, the gap in literacy and numeracy scores is mostly explained by the low performance of first-generation immigrants. Natives and second-generation migrants have a quite similar skill level, although they do not always follow the same trend and pace. With regard to average literacy scores, in France, Spain and England only in cycle 2, second-generation migrants have the smallest gap with natives. However, in Spain, second-generation migrants outperform natives over time as their scores increase compared to the decrease in native averages. Along with Spain, also in Ireland and Italy, second-generation migrants achieve higher scores than natives. This explains why the migrant line for Ireland is above the native one. Moreover, the overall small gap in Figure 2 stems from the higher scores achieved by second-generation migrants and their rise over time compared to their native-born counterparts. In terms of numeracy confirm the literacy trends. The steep pace for first-generation immigrants in Finland explains the overall progress

among migrants altogether. In Ireland and Italy G2 outperform native-born, however, the skills have declined first and the second cycle across all groups. Second-generation migrants' higher scores are not sufficient to counterbalance first-generation immigrants' low scores. This is also due to the very small second-generation migrant sample under study that likely do not well represent the true population. Conversely to literacy, in Spain, natives have surpassed second-generation migrants from cycle 1 to cycle 2.

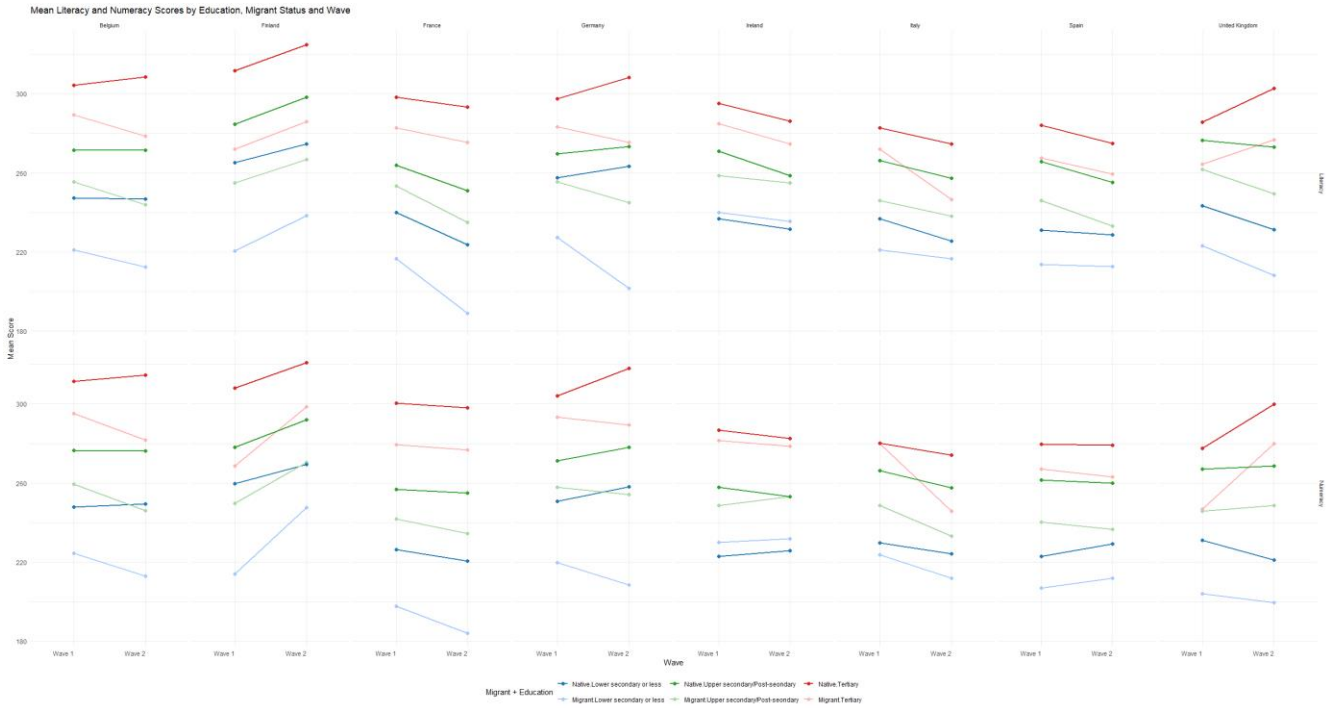
Figure 2: Literacy skill gap (upper panes) and Numeracy skill gaps (Lower panel) between Natives (blue), G1 (Yellow) and G2 (Green), 1st and 2nd PIAAC Cycles



The trends mentioned in Figure 2 are examined adding educational dimension in order to offer a more detailed explanation of the variations across countries and target groups (Figure 3). As expected, the main observation from the chart is that higher mean scores are reached by higher-educated individuals. The native line is in most of the countries constantly above the migrant line, with the exception of Ireland for the lowest education level. The literacy and numeracy outperformance of immigrants in Ireland is due to the outperformance of low-educated immigrants compared to natives. Both populations are progressing over time in Finland, whereas they are regressing in France, Ireland, Italy with a steep decline for high-educated immigrants and a steadier decline for lower-educated immigrants, and Spain. In Belgium, at every level, natives and immigrants have undergone, respectively, an upward and a downward trend. Lastly, as for United Kingdom, the two subgroups follow the same pattern with a disadvantage for immigrants. An interesting observation is that low-educated individuals have attained better results from cycle 1 to cycle 2, while secondary and tertiary-educated individuals have attained worse results.

Figure 3: Literacy and numeracy trends among native-born (full lines) and immigrants (pale lines) by educational attainment

BELGIUM FINLAND FRANCE GERMANY IRELAND ITALY SPAIN ENGLAND



Education: RED = High, Green = Medium, Blue = Low

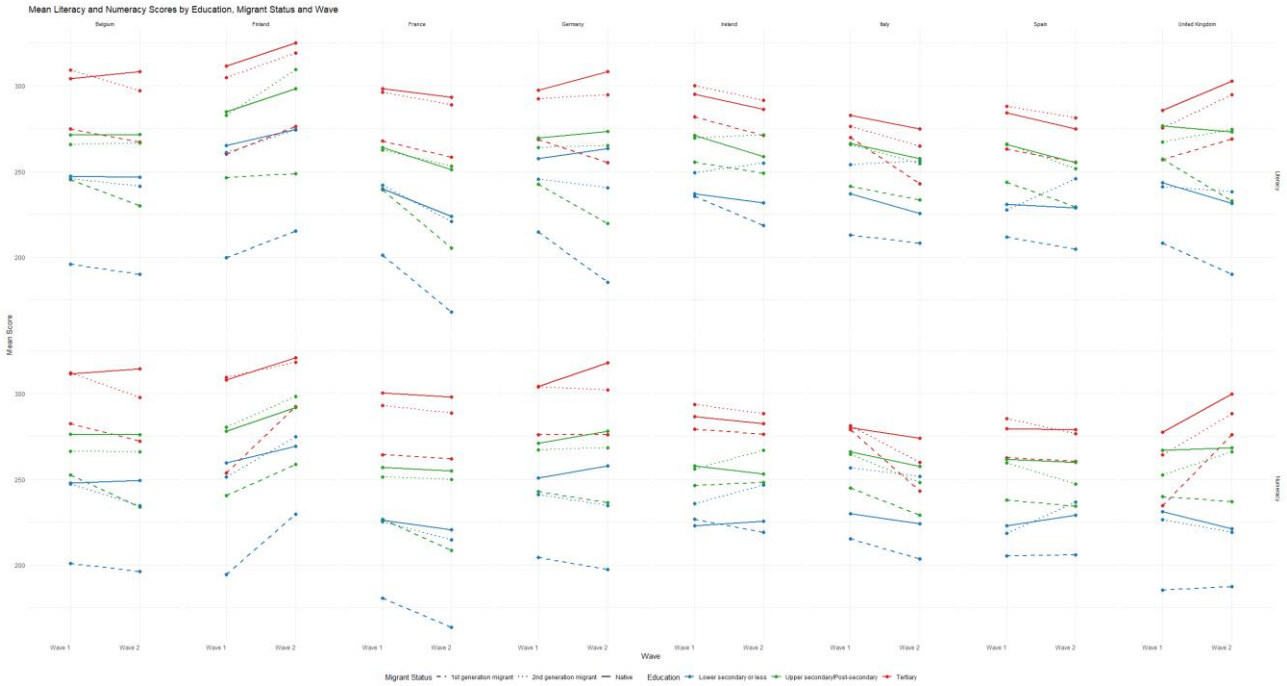
Figure 4 incorporates the intergenerational detail to the distribution of mean skill scores. The solid line, the dashed line and the dotted line denote natives, first-generation and second-generation immigrants, respectively. Overall, natives and second-generation immigrants follow the same pattern and pace. Finland shows the clearest progress over time, and the United Kingdom follows the high performance, despite the increasing scores among high-educated individuals and the decreasing scores among medium-low educated. France, Ireland, Italy and Spain have experienced deterioration with the exception of lower-educated second-generation immigrants. Italy and Spain stand out for their overall low performance compared to other countries. Belgium and Germany are characterised by mixed movements with natives' little progress and immigrants' little worsening. Concerning literacy, in Finland, all three groups have improved their scores from cycle 1 to cycle 2 across all education levels, with G2 immigrants approaching native scores, while, in France, all three groups have worsened. Italy and Spain have the same downward trend for the populations under study with the exception of low-educated first-generation immigrants. Belgium and Germany have a progressive native population and a regressive G1 population. As for G2 migrants, in Belgium, they follow the natives, excluding those high-educated. Conversely in Germany, low-educated G2 migrants' scores are the ones declining in opposition to natives' and the higher-educated immigrants. England has a completely different pattern, as natives and first-generation immigrants have progressed among the highest education level but regressed for the other two levels. Here, second-generation migrants witness a reversed trend with an increase for medium- and high-educated individuals and a decline for low-educated. Relevant result are the low-educated second-generation immigrants surpassing natives in cycle 2 and low-educated ones reaching the native level in Finland. Moreover, medium-educated second-generation migrants in England have reached the native level in cycle 2. The most significant gap between these two groups and first-generation immigrants is

observed in Belgium, Finland, France, Germany, i.e. countries where high-educated natives' scores are generally higher.

Concerning numeracy, the trends are nearly confirmed. The greatest gap is between first-generation immigrants and the other two. In Finland, both immigrants and natives have improved at every education level, while, in Italy and France, both have worsened their performance. Belgium and Germany again follow the same pattern with an increase among natives for all three educations and among G2 migrants for medium-educated against a decrease among G1 immigrants for all three educations and among G2 migrants for the two educational extremes. As in literacy, unlike the earlier conclusions, in Ireland, first-generation immigrants and natives have similar trends and a gap with the second generation is visible, especially among the two low-educated groups. In fact, G2 migrants appear to have attained higher results. This is also the case for low-educated individuals in Italy. In the UK, an interesting observation is that low educated G1 immigrants are slowing increasing their averages, conversely to the second generation and to the natives who are regressing. In the meantime, similar to Finland, high-educated G1 immigrants' scores have significantly risen almost reaching the other two. What can be concluded is that, once again, second-generation migrants, as integrated at a young age into the society where they were born and, therefore, into its educational system, are more likely to approach the advantages of natives, compared to the first generation. However, they are still affected by a rooted inequality. The underperformance of first-generation immigrants can be attributed to both the differences between the sending and the receiving educational systems and the limited access to the second one. Despite the often gap with first-generation immigrants, they do show improving trends across all educational categories.

Figure 4: Mean literacy (upper panel) and numeracy (lower panel) scores by nativity status and educational attainment

BELGIUM FINLAND FRANCE GERMANY IRELAND ITALY SPAIN ENGLAND



Natives = solid line, dashed line = G1, dotted line G2; Red – high edu, Green - medium edu.Blu = Low edu

4. REGRESION ANALYSIS

Regression results complement and refine the descriptive evidence. Baseline models, which include only migrant status or migrant generation, show sizeable and statistically significant migrant–native skill differences in both cycles (Table 1). In Cycle 1, migrants score roughly 10–12 points below natives in literacy and numeracy; in Cycle 2, these raw differences shrink slightly to around 8–10 points. When distinguishing between generations, first-generation immigrants show disadvantages of roughly 15–18 points relative to natives, while second-generation immigrants differ only modestly from natives—typically by 0–4 points, and often not significantly. These patterns underscore the importance of generational distinctions: the overall migrant–native gap is overwhelmingly driven by the first generation.

Fully adjusted models introduce controls for education, parental background, age, gender, employment status, language background, the country of highest qualification, and destination-country fixed effects. Adjusting for education alone reduces the migrant coefficient by roughly one third. Adding parental education and labour-market characteristics further attenuates the gap. Yet even after full adjustment, first-generation immigrants retain statistically significant disadvantages in both cycles and domains, indicating that compositional differences account for much—but not all—of the observed disparities. By contrast, adjusted differences between natives and second-generation immigrants are small and generally unstable, suggesting near-convergence once observed characteristics are taken into account.

4.1 Literacy main effects

The first final model includes main effects only. The two columns for each cycle in Table 1 display the model with the birth region detail and the model without. The exclusion of birth region was decided after acknowledging a noticeable loss of significance for the independent variable *migrant*, which indicates the

distinction between immigrants and natives. According to the intercept coefficient, i.e. the average score when all other predictors are at their baseline level, the reference group averagely scored 238.5 points in Cycle 1. The most relevant result concerns migration status, as it addresses the adjusted literacy skill gap between immigrants and natives. More specifically, immigrants scored an average of 12.0 points less than their native counterparts in Cycle 1, indicating a statistically significant coefficient immigrant disadvantage.

Focusing on the predictors of literacy performance, education has the strongest effect. Higher education explains better performance, in line with the literature. More specifically, tertiary-educated individuals scored 41.0 points higher than lower-secondary-educated and less and about 20 points higher than upper/post-secondary-educated. Likewise, parental education has a smaller beneficial effect. Both parents' education positively affects their children's literacy performance. Individuals with highly educated mothers and fathers scored, respectively, 12.1 and 10.2 points higher.

As for gender, the effect is particularly modest and non-significant. Similarly, younger age groups also show no significant effects, with individuals aged 25-44 scoring about 4.0 points better than those aged 16-24. Conversely, the effect for individuals aged 55-65 is strongly significant. This group scored 9.9 points less than the youngest group. This trend reflects the consequences of aging on cognitive skills and the cohort differences between individuals aged 16-24 and those aged 55-65 in educational systems, advancements and policies.

Although not statistically significant, the country where the highest qualification was obtained reveals interesting results. Respondents who attained their highest education in a non-OECD country are at a disadvantage of 15.8 points, remarkably showing differences in education systems across countries. This conclusion applies to first-generation immigrants, as most of the immigrant sample falls into the non-OECD category. Additionally, the obstacles arising from a lack of knowledge of the test language, i.e. the native language of the country of the interview, are confirmed. Poor proficiency in the test language causes a 16.9-point decline in performance, supported by high significance.

Employment status appears to be a considerably significant factor, except for inactivity. Individuals in education have higher literacy skills than the unemployed, with a 21.4-advantage. Moreover, those in employment have an 8.0-advantage over the unemployed.

With regard to the cross-national patterns, Finland confirms the highest scores already observed in the descriptive results, with 11.6 points better than Belgium. Italy and Spain have the lowest literacy scores with, respectively, 8.5 and 11.1 points less than Belgium. Overall, including the information on birth region does not considerably affect the model. The gap becomes narrow and non-significant, with a disadvantage for immigrants (-2.7). The other effects remain unchanged. All birth regions are associated with worse performance than Northern America and Western Europe. This is most pronounced for South and West Asia

(-40.9), followed by Sub-Saharan Africa (-26.6) and Arab States (24.6). Central Asia and richer countries in East Asia and Pacific show non-significant effects, reflecting small samples.

The column of estimates for Cycle 2 shows patterns similar to those in Cycle 1, although with greater or lesser magnitude. The reference group of natives scored an average of 233.3 points, with all other predictors being at their baseline level (a decrease of approximately 5.0 points). The literacy skill gap between natives and immigrants narrowed to 8.5 (from 12.0 in Cycle 1), revealing a slight convergence between the two groups This disadvantage loses certainty and reaches a level of zero when birth region is included.

The effect of an individual's education on their skills remained stable over time. Regarding parental education, the benefit of a higher-educated mother increased over time, whereas the benefit of a higher-educated father deteriorated. Performance is confirmed to improve as parents are more educated. However, if the temporal perspective is considered, the positive effect deriving from higher maternal education increased from Cycle 1 to Cycle 2, whereas the positive effect of higher paternal education decreased.

Focusing on demographics, gender did not vary considerably. As for age, apart from the stable significant disadvantage for the oldest age group, the ages between 25 and 44 underwent a non-significant deterioration from the age of 25 compared to the 16-24 age group. By Cycle 2, the 45-54 age group had gained significance, and its negative coefficient indicates that individuals in that group scored 6.6 points lower than those in the 16-24 age group and about 4.0 points higher than those in the 55-65 age group.

The disadvantage for individuals who received their highest qualification in a non-OECD country and for individuals who do not speak the test language increased by about 2.0 points from Cycle 1. An insightful result is the increased positive effect of being employed, slightly approaching the benefit of education. Individuals in employment scored 19.9 points higher than the unemployed. Conversely to Cycle 1, inactivity is strongly significant, and individuals in this group perform 8.8 points better than the unemployed.

The discrepancy across countries is consistent with the Cycle 1 trend and are noticeably amplified, with Ireland, Italy and Spain slowly converging and Finland showing a noticeable improvement. Lastly, Cycle 2 confirms and emphasizes the lower performance of individuals born in South and West Asia and Sub-Saharan Africa.

Table 1. Main effects - OLS regression on literacy scores. Cycle 1 vs Cycle 2.
(Reference: Low-educated, unemployed, female natives born of Belgium, aged 16-24, with low-educated parents, proficient in the test language, with highest qualification attained in an OECD country)

Note:
Source: Own

	Cycle 1		Cycle 2	
	- Birth Region	+ Birth Region	- Birth Region	+ Birth Region
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Intercept	238.54*** (2.61)	238.33*** (2.58)	233.28*** (3.02)	233.19*** (2.93)
Migration status				
Immigrant	-12.04*** (1.70)	-2.69 (2.06)	-8.45*** (1.35)	0.00 (1.88)
Education				
Upper/Post-secondary	24.47*** (1.17)	24.36*** (1.18)	20.77*** (1.24)	20.40*** (1.19)
Tertiary	41.07*** (1.22)	40.66*** (1.22)	40.96*** (1.29)	40.56*** (1.27)
Age or Gender				
Male	1.29 (0.89)	1.45 (0.89)	0.37 (1.01)	0.44 (1.01)
25-34	4.06* (1.77)	4.25* (1.77)	-1.54 (1.93)	-1.04 (1.90)
35-44	4.37* (2.12)	4.34* (2.09)	-2.84 (2.03)	-2.02 (2.05)
45-54	0.69 (2.11)	0.40 (2.09)	-6.70** (2.20)	-6.56** (2.14)
55-65	-9.90*** (2.10)	-10.34*** (2.08)	-10.14*** (2.34)	-10.47*** (2.31)
Parental education				
Maternal medium education	5.91*** (1.07)	5.58*** (1.05)	11.31*** (1.32)	10.51*** (1.31)
Maternal high education	12.12*** (1.66)	11.79*** (1.66)	17.60*** (1.71)	16.48*** (1.68)
Paternal medium education	6.11*** (1.16)	5.93*** (1.17)	3.74* (1.54)	4.34** (1.52)
Paternal high education	10.18*** (1.72)	10.30*** (1.68)	5.20*** (1.50)	6.28*** (1.46)
Country of qualification				
Non-OECD country	-15.76 (8.17)	-7.16 (8.47)	-19.48*** (2.62)	-6.37 (3.42)
Language				
Not speaking native language	-16.93*** (2.16)	-10.12*** (2.41)	-18.61*** (1.95)	-9.81*** (2.12)
Employment status				
In education	21.44*** (2.52)	20.78*** (2.48)	26.39*** (2.91)	25.21*** (2.81)
Inactive	0.40 (1.64)	-0.09 (1.62)	8.82*** (2.33)	8.33*** (2.31)
Employed	7.99*** (1.37)	7.77*** (1.36)	19.93*** (2.08)	19.09*** (2.02)
Country of the interview				
Finland	11.64*** (1.04)	12.46*** (1.01)	21.29*** (1.21)	22.25*** (1.21)
Ireland	-3.49* (1.31)	-3.25* (1.29)	-13.09*** (1.31)	-12.59*** (1.30)
Italy	-8.48*** (1.33)	-7.75*** (1.32)	-15.12*** (1.62)	-14.52*** (1.64)
Spain	-11.06*** (1.18)	-10.36*** (1.14)	-17.29*** (1.24)	-17.16*** (1.19)
United Kingdom	0.10 (1.56)	0.61 (1.53)	-2.08 (1.24)	-0.31 (1.24)
Birth region				
Arab States		-24.58*** (4.73)		-17.23** (5.57)
South & West Asia		-40.03*** (9.74)		-46.18*** (6.09)
Latin America & the Caribbean		-15.76*** (3.40)		-18.21*** (3.86)
Sub-Saharan Africa		-26.59*** (6.69)		-29.12*** (4.44)
East Asia & Pacific (poorer)		-19.42* (9.11)		-18.36* (8.71)
Central Asia		6.49 (27.85)		-11.47 (10.65)
East Asia & Pacific (richer)		16.93 (9.00)		4.73 (8.91)
Central & Eastern Europe		-23.69*** (3.63)		-22.73*** (3.66)
R-squared (pooled across PVs)	0.30	0.31	0.33	0.34

elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23). Implementation of survey-weighted linear regression models on each of the ten literacy plausible values pooled into a single output.

4.1.1 Literacy main effects by generation of immigrants

When distinguishing between first- and second-generation immigrants, interesting results emerge. To correctly analyze the skill gap between natives and immigrant generations, it is crucial to consider the limitations and uncertainty resulting from working with small samples, which may affect the outcome.

Table 2 displays the output of the linear regression analysis of plausible literacy values from an intergenerational perspective. According to the results, the reference group scored an average of 238.0 points in the first cycle. Before birth region was included in the analysis, the coefficient for G1 immigrants was highly significant, scoring 17.3 points lower than natives. However, the second generation was consistently non-significant across the regression attempts. Despite this non-significance, the discrepancy between natives and second-generation immigrants is minimal (1.9), showing converging patterns.

Regarding the control variables, the direction and magnitude of the effects are consistent with the pattern observed in Table 1. Education, employment and language proficiency contribute to better literacy performance. The cross-country outcomes observed in the descriptive analysis are confirmed with higher scores in Finland and lower scores in Italy and Spain.

Including information on birth region explains why the coefficient for G1 immigrants loses significance. The gap between this group and natives becomes smaller, converging with the gap between G2 immigrants and natives. Regarding the effect of birth region, all the significant coefficients are negative and considerable in magnitude, suggesting an advantage for European individuals. Since almost all natives and G2 immigrants were born in the reference region of Northern America and Western Europe, the coefficient of birth region is assumed to refer to G1 immigrants. In particular, among G1 immigrants, individuals whose origin region differs from Northern America and Western Europe perform worse. This result is particularly pronounced for South and West Asia (-39.5), followed by Sub-Saharan Africa (-26.1).

The direction of effects observed in Cycle 1 is confirmed in Cycle 2. Nevertheless, the magnitude and significance varied. The reference group averaged 232.5 points, which is slightly lower than in Cycle 1. The gap itself and the effects of the respondent's education, age and gender all showed the same downward trend. More specifically, the literacy gap between natives and first-generation immigrants witnessed a slight reduction (from 17.3 to 15.6 in favor of the former).

Similarly to the broader migrant-native regression output in Section 5.2.1, the impact of paternal education on the respondent's score is lower than in Cycle 1 by about 5.0 points, whereas the impact of maternal education is higher by the same amount.

The coefficient among the oldest age group remains stable and significant, conversely to the almost absent gender effect.

Moreover, an upward trend was observed in employment status, language proficiency and the country of highest qualification. Being in education or employment contributes more considerably to better performance.

The coefficient for inactivity increased in significance and magnitude from Cycle 1 to Cycle 2, proving less damaging than unemployment by 8.5 points. In addition, the disadvantage of not speaking the test language or having obtained the highest qualification in a non-OECD-country slightly increased from Cycle 1.

Focusing on the impact of the countries under study on literacy skills, the direction of the coefficients for each country aligns with Cycle 1. Finland maintains the lead, whereas Ireland, Italy and Spain show the lowest results. When birth region is included, the coefficients remain consistent with those in Cycle 1, with G1 immigrants born in South and West Asia performing 47.7 points worse than those born in Northern America and Western Europe and those born in Sub-Saharan Africa performing 30.7 points worse.

Note: *Table 2. Main effects - OLS regression on literacy scores by generation of immigrants. Cycle 1 vs Cycle 2. (Reference: Low-educated, unemployed, female natives born of Belgium, aged 16-24, with low-educated parents, proficient in the test language, with highest qualification attained in an OECD country)*

	Cycle 1		Cycle 2	
	- Birth Region	+ Birth Region	- Birth Region	+ Birth Region
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Intercept	237.81*** (2.60)	238.30*** (2.60)	232.47*** (3.09)	233.28*** (2.96)
Migration status				
1st-generation immigrant	-17.32*** (1.87)	-3.24 (2.63)	-15.58*** (1.91)	1.70 (3.20)
2nd-generation immigrant	-1.91 (2.44)	-2.32 (2.47)	0.44 (2.26)	-0.70 (2.24)
Education				
Upper/Post-secondary	24.56*** (1.17)	24.36*** (1.18)	20.77*** (1.22)	20.39*** (1.19)
Tertiary	40.88*** (1.21)	40.66*** (1.22)	40.79*** (1.28)	40.54*** (1.26)
Age or Gender				
Male	1.21 (0.89)	1.44 (0.89)	0.28 (1.00)	0.44 (1.01)
25-34	4.44* (1.77)	4.27* (1.77)	-0.95 (1.97)	-1.10 (1.93)
35-44	4.82* (2.10)	4.36* (2.09)	-1.98 (2.09)	-2.09 (2.06)
45-54	1.10 (2.10)	0.42 (2.09)	-5.96** (2.22)	-6.64** (2.15)
55-65	-9.62*** (2.10)	-10.33*** (2.08)	-9.50*** (2.37)	-10.56*** (2.33)
Parental education				
Maternal medium education	5.96*** (1.07)	5.58*** (1.05)	11.48*** (1.32)	10.48*** (1.30)
Maternal high education	12.32*** (1.66)	11.80*** (1.66)	17.85*** (1.70)	16.44*** (1.68)
Paternal medium education	6.24*** (1.16)	5.93*** (1.18)	3.94* (1.54)	4.34** (1.53)
Paternal high education	10.18*** (1.69)	10.30*** (1.67)	5.53*** (1.49)	6.26*** (1.46)
Country of qualification				
Non-OECD country	-12.57 (8.22)	-7.15 (8.47)	-14.39*** (2.79)	-6.35 (3.42)
Language				
Not speaking native language	-13.51*** (2.11)	-10.02*** (2.37)	-14.54*** (2.03)	-10.04*** (2.12)
Employment status				
In education	21.03*** (2.49)	20.77*** (2.48)	25.43*** (2.87)	25.26*** (2.79)
Inactive	0.10 (1.62)	-0.10 (1.62)	8.49*** (2.32)	8.34*** (2.31)
Employed	7.81*** (1.36)	7.77*** (1.36)	19.57*** (2.05)	19.11*** (2.02)
Country of the interview				
Finland	12.09*** (1.04)	12.47*** (1.01)	21.59*** (1.23)	22.25*** (1.21)
Ireland	-2.72* (1.31)	-3.21* (1.31)	-12.25*** (1.33)	-12.73*** (1.36)
Italy	-7.96*** (1.34)	-7.74*** (1.33)	-14.68*** (1.65)	-14.53*** (1.65)
Spain	-10.22*** (1.18)	-10.34*** (1.15)	-16.66*** (1.26)	-17.18*** (1.20)
United Kingdom	0.02 (1.54)	0.60 (1.53)	-1.96 (1.24)	-0.30 (1.24)
Birth region				
Arab States		-24.07*** (5.04)		-18.79** (5.93)
South & West Asia		-39.54*** (9.83)		-47.73*** (6.22)
Latin America & the Caribbean		-15.24*** (3.78)		-19.90*** (4.39)
Sub-Saharan Africa		-26.10*** (6.82)		-30.72*** (5.13)
East Asia & Pacific (poorer)		-18.94* (9.09)		-19.93* (8.63)
Central Asia		6.94 (27.74)		-12.97 (10.54)
East Asia & Pacific (richer)		17.44 (8.99)		3.12 (9.56)
Central & Eastern Europe		-23.22*** (3.98)		-24.24*** (4.16)
R-squared (pooled across PVs)	0.30	0.31	0.33	0.34

Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23). Implementation of survey-weighted linear regression models on each of the ten literacy plausible values pooled into a single output

4.2 Numeracy main effects

Having examined the survey-weighted linear regression output on literacy plausible values, the chapter proceeds with the analysis of the second domain, numeracy. Table 3 illustrates the estimates. The intercept

and migrant-native gap are slightly smaller than for literacy. Low-educated, unemployed female natives of Belgium aged 16-24, with low-educated parents, proficient in the test language and with their highest qualification attained in an OECD-country, scored averagely 229.2 points in Cycle 1. When all the regressors are controlled for, the numeracy migrant-native skill gap is nearly the same as for literacy, with immigrants performing 10.3 points worse than their native counterparts (about 2.0 points less than in literacy).

Regarding education, the upward trend observed with increasing educational level in the context of literacy is also evident in numeracy. Tertiary-educated individuals scored significantly 43.8 points higher than those with lower secondary education and about 20 points higher than those with upper/post-secondary education. The qualification level of both parents has a similar positive effect on their children's numeracy performance (an increase of about 11.0 points for those with highly educated parents).

Conversely to the non-significant gender effect in literacy, Table 3 reveals a significant 10.8-point advantage for men in numeracy scores over their female counterparts. However, this discrepancy will be almost completely absorbed when interaction terms are included (Appendix). An anomalous pattern compared to literacy concerns age. The previously significant and wide discrepancy between the youngest and the oldest age groups is no longer evident. Instead, the gap between the youngest age group and the clustered 25-44 age group gained significance with the latter achieving better numeracy results by about 8.0 points.

Similar results to literacy regression were reported for country of highest qualification, language proficiency and employment status. Although not significantly, individuals who attained their highest qualification in a non-OECD country scored 14.5 points lower than those who attained it in an OECD country. Additionally, individuals with no proficiency in the language of the test underperformed by 15.3 points. Lastly, the coefficients for employment status confirm the positive effect of being in education and, following, in employment compared to unemployment. The benefit of employment is more pronounced for numeracy (12.1 vs 8.0 for literacy).

Information about birth regions reduces the significance and magnitude of the migrant-native numeracy skill gap, which is almost absent in the new model. All other effects remained stable. Regarding the additional independent variable, the results for literacy mirror those for numeracy, with the worst performers born in South and West Asia (-44.6) and Sub-Saharan Africa (-20.8).

In Cycle 2, the reference group scored, on average, 224.7 points, which is slightly lower than in Cycle 1. The migrant-native gap was nearly confirmed, with immigrants experiencing a disadvantage of 9.6 points. Education maintains its strong role in improving numeracy skills, with greater benefits associated with maternal education (from 11.6 to 19.5 between the high- and low-educated) and smaller benefits associated with paternal education (from 11.1 to 6.3). This reversed outcome, which had already emerged in literacy,

continued in Cycle 2. Additionally, being inactive is more advantageous than being unemployed by 10.4 points, with strong significance, alongside being in education and employment.

Gender effect confirms its significance and the male outperformance. On the contrary, age loses significance across the groups and resembles literacy patterns, with worsening results at older ages. Moreover, receiving the highest education in a non-OECD country significantly and increasingly affects negatively individuals' numeracy skills (-21.7). Proficiency in the native language maintains the benefit already observed in the first cycle but with reduced intensity (from 15.3 to 10.8), compared to literacy.

Country effects follow literacy trends. Finland regained the best performance in Cycle 2, with a statistically significant coefficient of 11.9. The United Kingdom underwent progress, despite still scoring less than Belgium (-9.1). All other countries confirmed the results of the first cycle.

Table 3. Main effects - OLS regression on numeracy scores. Cycle 1 vs Cycle 2.
(Reference: Low-educated, unemployed, female natives born of Belgium, aged 16-24, with low-educated parents, proficient in the test language, with highest qualification attained in an OECD country)

	Cycle 1		Cycle 2	
	- Birth Region	+ Birth Region	- Birth Region	+ Birth Region
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Intercept	229.22*** (2.72)	229.11*** (2.69)	224.68*** (3.13)	224.50*** (3.06)
Migration status				
Immigrant	-10.32*** (1.65)	-1.60 (2.01)	-9.60*** (1.46)	-3.43 (1.81)
Education				
Upper/Post-secondary	28.03*** (1.17)	27.90*** (1.16)	23.28*** (1.44)	23.02*** (1.41)
Tertiary	43.83*** (1.30)	43.48*** (1.27)	44.55*** (1.61)	44.26*** (1.57)
Age or Gender				
Male	10.78*** (0.84)	11.04*** (0.83)	11.59*** (1.12)	11.71*** (1.12)
25-34	8.06*** (1.99)	8.35*** (1.99)	-3.18 (2.17)	-2.77 (2.14)
35-44	8.03*** (2.27)	8.14*** (2.23)	-1.86 (2.13)	-1.19 (2.13)
45-54	3.30 (2.23)	3.14 (2.21)	-4.88* (2.40)	-4.71* (2.35)
55-65	-3.95 (2.36)	-4.26 (2.34)	-5.22* (2.43)	-5.40* (2.37)
Parental education				
Maternal medium education	5.22*** (1.35)	4.82*** (1.31)	11.86*** (1.43)	11.12*** (1.42)
Maternal high education	11.58*** (1.66)	11.09*** (1.66)	19.46*** (1.95)	18.49*** (1.90)
Paternal medium education	7.55*** (1.21)	7.26*** (1.23)	5.09** (1.76)	5.58** (1.75)
Paternal high education	11.07*** (1.57)	11.23*** (1.51)	6.30*** (1.81)	7.27*** (1.79)
Country of qualification				
Non-OECD country	-14.48 (7.75)	-5.93 (7.50)	-21.70*** (2.78)	-11.08** (3.98)
Language				
Not speaking native language	-15.31*** (2.10)	-8.77*** (2.28)	-10.75*** (2.22)	-4.52 (2.42)
Employment status				
In education	22.01*** (2.75)	21.48*** (2.70)	26.82*** (2.96)	26.03*** (2.89)
Inactive	-0.96 (1.98)	-1.53 (1.96)	10.35*** (2.31)	9.98*** (2.31)
Employed	12.14*** (1.59)	11.81*** (1.58)	21.81*** (2.17)	21.23*** (2.14)
Country of the interview				
Finland	2.03 (1.09)	2.70* (1.09)	11.89*** (1.28)	12.57*** (1.28)
Ireland	-18.12*** (1.24)	-18.01*** (1.24)	-19.89*** (1.42)	-19.61*** (1.42)
Italy	-14.70*** (1.37)	-14.17*** (1.38)	-19.15*** (1.75)	-18.72*** (1.76)
Spain	-20.00*** (1.00)	-19.56*** (0.98)	-16.82*** (1.20)	-16.79*** (1.18)
United Kingdom	-15.45*** (1.73)	-14.75*** (1.68)	-9.09*** (1.37)	-7.62*** (1.32)
Birth region				
Arab States		-26.70*** (5.23)		-9.93 (6.39)
South & West Asia		-44.61*** (11.16)		-35.07*** (6.48)
Latin America & the Caribbean		-12.81*** (3.68)		-13.82*** (4.19)
Sub-Saharan Africa		-35.83*** (7.02)		-29.50*** (4.61)
East Asia & Pacific (poorer)		-3.00 (11.80)		-3.50 (10.15)
Central Asia		12.54 (25.94)		-3.37 (12.23)
East Asia & Pacific (richer)		20.87* (9.24)		17.44 (9.71)
Central & Eastern Europe		-20.79*** (3.66)		-15.94*** (3.31)
R-squared (pooled across PVs)	0.30	0.31	0.31	0.32

Note: Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23). Implementation of survey-weighted linear regression models on each of the ten numeracy plausible values pooled into a single output.

4.2.1 Numeracy main effects by generation of immigrants

As with the literacy models, the distinction between first- and second-generation immigrants in literacy migrant-native skills gap was explored. Nevertheless, this distinction causes a considerable decrease in the sample size, resulting in less certain findings regarding the gap. Therefore, when all the predictors are taken into account, the significance of the

effect of migration status on numeracy scores falls entirely onto the first generation due to the small size of the second generation. In other words, as reported in Table 4, G1 immigrants significantly scored 15.1 points lower than natives in Cycle 1, but the coefficient for G2 was not significant. However, the small disadvantage (-1.1) aligns with the concept of convergence between the relative patterns of natives and G2 immigrants, due to being raised in the same country and social and educational environment. Conversely, the first generation confirms the most pronounced disadvantage due to greater differences and challenges during the integration process. This explains the wide overall gap between natives and immigrants in Table 3.

Despite the non-significant coefficient of the second generation, all other coefficients remain stable between Table 3 and 4, in both magnitude and direction. When compared to literacy models, the reference group averaged lower scores in numeracy than in literacy, with an average score of 228.6 points in numeracy.

The gap between natives and G1 immigrants significantly narrows by about 2.0 points, whereas the gap with G2 immigrants widens by about 3.0 points, though not significantly. On the contrary, in literacy, the second gap narrowed to nearly zero. Additionally, an unexpected result in the column with information on birth region is the increase in significance of the gap between G2 immigrants and natives. The former scored 5.3 points lower than the latter, which is a downward trend from Cycle 1.

Given the analogous pattern across cycles, the focus shifts to the main discrepancies. Among these, age loses all significance in each group. Similarly to literacy, the advantage of individuals aged 25-44 over those aged 16-24 in Cycle 1 is reversed in Cycle 2. Performance deteriorates with age, though this is not significant in numeracy. Regarding the country of qualification and language barrier, the negative effect of the former increases and the negative effect of the latter decreases from Cycle 1 to Cycle 2, as in the earlier models.

Note: *Table 4. Main effects - OLS regression on numeracy score by generation of immigrants. Cycle 1 vs Cycle 2. (Reference: Low-educated, unemployed, female natives born of Belgium, aged 16-24, with low-educated parents, proficient in the test language, with highest qualification attained in an OECD country)*

	Cycle 1		Cycle 2	
	- Birth Region	+ Birth Region	- Birth Region	+ Birth Region
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Intercept	228.56*** (2.70)	229.11*** (2.70)	224.20*** (3.20)	224.76*** (3.09)
Migration status				
1st-generation immigrant	-15.13*** (1.91)	-1.65 (2.84)	-13.74*** (1.98)	1.18 (3.40)
2nd-generation immigrant	-1.08 (2.40)	-1.56 (2.44)	-4.44 (2.44)	-5.33* (2.42)
Education				
Upper/Post-secondary	28.11*** (1.17)	27.90*** (1.16)	23.28*** (1.43)	22.99*** (1.41)
Tertiary	43.65*** (1.29)	43.48*** (1.27)	44.46*** (1.60)	44.19*** (1.57)
Age or Gender				
Male	10.71*** (0.84)	11.03*** (0.83)	11.55*** (1.11)	11.71*** (1.13)
25-34	8.41*** (1.97)	8.35*** (1.99)	-2.83 (2.21)	-2.91 (2.16)
35-44	8.44*** (2.25)	8.14*** (2.23)	-1.37 (2.19)	-1.39 (2.14)
45-54	3.67 (2.21)	3.15 (2.21)	-4.45 (2.46)	-4.93* (2.39)
55-65	-3.70 (2.35)	-4.26 (2.34)	-4.85 (2.48)	-5.64* (2.42)
Parental education				
Maternal medium education	5.26*** (1.35)	4.82*** (1.31)	11.96*** (1.43)	11.05*** (1.42)
Maternal high education	11.76*** (1.66)	11.10*** (1.66)	19.60*** (1.95)	18.38*** (1.90)
Paternal medium education	7.66*** (1.21)	7.26*** (1.23)	5.21** (1.77)	5.58** (1.75)
Paternal high education	11.06*** (1.54)	11.23*** (1.51)	6.49*** (1.83)	7.22*** (1.79)
Country of qualification				
Non-OECD country	-11.57 (7.83)	-5.93 (7.51)	-18.75*** (3.02)	-11.01** (3.98)
Language				
Not speaking native language	-12.20*** (2.05)	-8.76*** (2.30)	-8.39*** (2.43)	-5.15* (2.44)
Employment status				
In education	21.64*** (2.72)	21.48*** (2.70)	26.26*** (2.92)	26.18*** (2.88)
Inactive	-1.23 (1.96)	-1.53 (1.96)	10.16*** (2.31)	9.98*** (2.31)
Employed	11.98*** (1.59)	11.81*** (1.58)	21.60*** (2.15)	21.27*** (2.14)
Country of the interview				
Finland	2.44* (1.10)	2.70* (1.09)	12.06*** (1.29)	12.58*** (1.27)
Ireland	-17.42*** (1.23)	-18.01*** (1.24)	-19.41*** (1.41)	-19.97*** (1.43)
Italy	-14.23*** (1.38)	-14.17*** (1.39)	-18.89*** (1.77)	-18.76*** (1.76)
Spain	-19.24*** (1.02)	-19.56*** (0.99)	-16.46*** (1.19)	-16.85*** (1.18)
United Kingdom	-15.53*** (1.72)	-14.75*** (1.68)	-9.02*** (1.37)	-7.59*** (1.32)
Birth region				
Arab States		-26.65*** (5.41)		-14.16* (7.00)
South & West Asia		-44.57*** (11.38)		-39.26*** (6.85)
Latin America & the Caribbean		-12.76** (4.34)		-18.38*** (5.02)
Sub-Saharan Africa		-35.78*** (7.24)		-33.83*** (5.71)
East Asia & Pacific (poorer)		-2.96 (11.39)		-7.75 (9.99)
Central Asia		12.59 (25.95)		-7.44 (12.19)
East Asia & Pacific (richer)		20.91* (9.18)		13.07 (9.88)
Central & Eastern Europe		-20.75*** (3.85)		-20.05*** (4.40)
R-squared (pooled across PVs)	0.30	0.31	0.31	0.32

Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23). Implementation of survey-weighted linear regression models on each of the ten numeracy plausible values pooled into a single output.

5. SUMMARY OF RESULTS

Fully adjusted models introduce controls for education, parental background, age, gender, employment status, language background, the country of highest qualification, and destination-country fixed effects. Adjusting for education alone reduces the migrant coefficient by roughly one third. Adding parental education and labour-

market characteristics further attenuates the gap. Yet even after full adjustment, first-generation immigrants retain statistically significant disadvantages in both cycles and domains, indicating that compositional differences account for much—but not all—of the observed disparities. By contrast, adjusted differences between natives and second-generation immigrants are small and generally unstable, suggesting near-convergence once observed characteristics are taken into account.

Including region-of-birth indicators yields further insights. The migrant coefficient diminishes substantially and, in several specifications, becomes statistically insignificant, while penalties for particular origin groups—including respondents born in South Asia, West Asia, and Sub-Saharan Africa—remain large (often 15–25 points). This pattern indicates that part of what appears as a "migrant penalty" in simpler models is more accurately interpreted as an origin-region effect linked to educational opportunities, linguistic environments, or institutional conditions in sending countries.

To sum up, the covariates behave as expected and mirror findings from earlier PIAAC research. Education is the strongest predictor of adult proficiency: tertiary-educated adults score roughly 40–45 points above respondents with lower-secondary education or less, and around 20–25 points above those with upper/post-secondary education. Parental education is also meaningful, with highly educated mothers and fathers associated with an additional 10–15 points, though maternal education becomes somewhat more predictive in Cycle 2. Language background exerts a sizeable influence: adults without native proficiency in the test language score 10–20 points lower, even after accounting for education and country of qualification. Similarly, respondents who obtained their highest qualification in a non-OECD country score substantially lower, reflecting either genuine skill differences or limited transferability of foreign credentials.

Gender differences are small in literacy but sizeable in numeracy, with men outperforming women by about 10 points, consistent with long-standing gender patterns in mathematics-related outcomes. Age gradients indicate declining proficiency among older adults, reflecting both cognitive ageing and cohort differences in schooling. Employment status also correlates with proficiency: adults in education or employment score substantially higher than the unemployed, with differences somewhat larger in Cycle 2.

Destination-country fixed effects reveal persistent cross-national contrasts. Finland consistently exhibits the highest adjusted proficiency, while Italy and Spain remain at the lower end of the distribution. Ireland and the United Kingdom have relatively small adjusted migrant–native gaps, reflecting, at least in part, favourable migrant selectivity. France and Germany, estimated separately due to replication and variable issues, show broadly similar patterns (Appendix B).

Across specifications, model R^2 values hover near 0.30, indicating that observed characteristics explain a meaningful share of skill variation but leave considerable heterogeneity unexplained. Interaction models between migrant background and key covariates (education, employment, language background) generally show limited evidence of systematic heterogeneity—effects tend to be small and imprecise (Appendix D).

Two patterns stand out: higher maternal education is associated with smaller migrant–native skill gaps, and non-native language background widens gaps more strongly in Cycle 1 than in Cycle 2, suggesting improvements in the skill assessment or language environments over time.

6. CONCLUSIONS

This study provided a comparative analysis of migrant–native differences in adult literacy and numeracy in Europe using harmonised microdata from PIAAC Cycles 1 (2011–12) and 2 (2022–23). By analysing two assessments conducted a decade apart and by consistently distinguishing between first- and second-generation immigrants, we provide new comparative evidence on the stability and evolution of adult skill disparities within and across national contexts. Taken together, the results paint a picture of substantial but patterned inequality: skill gaps between migrants and natives are widespread and persistent, yet their magnitude and determinants vary noticeably by migrant generation, national context, and compositional characteristics.

A first major finding is the strong and persistent disadvantage of first-generation immigrants in both literacy and numeracy. Across all countries studied, first-generation immigrants score lower than natives, and this ordering remains highly stable over time. Adjusting for education and other background factors substantially reduces but does not eliminate the differences. This suggests that the lower proficiency of first-generation adults is not solely the result of educational selectivity but also reflects mechanisms such as linguistic barriers, limited transferability or recognition of foreign qualifications, and differences in schooling quality or content between origin and destination countries. The pronounced penalties associated with having obtained one's highest qualification in a non-OECD country and with not speaking the test language natively reinforce this interpretation. These patterns are consistent with research showing that foreign-acquired human capital may not translate directly into host-country skill performance, whether because of differences in curricula, measurement, or the institutional contexts in which skills are used and maintained.

In contrast, the second generation's skill profiles are strikingly similar to those of natives. In both descriptive and adjusted models, second-generation adults score only slightly below natives, and in some cases match or exceed native proficiency. Once compositional factors such as education, parental resources, and language background are accounted for, remaining gaps are small and often statistically indistinguishable from zero. These results echo findings from school-age assessments showing that the second generation exhibits considerable convergence with natives and suggest that these patterns persist into adulthood. They also highlight the importance of early exposure to host-country institutions—particularly schooling, language environments, and peer networks—in shaping long-term skill development. The fact that second-generation adults do not appear to lose ground over time suggests that the cognitive benefits of host-country schooling are lasting and that the skill trajectories of immigrant-origin populations are far from uniform.

A second key finding concerns the evolution of skill gaps over time. Despite rising educational attainment among many immigrant populations and policy efforts aimed at improving integration, we find limited evidence of systematic narrowing of migrant–native gaps between 2011–12 and 2022–23. In most countries, migrants and natives move in parallel: both groups improve modestly (as in Finland and the United Kingdom) or decline (as in Italy and Spain). Yet the relative position of first-generation immigrants remains largely unchanged. This stability of disparities suggests that macro-level educational or labour-market improvements can benefit both groups without necessarily reducing the distance between them. Only in a few cases—such as Ireland, where migrants outperform natives in numeracy—do changes in immigrant selectivity, labour-market structure, or policy context appear to generate notably different

trajectories. These patterns underscore that the evolution of migrant–native skill gaps is shaped not only by individual educational backgrounds but also by the broader institutional settings in which migrants live and work.

A third key pattern concerns the role of educational attainment, both own and parental. Education is the strongest predictor of adult literacy and numeracy, with tertiary-educated adults scoring substantially higher than those with lower-secondary schooling. However, even within educational groups, large differences remain between first-generation immigrants and natives, suggesting that formal educational credentials alone do not capture skill-relevant differences. Parental education—especially maternal education—also emerges as a meaningful correlate of adult skills, and its increasing predictive power in Cycle 2 highlights the continued influence of intergenerational resource transmission. Yet these patterns vary across migrant generations: the second generation, whose parents may face linguistic or labour-market disadvantages, often benefits from aspirations, motivation, and educational investment shaped by migration experiences. These findings align with research on "ethnic mobility optimism," while also illustrating that parental resources continue to matter for adult skill acquisition even well beyond the transition to adulthood.

National context is another crucial axis of variation. Across cycles, Finland consistently displays the highest proficiency levels for migrants and natives alike, whereas Italy and Spain remain among the lowest performers. These rankings persist after adjusting for compositional factors, suggesting that institutional features such as the strength of vocational education systems, adult-learning opportunities, and labour-market structures play an important role in shaping skill levels. Countries with highly selective immigration systems, such as Ireland and the United Kingdom, tend to exhibit smaller migrant–native disparities or even migrant advantages, at least in numeracy. By contrast, countries receiving substantial inflows of refugees or lower-educated labour migrants often show wider gaps. These findings highlight the need to interpret migrant–native skill differences in light of migration regimes and opportunity structures that vary across contexts.

Several limitations of the study merit acknowledgement. First, the PIAAC public-use files lack detailed information on age at arrival, migration motive, legal status, language proficiency, and the duration and context of schooling, all of which are likely to shape adult skill trajectories. Without these variables, we cannot disentangle the experiences of refugees from those of labour or family migrants, nor can we examine the "1.5 generation," whose early arrival may produce distinct skill outcomes. Second, sample sizes for second-generation immigrants remain small in several countries, limiting the precision of some estimates. Third, although we use repeated cross-sections, PIAAC cannot provide longitudinal trajectories of skill development. Skill changes within individuals—whether shaped by labour-market experiences, training, or linguistic assimilation—remain unobserved. Fourth, while the availability of two cycles represents a significant advance, attributing changes over time to specific policies is inappropriate given the observational design and the multitude of contemporaneous changes between 2011–12 and 2022–23.

Despite these limitations, the findings carry important implications for policy and future research. First, the persistent disadvantages observed among first-generation immigrants underscore the need for policies that target adult skills directly. High-quality language instruction, support for recognising and upgrading foreign qualifications, and access to vocational training and lifelong learning opportunities may help reduce structural barriers to the effective use of skills. Second, the near parity between natives and the second generation highlights the long-term value of early investment in equitable schooling, language acquisition, and inclusive educational environments. Policies that foster integration from the earliest stages of the life course are likely to yield substantial returns well into adulthood. Third, the substantial cross-national variation observed in this study suggests that skill gaps are not immutable but reflect the institutional

environments in which immigrants settle. Comparative research can play a key role in identifying which combinations of migration regimes, education systems, and labour-market policies promote skill development and reduce inequalities. Future work could extend this analysis in several directions. The availability of additional PIAAC cycles will allow researchers to move beyond two time points and better understand whether the tentative improvements observed in some contexts represent emerging trends or temporary fluctuations. Linking PIAAC to administrative data—where possible—could illuminate how skills translate into employment trajectories, earnings mobility, and broader measures of social participation. Moreover, access to more detailed information on migration histories would enable finer-grained analyses of heterogeneity by age at arrival, migration motive, and legal status. Finally, qualitative and mixed-methods research could help contextualise the quantitative patterns documented here, shedding light on how immigrants perceive, develop, and deploy their skills in everyday life.

In conclusion, this study demonstrates that migrant–native differences in adult literacy and numeracy remain a salient feature of European societies. While the second generation shows clear signs of convergence, substantial disadvantages persist among first-generation adults. These gaps are shaped by educational and linguistic resources, origin-region characteristics, and institutional environments, and they have remained remarkably stable over the past decade. At the same time, the substantial cross-country variation observed in both absolute proficiency levels and the size of gaps underscores that these disparities are neither inevitable nor fixed. Institutions, policies, and opportunity structures matter—and understanding these contextual influences is essential for designing integration policies that support migrants' capacity to develop and use their skills over the life course.

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