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Working paper

Skill gaps between natives and immigrants in Europe: evidence from two cycles of PIAAC survey

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Abstract

The integration of immigrants into host societies is a widely debated issue with significant implications for host societies and economies. Unlocking immigrant human capital potential depends on the successful integration of immigrants and their children into the labor market and the society. The skills gap between immigrants and natives, including differences in qualifications and foundational skills, often hinders integration, limiting immigrants' opportunities. Using data from the first and second PIAAC cycles, this work examines the skills gap in European countries, focusing on its persistence, reduction or expansion over time and between first- and second-generation immigrants. More specifically, it addresses literacy and numeracy skills as a measure of immigrants' participation in the host social and economic context. This work explores the impact of factors such as one's own or parents' education and language barrier on literacy and numeracy performance, along with their impact on the migrant-native gap itself. It reveals the existence of a gap between immigrants' and natives' skills, with an immigrant disadvantage, more pronounced for the first generation and converging towards natives for the second generation. However, these trends vary over time, depending on the domain and country. This work provides useful insights to inform policies aimed at reducing disparities and promoting development in destination and origin countries.

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1. Introduction

Immigrants' socioeconomic integration is one of the most debated societal issues. Vis a vis shifting migration trends towards the EU, it has been at the core of policymakers' concerns, and it is widely discussed in academic literature as well as in public discourse, particularly with regard to immigrants from non-European countries. On the one hand, migration contributes to population and socioeconomic growth favoring both destination and origin country. Regarding the latter, academic literature has often discussed the fiscal impact of immigrants, meaning their contribution to taxes compared to the public spending such as child and housing support (Vargas-Silva, 2015; Sallam and Christl, 2024). Overall, this impact may be either beneficial or detrimental on public spending, depending on immigrants' gender, origin, educational status and migration channel. Among the benefits to the host society, for instance, immigration provides labor force and, to some extent, tackles labor shortages, hence, encouraging productivity and economic progress (Luz, 2025). Although immigrants tend to leave their home countries at their working age, and although they are positively selected in terms of their education with respect to their origin country, recent literature finds that net fiscal effects of first generation immigrants from outside EU is negative while opposite is true for the second generation (Christl et al., 2022; Sallam and Christl, 2024). Positive net fiscal impacts have been shown for high-skilled immigrants and those from other EU countries (Christl et al., 2022).

The benefits of immigration to both origin and destination country can solely be guaranteed if a successful integration process of immigrants and their children is achieved. Cognitive skills play a crucial role in shaping the integration pathways and the often-resulting difficulties immigrants face once they enter the destination country. Literacy, numeracy and problem-solving skills are foundational as they enable participation in society and the successful integration into the current and future labor markets (Batalova & Fix, 2015). Additionally, in the context of integration and adaptation, cognitive skills enable the determination and measurement of individuals' achievements in terms of health, wealth and other social and economic advancements (Levels et al., 2017). Nevertheless, these skills are often subject to comparison between immigrants and natives, with the latter defined in this work as individuals born in the receiving country with both parents also born there.

Evidence shows that the different educational, cultural and socio-economic background of immigrants contributes to increasing migrant-native skills gap and constitutes a barrier to the immigrant group's access to the destination society and labor market (Batalova & Fix, 2015). Therefore, exploring the skills gap between immigrants and natives may provide support to the understanding of an overall challenging integration process.

As widely discussed in the literature, on one hand, skills determine individuals' integration into the labor market in terms of functioning as criteria of admission to it, on the other hand, skills fall into a mechanism of possible mismatch. Skill mismatch is depicted as the misalignment between individuals' former skills (achieved prior to the job) and the skills required for that job. This mismatch can refer to either over- or under-education of individuals compared to the level of education and skills required for their new job (Pivovarova & Powers, 2022). According to Pivovarova and Powers,

immigrants are more likely overeducated and, hence, mismatched than the natives. This is mainly the case for first-generation immigrants, as a consequence of the non-transferable qualifications and skills, together with late access to the labor market and limited social capital at destination (Pivovarova & Powers, 2022). The arrival in adult age and the admission to an already structured society often leads the host population to perceive immigrants as strangers and as a threat to native's labor market prospects. Immigrants are often perceived as unfair competition at the job market and blamed for occupying jobs which causes unemployment among natives (Niyimbanira & Madzivhandila, 2016). Therefore, our analysis considers several dimensions of human capital, including educational attainment, functional literacy and numeracy as well as where immigrants received their qualifications. Educational attainment, time spent in formal education and the school system are among the most salient predictors of skills and, therefore, their socio-economic mobility in the host country (Schnepf, 2006).

As already mentioned, accounting for migrant generation is essential. The generation dimension within the immigrant subpopulation distinguishes between immigrants and their descendants and provides an analytical lens well suited to examine and evaluate the role of where the respondent was educated (Azzolini et al., 2012). In other words, if both first and second generations of immigrants are considered, it is possible to analyze how being educated in a certain educational system can affect individuals' competencies and performance in the local economy. First-generation immigrants (G1) who migrated as adults, after the age of 18 or so, find themselves catapulted directly into the dynamics of the receiving society and labor market and (Levels et al., 2017). On one hand, many move to a new country to seek job opportunities or better standards of living, on the other hand, these people are still confronted with a different work and social system. Recognition of qualifications, skills transferability and overeducation and brain waste are among the challenges G1 immigrants face at local labor markets. In contrast, second-generation immigrants (G2), i.e. the descendants of immigrant parents who were born in the host country, are socialized in the country and educated in the country's education system and cultural environment, resulting in potentially better applicability of skills and acquisition of social capital (Levels et al., 2017). Lastly, both generations differ in their language skills. Language proficiency is a significant barrier for first-generation immigrants who often possess an insufficient language proficiency (Eurostat, 2023). Language constitutes a smaller barrier for G2, as they were raised and educated in the host country and exposed to the host country's language at an early age.

In this work, G1 are defined as individuals born abroad and G2 are defined as individuals who were born in the host country and have at least one foreign-born parent. Research studies often differentiate between G1 and G1.5, i.e. immigrants were born abroad and arrived as children with their parents. These immigrants are partially socialized and integrated in the receiving context (Levels et al., 2017). The possibility to distinguish G1.5 from G1 in this work is, unfortunately, hampered by insufficient sample sizes, therefore, we limit the analysis to G1 and G2.

The purpose of this study is to investigate whether the skills gap between immigrants and natives persists, diminishes or widens over time and across generations, after measuring both counterparts' skills and controlling for their socio-economic and migrant characteristics. It aims to examine the relationship between immigrants' cognitive skills and their socio-demographic characteristics already widely discussed in the existing literature (further elaborated in the literature review in the next section). This work provides novel evidence and insights particularly focusing on temporal trends. This

is essential because the composition of immigrant and migration trends have profoundly changed since 2015 towards immigration from outside the EU and towards larger flows of irregular and humanitarian immigrants who are subject to regulated access to the labor markets. Existing studies exploited the first cycle of PIAAC (Programme for International Assessment of Adult Competencies) for this purpose (Cathles et al., 2021). More recently, OECD analyzed the second PIAAC cycle. To this day, we could not find any study that analyses both PIAAC cycles and focuses on temporal shifts. Therefore, this study aims to address this important research gap. Consequently, the results can support effective management of skilled migration and provide crucial evidence for maximizing its benefits for both immigrant and receiving populations.

Next, this work proceeds as follows. In the next Chapter 2, we introduce the objectives and the research questions. Chapter 3 provides a summary of the existing literature that explored the migrant skills gaps. Starting from this state of art we dive into the quantitative analysis itself. Chapter 4 first introduces the data and the data sources that are the empirical basis of the study. Next, we introduce the methodology. This chapter also details the data cleaning and the data processing, including a detailed overview of the two implemented descriptive and regression analyses. Chapter 5 presents first the descriptive results and thereafter the regression results. The results of both are summarized and juxtaposed to the state of art in the discussion in Chapter 6. Lastly, before the final conclusions, in Chapter 7, we acknowledge the limitations of the study in both data collection and methodology.

2. Objectives and research questions

We investigate four main research questions formulated from broader to narrower perspectives. The migrant-native gap has been at the center of several existing discussions confirming it. First, we ask whether what gaps exist in immigrants' and natives' education and skills. These skills are restricted to functional literacy and numeracy. Although many studies analysed skill gaps among adolescents and young adults using either solely PISA survey or a combination of PISA and PIAAC data, we focus on adults because their human capital forms the basis of current labor force.
Our first research question is, thus:

RQ1: "What is the skills gap between immigrants and natives starting from literacy and numeracy skills in European destination countries?"

Next, we specifically focus on different aspects of the gaps and their evolution.

RQ2 addresses the temporal shifts: "How has this gap evolved over time, specifically from Cycle 1 (between 2011-12) to Cycle 2 (2022-23)?"

RQ3 turns the perspective towards the generational perspective: "Is there a difference in pattern when we distinguish between first-generation immigrants and second-generation immigrants?"

And, finally, **RQ4** investigates the causes and explanatory variables of the skills gaps: "What are the variables that most affect the migrant-native literacy and numeracy skill gap? And how?"

With respect to RQ2, we examine whether the skills gap persists, narrows of widens over time as immigrants settle in the host society country. Investigation of the RQ3 sheds important light into the social mobility and adaptation of first-generation immigrants and second-generation immigrants. Descriptive analyses provide initial evidence for the first three research questions and help assess whether composition of immigrants and socio-demographic characteristics of both immigrant and native subpopulations shape the gaps. We perform regression analyses controlling for these characteristics and incorporate other important variables such as language proficiency for the sake of assessing the actual magnitude of the gaps in literacy and numeracy. Finally, employing regression analysis we investigate the effect of specific independent variables on the migrant-native skills gap. Multiple models need to be implemented to explore the role of socio-economic and demographic variables that influence migrant-native gap and the direction and magnitude of their effects. These are detailed in Section 4.2.

3. Past evidence on migrant – native skill gaps

Investigation into and a more nuanced understanding of migrant-native skill gaps has been enabled by implementation of comparative survey programs such as PISA and PIAAC supported by the OECD. Therefore, this topic is frequently explored by grey literature, starting from the OECD reports that comprehensively analyze skills gap to the concepts of selectivity, integration and education (OECD, 2014). Given the considerable relevance of the OECD as the data provider as well as knowledge producer, this literature overview will particularly rely on their reports. As a matter of fact, OECD reports present important support and clarity to the complex and dynamic concept of migrant-native skills gap. The studies referenced in this literature review refer either to the specific use of PIAAC data or to the theoretical concept of skills gap, along with different material or analytical methods.

Before delving into the details of skills gap and how to measure it, it is necessary to note that the concept of skills has been defined and conceptualized in various ways because of complexity and multidimensionality of skills and the gaps arising in different skill domains. The distinction between hard or cognitive skills and soft or non-cognitive skills is particularly relevant in the context of this study. Both groups of skills, combined or not, are often used as a tool of admission and integration of individuals into the labor market. Non-cognitive skills are influenced by personality traits, whereas cognitive skills are technical abilities (OECD, 2025). OECD considers cognitive skills as a tool for measuring the capacity of individuals to interact with professional and social contexts. This literature overview, therefore, focuses on cognitive skills, as measured in the Survey of Adult Skills (PIAAC).

Related concept in the context of skill differentials among immigrants is skill mismatch. Both the migrant-native skill gap and skill mismatch refer to the moment individuals gain access or try to access the host country's labor market, and both have long-term and multidimensional impact on individuals, shaping their social interactions as well as labor market trajectories. ***Skill mismatch*** refers to the actual misalignment between the educational skills obtained prior to the job and the skills required for the job (Pivovarova & Powers, 2022). ***Migrant-native skill gap*** refers to the moment immigrants' former skills and natives' former skills are compared resulting in discrepancy. This discrepancy reflects how

these two subgroups enter the labor market and, consequently, the society and is nested in differing levels of human, social and cultural capital individuals possess and have access to within the host society. Measuring both the gap and the mismatch can point towards immigrant disadvantage and the inequality within the host society.

The skill mismatch can arise because of an existing skill gap. Pivovarova and Powers (2022) refer to the human capital theory, according to which education and competencies cannot be straightforwardly transferred from the origin country's to the receiving labor market, because of differences in, for instance, the educational system or the language proficiency. Possession of skills relevant at the host country's labor market and transferability of skills, thus, play a crucial role and facilitate matching of immigrants to the vacancies corresponding to their skills. Based on PIAAC data by Pivovarova and Powers (2022) conclude that immigrants in the United States are more inclined to be overmatched for their jobs than natives, meaning that they usually have higher and stronger skills than what their job requires. Further, immigrants are more likely to be placed in occupations that require lower education than what they actually have achieved in their origin country, also due to the aforementioned non-transferability of skills. This mainly occurs among specific occupations held prior to migration that require additional investment in learning country-specific knowledge and training to access the same sector as in the origin country (Lancee & Bol, 2017). As a result, the abilities are not recognized and accurately utilized. Therefore, the productivity that arises from these individuals' work will not be maximized but rather constrained. As expected, problems with skill recognition can have a relevant and sustained impact on the individual's opportunities, impacting their social and economic integration as well. Moreover, the detrimental effect of skills mismatch spills over to the origin countries because of remittances that immigrants transfer to their families and local communities. Consequently, their home countries will also suffer from the underutilization of their skills. Likewise, immigrants' limited productivity negatively impacts host country's economy (Pivovarova & Powers, 2022).

Skill mismatch, skill waste and overmatching mainly affect the first generation (G1), as second-generation immigrants (G2) obtain their education in the country and face immediately its educational, working and societal environment., and thus, G2 possess more relevant social capital, i.e. the social networks among people in a certain society, that facilitates integration, adaptation and inclusion and the resulting benefits and stability (Pivovarova & Powers, 2022).

The existing peer-reviewed literature mainly focuses on measuring immigrants' skills and how these are influenced by socio-demographic factors (Batalova & Fix, 2015). While some studies focus on a single country-context (for example, Richwine, 2022) a few other studies are comparative (Cathles 2021; Levels et al. 2017). However, very few examine the cross-national perspective combined with an analysis of skills distribution over time. In terms of spatial coverage, the focus is on high-income countries, due to data availability. Many papers use US as case of study along with Western European countries (Batalova & Fix, 2015; Richwine, 2022). Furthermore, adults aged 16-65 are the focus of this work, conversely to the majority of existing literature exploring kids at the school age of 15 (Levels & Dronkers, 2008).

Cathles et al. introduce the evolution of the skills gap over time and the relevance of studying it to understand immigrants' integration (Cathles et al., 2021). The authors explore the skills gap between immigrants and natives by drawing on the

first cycle of PIAAC and the PISA (Programme for International Students Assessment) and performing both descriptive and regression analyses. These two data sources enable the analysis across generations, by taking 15-year-olds from PISA in the 2000 and 2003 cycles and the adults of the same birth cohort as in PISA from PIAAC in 2011-12 and 2014-15, i.e. before the major shift in migration patterns towards Europe and rise in humanitarian migration. Additionally, the authors examine how school quality variables, including school resources, autonomy and accountability, affect the skills gap. The results reveal a convergence of second-generation immigrants' and natives' skills over time, compared to first-generation immigrants, and an increase in the gap across generations. These findings align with earlier studies that provided theoretical explanations for the skills gap between natives and immigrants in the major destination countries[1] (Levels et al., 2017). The widest gap is between the first-generation immigrants and natives and, according to Levels (2017), this result is explained by the fact that PIAAC survey was administered in the local language. In this paper, the findings reveal that half the total cross-national skills gap between first-generation immigrants and natives and two thirds of the skills gap between 1.5 generations (immigrants who were born in a foreign country and migrated to a different country at a young age) and natives is explained by immigrants' educational attainment or parental background. However, these studies only focus on adolescents and young adults, leaving a gap in the assessment of the gaps among older working age population.

With regard to parental background, family and the environment in which children were raised play a considerable role in shaping children's qualifications and opportunities. This goes under the widely discussed concept of intergenerational transmission of education and social mobility, which consists in the transmission of educational level and qualifications from the parents to their children (Martin, 2011). Children's education and future socio-economic status are highly correlated with their parents' education and socio-economic status, as parents inflict their aspirations on children's educational choices and are in position to influence children's educational paths. Therefore, the education background of the family is relevant to understanding why competencies (skills) can vary from one group of individuals to another and from a generation to another of the same group. For instance, evidence shows that some groups of G2 immigrants tend to have high educational aspirations, as a consequence of their immigrant parents' high aspirations (Heisig & Schaeffer, 2020). The aforementioned study states that the immigration process requires motivation, aspiration and risk tolerance, subsequently, transmitted to the next generation. Furthermore, Richwine finds that wide skills gaps appear between natives and immigrants with the same age and educational attainment and the size of the gaps depends on where immigrants completed their education (Richwine, 2022).

Measuring individuals' cognitive skills is particularly complicated. The obstacles include lacking unique definition of skills as well as of migration. To reduce complexity arising from multidimensionality of skills, most of the existing literature focuses on specific variables that are potentially playing a relevant role in shaping the skills gap between natives and

[1] Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, the United Kingdom, and the United States.

immigrants. The examination of migrant-native skills gaps is often reduced to the evaluation of inequality in educational attainment and in quantity of schooling, pointing to the widely discussed disadvantage of immigrants (Schnepf, 2006). Multiple studies documented disparities in educational outcomes of immigrants and focused on the gap in achievements at school (Schnepf, 2006; Azzolini et al., 2012; Levels & Dronkers, 2008). Therefore, the age range of the target population was restricted to young individuals of school age.

Azzolini and Levels include the generational perspective to study of skills gaps (Azzolini et al., 2012; Levels & Dronkers, 2008). Similarly to this work, authors make comparisons between natives and immigrants and between G1 and G2, however, the focus is not on adults but on 15-year-olds. These studies suggest that multiple factors affect skill acquisition among adolescents. The conclusions from these papers differ depending on which predictors, such as family or educational background, are selected or which countries are considered. The common finding is that a gap between natives' and immigrants' skills exists, although who outperforms and to what extent is not straightforward. In fact, the direction and magnitude of the gap varies with the social, cultural and economic context. Azzolini et al. (2012) narrows the analysis to Italy and Spain and concludes that the gap is particularly evident among G1 pupils, whereas the G2 reveals a consistent disadvantage relative to natives but a better performance relative to the G1 (Azzolini et al., 2012).

Levels & Dronkers (2008) follow a wider cross-national perspective by analyzing thirteen European destination countries and only focusing on mathematical skills. Mixed results are found as a consequence of different effects from social and economic backgrounds, depending on the country of destination and a country of origin (Levels & Dronkers, 2008). Levels et al. (2017) later deepened the previous investigation by shifting the target population from adolescents to adults (age 16 to 64) and including both literacy and numeracy skills, and extended the scope to non-European OECD countries. The study confirmed the skill gap and that it varies depending on various factors. For instance, the language plays a crucial role. Surveys like PIAAC are administered in the language of the country of the interview, indicating selection towards respondents with some proficiency in host country's language. It also confirmed that G1 immigrants often seem to report a moderate disadvantage compared to natives (Levels et al., 2017). The existing literature is lacking in terms of temporal analysis and of recent times. For instance, the aforementioned papers that mostly use PIAAC or PISA data limit the study to the first cycle of survey. Therefore, the findings refer only to a specific time period, without considering the evolution of skills and the gap between native and immigrant populations over time.

4. Data and methods

4.1 Data

To examine the skill gaps between immigrants and natives and between G1 and G2 immigrants we utilize the data from the *Survey of Adults Skills* (PIAAC) which is part of OECD's cyclical *Programme for International Assessment of Adult Competencies* (PIAAC). We use datasets retrieved from the available microdata files for public use (PUFs - Public-Use

Files). PIAAC data measures adults' skills in functional literacy, numeracy and problem-solving through test scores and includes questions on family and educational background of the respondents. These three skill domains are recognized by the OECD as crucial for the complete integration into society and the labor market (OECD, 2024). PIAAC integrates a background questionnaire, administered using Computer Aided Personal Interviewing (CAPI), and the assessment of literacy, numeracy and problem-solving proficiency. This work focuses solely on literacy and numeracy proficiency and excluded the problem-solving dimension because of differences in its measurement across the cycles of PIAAC survey. The broad definition of literacy and numeracy skills used by the OECD and in this work are the following:

- *Functional literacy*: the ability to read and understand written texts,
- *Numeracy*: the ability to understand and use mathematical and numerical information.

Not only does functional literacy express the ability to read, but also how the information is understood and processed and how individuals use this ability in everyday life. This enables the assessment of individuals' ability to participate in societal and professional contexts. Literacy and numeracy scores and levels (further detailed in Section 4.2) are used in the analysis to determine immigrants' and natives' skills and compare them.

To date, two PIAAC survey cycles have been carried out, and this work combines the data from both. The first cycle (Cycle 1) was conducted in three rounds in 39 countries: the first round in 2011-12, the second round in 2014-15 and the third round in 2017. The second cycle (Cycle 2) was conducted in 2022-23 in 31 countries. To allow a consistent analysis across countries and the comparison of the patterns, only the countries that collected surveys in both cycles were taken into consideration. We selected European countries with sizeable immigrant populations for the purpose of the study: Belgium (the Flemish Region only), Finland, France, Germany, Ireland, Spain, Italy and the United Kingdom (England only). All the countries selected participated in Cycle 1 of the *Survey of Adults Skills* in 2011-12 and in Cycle 2 in 2022-23. The target sample consists of adults aged 16-65. Countries with small immigrant populations, such Poland, Slovakia and Czech Republic, as well as counties that did not release key socio-demographic variables (gender, educational attainment) could not be included in the analysis[2].

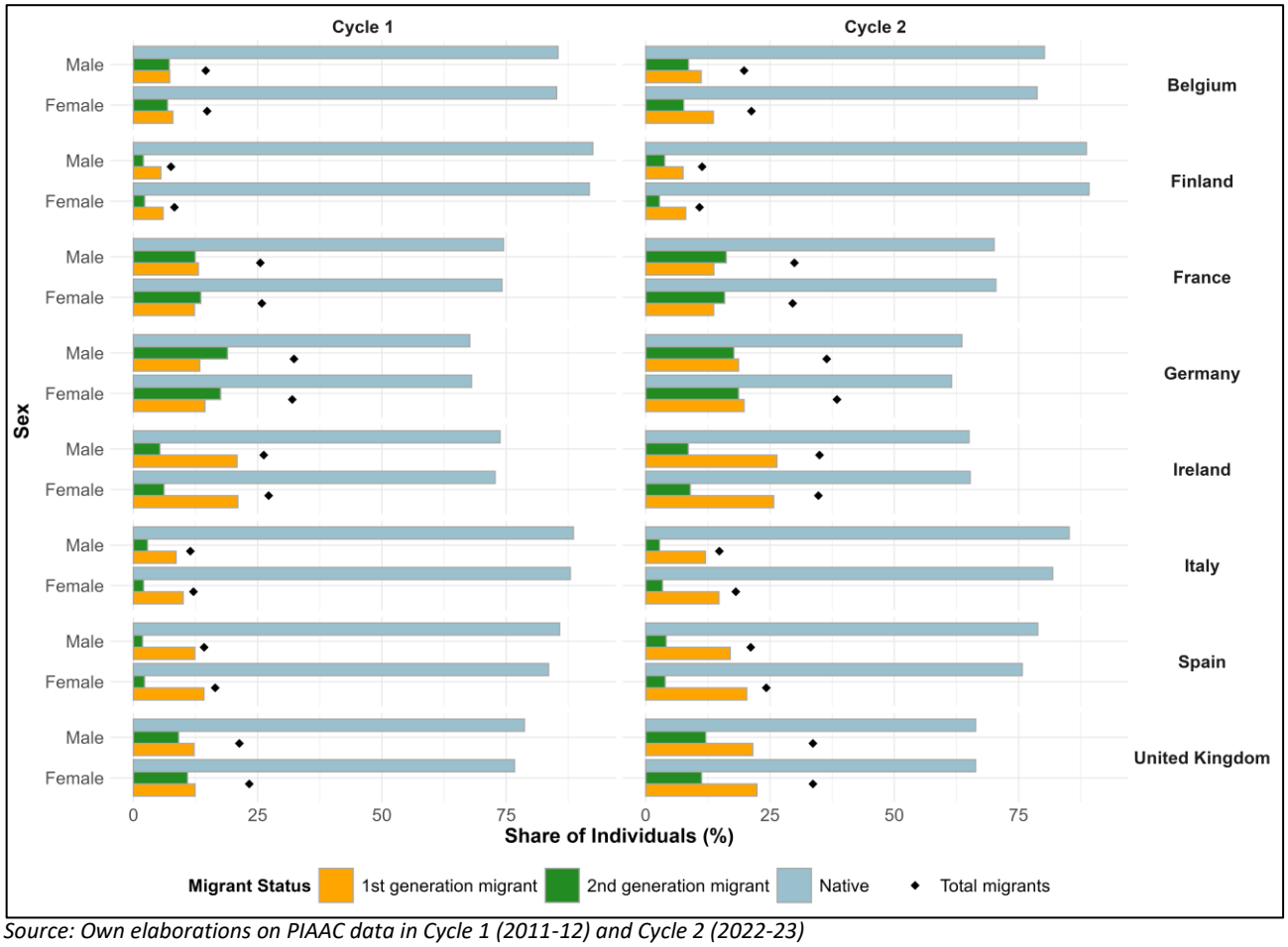
4.1.1 Immigrant-native demographic composition

First, we present demographic characteristics of these two groups and how these are represented in survey samples. Figure 1 shows composition by gender and migrant status (calculated as weighted shares) comparing two PIAAC cycles. The share of immigrants – whose total is represented by the black point – increased from 25% in the first cycle to 30% in the second cycle in France, from 33% to 37% in Germany and from 26% to 34% in Ireland, with similar trends in both genders. The United Kingdom has reached their level in the second cycle. The disaggregation by sex, in the first cycle, reveals the prevalence of female immigrants for all the countries except for France and Germany, and this trend is further

[2] This includes Sweden, Denmark and Norway.

emphasized in the second cycle. Finland and France have a quite even distribution across genders. Men were slightly less represented among immigrants in Ireland in the second cycle.

Figure 1. Share of individuals by sex, migrant status and cycle.

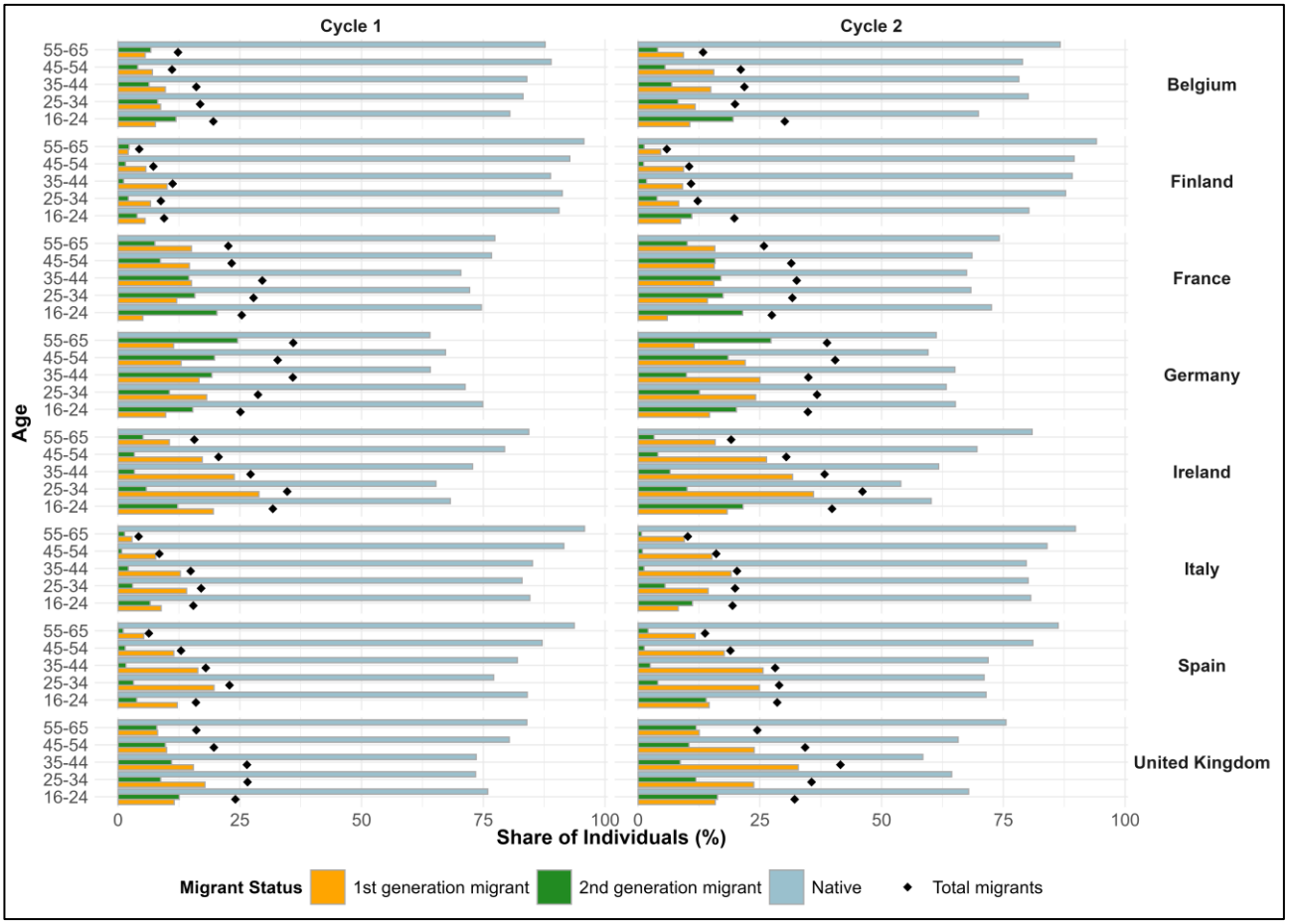


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

Figure 1 illustrates shift in generational composition of immigrant samples across cycles. As can be expected, most respondents among immigrants are G1 (yellow bar), and G2 (green bar) is less represented in cycle 1 as compared to Cycle 2. G2 shares are low in Ireland, Italy, Spain as these countries became important countries of destination later than the UK, France and Germany. Germany is an outlier with more G2 respondents than G1 in the first cycle. Furthermore, if gender disaggregation is considered, the G1 reflects more clearly a potential discrepancy between female and male immigrants within migrant stocks in the destinations and self-selection of respondents. It is unclear whether slightly higher representation of women is because of their greater representation in the migrant stock or because of selection effects among the respondents. Men tend to be more represented among recent G1 immigrant flows: according to Eurostat, in 2023, 55.0% of immigrants into the EU were men as opposed to 45.0% of women (Eurostat, 2025). However, gender composition of migrant stock reflects a longer migration history and chain migration, when women tend to be more represented in subsequent flows through family reunification. The controversial finding in Figure 1 may suggest a bias in the sampling and weighting process and greater participation of women in surveys, as discussed in limitations

(Section 7). Furthermore, the language barrier contributes to underrepresenting and underestimating the immigrant population overall, leading to imbalances between G1 and G2 such as n case of Germany, given the limited access to the survey and its tasks administered in the native language (OECD, 2024).

Figure 2. Share of individuals by age, migrant status and cycle.



Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

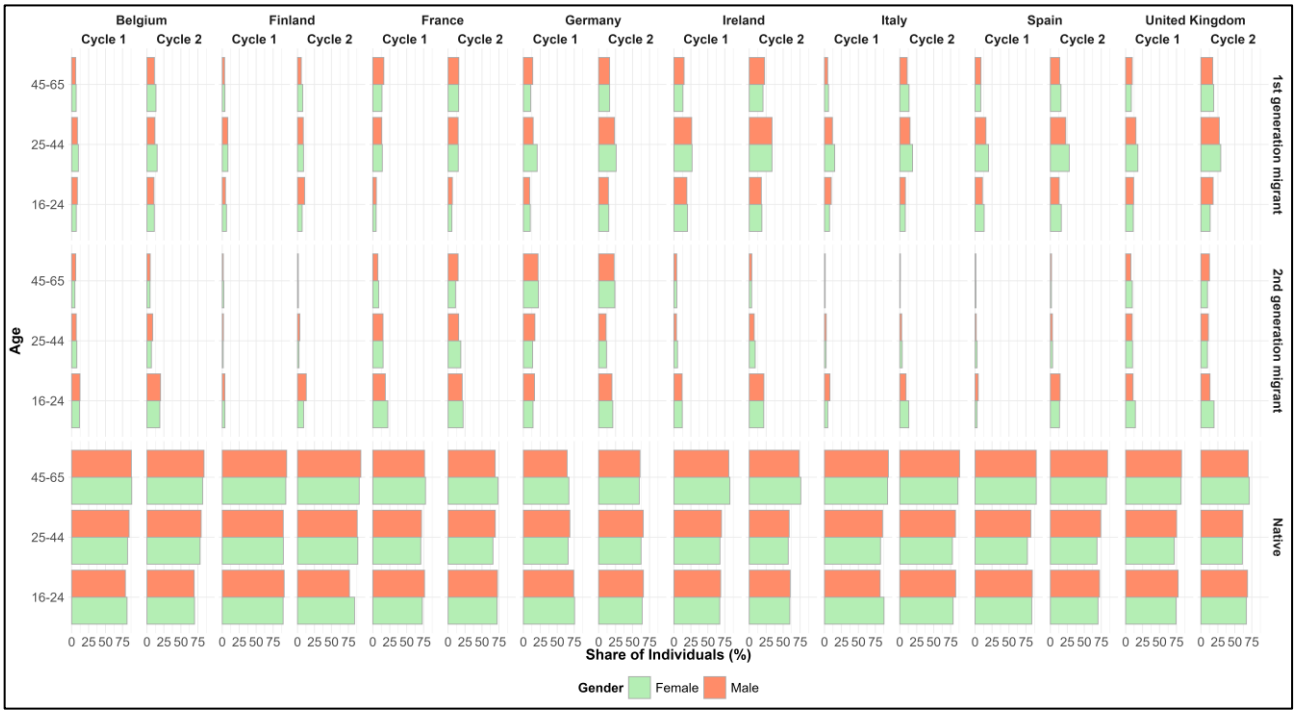
Figure 2 shows that the distribution of immigrants across age groups[3] is right-skewed with a majority among younger individuals, regardless the generation. Conversely, the native component shows a higher concentration in older age groups. This is not surprising as immigrant tend to be younger population than natives and this is commonly confirmed by existing statistics which show a higher concentration of working-age immigrants in many countries (Eurostat, 2022). On the contrary, most of the European countries are currently facing strong ageing and, hence, an increasing shift towards older age groups, as apparent for the natives who constitute majority in all countries. According to Eurostat, the population of the European Union aged 65 years and over on 1 January 2024 was about 21.6% of the total population and the median age was estimated to be 44.7 years, in opposition to 30.5 years for immigrants in 2023 (Eurostat, 2025).

[3] For simplicity, we present three broader groups “16-24”, “25-44” and “45-65”, however, regression use more detailed age groups.

Reflecting on the results shown in Figure 2, the two populations have opposite trends across time and countries. In particular, Ireland has the most accentuated pattern with a gap between younger and older age groups of 15% in the first cycle and a gap of 26% in the second cycle. This is not the case in Germany where the pattern is reversed with younger natives in Cycle 1 and more evenly distributed across ages for both populations in Cycle 2. Of particular note is the U-shaped trend for G2 immigrants in Germany, indicating the prevalence of people aged 16-24 and 55-65.

Figure 3 displays the gender disaggregation of immigrants and natives by age. The differences between the distribution of women and the distribution of men are not significant and the concentration of both genders in the three age groups has decreased over time. Concerning G1 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 25-44 across countries with the exception of 16-44 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 25-44 and expended toward older ages in Belgium for both and France for women. The charts present an overall increasing predominance of women in older age groups in Belgium, Italy, Spain and the UK. Among these countries, men dominate the 16-24 age group in Belgium, Italy and the UK. Finland, Ireland, Germany and France have experienced moderate change. Particularly, Ireland shows men prevailing in 45-65 conversely to average trends.

Figure 3. Share of individuals by age, sex, migrant status and cycle.



Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

Moving to G2, in Cycle 1, women and men are mostly aged 16-24 except for Germany where the highest shares are in the 45-65 group. By Cycle 2, this trend was confirmed once again. France, Germany and the UK have similar distributions across age groups. On average, men prevail on women in the youngest range in Belgium, Finland, Spain. An overall

increasing prevalence of women across every age group has occurred in most of the countries. In Italy, women have surpassed men in 16-44 with a noticeable gap in 16-24. The same has happened with men in Finland at younger ages and in France in the 45-65 group.

A conclusive observation is that female and male G2 are more concentrated in younger age groups and the distribution by gender is nearly even, resembling the one of natives. Among natives, Belgium, Finland and Ireland are characterized by a shift or stagnant concentration toward older age groups. Germany is the only country having experienced an opposite pattern with more individuals in younger age groups. France and the United Kingdom both present a U-shaped distribution, regardless the gender. As for Italy and Spain, these two countries reveal mixed patterns, with Italian men concentrated in older age groups and Italian women and Spanish women and men following a U-shaped distribution. The 16-24 age group was dominated by women in Belgium, Germany and Italy in Cycle 1 and only in Finland in Cycle 2, the 25-44 was consistently dominated by men in Cycle 1 and by women only in Finland in Cycle 2, the 45-65 by women in Belgium, France, Germany, and Ireland in Cycle 1 and in France, Ireland and the UK in Cycle 2. In conclusion, a shift towards male prevalence across all age groups has occurred among natives. However, it is possible to note a higher concentration of women in older ages and a higher concentration of men in younger ages.

4.2 Methods

4.2.1 Variables description

The variables that were selected for the purpose of the study were extracted from the PIAAC PUFs, i.e. the available public datasets. Most of the variables were taken directly from their original construction in the datasets, others were adjusted to the objective of the elaboration. In addition to this, the first and the second cycles of PIAAC survey have a different list of variables or different categorizations for the same variables. Therefore, before selecting them and creating the final dataset to use, it was necessary to harmonize the names of the variables and their construction to smoothly merge the two cycles.

The first step consisted in constructing the variables aimed at distinguishing individuals by their migration background and, therefore, analyzing the migrant-native gap.

- **migrant**, with categories “Migrant” and “Native”, to differentiate between immigrants and natives. The variable was constructed starting from two variables available in the PIAAC datasets: IMPARC2 (IMPAR for Cycle 1) with categories from 1 to 3, indicating whether the respondent has “Both parents foreign-born”, “One parent foreign-born”, “Both parents native-born” – and A2_Q03a (J_Q04a for Cycle 1) with categories 1 and 2 indicating whether the respondent was born in the country of the interview or not. The combination of these two variables allows us to identify the migration background of each respondent. Natives are defined as individuals born in the country of the interview and whose parents are both native-born (IMPARC2 == "3" & A2_Q03a == "1").

- **migrant_generation**, with categories “Native”, “1st generation migrant” and “2nd generation migrant”. Starting from migrant variable detailed above, G1 immigrants are classified as individuals born in a different country than the country of the interview, whereas G2 are classified as individuals born in the country of the interview to foreign-born parents, regardless of whether both parents or only one were foreign-born.

Additional relevant variables are:

- **Gender** (GENDER_R): “Male” and “Female”.
- **Age** (AGEG10LFS): “16-24”, “25-34”, “35-44”, “45-54”, “55-64 for in regression analysis; aggregated into “16-24”, “25-44”, “45-65” for descriptive analysis.
- **Educational attainment** (educ_3): derived from EDCAT6 in Cycle 1 and EDCAT6_TC1 in Cycle 2. Highest level of formal education obtained and classified by ISCED 97 classification. The categories were grouped and renamed: “Lower secondary or less”; “Upper secondary/Post-secondary” (includes “Upper secondary” and “Post-secondary, non-tertiary”); “Tertiary” (includes “Tertiary - professional degree”, “Tertiary - bachelor degree” and “Tertiary - master/research degree”).
- **Maternal and paternal highest qualification** (J_Q06b and J_Q07b in Cycle 1 and J2_Q04c and J2_Q05c in Cycle 2). The two cycles have three similar but different categories that are assumed to be classified as low, medium and high education; approximately corresponding to the three categories of respondents’ attainment described above.
- **Employment status** (employment_status). Represents the work status at the time of survey and is derived from C_Q07_T in Cycle 1 and C2_Q07_T in Cycle 2. Grouped into “Employed”, “Unemployed”, “In education” and “Inactive” (which combines “Retired”, “Doing unpaid household work” and “Other”).
- **Language** (bornlang_simple): It simplified BORNLANG variable by grouping the categories “Native-born and native-language”, “Native-born and foreign-language”, “Foreign-born and native-language”, “Foreign-born and foreign-language” into “native_language” and “foreign_language”. Simplied to aggregate small samples of first-generation and second-generation immigrants across the categories.
- **Birth region** (BIRTHRGN): “Arab States”, “South and West Asia”, “Latin America and the Caribbean”, “Sub-Saharan Africa”, “East Asia and the Pacific (poorer countries)”, “Central Asia”, “East Asia and the Pacific (richer countries)”, “Central and Eastern Europe”, “North America and Western Europe”.
- **Country of highest qualification** (CTRYQUAL_simple): aggregates CTRYQUAL (the same as BIRTHRGN) into “OECD” and “Non-OECD”, distinguishing individuals who obtained their highest qualification in a member of the OECD and those that did not.
- **Country of the interview** (country_name): – France, Belgium, Finland, Germany, Ireland, Italy, Spain, the United Kingdom

While the regression analysis explores all the above variables, only migrant, migrant_generation, GENDER_R, AGEG10LFS, educ_3 and country_name were used in the descriptive analysis.

4.2.2 Measurement of literacy and numeracy: test scores and proficiency levels

The central point of this study is to explore and compare immigrants' and natives' cognitive skills which are measured in PIAAC by literacy and numeracy test scores and the corresponding levels. OECD defines *functional literacy and numeracy levels* as groups of score ranges and uses these in their analyses. However, publicly available PUFs provide access to the test scores only, not to the variable with proficiency levels. Test scores are provided as ten plausible values[4] and can be defined as ten different guesses from each respondent's performance. This is because each respondent answers only a subset of all possible tasks and, thus, cannot be attributed a single exact test score, but ten plausible scores estimate how well that respondent would have done if s/he had taken the full test.[5]

The *proficiency levels* express population's cognitive skills distribution. Six skill levels were inferred from the test scores by grouping the scores, which range from 0 to 500. The scale of 500 points indicates both the proficiency of the respondent and the difficulty of the tasks responded can perform (OECD, 2024). This scale is independent for literacy and numeracy, making these two comparable only relatively (OECD, 2025). At each point on the scale, the respondent with that certain value of proficiency has a 67% chance of succeeding in the tasks of that value of difficulty (Survey of Adult Skills reader's Companion by OECD). Below Level 1 (scores from 0 to 176), Level 1 (176 to 226), Level 2 (226 to 276), Level 3 (276 to 326), Level 4 (326 to 376) and Level 5 (376 to 500). The interpretation of the five levels differs for literacy and numeracy (Insights and Interpretations published by the OECD in 2024). As for literacy, individuals below Level 1 are able to comprehend simple sentences only; those at Level 1 can understand short and clear texts and lists, locate connections and information; those at Level 4 and 5 are able to understand and interpret long and complex texts and exercises. Moving to numeracy, individuals below Level 1 can compute sums and differences between simple numbers; Level 1 indicates the ability to do basic calculations, identify little information from graphs and tables and solve simple tasks; individuals at Level 4 and 5 can handle more complex calculations with rates and ratios, assess charts and statistical statements.

Proficiency levels 0 and 1 are categorized as "Adults with low ability". Individuals at Level 2 and 3 are "Adults with moderate ability". Lastly, those at Level 4 and 5 are "Adults with high ability" and (OECD, 2024).

4.2.3 Descriptive analysis

The descriptive analysis addresses both socio-demographic dimensions and the distribution of literacy and numeracy skills focusing on education and temporal trends. The descriptive statistics enable the assessment of the existence and

[4] Variables PVLIT1 to PVLIT10 for literacy and PVNUM1 to PVNUM10 for numeracy.
[5] As introduced in the Survey of Adult Skills 2023 Technical Report (OECD, 2025), to achieve a more accurate estimation of cognitive skills, first, PIAAC implements an IRT (Item Response Theory) model – IRT consists in estimating respondents' skills starting from their item responses, regardless of the different set of items administered to each of them – to create a scale of proficiency based on background information and what scores are plausible given the respondent's answers to the items. From this, PIAAC draws ten different scores (the public plausible values) through a process of multiple imputation (OECD, 2025).

evolution of the skills gap between immigrants and natives from Cycle 1 to Cycle 2 in the selected eight European countries. First, we examine gaps in the educational composition of immigrants and natives, given the likely and relevant correlation between the level of education individuals have attained and their skills. The outcomes are visualized in bar charts document the differences between the subpopulations. Second, we document gaps in scores and levels by education and cycle to comprehend and visualize the association between educational attainment and literacy and numeracy proficiency. To investigate the literacy and numeracy gaps over time we use simple weighted means between the 10 plausible values for each domain. Analyses were conducted in *survey* and *srvyr* R packages using applying sample weights provided in the PUFs.

4.2.4 Regression analysis

We implement a linear regression model to supplement the descriptive findings by evaluating the effect that relevant factors (variables) have on the determination of skills and the migrant-native cognitive skills gap. The regression analysis mainly addresses the last research question of this study – "What are the variables that most affect the migrant-native literacy and numeracy skill gap? And how?". We implemented multiple models by survey cycle and cognitive skill domain (literacy and numeracy). Similar approach to the one presented by the OECD was used (OECD, 2024). A first model with *migrant* variable only as regressor was executed to examine the unadjusted migrant-native gap (reported in the Appendix). Following steps consisted in accounting for compositional differences between the two subgroups in relevant control variables that may be associated with skills, providing an estimation of the adjusted gap.

Three different final models were implemented on each cycle and skill domain. All three models have the literacy and numeracy average score pooled from the ten plausible values, as carefully described in Section 4.2 The first model was decided to have main effects only:

$$
\begin{aligned}
score = {} & \beta_0 + migrant\beta_1 \\
& + educ\_3\beta_2 + GENDER\_R\beta_3 + AGEG10LFS\beta_4 + J2\_Q04c\beta_5 + J2\_Q05c\beta_6 \\
& + CTRYQUAL\_simple\beta_7 + bornlang\_simple\beta_8 + employment\_status\beta_9 \\
& + country\_name\beta_{10} + BIRTHRGN\beta_{11} + \varepsilon
\end{aligned}
\tag{1}
$$

After testing each regressor by incorporating it into the model one by one, the one indicating the respondent's birth region (BIRTHRGN) was assessed to be the variable responsible for the loss of significance for the migrant status. Therefore, it was determined to separately run a model without birth region:

$$
\begin{aligned}
score = {} & \beta_0 + migrant\beta_1 \\
& + educ\_3\beta_2 + GENDER\_R\beta_3 + AGEG10LFS\beta_4 + J2\_Q04c\beta_5 + J2\_Q05c\beta_6 \\
& + CTRYQUAL\_simple\beta_7 + bornlang\_simple\beta_8 + employment\_status\beta_9 \\
& + country\_name\beta_{10} + \varepsilon
\end{aligned}
\tag{2}
$$

Next, the interaction terms were incorporated into model *(2)*. We added the interaction between the gender and employment dimensions, to assess how being in a certain employment situation (education, inactivity or (un)employment) influences the differences in cognitive skills between women and men. Additionally, the interactions between migrant status (whether the individual is migrant or native) and relevant regressors were included. Migration background is treated as a fixed control variable and its interactions with other predictors yield how the gap widens or narrows depending on these additional factors. The interaction terms aim to examine how the migrant-native skill gap varies across the different levels of each variable. The effects of the interactions were repeatedly found to be non-significant and were confirmed by testing the regression models with different packages – *intsvy*, *Rrepest* and *mitools*. Despite the non-significance of the interactions, the coefficients were logical, had expected direction and gradients and aligned with the literature. In order to not extremely simplify and omit relevant variables and, therefore, conclusions, the interactions were still included separately from the model with main effects only.

(3)

$$
\begin{aligned}
score = \ & \beta_0 + migrant\beta_1 \\
& + educ\_3\beta_2 + GENDER\_R\beta_3 + AGEG10LFS\beta_4 + J2\_Q04c\beta_5 + J2\_Q05c\beta_6 \\
& + CTRYQUAL\_simple\beta_7 + bornlang\_simple\beta_8 + employment\_status\beta_9 \\
& + country\_name\beta_{10} + GENDER\_R \times employment\_status\beta_{11} + migrant \times educ\_3\beta_{12} \\
& + migrant \times J2\_Q04c\beta_{13} + migrant \times J2\_Q05c\beta_{14} + migrant \times bornlang\_simple\beta_{15} \\
& + migrant \times employment\_status\beta_{16} + migrant \times country\_name\beta_{17} + \varepsilon
\end{aligned}
$$

All the aforementioned models were repeated for both **migrant** and **migrant_generation** variables to differentiate the analysis of the overall migrant-native skill gap and the intergenerational perspective of it by splitting immigrants by generation. The reference group was decided to be low-educated unemployed female natives born in Belgium, aged 16-24 with both low-educated parents, with proficiency in the test language and highest qualification attained in an OECD-country. Pooled models were implemented for Belgium, Finland, Ireland, Italy, Spain, the UK. Germany and France were excluded from the pooled models because of methodological differences in replication methods and separate models for these countries are detailed in the next subsection.

All models were constructed by choosing the initial scores (ten plausible values PVLIT1 to PVLIT10 and PVNUM1 to PVNUM10) as **dependent variable**. This approach is recommended by the OECD in the *Survey of Adult Skills 2023 Technical Report* (OECD, 2025), although some previously published academic papers that investigate the native-migrant skill gaps use only the first literacy and numeracy plausible values or the simple weighted mean between all ten values (i.e. Cathles et al. 2021). Use of the first values only can impact accuracy and reliability on the results given the complex survey methodology. Therefore, the OECD recommends executing a separate model for each plausible value and then pool the ten models using Rubin's rules to achieve a unique result. This approach increases the accuracy in estimating proficiency distribution and, therefore, the effects under study. We follow the recommended approach and use the *mitools* R package 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.

Subsequently, as suggested by OECD, the models were pooled following Rubin's Rules and using the *MIcombine* function from the *mitools* package. Given the decision to designate a normally distributed continuous numerical variable, i.e. the plausible value, as outcome of the regression, an OLS model (survey-weighted linear regression) was adopted[6]. The *svyglm* function from the *survey* package was applied as it offers a clean and straightforward implementation of the model considering the weights provided by the PIAAC dataset. Furthermore, following similar pooling approach, the goodness of fit of each model was measured by calculating the mean of the ten R^2 of each one-plausible-value-models.

The **independent variables** fall into two groups (coding of the independent variable has already been detailed in 4.2.1). The first group focuses on the demographic predictors (gender, age) and estimate the impact of socio-demographic characteristics on scores in literacy and numeracy. An interaction between gender and employment was added in model (3) as explained above. The second group of predictors affect both immigrant and native subpopulations and encompasses two different clusters. A first cluster is incorporated into the model through an interaction with migration background to examine the gap between immigrants and natives. This cluster consists of the educational attainment of the respondent (educ_3) and respondent's parents (J2_Q04 and J2_Q05), the proficiency in the test language (bornlang_simple), employment (employment_status) and country of the interview (country_name). The second cluster consists of the region of birth (BRTHGGN) and the country where the highest qualification was attained (CNTRYQUAL_simple). The predictors in the second cluster do not need to interact with the migration background, as this information is already included in the definitions of these predictors. In other words, region of birth and country of highest qualification can be used as a proxy for the distinction between immigrants and natives as immigrant and native respondents fall, relatively, into non-European and European categories, even though the country of highest qualification was integrated into the model as non-OECD and OECD countries.

The selected variables concerning the education dimension are particularly relevant to the purpose of the study, considering the existing discussions in literature. The respondent's highest qualification, along with the country where they obtained it and their parents' highest qualification are essential factors in human capital formation. The country of highest qualification may reflect differences in quality of education received and its relevance and in case if immigrants its transferability within destination country's context. In other words, the differences in educational systems may be a proxy for the differences in the socio-economic condition of a given country. Educational systems and the overall level of educational attainment differ across countries, and these disparities can increase the risk of non-recognition of immigrants' skills from the origin to the destination country, leading to unemployment and skill mismatch (OECD, 2018). For the same reasons, the region of birth can also be particularly informative, although the samples of immigrants coming from each region differ significantly in size and some of them are particularly small affecting the outcomes of the analysis.

Employment status may also shed light on the skill mismatch and, therefore, the correlation between the individual's competencies and their access to the labor market. Further, being in employment is associated with the use of skills and

[6] As recommended by the OECD approach (2024) and similar to other studies such as that of Heisig (2020).

existing literature argues that use of skills is associated with better cognitive performance (use it or lose it). We also expect a gendered impact of employment as women tend to be primary childcare providers which is associated with (temporary or protracted) absence from the labor market. Analyses based on Labour Force Survey data show that in particular immigrant women born outside the EU are particularly at risk of being excluded from the labour market, irrespective of their educational level (Marois et al. 2020).

The language variable is interesting to study as language is one of the biggest barriers to successful integration. According to Eurostat, in 2021, the lack of the host country's language proficiency was the most reported obstacle to obtaining suitable work among foreign-born individuals (Eurostat, 2023). Immigrants who speak the host-country language are more advantaged and have more access to the receiving educational and working system and, as a result, their skills improve (OECD, 2018). This also characterizes the differences in the skills gap between G1 immigrants and natives and between G2 immigrants and natives, as those who were born in the new country with at least one parent with a migration background did not have to go through an adaptation process and started the education in the new environment with the new language, even though, according to the literature, they still have disadvantages compared to their native counterparts (Heisig et al., 2020).

The management of the **weights** was crucial in the regression models. We applied both the final full sample weight and 80 final replicate weights. The 80 replicate weights are used to estimate the sampling variance, instead of working on a single complex variance formula (OECD, 2025). Unfortunately, different replication methods were applied in some country's PIAAC survey, and these discrepancies prevented inclusion of all countries into the pooled model because of the implications on variance and standard errors. In the first cycle, the paired jackknife (JK2) replication method was implemented in all acountries, except for JK1 in Germany. Inconsistency in replication weights arises in the second cycle, because France applies JK2 in both cycles, whereas all other countries switch to Fay method[7] in the second cycle. Inconsistency across cycles and countries has important implications for appropriate execution of the regressions. First of all, the selection of packages requires caution, as not all the packages and functions consider the different replication methods. In particular, the initial attempt consisted in using *survey* and *mitools* packages together. Consequently, *intsvy* and *Rrepest* packages were tested. Despite similar functioning and outcomes, it was determined that survey package combined with *mitools* package would be adopted as more flexible and configurable to specific replication methods across countries. In order to adapt the regression model to each country, i.e. each replication method, one common survey-weighted design with JK2 specification was formulated for the models in Cycle 1 with Fay specification in Cycle 2 for Belgium, Finland, Ireland, Italy, Spain, the United Kingdom. Because of differences in weighting and replication methods, separate models were executed for France- and Germany (next section). Two separate designs were formulated with JK2 specification for France in both cycles and JK1 and Fay in, respectively, Cycle 1 and Cycle 2 for Germany.

[7] The paired jackknife uses "two variance units per stratum" and "is appropriate for sample designs where primary units are stratified or selected with systematic sampling from a sorted list", whereas the Fay's method is "a variant of the BRR approach", where the latter stands for "balanced repeated replication" (OECD, 2025).

4.2.5 Models for France and Germany

France and Germany were excluded from the full models, and their regression models were run separately, removing *country_name* variable. The models for **France** follow the specifications *(1)*, *(2)* and *(3)* reported in Section 4.1. and separate models had to be run because of differences in replication weight as detailed above. Results from the model (3.1) without the generation detail are discussed in the results section, whereas the detailed models by generation of immigrants are reported in the Appendix.

$$
\begin{aligned}
score = {} & \beta_0 + migrant\beta_1 \\
& + educ\_3\beta_2 + GENDER\_R\beta_3 + AGEG10LFS\beta_4 + J2\_Q04c\beta_5 + J2\_Q05c\beta_6 \\
& + bornlang\_simple\beta_7 + employment\_status\beta_8 \\
& + GENDER\_R \times employment\_status\beta_9 + migrant \times educ\_3\beta_{10} \\
& + migrant \times J2\_Q04c\beta_{11} + migrant \times J2\_Q05c\beta_{12} + migrant \times bornlang\_simple\beta_{13} \\
& + migrant \times employment\_status\beta_{14} + migrant \times country\_name\beta_{15} + \varepsilon
\end{aligned}
\qquad (3.1)
$$

Additionally, Germany was not considered together with the other countries because two important independent variables - birth region and the country where the highest qualification was attained - were not available in PUFs for this country. For this reason, the models for Germany were simplified by omitting the variables BIRTHRGN and CTRYQUAL_simple (qualification attained in OECD or non-OECD country), as follows and the results are only available in the Appendix:

$$
\begin{aligned}
score = {} & \beta_0 + migrant\beta_1 \\
& + educ\_3\beta_2 + GENDER\_R\beta_3 + AGEG10LFS\beta_4 + J2\_Q04c\beta_5 + J2\_Q05c\beta_6 \\
& + bornlang\_simple\beta_7 + employment\_status\beta_8 \\
& + GENDER\_R \times employment\_status\beta_9 + migrant \times educ\_3\beta_{10} \\
& + migrant \times J2\_Q04c\beta_{11} + migrant \times J2\_Q05c\beta_{12} + migrant \times bornlang\_simple\beta_{13} \\
& + migrant \times employment\_status\beta_{14} + \varepsilon
\end{aligned}
\qquad (3.2)
$$

5. Results

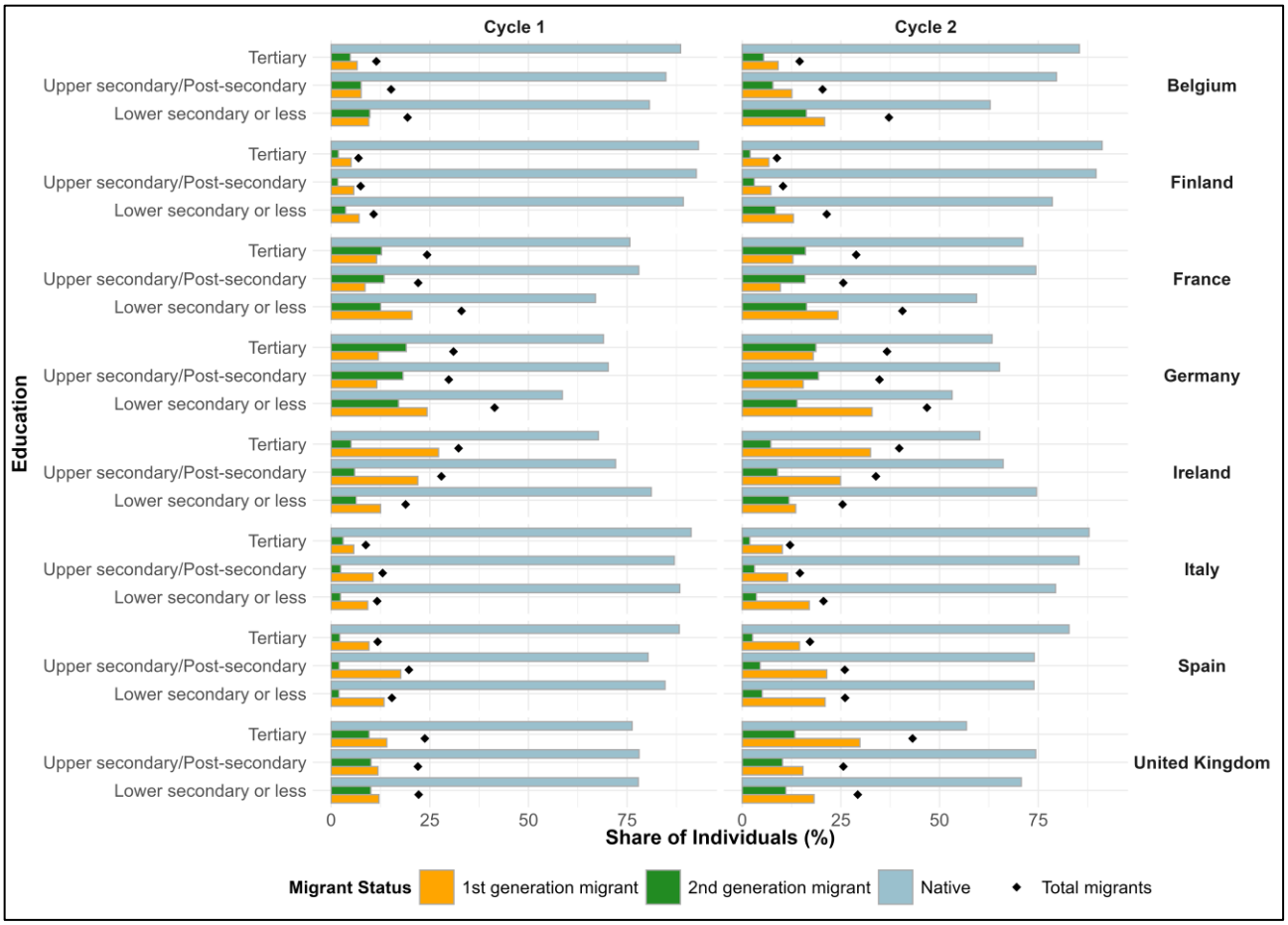
5.1 Descriptive analysis

5.1.1 Migrant-native gap in educational attainment

The descriptive analysis confirms the existence of a migrant-native gap in both, educational attainment as well as in skills. Figure 4 depicts differences by education level, country and cycle (medium education refers to completed upper secondary and/or post-secondary education non-tertiary qualification; higher education refers to tertiary education, i.e.

professional, bachelor's and/or master's degrees). The graph highlights a higher concentration of immigrants in lower education and a higher concentration of natives in higher education. This disparity diminishes in Italy, Spain and the United Kingdom. In particular, the UK, together with Ireland, present a completely reversed trend where immigrants are more highly educated than natives. This can be caused by higher representation of persons/respondents from the EU and other high-income countries in Ireland and the UK compared to others. Considering the intergenerational perspective, while the G1 shows a higher low-education prevalence compared to natives, the G2 are more equally distributed across the education levels in all countries, and their attainment levels resemble natives rather than G1.

Figure 4. Share of individuals by educational attainment, migrant status and cycle.

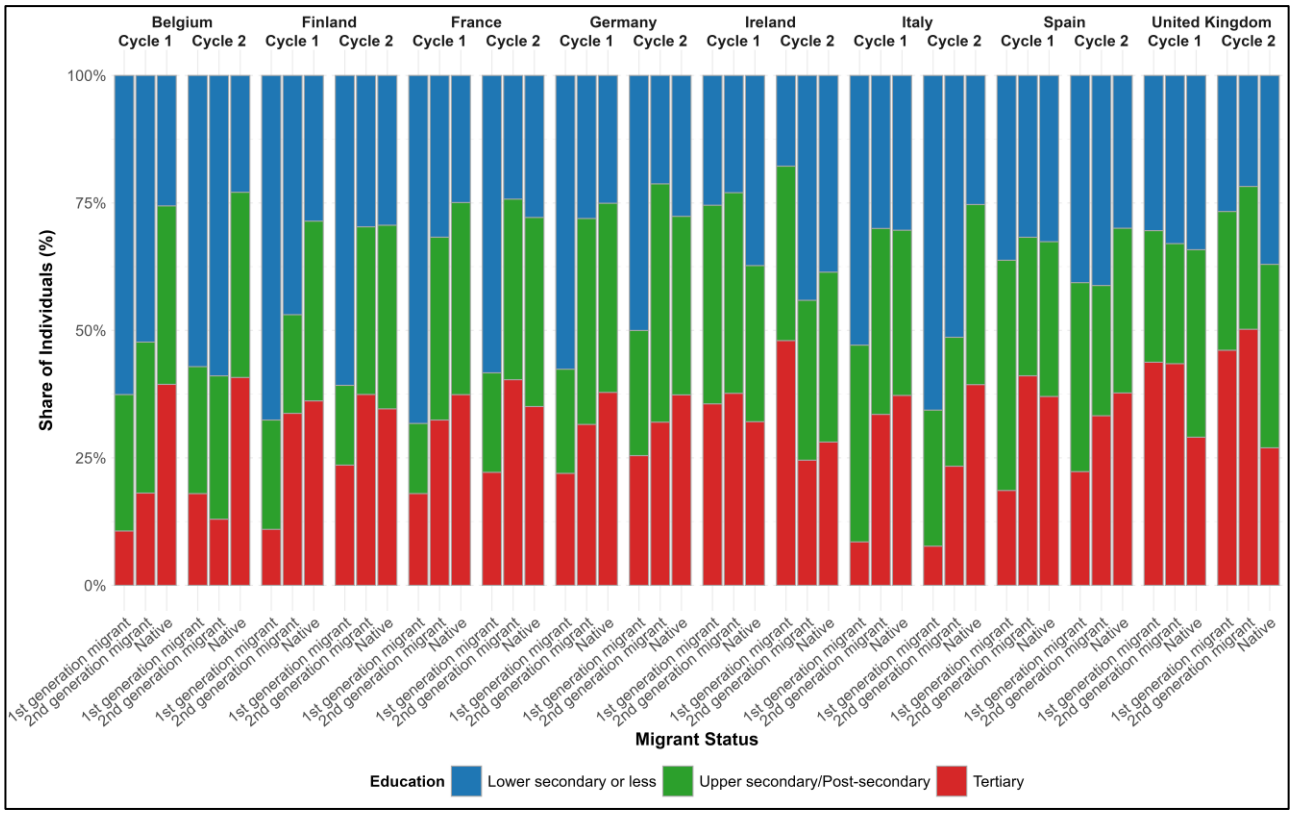


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

We further focus on the 25-34 age group because of high concentration of immigrants in this age group and because younger individuals are more likely to have higher education than older population due to ongoing educational expansion in both origin and destination countries. The highest education level immigrants aged 25-34 is associated with the labor market integration, and more broadly integration into the society. Figure 5 shows that the share of natives in the highest education level remained the same from Cycle 1 to Cycle 2 in all countries. On the contrary, it increased for G1 immigrants in all countries except for Italy where it stayed the same. As for G2 immigrants, it increased in all countries except for Belgium, Ireland and Spain where it decreased. In Finland and France, G2 immigrants surpass natives in Cycle 2, while the

share of G2 immigrants with the highest-level dropped below natives in Spain. Trend for the G2 suggest an upward mobility of immigrants in education in some of the countries under study. The educational gap between generations of immigrants is substantial in most countries (Belgium, Finland, France, Germany and Italy). In Belgium, the gap between immigrants and natives is significant within the highest level, while, in Finland, France, Italy and Spain, second-generation immigrants seem to follow the same trend as natives. Results for the young adults' educational advantage of the G1 in Ireland and of both G1 and G2 in the United Kingdom. Germany shows a lower gap between the two populations within the highest level and a great gap within the lowest confirming the migrant disadvantage.

Figure 5. Share of individuals aged 25-34 by educational attainment, migrant status and cycle.

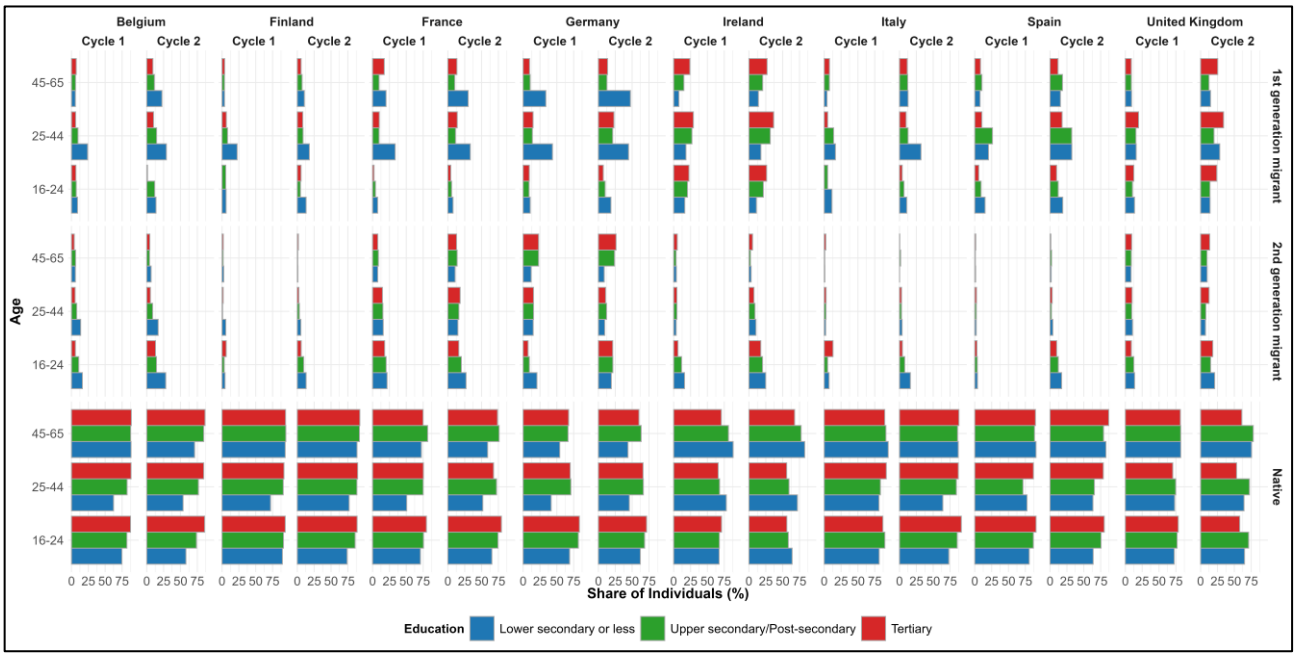


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

Trend over age groups depicted in Figure 6 confirms higher share of low-educated among the G1 in all countries except the UK and Ireland. In Germany, the share of low-educated among G1 has increased in the second cycle, potentially due to changed composition of immigrants and higher share of low educated among the new immigrants who arrived after the cycle. Taking all the countries and subgroups into consideration, moderate change has characterized the education trend by age from Cycle 1 to Cycle 2. Natives are particularly distributed in higher education levels (tertiary and upper/post-secondary education) across all age groups. In contrast, the share of native-born individuals at lower levels is significantly pronounced, especially at older ages. Germany, Ireland, the United Kingdom and younger individuals in Spain have experienced a downward pattern, whereas the rest of the countries have remained fairly stagnant. In particular, Ireland and the UK have higher concentration of natives in medium-low education. For both generations of immigrants, the progress was moderate from Cycle 1 to Cycle 2. Nonetheless, the improvement is more visible for these groups

compared to natives. The most marked shares of high-educated first-generation immigrants are in Ireland and the United Kingdom across all age groups, whereas the most marked shares of low-educated individuals are in France and Germany. The United Kingdom is the country that has experienced greater improvement over time, in opposition to a stagnant trend for Belgium, Finland, France and Germany and a downward trend for Italy and Spain.

Figure 6. Share of individuals by age, educational attainment, migrant status and cycle.



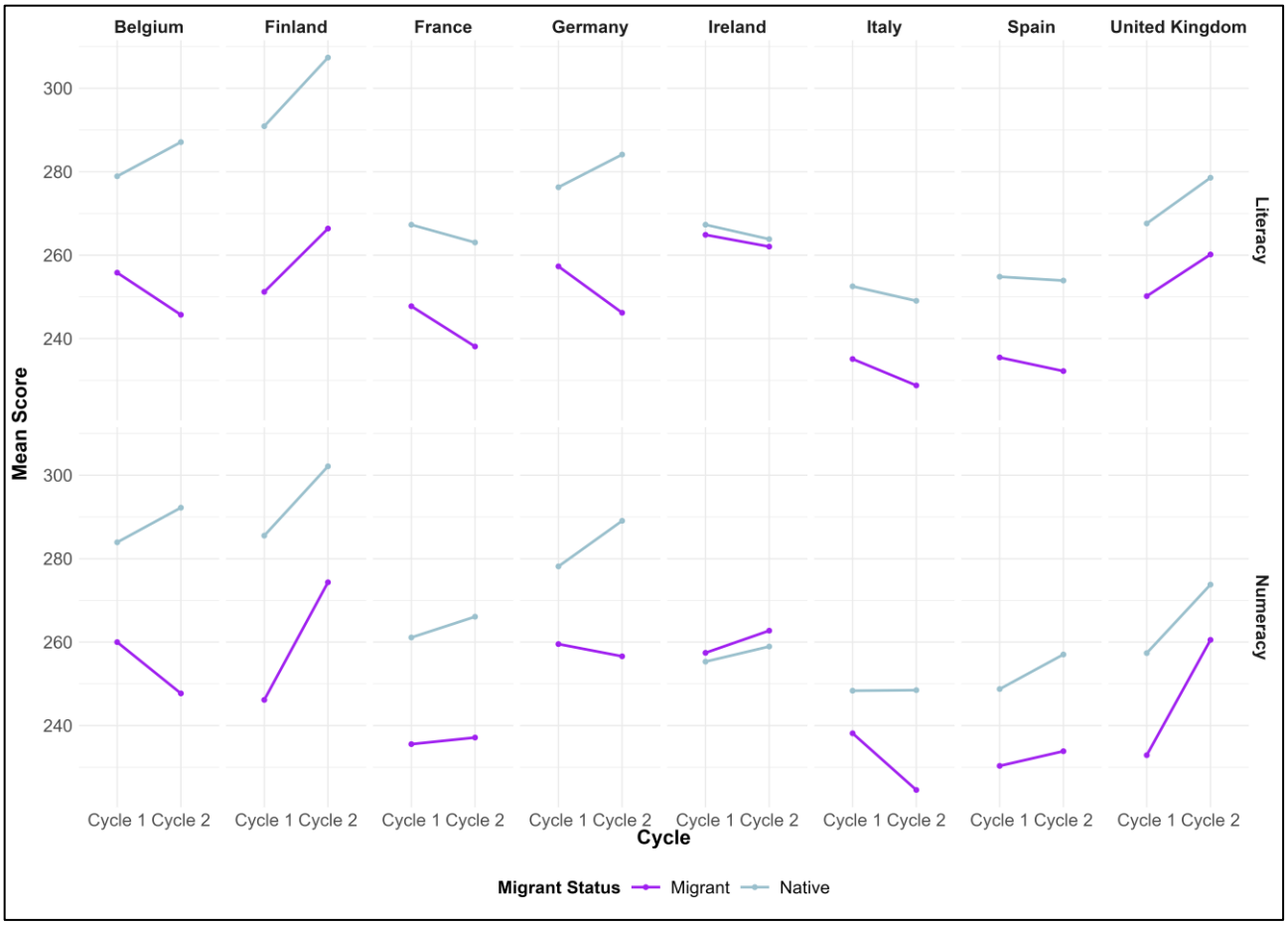
Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

5.1.2 Migrant-native skills gap in scores and levels

We can expect that the differences in educational attainment across age, gender and migrant status will translate into achievements in literacy and numeracy. We descriptive explore both mean scores and proficiency levels and investigate the relationship between immigrants' and natives' education and their relative literacy and numeracy.

Figure 7 illustrates the comparison in mean literacy and numeracy scores between natives (blue) and immigrants (purple) from Cycle 1 to Cycle 2. Literacy and numeracy mean scores cannot be directly compared, therefore, the descriptive analysis of the evolution in immigrants' and natives' performances is limited to the comparison of their performances within each domain. The top chart displays average literacy scores. In Finland and the United Kingdom, both immigrants and natives have improved over time, while in France, Ireland, Italy and Spain both have regressed. In Belgium and Germany, the two groups diverge: increases were recorded for natives and a decrease for immigrants. The widest gap between the two populations is presented in Finland, followed by Belgium in Cycle 2. Ireland displays the narrowest gap.

Figure 7. Mean literacy and numeracy scores by migrant status and cycle.



Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

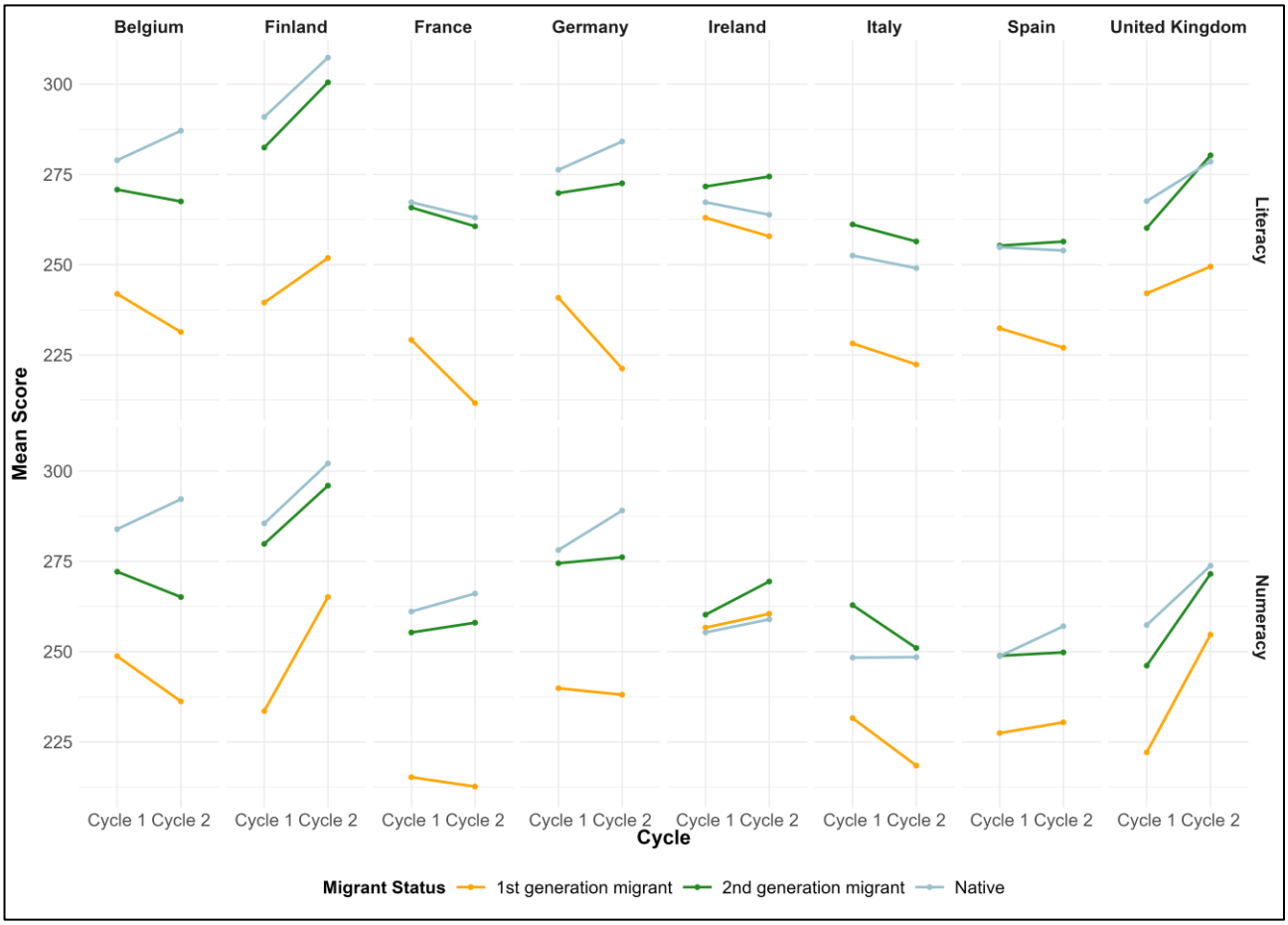
As for numeracy (in the bottom of the chart), both natives and immigrants have improved in their scores in Finland, France, Ireland, Spain and the United Kingdom. Immigrants' numeracy scores have declined in Belgium (from 260 to 248), Germany (from 260 to 257) and Italy (238 to 225), in contrast to the natives' improvements. As a result, the native-immigrant gap has widened in these countries.

Taken together, the skill gap between immigrants and natives exists in both skill domains and the gap has widened in 5 out of 8 countries. Within each domain, natives outperform immigrants, except for Ireland. Regardless of the consistent advantage of natives, improvements over time are more noticeable among immigrants, mainly in Finland and the United Kingdom. Lastly, Finland reveals the steepest improvement for both groups and domains, along with immigrants' mean numeracy score in the UK.

When plotted by generation (Figure 8), the gap in literacy and numeracy scores is mostly explained by the low performance of G1 immigrants. Natives and G2 immigrants have quite similar skill level, although they do not always follow the same trend and pace. With regard to average literacy scores, G2 have the smallest gap with natives in France,

Spain and the UK in Cycle 2. However, G2 immigrants outperformed natives in Spain, as their scores increased in Cycle 2 and the native mean literacy slightly decreased. Along with Spain, G2 immigrants achieve higher scores than natives also in Ireland and Italy (where literacy deteriorated for all groups). This explains why the migrant line for Ireland, in Figure 7, is above the native one. Moreover, the overall small gap in Figure 7 stems from the higher results achieved by second-generation immigrants and their rise over time compared to their native-born counterparts.

Figure 8. Mean literacy and numeracy scores by migrant status, generation of immigrants and cycle.



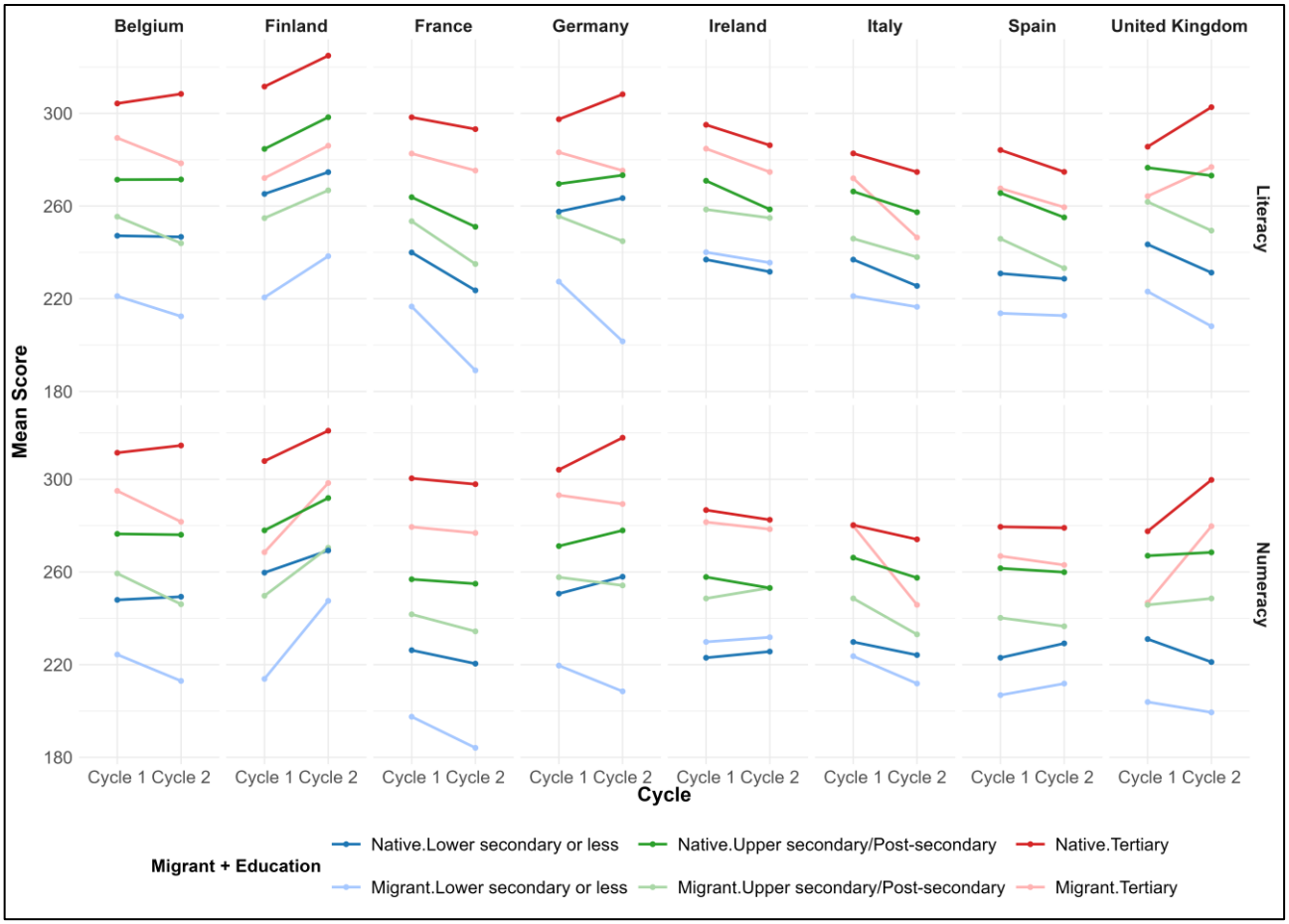
Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

Numeracy trends generally confirm the discrepancies in literacy. G1 gap to both natives and G2 is substantial in all countries but Ireland. Persistent G1 gap is visible in France and Germany, and particularly wide gap due to deteriorating numeracy skills of G1 emerged in Belgium and Spain. An interesting finding is the steep pace for G1 in Finland that explains the overall progress among immigrant group depicted in Figure 7. Same as in literacy, G2 outperforms natives in numeracy, in spite of the decline for G2 in Italy over time. Conversely to literacy, in Spain, natives have surpassed G2 immigrants from Cycle 1 to Cycle 2.

For a more substantive explanation of the trends described above, Figure 9 adds the educational dimension. 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 the 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 9. Mean literacy and numeracy scores by educational attainment, migrant status and cycle.



Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

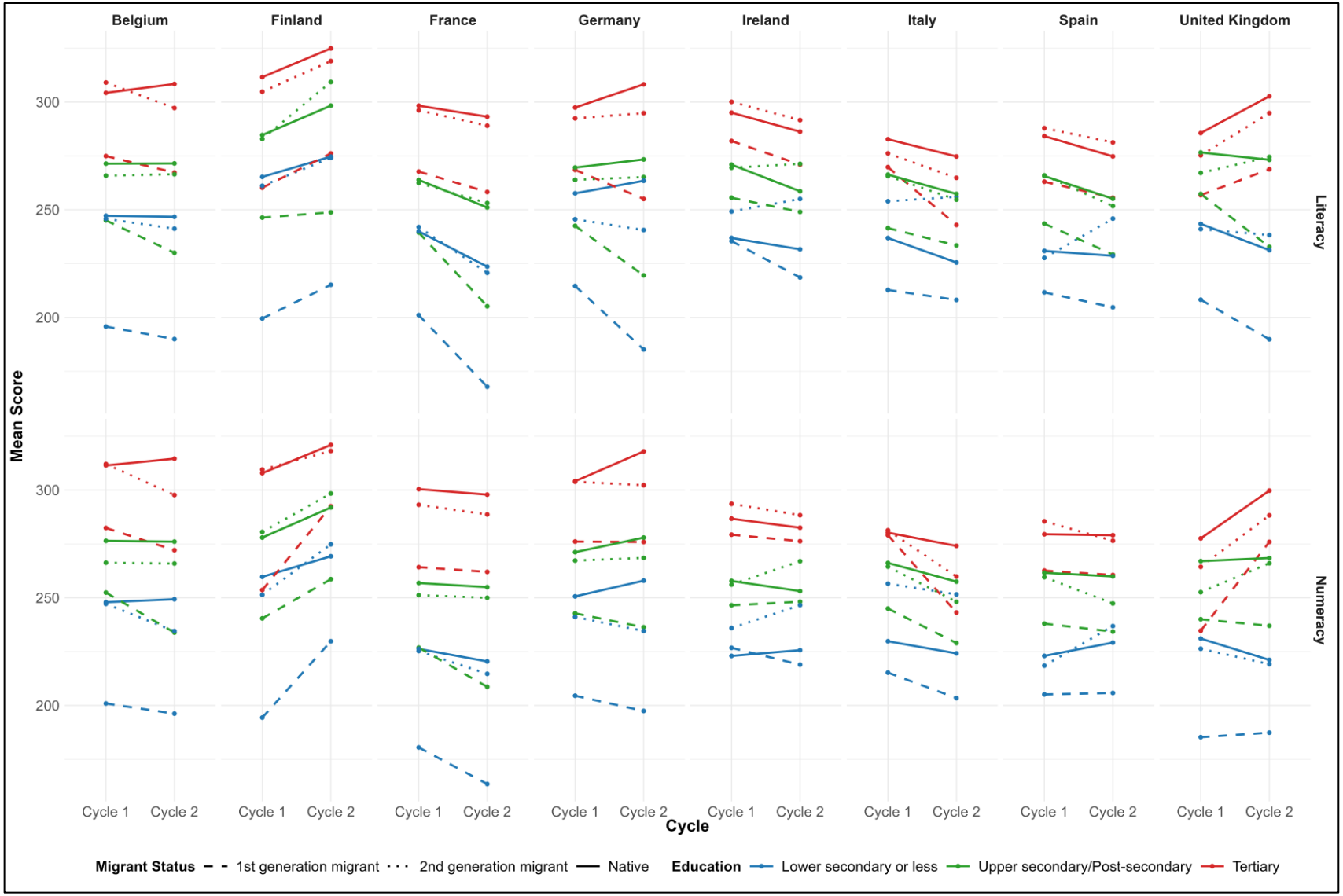
Figure 10 maintains educational detail (colours) and separates G1 (dashed lines) from G2 (dotted lines). Overall, natives (solid lines) and G2 immigrants follow the same pattern and pace. The discrepancies between the groups, are, however, substantial. In Finland, tertiary-educated G1 immigrants achieve similar literacy scores as low-educated natives, and G1 immigrant with lower educational attainments show even lower levels. In Belgium and Spain, tertiary educated G1 reach similar literacy scores as medium-educated natives. This has been the case in Germany as well in the Cycle one, however,

in Cycle 2 G literacy abruptly deteriorated in G1 across all educational attainment levels and similarly to Finland, in Cycle 2 tertiary educated G1 have lower literacy skills than low-educated natives.

Italy and Spain stand out for their overall low performance compared to other countries. Belgium and Germany are characterized by mixed movements with natives' little progress and immigrants' little worsening. 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 except for low-educated G1 immigrants. Belgium and Germany have a progressive native population and a regressive G1 population. The United Kingdom has a completely different pattern, as natives and G1 immigrants have progressed among the highest education level but regressed for the other two levels. G2 in the UK witness an increase for medium- and high-educated individuals and a decline for low-educated. Low-educated G2 surpassed natives and medium-educated G2 have reached the native level in Cycle 2.

Numeracy trends generally mirror those in literacy albeit mean scores may differ. The gap is particularly pronounced between G1immigrants and the other two groups. 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 immigrants for medium-educated against a decrease among G1 immigrants for all three educations and among G2 immigrants 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 immigrants 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, like Finland, high-educated G1 immigrants' scores have significantly risen almost reaching the other two. What can be concluded is that, once again, G2 immigrants, 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 rooted inequality. The underperformance of G1 immigrants can be attributed to both the differences between the origin and the host country's educational systems and the limited access to the second one. This will be further tested using statistical inference.

Figure 10. Mean literacy and numeracy by educational attainment, migrant status, generation of immigrants and cycle.

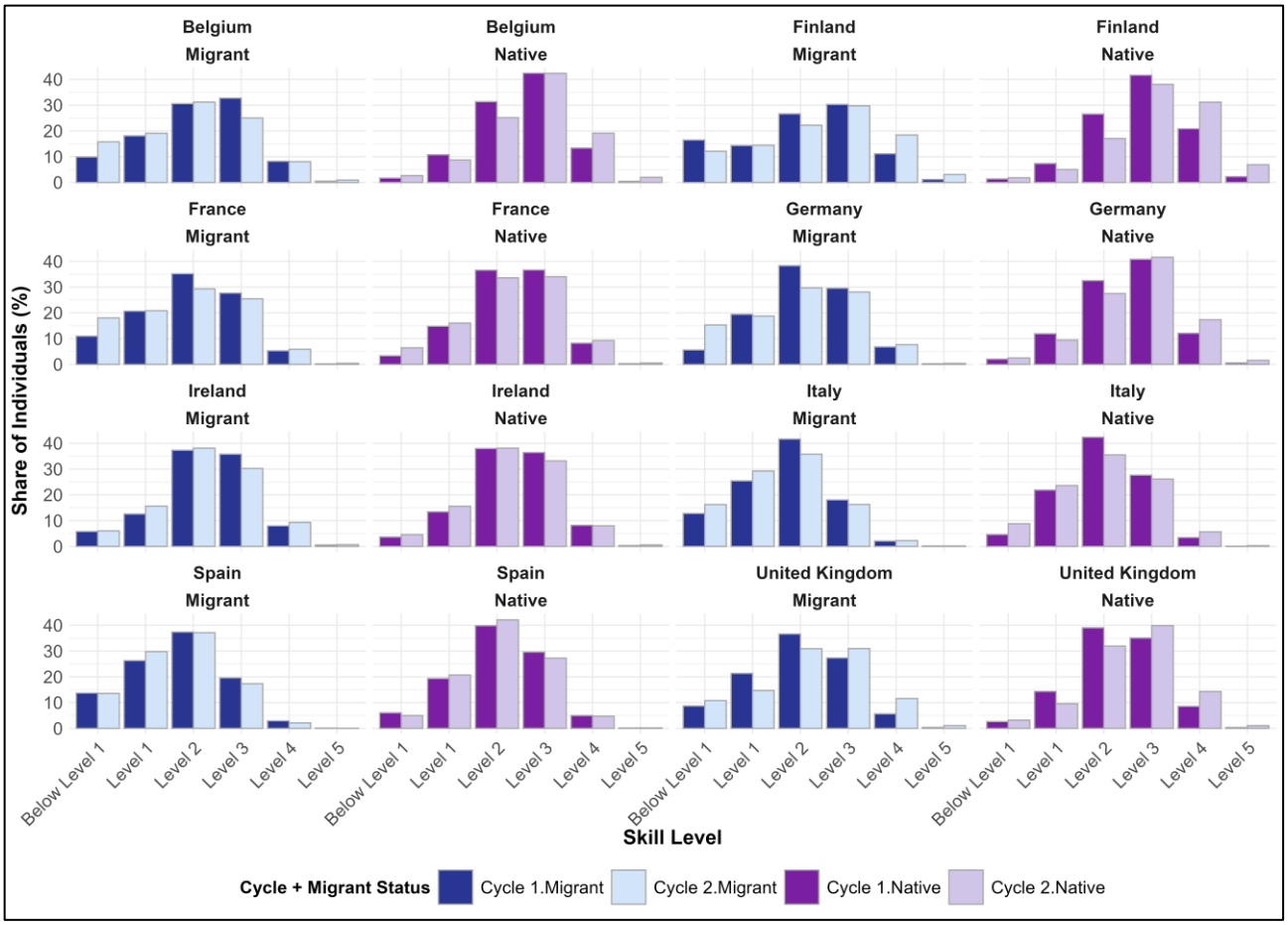


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

Figures 11 and 12 depict the distribution of immigrants and natives across literacy and numeracy levels, in corresponding order, by cycle in each country. The six proficiency levels go from Below Level 1 to Level 5. The dark bars represent the first cycle, and the light bars represent second cycle; the blue colours indicate the percentages of immigrants who have reached a given level, whereas the purple ones indicate the corresponding percentage among natives.

The change from Cycle 1 to Cycle 2 has been modest in both literacy and numeracy. A glance, histograms for the natives resemble normal distribution more closely while distributions for immigrants tend to be more skewed to the left, i.e. towards very low and low proficiency levels. The histograms shows that higher shared of Level 4 and Level5 among natives as compared to migrants. Very small share of migrants and natives reaches highest Level 5, with Finland being the exception in terms of highest share of individuals with high literacy skills across all countries as well as with respect to improvements in the Cycle 2. Looking at the cross-national and time detail and for both domains, Finland, followed by the United Kingdom, has reported the most evident improvement over time. Finland has revealed the widest reduction in the percentage of both immigrants and natives who have attained lowest levels and the widest increase in the percentage of those who have attained higher levels. Here, both groups have undergone an upward change, despite the noticeable disadvantage for immigrants.

Figure 11. Distribution of literacy levels by migrant status and cycle.



Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

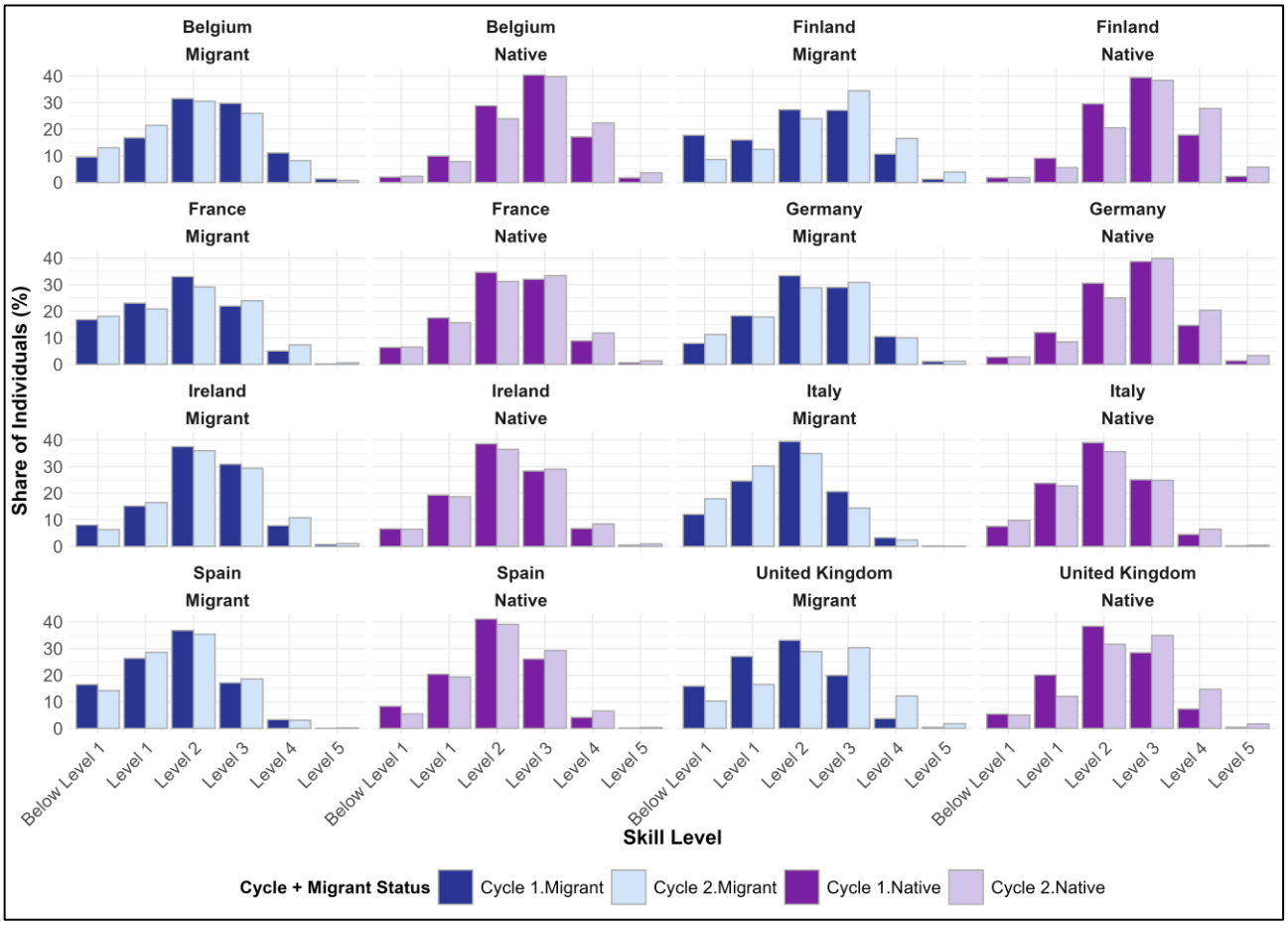
Italy and to lesser extent in Spain have showed a downward trend and a shift towards lower proficiency levels. Despite the overall underperformance of both immigrants and natives compared to the other countries, the gap between the two at lower and higher levels is still substantial in Spain. Similarly to Spain, Italy has witnessed a notable regression for both subgroups. Like Ireland, the migrant-native literacy gap in the United Kingdom is narrower than in other countries, revealing an increase at Level 3 and Level 4 for all individuals, regardless their migration background.

Belgium, France and Germany have revealed a less straightforward trend with little change. In Ireland, the progress has also been modest but more promising, especially for immigrants, than in the earlier group. Belgium has witnessed a deterioration in migrant performance in comparison to natives. However, the stable share of immigrants at Level 4 suggests this decline is not entirely discouraging. Similarly, in Germany, the increase in the percentage of immigrants at Below Level 1 should be noted, despite a slight increase at Level 4, whereas German natives have revealed an overall progress in their performance. In France, the two populations have undergone an overall downward trend and moderate change with a greater accentuation of the gap, especially focusing on the lowest level. The migrant-native discrepancy is not particularly pronounced in Ireland.

The trends in numeracy (Figure 12) are considerably resembling literacy distributions. Once again, Finland emerges for the evident improvement in both migrant and native results, still confirming a disadvantage in the former. Both curves have shifted to right, meaning higher proficiency levels. Once again, Belgium has experienced an increase across lower levels and a decrease across higher levels, conversely to the reversed trend for natives. The gap is particularly observable. As for France, when contrasted to literacy shares, the histogram reveals an upward trend for both subgroups. However, the native share at the lowest level is significantly lower than the migrant share. In Germany, both populations have experienced a less pronounced change, but natives have shown a greater improvement. Similarly, little change has occurred in Ireland, where immigrants seem to outperform natives, recalling the literacy distribution. Italy, followed by Spain, is the country with the poorest outcomes among immigrants and natives, presumably explaining the little gap between the two. While, in Italy, the pattern is consistent from literacy to numeracy, Spain sees an overall increase in migrant and native percentages within the higher levels, versus the regressing literacy results. Lastly, the United Kingdom reveals an evident improvement for all individuals, which is particularly emphasized for immigrants. Finland is the country with higher shares of immigrants and natives attaining Level 4 in Cycle 2 in both literacy and numeracy. On the other hand, Italy is the country with higher shares of immigrants and natives at Below Level 1 in Cycle 2.

To conclude, immigrants are mostly concentrated at lower levels with higher shares at Level 2, whereas natives are mostly concentrated at Level 3 and Level 4. Figure 11 and Figure 12 suggest a correlation between natives and higher proficiency levels and between immigrants and lower proficiency levels, as underlined by the prevalence of immigrants on the left side of the chart and the prevalence of natives on the right.

Figure 12. Distribution of numeracy levels by migrant status and cycle.



Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23)

5.2 Regression results

This chapter delineates the outcomes of the regression analysis performed to examine how relevant variables affect the skills gap between immigrants and natives. After a descriptive overview, the regression analysis explores the factors that most explain the discrepancy in the performance of these two subpopulations. The results may help us understand the causes and suggest responses and solutions aimed at reducing the skill gaps. Multiple models were tested and all models show an R^2 of approximately 0.3, meaning that the models explain about 30% of the variation in literacy and numeracy scores. For all models, the reference group was determined to be unemployed, low-educated women born in Belgium, aged 16-24, with low-educated parents, proficient in the test language and with the highest qualification attained in an OECD-country.

5.2.1 Literacy main effects

The final model for literacy includes main effects only. Table 1 displays the models for Cycle 1 and Cycle 2 with and without the birth region in separate columns. 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. 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, as expected. 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.

Besides education, 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.

Demographic characteristics are not decisive. 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 G1 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.

Regarding the country comparisons, Finland performs the best, confirming descriptive results, with 11.6 points better than Belgium. Italy and Spain reach 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, suggesting that composition of immigrants and their origin and educational characteristics are responsible for significant gaps found in the descriptive analysis

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)

	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

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 literacy plausible values pooled into a single output.

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.

We find increased positive effect of being employed in Cycle 2, 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.

5.2.1.1 Literacy main effects by generation of immigrants

When distinguishing between G1 and G2, 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 sampled of G2, which may affect the outcome, particularly for new counties of immigration with small G2. 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 the birth region explains why the coefficient for G1 immigrants loses significance. The gap between G1 and natives is reduced, 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 G1 immigrants witnessed a slight reduction (from 17.3 to 15.6 in favor of the former).

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. This confirms the results from the previous regression. The coefficient among the oldest age group remains stable and significant, conversely to the almost absent gender effect.

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.

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.

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

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 literacy plausible values pooled into a single output

5.2.2 Literacy interaction effects

At this stage of the analysis, interaction terms between migration status and the relevant control variables were considered to explore the main factors affecting the migrant-native skill gap. Nevertheless, after various attempts, the interaction effects were consistently found to be non-significant. Overall, the main effects account for most of the variation in literacy and numeracy performance, with similar magnitude and direction as in previous models. In other words, little evidence that the migrant-native skill gap varies across levels of each control variable is observed, despite the gap being assessed at the same level (main effect). Insightful assumptions and interpretations can still be developed, based on the magnitude and direction of the coefficients. In these models, non-significance mainly occurs in Cycle 1, unlike the various statistically significant interactions in Cycle 2. All models incorporating interaction terms omit birth region as it is not particularly significant.
To better delineate the results, the full tables illustrating both main effects and interactions can be found in the Appendix (Table 10.2), while the individual interactions are displayed in plots, indicating coefficients and confidence intervals and are discussed throughout the text. The main effects will not be the focus of the text.

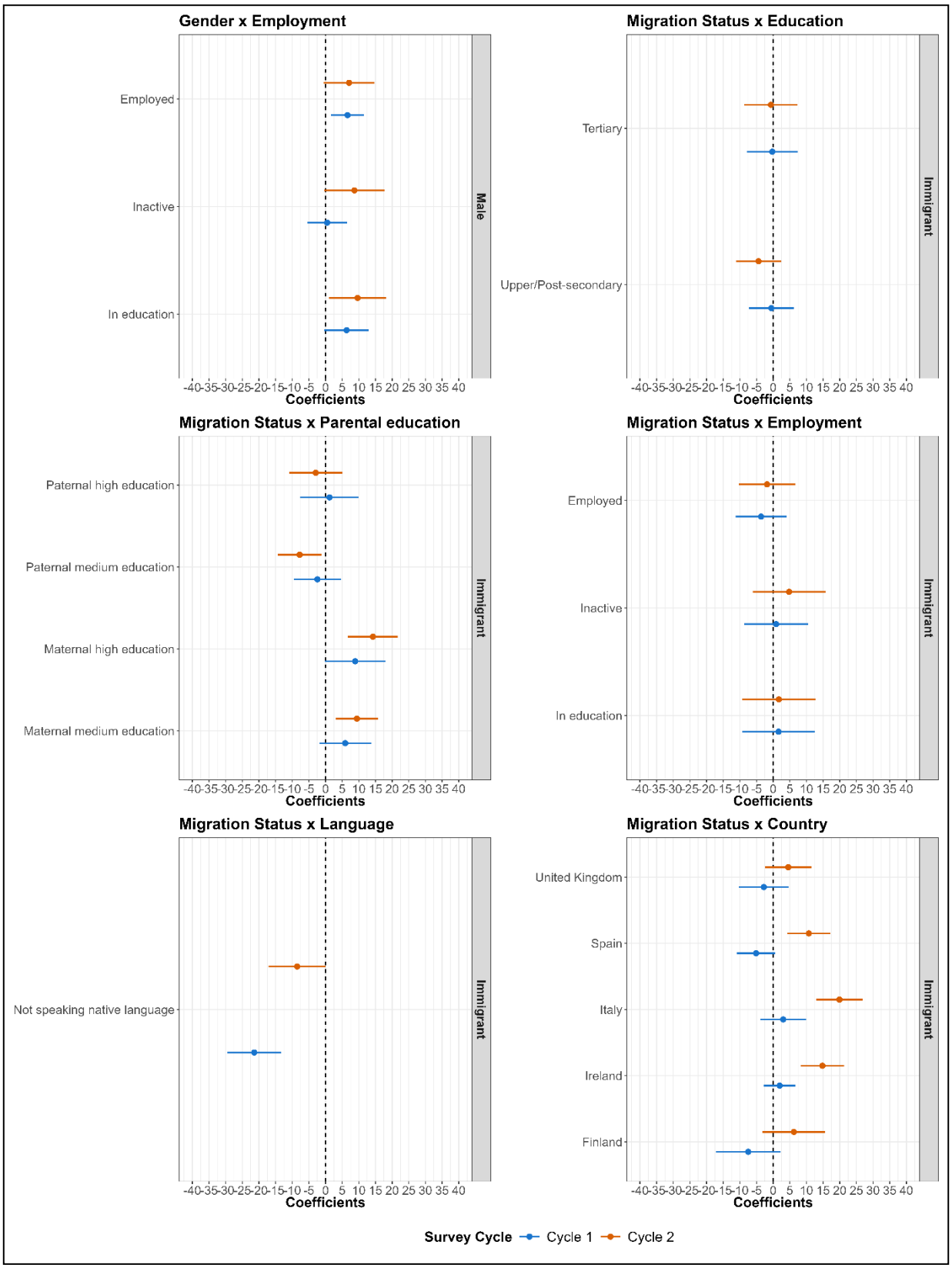
Before examining the interactions, it is relevant to note that only in Cycle 1 does the inclusion of interactions absorb the significance of the migration effect in literacy. More precisely, although not significantly, immigrants score 6.6 points lower than natives. Conversely, the migration variable maintains high level of significance in Cycle 2, with immigrants experiencing a disadvantage of 18.0 points. At this stage, the focus can shift to interactions.

The first interaction in Figure 13 does not regard the migrant-native skill gap. Given the non-significant discrepancy between women and men, as shown in the Appendix (Table 10.2), the purpose of this interaction was to investigate whether this discrepancy changes when considering the employment status of individuals. Nevertheless, the effects are weakly significant, indicating a greater male advantage in education and employment, relative to unemployment.

Turning to how the migrant-native skills gap varies within each category, it is interesting to note that, despite the strong impact of education on scores, the small and non-significant interaction with migration status indicates little evidence of changes in the gap across educational levels. However, according to the direction of the coefficient, the gap widens at increasingly higher levels of education. Proceeding with parental education, the focus will be on maternal education in Cycle 2 as this is particularly significant. Maternal education reduces the immigrant-native gap, conversely to paternal education which seems to have no significant impact. The gap between immigrants and natives with highly educated parents is smaller than among individuals with less educated parents. Adding the main effect of -18.0 for immigrants in Cycle 2 to the interactions of +9.2 for medium-educated mothers and +14.2 for high-educated mothers results that immigrants with medium-educated mothers score 8.8 points less than natives with medium-educated mothers and immigrants with high-educated mothers score 3.9 less than natives with high-educated mothers. At higher levels, the gap is smaller, but natives still perform better.

With regard to employment status, the gap in each category relative to unemployment varies moderately and non-significantly. Although education and inactivity have a positive coefficient in both cycles, suggesting a slight improvement in the gap within each cycle and over time, despite immigrants being at a disadvantage, the negative coefficient for employment indicates that the gap between employed immigrants and natives is widening more quickly than the gap between unemployed immigrants and natives.

Figure 13. Interactions - 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 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. Only the interaction coefficients of a model with main and interaction effects are illustrated. Full tables are reported in Appendix.

The gap between immigrants and natives who do not speak the test language is 21.4 points wider than the gap between immigrants and natives who do. Immigrants with no proficiency in the test language score 28.0 points lower than natives with no proficiency (combining the main effect of migration status and the interaction with language). Not speaking the test language is disadvantageous for both subpopulations, yet more pronounced among immigrants. However, it improves slightly and not significantly over time.

Lastly, it is important to highlight the significant cross-national discrepancies in Cycle 2. The coefficients for the countries under study are positive, indicating improvement in comparison with Belgium. Italy shows the most significant improvement (19.9 points), followed by Ireland (14.8) and Spain (10.7). Across countries, immigrants still perform worse than their native counterparts, except in Italy, where immigrants experience a small benefit of 1.9 points. Finland and the United Kingdom have little and non-significant decrease in the gap. In Cycle 1, the immigrant-native gap widens in Finland, Spain and the United Kingdom and narrows slightly in Ireland and Italy. Overall, in both cycles, the most extensive gap is found in Finland and the UK, whereas the smallest gap is found in Ireland and Italy.

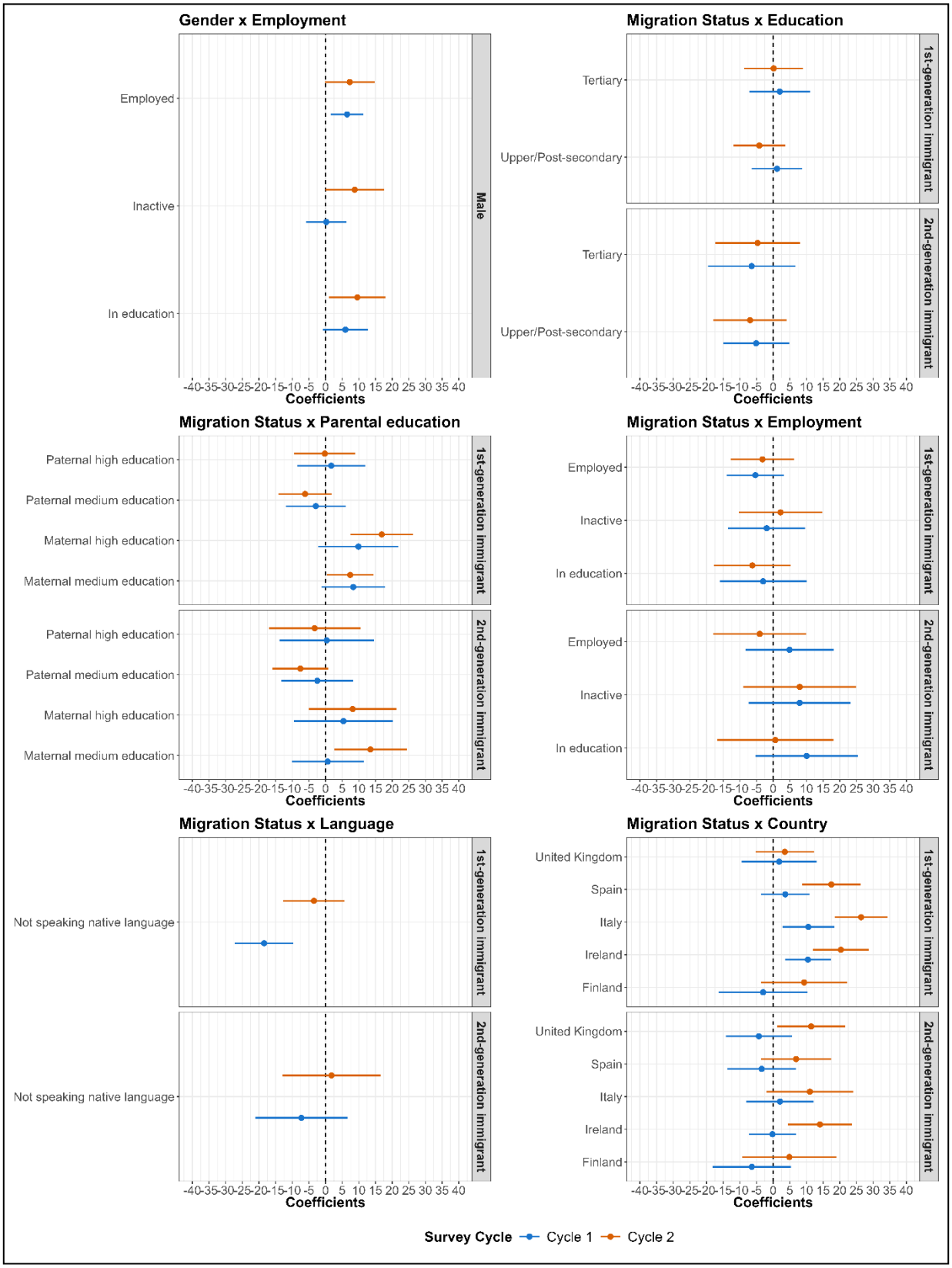
5.2.2.1 Literacy interactions by generation of immigrants

The literacy regression model by generation of immigrants with both main effects and interactions does show differences in most coefficients, as shown in the Appendix (Table 10.4). The direction and magnitude of the coefficients for education, age and gender are consistent with previous models. The coefficient for G1 is highly significant, whereas the G2 is not significant across cycles. On average, G1 scored 17.7 points less than the natives in Cycle 1, and 28.3 points in Cycle 2, indicating a widening native-G1 literacy skill gap. In contrast, the gap for the G2 is narrower and non-significant, suggesting a smaller disadvantage than for G1. G2 immigrants scored averagely 3.3 (Cycle 1) and 7.9 points (Cycle 2) lower than the natives.

The effects of control variables on the literacy skill gap (Figure 14) are mostly non-significant but the direction aligns with previous conclusions and the literature. The gap between G1 immigrants and natives changes minimally at upper/post-secondary and tertiary levels, relative to low secondary and less. As for G2, the gap also reveals no significant variations from lower secondary education and less. The magnitude of the effect is slightly greater for the G2, increasing with educational level. Regarding parental education, maternal qualification reveals a stronger positive effect on the individual's performance. Higher maternal education levels correspond to narrower gaps across generations and cycles. The most significant coefficient is for the gap between natives and G1 with high-educated mother in Cycle 2. Here, the gap narrows by 16.9 points compared to those with whose mothers are less educated. A further interpretation of this coefficient is that, among individuals with high-educated mother, G1 immigrants score (-28.3) + (+16.9) = -11.4 points less than natives. Conversely, when considering individuals in education, inactivity and employment, the gap between natives and the two generations of immigrants remains roughly the same.

Not speaking the language of the country widens the gap. This is significantly pronounced in the gap between G1 immigrants and natives in Cycle 1, which widens by 18.5 points. This result indicates that G1 immigrants score (-3.5) + (-18.5) = -22.0 points (from the main effect of language variable) less than their non-proficient counterparts and G2 immigrants score (-3.5) + (-7.3) = -10.8 points less than their non-proficient counterparts, although not significantly. Therefore, language is a greater obstacle for the first generation. The negative effect decreases over time for both gaps.

Figure 14. Interactions - 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)



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 literacy plausible values pooled into a single output. Only the interaction coefficients of a model with main and interaction effects are illustrated. Full tables are reported in Appendix.

The last observation concerns the differences in the gap between countries under study. In the first cycle, Italy and Ireland were the only countries to reveal a significant decrease in the gap between G1 and natives of about 10.0 points., relative to the gap in Belgium. In Cycle 2, more coefficients are significant, all indicating a reduction in the gaps. The highest improvement occurs in Italy, Ireland and Spain, respectively by 26.4, 20.3 and 17.5 for the gap with the G1, in comparison with Belgium and with G1 immigrants scoring 1.9, 8.0 and 10.8 less than natives. As for G2 immigrants, the gap significantly narrows by 14.1 in Ireland and by 11.4 in the UK, followed by Italy (11.0), less significantly. In these countries, G2 immigrants score, respectively, 6.2, 3.5 and 3.1 points less than natives.

5.2.3 Numeracy main effects

We proceed with the analysis of the second domain, numeracy, with the estimates depicted in Table 3. 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).

In contrast 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.

We find similar results to literacy 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).

We also find differences to literacy in country comparisons. Finland's leading position is no longer significant and wide, and the coefficient for the United Kingdom increased in significance in negative direction. Spain scored the worst results, 20.0 points lower than Belgium, followed by Ireland (-18.1), the United Kingdom (-15.5) and Italy (-14.7).

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 confirmed, with immigrants experiencing a disadvantage of 9.6 points. Education maintains its strong role in predicting 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. 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.

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.

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. As noted above, including birth regions explains the loss of significance for migrant status. The only differences among the other regressors are in the country of highest qualification and proficiency in the test language. The former shows a reduction in the disadvantage arising from a non-OECD education system and a slight reduction in significance (from -21.7 to -11.1), all other things being equal. This occurs for the language variable and to a greater extent. The negative impact of not knowing the test language narrows and becomes non-significant (from -10.8 to 4.5). Focusing on the role of birth region, the results for individuals born in South and West Asia and Sub-Saharan Africa, who performed worst in Cycle 1 and in all previous models, improved slightly by Cycle 2. While not significant, an interesting pattern emerges for individuals born in the Arab States, who experienced a noticeable improvement over time, going from 26.7 points less than those born in Northern America and Western Europe to 9.9 points less.

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.

5.2.3.1 Numeracy main effects by generation of immigrants

Same as for the literacy models, the distinction between G1 and G2 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 is restricted to G1 and the effect for G2 is non-significant due to the small sample size of G2. As reported in Table 4, G1 immigrants 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 convergence hypothesis towards the natives, due to being raised in the same country and social and educational environment. G1 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 G2, all other coefficients remain stable in both magnitude and direction when comparing Tables 3 and 4. 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.

Like the overall model in Table 3, Cycle 2 presents differences from Cycle 1 in the context of numeracy. The gap between natives and G1 significantly narrows by about 2.0 points, whereas the gap with G2 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. 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.

As for differences to previous models, 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.

As anticipated above, the coefficient for Finland gained significance in Cycle 2, revealing 12.1 points higher than in Belgium. Furthermore, the gap between the United Kingdom and Belgium narrowed with individuals living in the UK scoring higher than in Cycle 1. Additionally, Spain improved by about 3.0 points, but was surpassed by Italy and, mainly, Ireland in low performance. As for differences in origin, South and West Asia and Sub-Saharan Africa, the two regions with the lowest performance, experienced little progress in literacy, from Cycle 1 to Cycle 2. Along with these two regions, the Arab States achieved better points than in Cycle 1, with individuals scoring 14.2 points lower than those born in Northern America and Western Europe (about 12.0 points better than in Cycle 1).

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

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.

5.2.3.2 Numeracy interaction effects

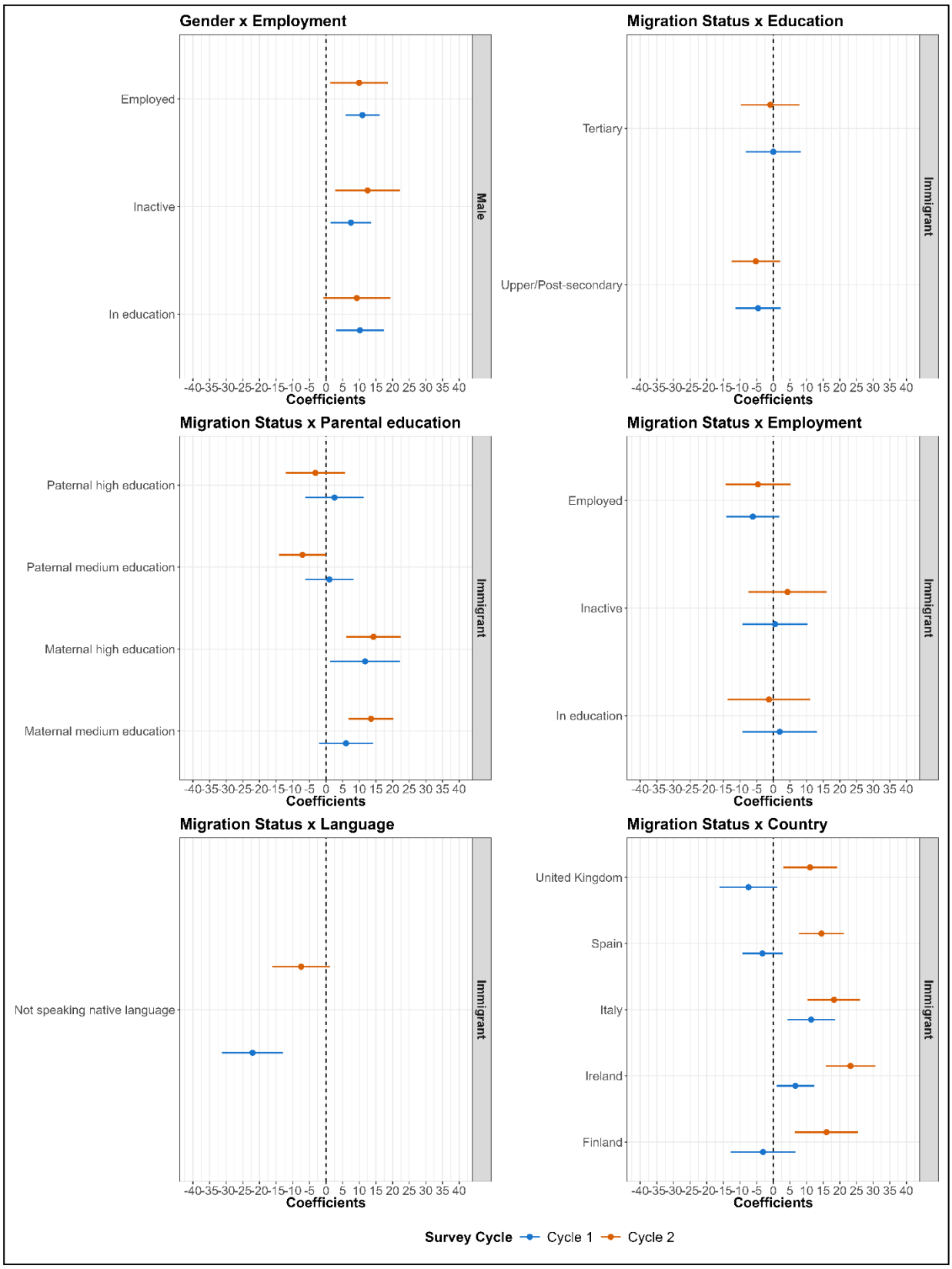
Figure 15 plots the interaction coefficients and confidence intervals for numeracy. Similarly to literacy, this model does not consider the impact of birth region. Additionally, the migration variable loses significance in Cycle 1, and the interaction effects are mostly non-significant in both cycles. The reference group scored an average of 234.1 in Cycle 1 and 232.3 in Cycle 2 (higher than the model with main effects only and lower than literacy). Although not significantly, immigrants scored 6.0 points lower than their native counterparts in the first cycle. In Cycle 2, the gap widens considerably reaching a statistically significant disadvantage of 21.9 points for immigrants. The main effects can be viewed in detail in the Appendix (Table 10.6).

The main difference from the model with main effects only concerns gender, whose effect narrowed and lost significance in both cycles. To further analyze this effect, the interaction between gender and employment status was examined. Overall, a male advantage is confirmed across categories. This advantage increases by respectively 10.2, 7.5, 11.0 in Cycle 1 and 9.2, 12.5, 10.0 in Cycle 2 when individuals in education, inactivity and employment are considered. Focusing on the most significant coefficients and summing the main effects and interactions, men in education scored (+2.1) + (+10.2) = 12.2 points higher than women in education in Cycle 1 and (+2.5) + (+9.2) = 11.7 points higher in Cycle 2. As for employment, employed men scored (+2.1) + (+11.0) = 13.1 points higher than employed women in Cycle 1 and (+2.5) + (+10.0) = 12.5 higher in Cycle 2. The male advantage decreases moderately over time.

Similarly to literacy, education loses the strong impact as main effect, suggesting that the migrant-native skill gap is consistent with the gap among low-educated individuals across educational levels. When the main effect of education and the interaction are combined, immigrants' performance improves with higher levels of education. Taken together, the benefit is greater for natives, and the gap widens with higher levels of education, peaking at the upper/post-secondary level. When parental education is considered, the mother's highest qualification has the strongest impact, especially in Cycle 2, as with literacy. Maternal education benefits both natives and migrants. The gap narrows with higher levels of maternal education. Focusing on the significant estimates of Cycle 2, immigrants with a medium-educated mother score (-21.9) + (+13.5) = -8.4 points lower than natives with a medium-educated mother. Immigrants with a high-educated mother score (-21.9) + (+14.2) = -7.7 lower than natives with a high-educated mother. This suggests that, anew, parental education contributes to better performance among both natives and immigrants. However, immigrants still experience a disadvantage, which is more pronounced at the medium level.

Employment has the strongest effect, slightly widening the gap relative to unemployment. Employed immigrants scored (-6.0) + (-6.2) = -12.2 points less than employed natives in Cycle 1 and (-21.9) + (-4.6) = -26.5 points less in Cycle 2. Over time, natives are increasingly more advantaged than immigrants. The barrier of not speaking the test language is significant only in Cycle 1 with an increased gap between immigrants and natives who are not proficient in the language by 22.1, similarly to literacy. Among individuals with no proficiency, immigrants score (-6.0) + (-22.1) = -28.1 lower than natives in Cycle 1. The coefficient in Cycle 2 confirms the direction of the effect and suggests a smaller barrier, although not significantly. Lastly, the numeracy gap varies across countries. Relative to Belgium, the gap decreases particularly in Finland, Ireland, Italy, Spain and the United Kingdom in Cycle 2. Ireland is the only country with a slight immigrant advantage (+1.3). Conversely, immigrants in the United Kingdom score 10.8 points lower than natives, followed by those in Spain (7.4 points lower), Finland (5.9 points lower) and Italy (3.7 points lower).

Figure 15. Interactions - 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)



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. Only the interaction coefficients of a model with main and interaction effects are illustrated. Full tables are reported in Appendix.

5.2.4.1 Numeracy interactions by generation of immigrants

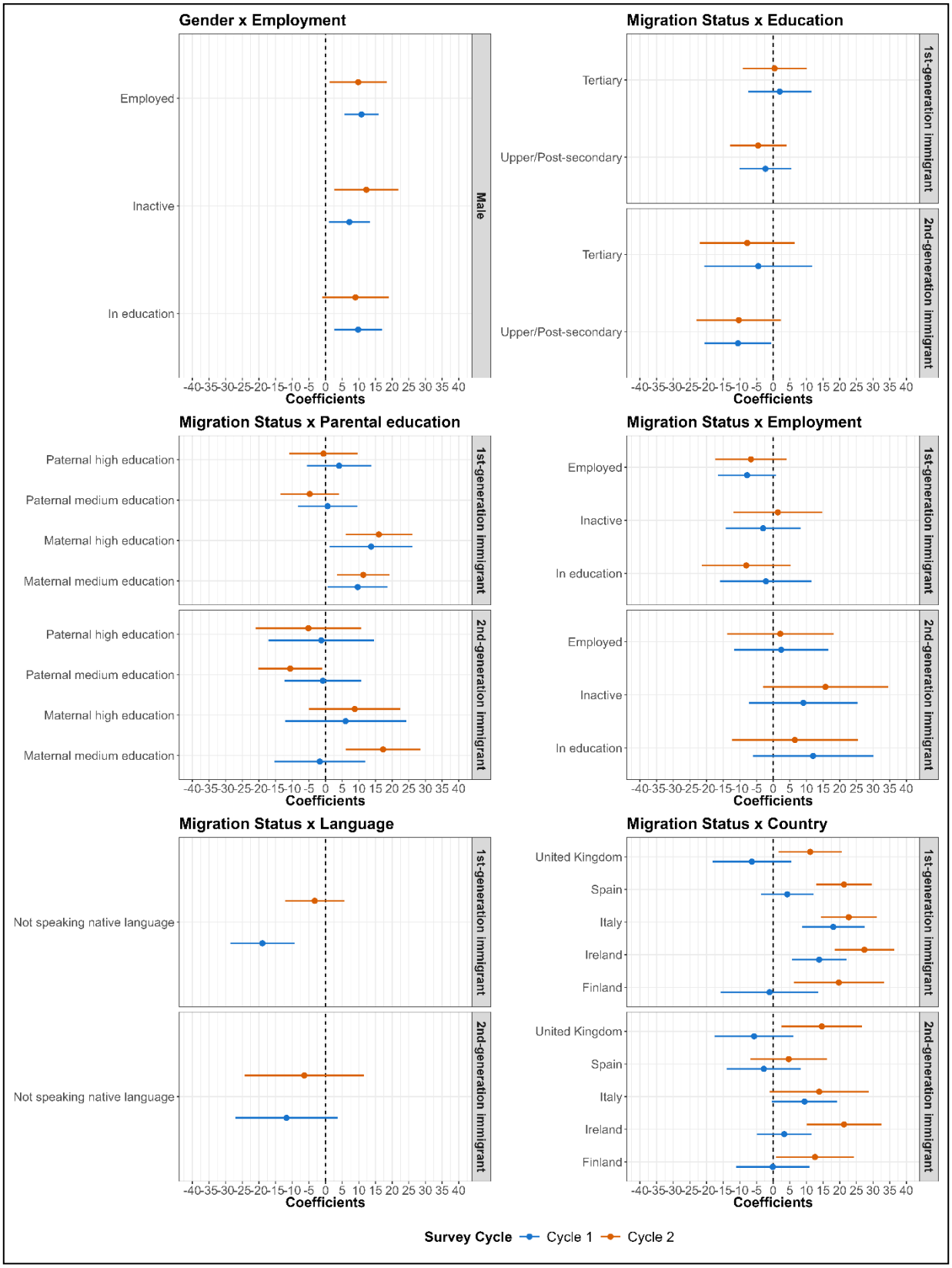
As in literacy, both immigrant generations confirm the disadvantage relative to natives once the interactions terms are integrated into the model. In Cycle 1, contrary to the moderate magnitude and lack of significance of the second generation, the first generation scores significantly 16.3 points lower than natives in Cycle 1 and 24.2 points lower in Cycle 2 (Appendix, Table 10.8). Regardless of significance, the magnitude and direction support the converging patterns of the second generation and natives converge in their trends, and both outperform the first generation. In Cycle 2, however, second-generation immigrants also score, on average, 16.8 points lower, though not significantly.

Focusing on the interactions displayed in Figure 16, in the context of numeracy, as in previous models, the numeracy gap does not vary significantly across educational levels. This mainly occurs in the context of the gap between G1 immigrants and natives. As with literacy, maternal education positively and significantly reduces the gap within and across cycles, especially the gap with the first generation. Regarding employment status, although not significantly, education and employment moderately contribute to a smaller gap for both G1 and G2 immigrants, particularly in Cycle 2.

Focusing on the effectiveness of speaking the test language, the gap between G1 and G2 immigrants and natives expands among non-proficient individuals by 18.9 in Cycle 1 and 3.2 in Cycle 2 for the former and by 11.7 in Cycle 1 and 6.4 in Cycle 2 for the latter. Therefore, the negative effect narrows over time. From a within-category perspective, G1 immigrants are the most disadvantaged group.

Lastly, the differences in the numeracy gap across countries align with the literacy results. In Cycle 1, the cross-national gap does not report significant differences relative to Belgium. In Cycle 2, all countries experienced a trend of narrowing gaps. The biggest change was witnessed in Ireland, by 27.4 for the first generation and by 21.3 for the second, followed by Italy with changes of, respectively, 22.7 and 13.8, Spain with changes of 21.3 and 4.7, Finland (19.7 and 12.6) and the UK (11.1 and 14.6). In Ireland, G2 immigrants score (-16.8) + (+21.3) = +4.5 points higher than natives. This is the only exception to a G2 immigrant advantage. Lastly, the UK and Finland report the widest gap between G1 immigrants and natives, with G1 immigrants scoring, respectively, (-29.6) + (+11.1) = -18.5 and (-29.6) + (+19.7) = -9.9 points lower than natives.

Figure 16. Interactions -OLS regression on numeracy 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)



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. Only the interaction coefficients of a model with main and interaction effects are illustrated. Full tables are reported in Appendix

5.2.5 Results for France

Due to discrepancies in the replication methods, France was analyzed separately using country-specific linear regressions. France was selected as a specific example to more precisely assess the evolution of the gap and the effects of individual predictors on skills over time. The Appendix provides detailed regression outputs by generation of immigrants to ensure complete and transparent documentation. Because missing variables obscure comparisons of the results for Germany to other countries, German models are not interpreted but attached for reference in the Appendix.

Table 5 reports the outcomes of the **survey-weighted linear regression on literacy** plausible values in France. First, the reference group scored an average of 236.0 points in Cycle 1 and 232.2 in Cycle 2, when birth region is excluded from the model and all other predictors are at their base level. In France, the gap adjusted for the other predictors confirms the immigrant disadvantage of the cross-national outputs. In particular, immigrants score 8.0 points lower than natives. This gap narrows by Cycle 2 with immigrants scoring 5.9 points lower.

Education maintains its relevance and magnitude with higher levels of education leading to higher skills. Specifically, tertiary education provides an advantage of approximately 50.0 points compared to lower secondary education and below in both cycles. Parental education has a significant impact at a lower magnitude and in the same direction. Overall, the trend of decreasing positive effects of fathers' education and increasing positive effect of mothers' education across countries is confirmed for France.

The gender effect is not significant and the discrepancy between women's and men's skills is moderate, slightly disadvantaging men in Cycle 2. As for age, the deteriorating pattern is confirmed, with individuals aged 55-65 scoring 11.3 and 16.8 points lower than those aged 16-24 in Cycle 1 and Cycle 2, respectively.

The benefit of attaining the highest qualification in an OECD country rose from 30.1 points in Cycle 1 to 52.9 points in Cycle 2. Conversely, the benefit of speaking the test language decreased from 24.4 to 17.1. Both effects were statistically significant.

Regarding employment status, while employment was beneficial in the cross-national models along with education, its positive effect loses significance in the France-specific regression. Here, being in education has the strongest effect, contributing 22.3 points more than unemployment in Cycle 1 and 19.2 in Cycle 2.

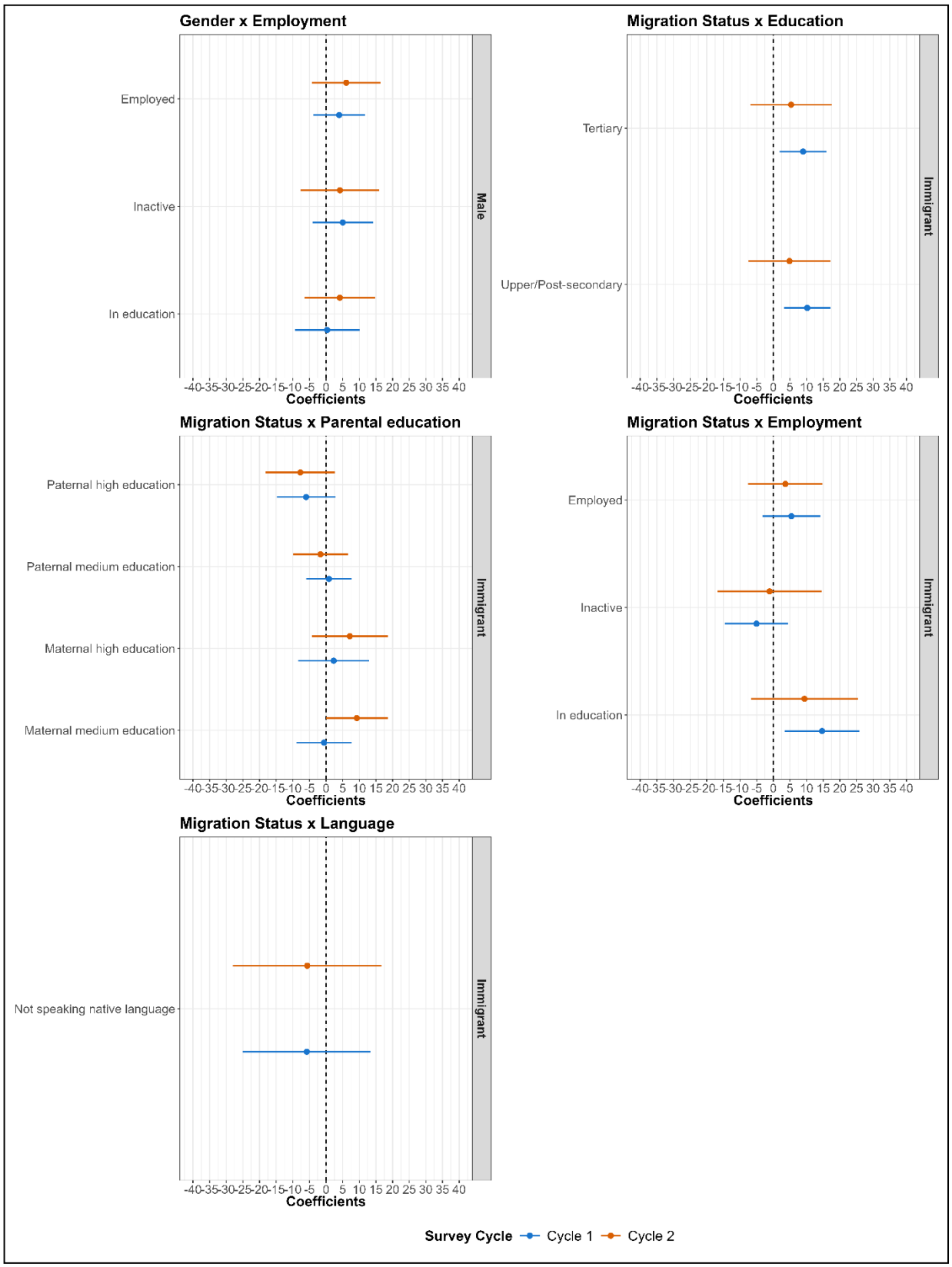
Lastly, the model with birth region reveals different patterns than previous models. Specifically, in the first cycle, Central and Eastern Europe has the worst performance, followed by poorer countries in east Asia and Pacific and Sub-Saharan Africa. However, the most critical performance returns to South and West Asia and Sub-Saharan Africa by the second cycle.
In the France-specific regression with interactions the reference group scores 241.3 in Cycle 1 and 238.3 in Cycle 2. Focusing on the literacy gap between immigrants and natives in France, immigrants significantly score 18.5 points lower than their native counterparts, all other things being equal. A similar pattern emerges in Cycle 2, though not significantly, with an immigrant disadvantage of 15.7. As with the cross-national models with interactions, the focus will be on interaction effects illustrated in Figure 17. Few effects are statistically significant, meaning that the migrant-native gap does not vary across levels of the control variables, similarly to cross-national models.

Table 5. France: 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)

	Cycle 1		Cycle 2	
	- Birth Region	+ Birth Region	- Birth Region	+ Birth Region
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Intercept	236.02*** (3.10)	236.36*** (3.08)	232.19*** (4.42)	231.11*** (4.44)
Migration status				
Immigrant	-8.03*** (1.41)	-2.26 (1.50)	-5.94** (1.78)	-1.57 (1.77)
Education				
Upper/Post-secondary	23.51*** (1.57)	22.47*** (1.56)	16.68*** (2.59)	17.05*** (2.57)
Tertiary	50.28*** (1.74)	49.48*** (1.75)	50.80*** (2.53)	51.02*** (2.57)
Age or Gender				
Male	0.69 (0.95)	0.86 (0.93)	-1.52 (1.39)	-1.29 (1.35)
25-34	6.91** (2.33)	7.90*** (2.33)	3.08 (2.60)	3.77 (2.53)
35-44	-0.83 (2.51)	0.65 (2.50)	4.58 (2.62)	5.40* (2.56)
45-54	-5.83* (2.46)	-4.67 (2.46)	-8.04** (2.81)	-7.71** (2.80)
55-65	-11.34*** (2.48)	-10.07*** (2.48)	-16.81*** (3.35)	-16.18*** (3.32)
Parental education				
Maternal medium education	4.84** (1.47)	4.53** (1.48)	9.04*** (1.71)	8.42*** (1.67)
Maternal high education	10.70*** (2.01)	10.89*** (2.00)	16.51*** (2.06)	16.16*** (2.05)
Paternal medium education	3.11* (1.42)	3.44* (1.42)	1.12 (1.65)	1.37 (1.65)
Paternal high education	12.56*** (2.16)	13.43*** (2.22)	9.25*** (2.08)	10.80*** (2.08)
Country of qualification				
Non-OECD country	-30.09** (10.54)	-15.57 (10.64)	-52.85*** (5.39)	-33.68*** (6.38)
Language				
Not speaking native language	-24.36*** (2.68)	-15.33*** (2.73)	-17.05*** (3.97)	-11.17* (4.64)
Employment status				
In education	22.33*** (2.82)	21.25*** (2.90)	19.55*** (3.73)	19.19*** (3.76)
Inactive	0.42 (2.40)	-0.45 (2.45)	-7.94* (3.53)	-7.55* (3.40)
Employed	3.17 (2.18)	2.13 (2.25)	2.84 (2.62)	2.85 (2.55)
Birth region				
Arab States		-16.66*** (2.94)		-26.63*** (5.65)
South & West Asia		-26.16* (10.20)		-41.95*** (11.45)
Latin America & the Caribbean		-29.35** (11.21)		-6.51 (11.64)
Sub-Saharan Africa		-32.00*** (4.51)		-33.36*** (7.10)
East Asia & Pacific (poorer)		-32.97*** (8.58)		-10.72 (13.88)
Central Asia		-38.43 (27.28)		-19.19 (19.95)
East Asia & Pacific (richer)		11.57 (8.81)		16.47 (23.10)
Central & Eastern Europe		-36.08*** (7.05)		-26.44** (8.20)
R-squared (pooled across PVs)	0.35	0.36	0.38	0.39

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 literacy plausible values pooled into a single output.

Figure 17. France: Interactions - 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 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. Only the interaction coefficients of a model with main and interaction effects are illustrated. Full tables are reported in Appendix.

First, education does not significantly widen or narrow the gap across educational levels. Nonetheless, the magnitude of the effect and its weak significance, particularly in Cycle 1, reveal a decrease in the gap when comparing higher-educated immigrants and natives. As for parental education, the effectiveness of both parents' qualifications is non-significant, meaning there is little evidence of variation in the gap. Nevertheless, in Cycle 2, maternal education suggests a narrowing gap at higher levels, conversely to paternal education. With regard now to employment status, education narrows the gap by 14.7 in Cycle 1 and 9.4 in Cycle 2, relative to unemployment, with weak significance. The gap among employed individuals does not differ considerably from that among the unemployed. Given the non-significance of the language effect, it is not possible to reach a definitive conclusion. Nonetheless, the results are consistent with the disadvantages discussed in earlier models and in the literature.

Table 6 shows the **numeracy regression for France**. The patterns across countries are nearly confirmed. In Cycles 1 and 2, the overall average score among the reference group is respectively 210.6 and 217.7, which is lower than in literacy. One interesting difference from the cross-national models is that the immigrant literacy disadvantage was wider than the immigrant numeracy disadvantage in Cycle 1, though it was slightly narrower in Cycle 2. In the case of France, however, immigrants experienced greater disadvantage in numeracy in both cycles, scoring 12.0 (vs -8.0 in Cycle 1 in literacy) and 11.5 (vs -8.0 in Cycle 2 in literacy) points lower than their native counterparts. Nevertheless, the pattern observed in the cross-national models of a more rapid improvement in the migrant-native literacy skill gap over time, in opposition to a slower pace in numeracy, is validated by the case of France.

The positive effect of the respondents' and the parents' education is stronger for numeracy, especially for the former, as in previous models. Concerning gender, the male advantage of above 12.0 points in both cycles resembles the numeracy models across countries.

Regarding the country of highest qualification, the patterns of literacy and numeracy are similar, showing a negative impact on the average score of about 30.0 points in Cycle 1, which worsens in Cycle 2. Conversely, the disadvantage of not speaking French narrows over time, shifting from an average score 27.0 points lower than that of proficient French speakers in Cycle 1 to an average score 10.8 points lower in Cycle 2. This progress appears to be more pronounced for numeracy than for literacy.

According to the employment status coefficients, being in education and employment are both significantly beneficial, particularly the former. However, the positive effect decreased slightly in Cycle 2.

Lastly, when information on birth region was included, Cycle 1 presented lower results for individuals born in South and West Asia, Sub-Saharan Africa and poorer countries in East Asia and the Pacific and Cycle 2 presented lower results for those born in South and West Asia and Sub-Saharan Africa.

In the numeracy model with main effects and interactions for France, the migration variable maintains solid significance. In Cycle 1, immigrants scored 24.0 points lower than natives, and in Cycle 2, they scored 19.0 points lower, holding all other regressors constant. Furthermore, the gap is more pronounced in the model with interactions, than in the models with main effects only.

Table 6. France: 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	210.64*** (3.25)	210.87*** (3.22)	217.65*** (4.53)	216.77*** (4.61)
Migration status				
Immigrant	-12.02*** (1.58)	-5.62*** (1.64)	-11.52*** (2.05)	-7.04** (2.07)
Education				
Upper/Post-secondary	29.74*** (1.57)	28.62*** (1.56)	20.23*** (2.92)	20.54*** (2.93)
Tertiary	65.34*** (1.71)	64.50*** (1.74)	55.65*** (2.94)	55.80*** (3.01)
Age or Gender				
Male	12.23*** (1.27)	12.46*** (1.26)	12.86*** (1.58)	13.06*** (1.54)
25-34	6.90** (2.55)	8.11** (2.53)	4.53 (3.06)	5.24 (2.95)
35-44	3.47 (2.89)	5.11 (2.83)	8.70** (3.04)	9.47** (3.02)
45-54	-2.36 (2.80)	-1.05 (2.74)	0.18 (3.24)	0.49 (3.22)
55-65	-5.05 (2.89)	-3.62 (2.83)	-8.19* (3.42)	-7.57* (3.36)
Parental education				
Maternal medium education	3.24* (1.51)	2.81 (1.53)	9.38*** (1.75)	8.82*** (1.74)
Maternal high education	9.92*** (2.37)	9.86*** (2.36)	16.90*** (2.23)	16.40*** (2.19)
Paternal medium education	5.06*** (1.50)	5.38*** (1.49)	1.74 (1.83)	2.06 (1.84)
Paternal high education	14.86*** (2.35)	15.94*** (2.34)	9.71*** (2.23)	11.46*** (2.21)
Country of qualification				
Non-OECD country	-30.56*** (9.06)	-13.47 (9.10)	-49.70*** (6.22)	-28.45*** (7.45)
Language				
Not speaking native language	-27.02*** (3.26)	-18.23*** (3.42)	-10.76* (4.28)	-5.77 (4.77)
Employment status				
In education	27.11*** (2.83)	26.18*** (2.89)	20.16*** (3.94)	19.63*** (4.03)
Inactive	0.93 (2.79)	-0.00 (2.87)	-4.32 (4.03)	-4.04 (4.01)
Employed	7.68*** (2.28)	6.66** (2.34)	6.24* (2.74)	6.04* (2.73)
Birth region				
Arab States		-17.64*** (3.31)		-27.24*** (6.35)
South & West Asia		-39.87*** (9.82)		-47.87*** (12.80)
Latin America & the Caribbean		-28.70* (12.19)		-16.81 (13.57)
Sub-Saharan Africa		-38.64*** (5.24)		-36.55*** (8.47)
East Asia & Pacific (poorer)		-37.17*** (9.43)		1.27 (13.66)
Central Asia		-33.05 (22.15)		-23.84 (19.82)
East Asia & Pacific (richer)		6.07 (22.09)		12.09 (25.70)
Central & Eastern Europe		-28.87*** (7.28)		-17.10 (9.03)
R-squared (pooled across PVs)	0.39	0.40	0.33	0.35

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.

Figure 18 reports the interaction coefficients. An interesting result concerns the impact of education on the migrant-native gap. The significant coefficient of 11.4 for upper/post-secondary education in Cycle 1 indicates a noticeable

decrease in the gap, relative to the lower secondary level. A smaller decrease occurs at the tertiary level (8.4). Conversely, Cycle 2 shows moderate and non-significant change from lower education levels.

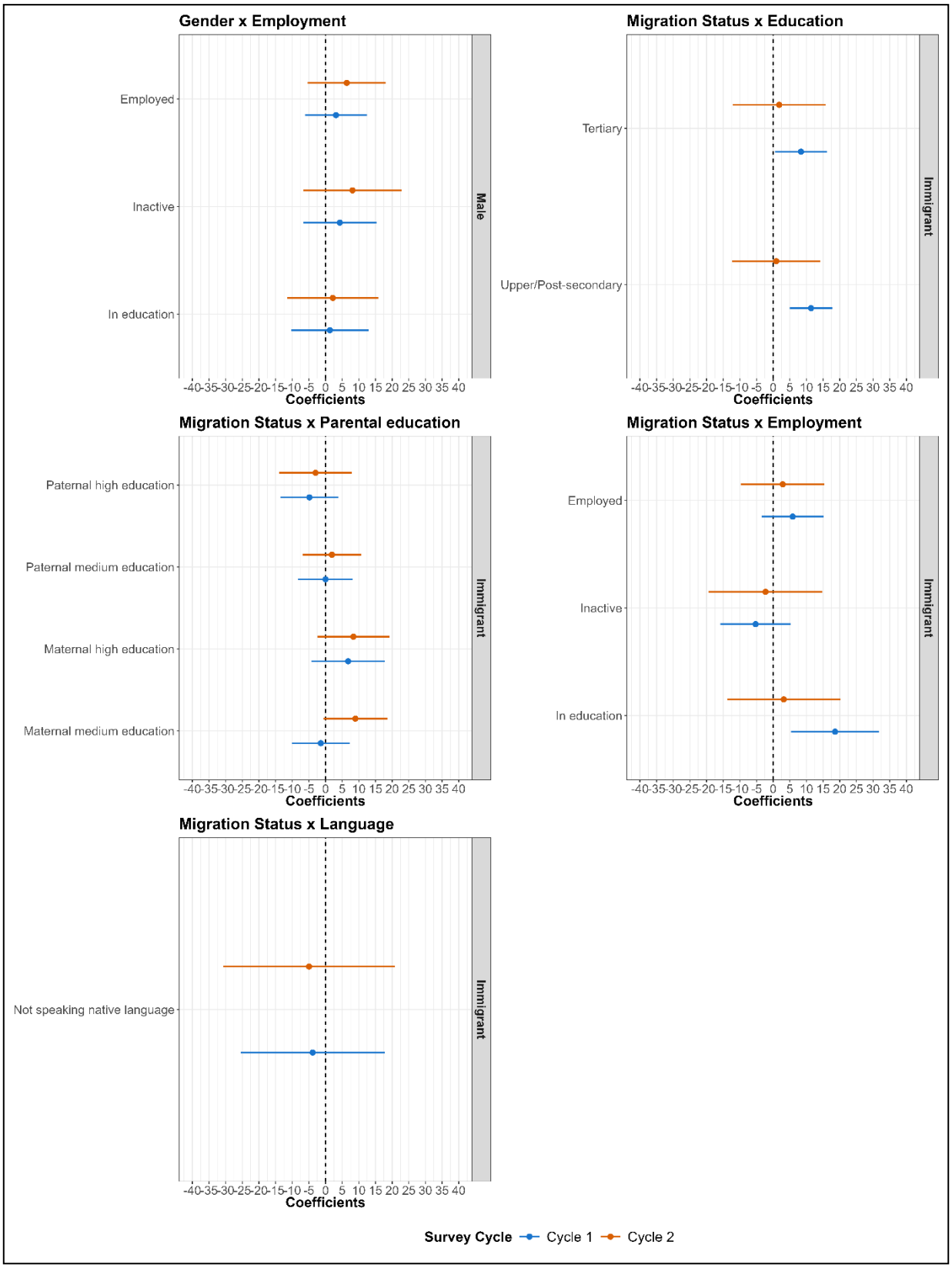
Education confirms its positive effect through the employment status coefficients, although natives still outperform in Cycle 1. As for employment and inactivity, no significant change from unemployment is observed. Similarly, the small size and non-significance of the language coefficients reveal no evidence of change in the gap, despite the negative direction supporting the literature.

The results of the survey-weighted linear regression on numeracy and literacy plausible values by immigrant generation are illustrated in the Appendix, as the patterns resemble overall the broader migrant-native skill gap perspective and the cross-national models which are the focus of the study. Generally, as in the cross-national models, including intergenerational detail diminishes the significance of migration status. This results in a strongly significant effect of being a first-generation immigrant and a non-significant effect in literacy and a weakly significant effect in numeracy of being a second-generation immigrant. Despite a considerable gap for both in Cycle 2, the France-specific outcome confirms the wide gap between natives and G1 immigrants and the convergence between natives and G2 immigrants.

When interaction terms are incorporated in the literacy model, the main effect of migration background reveals a 30.5-point disadvantage for G1 immigrants in Cycle 1 and a 24.3-point disadvantage in Cycle 2, as well as a 5.0-point disadvantage for G2 immigrants in Cycle 1 and a 13.5-point disadvantage in Cycle 2. In numeracy, G1 immigrants scored 36.5 less than natives in Cycle 1, and 22.9 points less in Cycle 2, whereas G2 scored 9.0 and 20.8 points less than natives. A further interpretation is that G1 immigrants improve over time, compared to G2 immigrants.

Recalling previous models, both literacy and numeracy interaction coefficients have weak or no statistical significance. Two exceptions emerge. First, among upper-/post-secondary-educated individuals, the gap between G1 immigrants and natives becomes smaller, relative to low secondary educated individuals. This positive effect decreases and loses certainty at the tertiary level. Second, again in the context of the gap between G1 immigrants and natives, being in education narrows the differences in both literacy and numeracy performances observed among unemployed individuals. In literacy, evidence is weak, yet the gap narrows over time, whereas, in numeracy, the strongest effect is in Cycle 1, losing magnitude and significance by Cycle 2.

Figure 18. France: Interactions - 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)



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. Only the interaction coefficients of a model with main and interaction effects are illustrated. Full tables are reported in Appendix.

6. Discussion

Taking all results together, this work provides evidence for skills gaps in literacy and literacy among the G1 immigrants and the natives and for convergence between the G2 and natives. Using cross-temporal perspective and utilizing two cycles of PIAAC we provide novel insights into the temporal evolution of these gaps among adults aged 16-64. The descriptive results confirm the existence of a skills gap between immigrants and natives already discussed in previous studies (Batalova & Fix, 2015, Cathles et. al., 2021). These studies solely used the first cycle of PIAAC survey.

Descriptive results showed pronounced skill gaps of G1, with worsening trend over time in some countries, such as in Germany where natives and G2 showed improving trends while G1 showed worsening literacy and numeracy skills, in result of which the skill gaps widened over time. It is striking that highly-educated G1 immigrants have skill levels comparable only to medium-skilled natives, and in case of Finland, a country with highest skills, only comparable to low-educated natives. The main results show that, in terms of demographic gap, first-generation immigrants are mainly low-educated and young individuals, aged 25-34. As for gender, the difference is negligible, with increasing female stocks over time. These patterns are consistent with the statistics on trends over the past years reported by Eurostat (2025). It is necessary to explore the trends that characterize the overall immigrant population and its comparison to the native. Poor skill levels of G1 immigrants in all countries but Ireland and to some extend the UK are responsible for the overall native-migrant skills gaps, as G2 is comparatively smaller.

Most countries witnessed overall greater improvement in numeracy proficiency than in literacy proficiency over time, regardless of the migration background. Particularly, among the countries under study, natives' literacy performance improved in Belgium, Finland, Germany and the United Kingdom, in opposition to an improvement in immigrants' performance in Finland and the UK. As for numeracy, natives improved in all countries under study, including France, Ireland, Italy and Spain, whereas immigrants improved in Finland, France, Ireland, Spain and the UK. Finland is the country that most experienced an upward trend in both literacy and numeracy. The differences and changes in individuals' performance in literacy and numeracy over time align with the trends reported by OECD (2024).

Regardless of the generation, immigrant skills gaps reveal a consistent disadvantage over time in both literacy and numeracy, particularly in the former. As for numeracy, immigrants' proficiency underwent stronger improvements than among natives in countries such as Finland and the United Kingdom, reducing the gap between the two subgroups by Cycle 2. In these countries, immigrants' trend is steeper than natives' suggesting a potential ability to improve or an increasing selectivity towards high-educated immigrants due to migration policies in the receiving country. Lastly, the trends in literacy and numeracy scores reveal that immigrants and natives tend to follow the same increasing or decreasing pattern, except for Belgium and Germany, where natives improved over time and immigrants regressed.

The educational gap between natives and immigrants explains partially the literacy and numeracy skills gap. In fact, the charts in Section 5.1 of Chapter 5 clearly highlight the concentration of immigrants in lower levels. Moreover, younger immigrants report higher education level suggesting an improvement in education and in the access to it, given the patterns followed by the two different cohorts. This can also be seen in the cross-cycle detail.

Worth noting and critical point of this work is to disentangle the skills gap between migrant generations. Overall, G1 immigrants are the most disadvantaged group. Having been raised in a country different from the host one or by parents with migration background often contributes to discrimination, stereotypes and, consequently, deprivation of the rights

that natives experience daily. On the other hand, G2 immigrants and natives follow mostly the same pattern, although the migration background still and often provokes disparity. However, second-generation immigrants, raised by immigrant parents, are integrated into local schools, culture and society at an early age, explaining the similarity in the trends. These findings were expected based on existing evidence. Authors such as Cathles et al. (2021), Azzolini et al. (2012) and Rindermann and Thomson (2014) previously investigated and assessed a convergence between natives' and G2 immigrants' skills as a consequence of an earlier adaptation of the latter group to the host social context. Furthermore, the sample of countries suggests an interesting trend across Europe, between Northern and Southern countries. The former shows a greater performance, suggesting more favorable educational environment and system, conversely to the latter whose performance is more stable.

The survey-weighted regression on literacy and numeracy plausible values explored the adjusted gap between immigrants' and natives' performance by education, both own and parental, gender, age, employment status, country of highest qualification, proficiency in the test language, country of the interview and, occasionally, birth region. Overall, most results, meaning the effects of each control variable on literacy and numeracy scores, align with what found by OECD and other authors, as will be delineated throughout this section.

The models with main effects reveal insightful and statistically significant results. The first research asked whether the gap between immigrants' and natives' skills existed and the descriptive analysis already found sizeable lagging behind of the G1. The regression models represent solid support confirming significant migrant-native gaps, which depend on the skill domain and varies over time. Moreover, the main patterns are confirmed across both domains and cycles. Overall, immigrants experience a significant disadvantage when education, parental education, gender, age, employment status, country of highest qualification, language proficiency and the country under study are accounted for. In the pooled models with main effects only and no generation detail, the migrant-native skills gap and, hence, the immigrant disadvantage, are wider for literacy in Cycle 1 and slightly for numeracy in Cycle 2. Nonetheless, the literacy output reveals a more noticeable improvement across cycles than the numeracy output, reaching a narrower gap in Cycle 2. Conversely, the migrant-native numeracy skill gap underwent a smaller change, although remained. Once the disaggregation of immigrant population by generation is included, the gap between G1 and natives maintains considerable magnitude and significance, whereas the gap between second-generation immigrants and natives has little magnitude and no significance. Both gaps confirm the immigrant disadvantage across cycles and domains, particularly for the first generation. As for the second generation, the moderate gap suggests a converging pattern with natives (Cathles et al., 2021; Azzolini et al., 2012). The literacy gap narrows over time for both generations. Conversely, the numeracy gap narrows for the G1 and widens, though not significantly, for the G2, from Cycle 1 to Cycle 2. Overall, the literacy gap is wider than the numeracy gap.

All regression models, regardless of the skill domain, the cycle or the subpopulation under study, emphasize that education is paramount in determining the respondent's skill and performance. Higher levels of education correspond to higher scores. As discussed in the literature, this interpretation supports the relationship between education and skills (Schnepf, 2006; Levels & Dronkers, 2008). It suggests the relevance of intervening on the former to reduce a potential gap between subpopulations, more specifically between immigrants and natives. Different educational systems and backgrounds affect the overall qualification and, subsequently, the integration between diverse individuals into the social and economic context. Additionally, education plays a role in measuring skills and the migrant-native skills gap from a different perspective, i.e. the influence of parents' education on their children's performance. The concept of intergenerational transmission of education is supported by these results, recalling what stated by Martin (2011). High-

qualified parents tend to invest in their children's education and encourage their future social mobility and opportunities. Additionally, this interpretation is supported by the generational skill differences. More specifically, as Heisig et al. (2020) argue, the effect of parents' higher aspirations on their children's performance is particularly pronounced among G2 immigrants, due to the motivation and ambitions shaped by the immigration process their parents experienced. In this work, the integration of PIAAC Cycle 2 and older ages in the population under study contributes to investigating the effect of one's own education and parental education on skills and the resulting gap to a wider extent. Conversely to previous studies, such as Levels & Dronkers (2008) or Azzolini et al. (2012), the perspective is no longer limited to specific school achievement gaps but extends to a broader everyday-life context.

Concerning demographic factors, the effect is weaker for both gender and age. The gender coefficient reveals a non-significant and little gap between women's and men's literacy average scores, whereas the gap widens in numeracy, showing male advantage. This result is consistent with literature and what was found by OECD (2024). In Cycle 1, individuals aged 25-44 perform better than those aged 16-24 in literacy. After the age of 45, the advantage considerably declines. In numeracy, the advantage over individuals aged 16-24 begins to decline starting from the age of 35 and more steeply from 45. Both domains witness the strongest deterioration for the age group 55-65, reaching a significantly lower performance than younger individuals. In Cycle 2 and in both literacy and numeracy, all individuals aged 25-65 score worse than those aged 16-24, worsening at each older age group. The pronounced disadvantage for older individuals is consistent with age and cohort effects. Considering the former, health, cognitive and physical abilities deteriorate with age, affecting the individual's performance in the literacy and numeracy test. As for the cohort effect, the group of people aged 55-65 may have experienced different educational systems, policies and lifestyles that directly and indirectly influence their performance.

Speaking of differences in the background, and confirming previous evidence, the language and the country of highest qualification represent a barrier (Cathles et al., 2021, Ghio et al, 2022). Not being proficient in the test language and having been educated in a non-OECD country undermines the test scores. Particularly, the second suggests and emphasizes what is mentioned above, i.e. different educational systems, along with different social and economic environments, explain differences in individuals' performances (Richwine, 2022). Moreover, being in education, followed by being employed, has a strong positive effect, which increases over time, on both literacy and numeracy test scores.

Lastly, regarding cross-national differences, Finland seems to be an outlier in the trend, revealing a considerably high performance among individuals, relative to Belgium. Conversely, the remaining countries show lower performance, particularly in Spain and Italy.

Shifting the focus to the interactions, the conclusions on the gap are different. The immigrant disadvantage follows a reversed pattern. Instead of decreasing overtime as shown in the previous models, when the interactions are included, both literacy and numeracy gaps widen over time in magnitude and significance, with similar gaps across domains in Cycle 1 and a wider gap for numeracy in Cycle 2. Overall, numeracy reaches a higher gap than literacy by the second cycle. This contradicts the descriptive analysis of a narrowing numeracy proficiency gap in Finland and the UK and the overall lower literacy proficiency among immigrants confirmed by OECD (OECD, 2024). Regarding the disaggregation by generation of immigrants, similarly, literacy and numeracy gaps increase from Cycle 1 to Cycle 2. In the first cycle, a moderate difference across domains and cycles occurs when the gap between G1 immigrants and natives is considered. Regarding the gap between natives and G2, a higher disadvantage for the latter is presented in Cycle 1 for literacy and a higher disadvantage in Cycle 2 for numeracy, resembling the first generation, although to a greater extent. The magnitude of this gap is lower

than the gap with the first generation. Nevertheless, second-generation immigrants experience a more intense deterioration in their performance, relative to their first-generation counterparts. At this stage, the existence of a gap in immigrants' and natives' skills is assessed.

The interactions may contribute to investigating what factors affect this gap and who benefits and who does not. Nevertheless, the regression output reveals little or no evidence of changes in the migrant-native gap across levels of control variables. The highest impact derives from the language barrier, particularly in Cycle 1 and for both domains at the same intensity. As expected, not speaking the test language, i.e. the language of the country of the interview, significantly widens the gap between immigrants and natives, relative to the gap among individuals with language proficiency. Lacking the test language is an obstacle for both subgroups, but immigrants are considerably more disadvantaged. This disadvantage slightly narrows over time, along with the overall gap.

We find strong positive effect of education and employment on both literacy and numeracy performance for both immigrants and natives. Once the impact of employment status on migrant-native skill gap is examined, the gap does not significantly vary across levels. Overall, for both literacy and numeracy, maternal education narrows the gap, increasingly at higher educational levels and over time. As for paternal education, conversely, the effect is small. the gap expands among individuals with no proficiency in the test language across generations, domains and cycles. Nevertheless, the negative effect observed in Cycle 2 is no longer pronounced as in Cycle 1. Numeracy shows a bigger gap between natives and second-generation immigrants compared to literacy, conversely the gap with first-generation immigrants is consistent.

Lastly, in Cycle 1, Finland, Spain and the United Kingdom present a wider gap than in Belgium, whereas Ireland and Italy present a narrower gap. On the contrary, in Cycle 2, all five countries present a narrower gap, significantly. This pattern characterizes both literacy and numeracy. More specifically, in the first cycle for literacy, Finland shows the widest immigrant disadvantage, followed by Spain, and Ireland and Spain show the narrowest disadvantage. In the second cycle, the United Kingdom surpasses Finland in terms of gap width, whereas Italy is the only country to present a slight immigrant advantage. Regarding numeracy, in the first cycle, Ireland and Italy are the exception to a negative and non-significant trend, with the former presenting a more noticeable immigrant advantage and the latter presenting an almost absent gap between immigrants and natives. Lastly, in the second cycle, Ireland witnesses a further improvement and immigrant advantage, whereas Italy aligns with the negative trend of the remaining countries, although still moderately. The United Kingdom presents the widest gap, followed by Spain and then, Finland. Taken together, Finland, Spain and the UK maintain a considerable immigrant disadvantage over time. Italy and Ireland show the narrowest gap across domains and cycles. Additionally, in the former, immigrants reach slightly higher literacy scores in Cycle 2 and higher numeracy scores in Cycle 1. However, natives surpass immigrants in numeracy by Cycle 2. Concerning Ireland, while natives still outperform immigrants in literacy, the pattern is reversed in numeracy, although by little.

The cross-national trends between literacy and numeracy do not particularly differ. The United Kingdom reveals the widest gap between both generations and natives. Ireland shows a small advantage for G2 immigrants in Cycle 2.

The France-specific regression model provides insights into the dynamics concerning the migrant-native skill gap and help assess or not the interpretations across countries. Most of the results are consistent with the cross-national models. First, the gap between immigrants and natives in both literacy and numeracy is confirmed and seems to slightly narrow over time. Nevertheless, whereas, in the cross-national model, the immigrant literacy disadvantage was wider than the

numeracy disadvantage in Cycle 1 and slightly narrower in Cycle 2, the numeracy immigrant disadvantage is wider in both cycles. Second, the small and non-significant literacy proficiency gap between women and men and the male advantage in numeracy are observed. Third, education has a strong impact on the determination of skills, along with maternal qualification. Fourth, having attained the highest qualification in an OECD country and being proficient in the native language supports the considerable benefit already discussed cross-nationally. Difference in the results concerns employment status in literacy, as being employed does not reveal significant changes compared to being unemployed. Moving to interaction effects, the gap follows similar patterns to cross-national models, showing non-significant variation across levels of control variables.

When examining migrant-native skills gap, compositional effects need to be considered. First, as displayed in Figure 4 of descriptive results (Section 5.1, Chapter 5), immigrants are over-represented at lower education levels, due to the high concentration of first-generation immigrants in these levels. Second, the consistently significant migrant-native skills gap in regression models after controlling for education and other variables is consistent with the existence of a gap. Nevertheless, this is mainly driven by G1. The base models for both literacy and numeracy, meaning the models with migration variable only, displayed in the Appendix, show large gaps between immigrants and natives, particularly for G1. After controlling for education and other variables, the gaps shrink considerably. In particular, the gap with G2 immigrants loses magnitude and significance, suggesting that compositional differences largely explain the disadvantage for G2 immigrants. As for G1, compositional differences do not entirely explain their disadvantage, given that the gap remains significant and large when control variables are included.

Additionally, when the broader immigrant group is examined and birth region is accounted for, the immigrant effect shrinks. In other words, before including birth region, the gap widens as it combines differences in immigrants' origin and other factors, without considering that most G1 immigrants in the sample may come from regions with lower literacy or numeracy performance. When birth region is included, the gap becomes smaller as it compares skills among immigrants with same origin.

The case of Ireland represents an example of the relevance of compositional effects - immigrants in Ireland are mostly highly educated, and higher share has high education compared to other countries under study. Conversely to other countries and the widely discussed disadvantage of G1 relative to G2, the G1 in Ireland outperformed G2. This result reinforces the trend of an overall narrow gap between immigrants and natives and the immigrant advantage observed in numeracy. Additionally, the high concentration of high-educated immigrants possibly suggests selective migration with a stronger demand for high-skilled individuals. Concerning the implementation of policies, migration policies need to be adjusted and tailored to specific target groups, including their pre-migration skills and the compositional differences to account for the heterogeneity of the phenomenon itself.

7. Limitations

In the context of a complex and multifaceted phenomenon such as migration, data collection encounters many challenges. It is challenging to include representative samples of the immigrant population in surveys. Therefore, the data suffers from limitations and biases. Measuring literacy and numeracy skills is an arduous task to an even greater extent, given the type of survey and questions with which respondents are confronted. As previously mentioned, the PIAAC survey consists in, first, a set of background questions and, later, a set of exercises in both literacy and numeracy to test

the respondents' abilities. Thereby, despite the untimed test, the respondents may feel pressured or fear the level of difficulty, leading them to a non-response. In addition to this, language represents a relevant obstacle and increases the probability of non-response. The test language is usually the native language of the country of the interview. Immigrants, particularly the G1, are disadvantaged, and a lack of language proficiency often prevents them from answering the background questions and, subsequently, completing the literacy and numeracy tasks. Non-response bias is defined as the result of a discrepancy between individuals who decide to participate in the survey and those who do not. The outcome is a sample that does inadequately represents the target population, complicating the interpretation of the latter and its patterns. In other words, the immigrant population and its subgroups risk being over- or underrepresented. This limitation was particularly problematic in the first cycle of the Survey of Adult Skills. More precisely, 1.5% of adults did not participate in the survey between 2012 and 2018, as they were not able to answer due to inadequate language proficiency. For instance, in Belgium (only the Flemish region), over 5.0% of adults did not participate, similar to the United States (OECD, 2024). As the OECD claims, a solution to this limitation was found for the second cycle in 2023 by including a doorstep interview for individuals with language barriers. This section of the survey consists of self-administered questions in 43 different languages about the respondents' socio-demographic background, such as their age, gender and educational level. Based on these responses, it was possible to estimate the respondents' skills.

Overall, many new tools and improvements were implemented in the second cycle, to considerably reduce the risk of non-response bias. Nevertheless, the limitation persists in this study due to the cross-time perspective. On the one hand, introducing the doorstep interview decreases the risk of non-response bias, on the other hand, a problem of non-comparability between the two cycles is advanced, considering that the first cycle handles non-respondents as literacy-related non-respondents. For this reason, doorstep-interview variables were not considered in this work. The missing observations from Cycle 1 due to non-response, as well as the observations from Cycle 2 that were excluded because respondents answered the doorstep interview to harmonize and compare the two cycles, explain the small size of the immigrant sample. The sample size decreases as more dimensions are included. In addition to the non-response bias, the small samples in this study are due to scarce data availability across European countries. In the public PIAAC PUFs, many observations had at least one missing value, leading to restricting the sample to the available ones. Public data availability also influenced the selection of countries and variables, limiting the study to fewer perspectives than originally planned.

Considering the cross-national discrepancies, each of the eight countries with available data has relevant sampling details that must be acknowledged before exploring the differences in the results. According to the OECD, in Cycle 2, removing respondents who were administered the doorstep interview and, therefore, did not take the full assessment with cognitive test tasks had a small impact on France, the UK, Ireland and Italy but a more considerable impact on Finland, Belgium, Germany and Spain, as the share of immigrants participating to only DI questionnaire was much wider in this second group. Additionally, some countries oversampled portions of the target population. Italy oversampled the immigrant population and individuals aged 16-29, whereas France oversampled small regions.

The methodological limitations mainly concern two types of incomparability. The first type occurs in the cross-national and within-cycle perspectives of the regression analysis. Discrepancies in the weighting replication methods used across countries contributed to a limited comparative analysis. Particularly, France and Germany, which was formerly excluded for missing variables, were separated from the main models, constituting a barrier to a wider cross-national study within survey cycle. Using a common replication method across countries and cycles would harmonize the analysis.

Additionally, a second incomparability issue emerges at the stage of comparing literacy and numeracy trends. This issue results from incomparability between literacy and numeracy test score scales. Due to these differences, it is not possible to compare scores across domains but only within domains. It is not possible to state whether immigrants perform higher or lower in literacy than in numeracy, only whether they perform higher or lower than natives or than immigrants in a different country or cycle, within literacy. Therefore, proficiency levels were created to enable cross-domain comparisons. Similarly, one reason for excluding problem-solving skills from the study was the change in assessment approach from Cycle 1 to Cycle 2. Including problem-solving skills would have incorporated an additional perspective and outcome.

Data availability and missing variables in PUFs restricted the scope of the study. We could not include any Nordic country, although Sweden would be of great interest due to its large immigrant population. PIAAC survey investigates different perspectives of language proficiency, including the proficiency in the native language and the language spoken at home, however, these variables are not publicly available for all countries under study. Future research can explore the specific effects of all these PIAAC variables on the migrant-native skill gaps. We also could not include the date of arrival and the age of immigration, which are important to capture gradual process in integration and adaptation into host country's society. The differences between recent and already settled immigrants, encompass opportunities to develop and utilize skills change over time and with age for immigrants and natives.

Lastly, PIAAC investigates whether the respondent took or is currently in a training program. This aspect offers insight into the process of skills development over time, including whether training improves cognitive skills and, if so, how. It also increases along respondents' access to the labor market and integration opportunities. However, training variables were also not available for all the countries under study and, additionally, this aspect is not the primary focus of this work.

Complications arising from data collection and availability represent a notable issue in migration research. It is important to acknowledge these limitations and consistently keep them in mind when executing the analysis and interpreting the outcomes. The more improved and precise the data and analytical tools are, the easier it will be to make conclusions about a complex phenomenon like migration.

8. Conclusions

Immigration has a strongly debated impact on both origin and destination countries. In host societies, new arrivals can cause fear of not being able to control them and tension resulting from the fusion of individuals with different backgrounds (Rindermann & Thompson, 2014). Conversely, properly integrating immigrants into the host society allows them to contribute to the socioeconomic growth of both sending and receiving countries. Successful integration benefits immigrants by providing them with job opportunities and more favorable standards of living. In turn, origin countries benefit from immigrants' remittances and overall economic advancement. Lastly, host countries mainly benefit from an expanded labor force that contributes to productivity and an efficient economy, if immigrant are integrated.

Given the role that cognitive skills play in guaranteeing immigrants' access to the receiving labor market, this work explored the gap between immigrants' and natives' skills, specifically literacy and numeracy. Once the existence and properties of the gap have been assessed, measures can be proposed to narrow it, facilitating integration. This work is based on the idea that literacy and numeracy skills can be representative of individuals' ability to interact with the

surrounding social and economic environment (Batalova & Fix, 2015). Using PIAAC data provided by the OECD which evaluates respondents' skills through tasks in addition to a background questionnaire, this study aimed to measure the migrant-native gap and identify its determinants. Immigrants' and natives' literacy and numeracy skills were explored in the following countries: Belgium (Flemish region only), Finland, France, Germany, Ireland, Italy, Spain and the United Kingdom (England only).

The results of descriptive and regression analyses confirm the existence of a skills gap between immigrants and natives, answering the first three questions. This finding is consistent with previous studies on the first PIAAC cycle, such as the papers by Batalova and Fix (2015) and the one by Cathles et al. (2021) which also integrate PISA data. However, this work contributes to the aforementioned studies by expanding the target population of the analysis to older ages.

We find a consistent immigrant disadvantage across domains, cycles and countries. Focusing on the shifts over time (between the two PIAAC cycles), immigrants and natives seem to follow similar trends in most countries (i.e. the performance of both either improves or deteriorates). Belgium and Germany are exceptions and we find divergence and widening native – migrant gaps because natives' literacy and numeracy scores improved from Cycle 1 to Cycle 2, whereas those of immigrants deteriorated.

Disaggregating immigrants by generation reveals a narrower gap or even similar skill levels between natives and G2 while the gap between G1 and natives persist. In other words, while G1 shows significantly lower literacy and numeracy performance than natives, G2 converges in terms of test outcomes over time towards the natives – a positive news with respect migrant integration in most countries under study. Once more, these findings resemble studies on PISA and PIAAC Cycle 1 which assessed a smaller disadvantage for G2 immigrants compared to G1, as well as the convergence of their skills with those of their native counterparts (Cathles et al., 2021; Azzolini et al., 2012). These results support the idea that being raised in the host social context contributes to better performance (resembling that of natives), by anticipating and facilitating their social networks and cultural adaptation (Rindermann & Thompson, 2014). The fifth result illustrates that, in Finland with the widest migrant-native gap and the United Kingdom, G1 tend to experience a more rapid and noticeable progressing evolution from Cycle 1 to Cycle 2 than natives and G2. Additionally, Ireland reports the narrowest gap with immigrants, particularly with the second generation performing better than natives in numeracy.

The causes for the skill gaps were mainly addressed using regression models. A considerable focus was placed on education, as a direct supplier of competencies. Both descriptive charts and regression tables confirm the leading role of education, both own and parental education, in determining skills. These results also confirm existing evidence on the impact of education on skills, such as Schnepf (2006) and Levels & Dronkers (2008). Nevertheless, existing studies focus on young individuals at school age. This work integrates the perspective of education on adults' performance, shedding light on the long-term effects of education skill development and the differences between immigrants and natives. Despite the moderate change in the gap across educational levels, the high concentration of immigrants at lower levels explains the overall low performance. A further explanation for this conclusion may be the negative effect of having attained the highest qualification in a non-OECD country, given the differences in educational systems across countries, as previously discussed by Richwine (2022). Moreover, the gap is consistent at each educational level. This suggests that, despite the educational benefits for both immigrants and natives, other factors maintain immigrants' performance low. One relevant influence is the linguistic barrier. Not speaking the native language considerably affects individuals' results, confirming patterns explored in PIAAC Cycle 1 and PISA (Cathles et al., 2021). Lastly, along with education, employment reduces the gap. In conclusion, policies aimed at narrowing the skills gap should address the linguistic barrier and enable

immigrants' access to the receiving educational system and labor market, for instance, by offering training and language programs.

It is relevant to note that this work acknowledges the limitations in the context of migration data analysis. Immigration is a heterogeneous demographic phenomenon involving diverse and complex dynamics. It encompasses numerous individuals with different backgrounds, migration reasons and pathways. Therefore, identifying, tracking and studying immigrants is challenging. Measuring skills requires additional caution. PIAAC data is an innovative and efficient tool. Nevertheless, limitations need to be accounted for. Among these, improvements in comparability across cycles and test domains are necessary. Additionally, the incomparability issue emerges from the use of different replication methods at the stage of weighting, undermining a smooth comparison across countries and, hence, a wider selection of countries under study. Furthermore, data availability, due to the anonymized public-use files, and the often-discussed small immigrant samples represent a noticeable obstacle to a fully comprehensive analysis. Progress in collecting migration data and measuring skills is encouraged to promote more solid and efficient research.

Due to data availability and comparability issues, a stricter selection of countries under study and the drivers of the migrant-native skills gap was made. Future research should maintain and deepen the cross-national and cross-temporal perspective advanced by this work. More countries could be included within European, non-European and global contexts. Furthermore, the analysis of factors affecting the gap could be extended to additional variables. For instance, this work mentioned the potential effect of offering immigrants a training course when they enter the receiving country. This perspective suggests a central focus for integration policies aimed at optimizing benefits for both immigrants and natives. Additionally, as Levels et al. (2017) discussed, including 1.5 generation of immigrants, meaning foreign-born individuals who migrated at a young age, is interesting, to cover a wider range of individuals and differentials. Including this disaggregation in this work would have provided insight into the effect of accessing the host social context at an earlier age on individuals' skills and integration. However, the small size of immigrant samples did not allow it. Similarly, in this work, first-generation immigrants are defined as foreign-born individuals with both native-born parents, whereas second-generation of immigrants are defined as individuals born in the host country to one or two foreign-born parents. Given the impact that parents and their background have on children, distinguishing between second-generation immigrants with one foreign-born parent and those with two could provide insight into the resulting advantages and disadvantages. For instance, this distinction could emphasize the evidence of a linguistic barrier during skill assessment and the overall integration process.

In conclusion, migration is an important and current global phenomenon that requires cautious investigation and comprehension. Knowledge is the key to understanding the complexity of migration and responding properly to it. Data provides this knowledge, yet consistent updates and advancements in collection and analysis are needed. Together with interest in and openness to the other and the different, knowledge contributes to overcoming the fear and uncertainty that often result in misinterpretations. This work sheds light on the relevance of recognizing the gap between immigrants' and natives' skills that undermines the proper integration of immigrants into receiving societies and the interaction between the two populations. This work encourages further research and intervention to narrow the gap and enable the mutual benefits for both immigrants and natives and their respective home countries.

References

Azzolini, D., Schnell, P., & Palmer, J. R. (2012). Educational achievement gaps between immigrant and native students in two "new" immigration countries: Italy and Spain in comparison. *The Annals of the American Academy of Political and Social Science*, 643(1), 46-77.

Batalova, J. and Fix, M. (2015). What Does PIAAC Tell Us About the Skills and Competencies of Immigrant Adults in the United States? Retrieved January 4, 2025, from http://static1.squarespace.com/static/51bb74b8e4b0139570ddf020/t/54da7824e4b026d7c8ca7cce/1423603748680/Batalova_Fix_PIAAC.pdf.

Cathles, A., Ou, D., Sasso, S., Setrana, M., & Van Veen, T. (2021). Where do you come from, where do you go? Assessing skills gaps and labour market outcomes for young adults with different immigration backgrounds. *International Journal of Educational Development*, 86, 102466. https://doi.org/10.1016/j.ijedudev.2021.102466

Christl, M., Bélanger, A., Conte, A., Mazza, J., & Narazani, E. (2022). Projecting the fiscal impact of immigration in the European Union. *Fiscal Studies*, 43(4), 365–385. https://doi.org/10.1111/1475-5890.12314

Eurostat (2022). Main characteristics of foreign-born people on the labour market. In Statistics Explained. Eurostat. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Main_characteristics_of_foreign-born_people_on_the_labour_market

Eurostat (2023). Main obstacles for foreign-born people to enter the labour market. In Statistics Explained. Eurostat. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Main_obstacles_for_foreign-born_people_to_enter_the_labour_market

Eurostat (2025). Migration to and from the EU. In Statistics Explained. Eurostat. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Migration_to_and_from_the_EU

Ghio, D., Bratti, M., & Bignami, S. (2022). Linguistic barriers to immigrants' labor market integration in Italy. *International Migration Review*, 57(1), 357–394. https://doi.org/10.1177/01979183221107923

Heisig, J. P., & Schaeffer, M. (2020). The Educational System and the Ethnic Skills Gap among the Working-Age Population: An Analysis of 16 Western Immigration Countries. Socius Sociological Research for a Dynamic World, 6. https://doi.org/10.1177/2378023120925717

Kalfa, E., & Piracha, M. (2015). Social networks and the labour market mismatch. *Journal of Population Economics*, 31(3), 877–914. https://doi.org/10.2139/ssrn.2690741

Lancee, B., & Bol, T. (2017). The Transferability of Skills and Degrees: Why the Place of Education Affects Immigrant Earnings. *Social Forces*, 96(2), 691–716. https://doi.org/10.1093/sf/sox058

Levels, M., & Dronkers, J. (2008). Educational performance of native and immigrant children from various countries of origin. *Ethnic And Racial Studies*, 31(8), 1404. https://doi.org/10.1080/01419870701682238

Levels, M., Dronkers, J., & Jencks, C. (2017). Contextual explanations for numeracy and literacy skill disparities between native and foreign-born adults in western countries. *PLoS ONE*, 12(3), e0172087. https://doi.org/10.1371/journal.pone.0172087

Luz, A., Neves, P. C., Afonso, O., & Sochirca, E. (2025). Meta-Analysis: The impact of immigration on the economic performance of the host country. *Economies*, 13(8), 213. https://doi.org/10.3390/economies13080213

Marois, G., Sabourin, P. & Bélanger, A. (2020). Implementing Dynamics of Immigration Integration in Labor Force Participation Projection in EU28. Population Research and Policy Review 39, 339-363. Doi:10.1007/s11113-019-09537-y

Martin, M. A. (2011). Family structure and the intergenerational transmission of educational advantage. *Social Science Research*, 41(1), 33–47. https://doi.org/10.1016/j.ssresearch.2011.07.005

Niyimbanira, F., & Madzivhandila, T. S. (2016). Myth That Immigrants “Steal Jobs”: An Economic Blame Game? DOAJ (DOAJ: Directory of Open Access Journals). https://doaj.org/article/ed5c869beb914499bc8f90adf6366841

OECD/European Union (2014), Matching Economic Migration with Labour Market Needs, OECD Publishing. http://dx.doi.org/10.1787/9789264216501-en

OECD (2018), Skills on the Move: Migrants in the Survey of Adult Skills, OECD Skills Studies, OECD Publishing, Paris. https://doi.org/10.1787/9789264307353-en

OECD (2024), Do Adults Have the Skills They Need to Thrive in a Changing World?: Survey of Adult Skills 2023, OECD Skills Studies, OECD Publishing, Paris, https://doi.org/10.1787/b263dc5d-en

OECD (2024), Survey of Adult Skills – Reader's Companion, OECD Skills Studies, OECD Publishing, Paris, https://doi.org/10.1787/3639d1e2-en

OECD (2025), Skills that Matter for Success and Well-being in Adulthood: Evidence on Adults' Social and Emotional Skills from the 2023 Survey of Adult Skills, OECD Skills Studies, OECD Publishing, Paris, https://doi.org/10.1787/6e318286-en

OECD (2025), Survey of Adult Skills 2023 Technical Report, OECD Skills Studies, OECD Publishing, Paris, https://doi.org/10.1787/80d9f692-en

Pivovarova, M., & Powers, J. M. (2022). Do immigrants experience labor market mismatch? New evidence from the US PIAAC. *Large-scale Assessments in Education*, 10(1). https://doi.org/10.1186/s40536-022-00127-7

Richwine, J. (2022). Skill deficits among foreign-educated immigrants: Evidence from the U.S. PIAAC. PLoS ONE, 17(8), e0273910. https://doi.org/10.1371/journal.pone.0273910

Rindermann, H., & Thompson, J. (2014). The Cognitive Competences of Immigrant and Native Students Across the World: An Analysis Of Gaps, Possible Causes And Impact. *Journal of Biosocial Science*, 48(1), 66–93. https://doi.org/10.1017/s0021932014000480

Sallam, H., Christl, M. (2024). Do Migrants Pay Their Way? A Net Fiscal Analysis for Germany, GLO Discussion Paper, No. 1530, Global Labor Organization (GLO), EssenSchleicher A and Scarpetta S (2024) Survey of Adult Skills 2023: insights and interpretations, OECD, https://hdl.voced.edu.au/10707/694399

Schnepf, S. V. (2006). Immigrants’ educational disadvantage: an examination across ten countries and three surveys. Journal of Population Economics, 20(3), 527–545. https://doi.org/10.1007/s00148-006-0102-y

Vargas-Silva, C. (2015), The fiscal impact of immigrants: taxes and benefits, in B. R. Chiswick and P. W. Miller (eds), Handbook of the Economics of International Migration, Vol. 1, Chapter 16, Amsterdam: North-Holland, 845–75.

APPENDIX

10.1 *Base OLS regression model on literacy scores. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
Predictor	**Estimate**	**Estimate**
Intercept	259.35*** (0.55)	262.15*** (0.70)
Migration status		
Immigrant	-16.50*** (1.56)	-16.34*** (1.45)
R-squared (pooled across PVs)	0.02	0.02

10.2 *Main effects & Interactions - OLS regression on literacy scores. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
	Interactions	**Interactions**
Predictor	**Estimate**	**Estimate**
Intercept	240.96*** (2.70)	239.31*** (3.23)
Migration status		
Immigrant	-6.61 (4.98)	-18.00** (6.03)
Age or Gender		
Male	-3.31 (2.25)	-6.35 (3.53)
25-34	4.02* (1.73)	-1.82 (1.91)
35-44	4.23* (2.07)	-3.04 (2.02)
45-54	0.38 (2.07)	-7.04** (2.15)
55-65	-9.89*** (2.07)	-10.66*** (2.38)
Education		
Upper/Post-secondary	24.59*** (1.19)	21.66*** (1.37)
Tertiary	41.04*** (1.20)	41.40*** (1.32)
Parental education		
Maternal medium education	4.72*** (1.15)	9.00*** (1.47)
Maternal high education	10.34*** (1.57)	13.41*** (1.88)
Paternal medium education	6.63*** (1.26)	5.09** (1.71)
Paternal high education	9.95*** (1.76)	5.77*** (1.65)
Country of qualification		
Non-OECD country	-12.43 (8.46)	-20.62*** (2.78)
Language		
Not speaking native language	-3.49 (3.12)	-12.14*** (3.29)
Employment status		
In education	17.63*** (2.89)	21.13*** (3.58)
Inactive	-1.21 (2.28)	3.85 (2.98)
Employed	4.77* (2.16)	16.65*** (2.68)
Country of the interview		
Finland	12.29*** (1.02)	19.78*** (1.20)
Ireland	-4.62** (1.34)	-16.93*** (1.55)
Italy	-8.88*** (1.41)	-18.81*** (1.71)
Spain	-10.76*** (1.25)	-19.78*** (1.13)
United Kingdom	0.61 (1.71)	-2.05 (1.37)

10.2 (continued)

	Cycle 1	Cycle 2
	Interactions	Interactions
Predictor	**Estimate**	**Estimate**
Interactions: Gender x Employment		
Male x In education	6.32 (3.41)	9.63* (4.38)
Male x Inactive	0.49 (3.06)	8.66 (4.61)
Male x Employed	6.61** (2.54)	7.07 (3.87)
Interactions: Migration Status x Education		
Immigrant x Upper/Post-secondary	-0.55 (3.44)	-4.39 (3.47)
Immigrant x Tertiary	-0.26 (3.90)	-0.68 (4.10)
Interactions: Migration Status x Parental education		
Immigrant x Maternal medium education	5.93 (3.97)	9.42** (3.21)
Immigrant x Maternal high education	8.90 (4.67)	14.22*** (3.83)
Immigrant x Paternal medium education	-2.46 (3.62)	-7.76* (3.33)
Immigrant x Paternal high education	1.18 (4.47)	-2.95 (4.06)
Interactions: Migration Status x Employment		
Immigrant x In education	1.62 (5.53)	1.72 (5.62)
Immigrant x Inactive	0.89 (4.87)	4.79 (5.58)
Immigrant x Employed	-3.62 (3.88)	-1.83 (4.32)
Interactions: Migration Status x Language		
Immigrant x Not speaking native language	-21.41*** (4.10)	-8.52 (4.36)
Interactions: Migration Status x Country		
Immigrant x Finland	-7.49 (4.93)	6.24 (4.80)
Immigrant x Ireland	1.97 (2.44)	14.81*** (3.32)
Immigrant x Italy	3.00 (3.50)	19.91*** (3.59)
Immigrant x Spain	-5.11 (2.95)	10.71** (3.28)
Immigrant x United Kingdom	-2.78 (3.82)	4.53 (3.57)
R-squared (pooled across PVs)	0.31	0.33

10.3 *Base OLS regression model on literacy scores by generation of immigrants. Cycle 1 vs Cycle 2*

	Cycle 1	Cycle 2
Predictor	**Estimate**	**Estimate**
Intercept	259.35*** (0.55)	262.15*** (0.70)
Migration status		
1st-generation immigrant	-23.69*** (1.71)	-25.77*** (1.73)
2nd-generation immigrant	1.74 (2.15)	9.80*** (2.31)
R-squared (pooled across PVs)	0.02	0.04

10.4 *Main effects & Interactions - OLS regression on literacy scores by generation of immigrants. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
	Interactions	Interactions
Predictor	**Estimate**	**Estimate**
Intercept	240.68*** (2.69)	239.06*** (3.20)
Migration status		
1st-generation immigrant	-17.71** (6.05)	-28.29*** (6.72)
2nd-generation immigrant	-3.27 (6.41)	-7.91 (9.31)
Age or Gender		
Male	-3.16 (2.25)	-6.55 (3.48)
25-34	4.25* (1.74)	-1.37 (2.00)
35-44	4.51* (2.07)	-2.44 (2.09)
45-54	0.65 (2.08)	-6.63** (2.19)
55-65	-9.73*** (2.08)	-10.34*** (2.41)
Education		
Upper/Post-secondary	24.58*** (1.19)	21.64*** (1.37)
Tertiary	41.02*** (1.21)	41.34*** (1.32)
Parental education		
Maternal medium education	4.74*** (1.15)	9.00*** (1.46)
Maternal high education	10.37*** (1.58)	13.43*** (1.87)
Paternal medium education	6.63*** (1.26)	5.08** (1.71)
Paternal high education	9.94*** (1.76)	5.78*** (1.65)
Country of qualification		
Non-OECD country	-10.09 (8.55)	-17.24*** (2.82)
Language		
Not speaking native language	-3.49 (3.12)	-12.12*** (3.29)
Employment status		
In education	17.98*** (2.89)	21.48*** (3.53)
Inactive	-1.09 (2.28)	3.80 (2.95)
Employed	4.82* (2.15)	16.53*** (2.66)
Country of the interview		
Finland	12.29*** (1.02)	19.77*** (1.20)
Ireland	-4.63** (1.34)	-16.94*** (1.55)
Italy	-8.89*** (1.41)	-18.83*** (1.71)
Spain	-10.76*** (1.25)	-19.80*** (1.13)
United Kingdom	0.63 (1.71)	-2.04 (1.37)
Interactions: Gender x Employment		
Male x In education	5.96 (3.42)	9.55* (4.32)
Male x Inactive	0.24 (3.06)	8.75 (4.51)
Male x Employed	6.47* (2.52)	7.26 (3.83)
Interactions: Migration Status x Education		
1st-generation immigrant x Upper/Post-secondary	1.15 (3.85)	-4.15 (3.97)
2nd-generation immigrant x Upper/Post-secondary	-5.10 (5.06)	-6.92 (5.60)
1st-generation immigrant x Tertiary	1.99 (4.67)	0.15 (4.51)
2nd-generation immigrant x Tertiary	-6.44 (6.67)	-4.66 (6.47)

10.4 (continued)

	Cycle 1	Cycle 2
	Interactions	Interactions
Predictor	**Estimate**	**Estimate**
Interactions: Migration Status x Parental education		
1st-generation immigrant x Maternal medium education	8.34 (4.87)	7.40* (3.59)
2nd-generation immigrant x Maternal medium education	0.64 (5.52)	13.49* (5.57)
1st-generation immigrant x Maternal high education	9.85 (6.15)	16.88*** (4.83)
2nd-generation immigrant x Maternal high education	5.38 (7.60)	8.13 (6.73)
1st-generation immigrant x Paternal medium education	-2.92 (4.55)	-6.14 (4.06)
2nd-generation immigrant x Paternal medium education	-2.47 (5.50)	-7.55 (4.29)
1st-generation immigrant x Paternal high education	1.72 (5.20)	-0.22 (4.69)
2nd-generation immigrant x Paternal high education	0.37 (7.25)	-3.26 (7.01)
Interactions: Migration Status x Employment		
1st-generation immigrant x In education	-3.01 (6.65)	-6.23 (5.86)
2nd-generation immigrant x In education	10.06 (7.86)	0.66 (8.90)
1st-generation immigrant x Inactive	-1.94 (5.89)	2.21 (6.40)
2nd-generation immigrant x Inactive	7.95 (7.82)	7.98 (8.66)
1st-generation immigrant x Employed	-5.34 (4.39)	-3.20 (4.87)
2nd-generation immigrant x Employed	4.90 (6.75)	-4.02 (7.13)
Interactions: Migration Status x Language		
1st-generation immigrant x Not speaking native language	-18.46*** (4.48)	-3.48 (4.68)
2nd-generation immigrant x Not speaking native language	-7.26 (7.06)	1.81 (7.49)
Interactions: Migration Status x Country		
1st-generation immigrant x Finland	-3.00 (6.82)	9.30 (6.61)
2nd-generation immigrant x Finland	-6.42 (6.01)	4.86 (7.23)
1st-generation immigrant x Ireland	10.44** (3.52)	20.34*** (4.28)
2nd-generation immigrant x Ireland	-0.22 (3.61)	14.06** (4.90)
1st-generation immigrant x Italy	10.56** (3.97)	26.41*** (4.03)
2nd-generation immigrant x Italy	2.05 (5.14)	11.03 (6.67)
1st-generation immigrant x Spain	3.64 (3.73)	17.46*** (4.48)
2nd-generation immigrant x Spain	-3.45 (5.23)	6.90 (5.39)
1st-generation immigrant x United Kingdom	1.81 (5.73)	3.52 (4.45)
2nd-generation immigrant x United Kingdom	-4.29 (5.07)	11.41* (5.23)
R-squared (pooled across PVs)	0.31	0.34

10.5 *Base OLS regression model on numeracy scores. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
Predictor	**Estimate**	**Estimate**
Intercept	253.34*** (0.56)	261.39*** (0.73)
Migration status		
Immigrant	-17.43*** (1.65)	-15.75*** (1.46)
R-squared (pooled across PVs)	0.01	0.01

10.6 *Main effects & Interactions - OLS regression on numeracy scores. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
	Interactions	**Interactions**
Predictor	**Estimate**	**Estimate**
Intercept	234.07*** (2.82)	232.25*** (3.33)
Migration status		
Immigrant	-6.04 (5.05)	-21.94** (6.82)
Age or Gender		
Male	2.05 (2.34)	2.46 (4.09)
25-34	8.21*** (1.97)	-3.47 (2.16)
35-44	8.02*** (2.21)	-2.24 (2.12)
45-54	3.10 (2.21)	-5.43* (2.38)
55-65	-4.01 (2.37)	-6.00* (2.45)
Education		
Upper/Post-secondary	28.68*** (1.15)	24.20*** (1.62)
Tertiary	43.71*** (1.23)	44.72*** (1.59)
Parental education		
Maternal medium education	3.92** (1.37)	8.78*** (1.58)
Maternal high education	9.15*** (1.80)	15.37*** (2.16)
Paternal medium education	7.30*** (1.34)	6.17** (1.99)
Paternal high education	10.78*** (1.69)	6.80*** (1.95)
Country of qualification		
Non-OECD country	-7.42 (7.69)	-21.70*** (3.11)
Language		
Not speaking native language	-2.37 (3.54)	-4.54 (3.62)
Employment status		
In education	16.27*** (3.16)	22.71*** (3.74)
Inactive	-5.41* (2.53)	4.28 (2.99)
Employed	6.94** (2.26)	18.10*** (2.88)
Country of the interview		
Finland	2.19 (1.11)	9.44*** (1.17)
Ireland	-20.23*** (1.31)	-26.06*** (1.82)
Italy	-16.15*** (1.44)	-22.73*** (1.87)
Spain	-20.02*** (1.01)	-20.14*** (1.28)
United Kingdom	-13.50*** (1.87)	-10.59*** (1.49)

10.6 (continued)

	Cycle 1	Cycle 2
	Interactions	Interactions
Predictor	**Estimate**	**Estimate**
Interactions: Gender x Employment		
Male x In education	10.16** (3.66)	9.24 (5.14)
Male x Inactive	7.48* (3.13)	12.49* (4.97)
Male x Employed	10.95*** (2.62)	9.95* (4.41)
Interactions: Migration Status x Education		
Immigrant x Upper/Post-secondary	-4.59 (3.48)	-5.24 (3.75)
Immigrant x Tertiary	0.02 (4.24)	-0.90 (4.46)
Interactions: Migration Status x Parental education		
Immigrant x Maternal medium education	5.99 (4.14)	13.54*** (3.45)
Immigrant x Maternal high education	11.76* (5.38)	14.24*** (4.20)
Immigrant x Paternal medium education	0.99 (3.69)	-7.07 (3.63)
Immigrant x Paternal high education	2.55 (4.48)	-3.20 (4.57)
Interactions: Migration Status x Employment		
Immigrant x In education	1.94 (5.72)	-1.31 (6.33)
Immigrant x Inactive	0.55 (5.02)	4.27 (6.02)
Immigrant x Employed	-6.15 (4.05)	-4.62 (5.00)
Interactions: Migration Status x Language		
Immigrant x Not speaking native language	-22.08*** (4.68)	-7.49 (4.40)
Interactions: Migration Status x Country		
Immigrant x Finland	-3.10 (4.96)	15.99** (4.84)
Immigrant x Ireland	6.66* (2.91)	23.19*** (3.80)
Immigrant x Italy	11.40** (3.67)	18.24*** (4.02)
Immigrant x Spain	-3.25 (3.08)	14.48*** (3.43)
Immigrant x United Kingdom	-7.44 (4.45)	11.07** (4.14)
R-squared (pooled across PVs)	0.31	0.31

10.7 *Base OLS regression model on numeracy scores by generation immigrants. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
Predictor	**Estimate**	**Estimate**
Intercept	253.34*** (0.56)	261.39*** (0.73)
Migration status		
1st-generation immigrant	-23.94*** (1.89)	-22.58*** (1.63)
2nd-generation immigrant	-0.91 (2.30)	3.19 (2.69)
R-squared (pooled across PVs)	0.02	0.02

10.8 *Main effects & Interactions - OLS regression on numeracy scores by generation of immigrants. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
	Interactions	Interactions
Predictor	**Estimate**	**Estimate**
Intercept	233.84*** (2.82)	232.12*** (3.34)
Migration status		
1st-generation immigrant	-16.25* (6.27)	-29.61*** (7.44)
2nd-generation immigrant	-1.92 (6.91)	-16.75 (10.64)
Age or Gender		
Male	2.24 (2.35)	2.57 (4.07)
25-34	8.35*** (1.97)	-3.35 (2.23)
35-44	8.24*** (2.22)	-2.02 (2.20)
45-54	3.29 (2.21)	-5.35* (2.44)
55-65	-3.93 (2.37)	-5.99* (2.50)
Education		
Upper/Post-secondary	28.68*** (1.15)	24.19*** (1.62)
Tertiary	43.70*** (1.23)	44.70*** (1.59)
Parental education		
Maternal medium education	3.94** (1.37)	8.76*** (1.58)
Maternal high education	9.17*** (1.80)	15.36*** (2.15)
Paternal medium education	7.30*** (1.33)	6.16** (1.99)
Paternal high education	10.78*** (1.69)	6.80*** (1.95)
Country of qualification		
Non-OECD country	-4.74 (7.84)	-19.90*** (3.18)
Language		
Not speaking native language	-2.37 (3.55)	-4.54 (3.62)
Employment status		
In education	16.59*** (3.17)	22.92*** (3.73)
Inactive	-5.25* (2.53)	4.40 (2.97)
Employed	7.01** (2.25)	18.15*** (2.86)
Country of the interview		
Finland	2.19 (1.11)	9.44*** (1.17)
Ireland	-20.24*** (1.31)	-26.08*** (1.82)
Italy	-16.16*** (1.44)	-22.74*** (1.87)
Spain	-20.03*** (1.01)	-20.15*** (1.28)
United Kingdom	-13.49*** (1.87)	-10.59*** (1.49)
Interactions: Gender x Employment		
Male x In education	9.79** (3.65)	8.98 (5.11)
Male x Inactive	7.16* (3.14)	12.26* (4.93)
Male x Employed	10.79*** (2.60)	9.82* (4.39)
Interactions: Migration Status x Education		
1st-generation immigrant x Upper/Post-secondary	-2.32 (3.96)	-4.51 (4.33)
2nd-generation immigrant x Upper/Post-secondary	-10.56* (5.12)	-10.32 (6.45)
1st-generation immigrant x Tertiary	1.98 (4.85)	0.44 (4.91)
2nd-generation immigrant x Tertiary	-4.47 (8.28)	-7.79 (7.28)

10.8 (continued)

	Cycle 1	Cycle 2
	Interactions	Interactions
Predictor	**Estimate**	**Estimate**
Interactions: Migration Status x Parental education		
1st-generation immigrant x Maternal medium education	9.65* (4.59)	11.34** (3.99)
2nd-generation immigrant x Maternal medium education	-1.73 (6.94)	17.29** (5.70)
1st-generation immigrant x Maternal high education	13.68* (6.34)	16.03** (5.11)
2nd-generation immigrant x Maternal high education	6.02 (9.28)	8.76 (7.00)
1st-generation immigrant x Paternal medium education	0.63 (4.58)	-4.74 (4.49)
2nd-generation immigrant x Paternal medium education	-0.80 (5.88)	-10.60* (4.90)
1st-generation immigrant x Paternal high education	4.08 (4.92)	-0.63 (5.23)
2nd-generation immigrant x Paternal high education	-1.26 (8.07)	-5.14 (8.05)
Interactions: Migration Status x Employment		
1st-generation immigrant x In education	-2.17 (6.99)	-8.05 (6.82)
2nd-generation immigrant x In education	11.98 (9.22)	6.51 (9.66)
1st-generation immigrant x Inactive	-3.02 (5.73)	1.40 (6.83)
2nd-generation immigrant x Inactive	9.08 (8.31)	15.71 (9.59)
1st-generation immigrant x Employed	-7.82 (4.45)	-6.67 (5.45)
2nd-generation immigrant x Employed	2.42 (7.20)	2.14 (8.15)
Interactions: Migration Status x Language		
1st-generation immigrant x Not speaking native language	-18.94*** (4.92)	-3.26 (4.55)
2nd-generation immigrant x Not speaking native language	-11.72 (7.87)	-6.39 (9.15)
Interactions: Migration Status x Country		
1st-generation immigrant x Finland	-1.08 (7.48)	19.72** (6.91)
2nd-generation immigrant x Finland	-0.12 (5.59)	12.57* (5.96)
1st-generation immigrant x Ireland	13.82** (4.20)	27.40*** (4.54)
2nd-generation immigrant x Ireland	3.33 (4.21)	21.27*** (5.73)
1st-generation immigrant x Italy	18.04*** (4.78)	22.70*** (4.28)
2nd-generation immigrant x Italy	9.43 (4.99)	13.83 (7.61)
1st-generation immigrant x Spain	4.23 (4.05)	21.26*** (4.26)
2nd-generation immigrant x Spain	-2.80 (5.68)	4.69 (5.86)
1st-generation immigrant x United Kingdom	-6.40 (6.03)	11.14* (4.87)
2nd-generation immigrant x United Kingdom	-5.72 (6.04)	14.62* (6.17)
R-squared (pooled across PVs)	0.31	0.32

10.9 *France: Base OLS regression model on literacy scores. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
Predictor	**Estimate**	**Estimate**
Intercept	267.29*** (0.68)	263.04*** (0.75)
Migration status		
Immigrant	-19.53*** (1.34)	-24.93*** (1.87)
R-squared (pooled across PVs)	0.03	0.04

10.10 *France: Main effects & Interactions – OLS regression on literacy scores. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
	Interactions	**Interactions**
Predictor	**Estimate**	**Estimate**
Intercept	241.26*** (4.37)	238.29*** (5.33)
Migration status		
Immigrant	-18.54*** (5.41)	-15.68 (8.34)
Age or Gender		
Male	-2.75 (3.75)	-6.68 (4.75)
25-34	7.13** (2.39)	2.74 (2.59)
35-44	-0.68 (2.60)	4.29 (2.65)
45-54	-5.74* (2.55)	-8.65** (2.82)
55-65	-12.04*** (2.60)	-17.69*** (3.37)
Education		
Upper/Post-secondary	20.17*** (1.89)	14.97*** (2.99)
Tertiary	47.07*** (1.98)	48.95*** (3.11)
Parental education		
Maternal medium education	5.28** (1.79)	6.46*** (1.71)
Maternal high education	10.92*** (2.22)	14.30*** (2.68)
Paternal medium education	3.00 (1.58)	1.87 (1.55)
Paternal high education	13.71*** (2.34)	11.53*** (2.20)
Country of qualification		
Non-OECD country	-28.97** (10.75)	-50.64*** (5.51)
Language		
Not speaking native language	-17.51 (9.24)	-11.03 (11.24)
Employment status		
In education	17.45*** (4.45)	14.60** (4.85)
Inactive	-0.55 (3.35)	-9.66* (4.41)
Employed	-0.33 (3.25)	-1.13 (3.49)

10.10 (continued)

	Cycle 1	Cycle 2
	Interactions	Interactions
Predictor	**Estimate**	**Estimate**
Interactions: Gender x Employment		
Male x In education	0.35 (4.96)	4.14 (5.44)
Male x Inactive	5.03 (4.64)	4.19 (6.01)
Male x Employed	3.94 (3.96)	6.08 (5.29)
Interactions: Migration Status x Education		
Immigrant x Upper/Post-secondary	10.20** (3.55)	4.88 (6.31)
Immigrant x Tertiary	8.96* (3.59)	5.36 (6.25)
Interactions: Migration Status x Parental education		
Immigrant x Maternal medium education	-0.62 (4.25)	9.26 (4.75)
Immigrant x Maternal high education	2.31 (5.45)	7.13 (5.83)
Immigrant x Paternal medium education	0.89 (3.49)	-1.64 (4.20)
Immigrant x Paternal high education	-5.98 (4.51)	-7.71 (5.32)
Interactions: Migration Status x Employment		
Immigrant x In education	14.66* (5.75)	9.37 (8.21)
Immigrant x Inactive	-5.04 (4.83)	-1.11 (8.00)
Immigrant x Employed	5.44 (4.43)	3.63 (5.72)
Interactions: Migration Status x Language		
Immigrant x Not speaking native language	-5.80 (9.80)	-5.65 (11.40)
R-squared (pooled across PVs)	0.35	0.38

10.11 *France: Base OLS regression model on literacy scores by generation of immigrants. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
Predictor	**Estimate**	**Estimate**
Intercept	267.29*** (0.68)	263.04*** (0.75)
Migration status		
1st-generation immigrant	-38.11*** (1.80)	-51.34*** (2.83)
2nd-generation immigrant	-1.46 (1.74)	-2.40 (2.06)
R-squared (pooled across PVs)	0.07	0.09

10.12 *France: Main effects & Interactions – OLS regression on literacy scores by generation of immigrants. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
	Interactions	Interactions
Predictor	**Estimate**	**Estimate**
Intercept	240.02*** (4.39)	237.10*** (5.32)
Migration status		
1st-generation immigrant	-30.45*** (6.89)	-24.29* (11.84)
2nd-generation immigrant	-5.01 (6.87)	-13.48 (8.21)
Age or Gender		
Male	-2.24 (3.84)	-6.35 (4.63)
25-34	7.60** (2.32)	3.65 (2.51)
35-44	0.00 (2.59)	5.25* (2.56)
45-54	-4.38 (2.55)	-7.76** (2.74)
55-65	-10.44*** (2.58)	-15.76*** (3.26)
Education		
Upper/Post-secondary	20.29*** (1.89)	14.98*** (2.98)
Tertiary	47.21*** (1.98)	48.89*** (3.11)
Parental education		
Maternal medium education	5.56** (1.79)	6.72*** (1.72)
Maternal high education	11.22*** (2.24)	14.60*** (2.67)
Paternal medium education	3.15* (1.57)	1.94 (1.55)
Paternal high education	13.77*** (2.34)	11.57*** (2.21)
Country of qualification		
Non-OECD country	-21.60* (10.92)	-39.73*** (6.14)
Language		
Not speaking native language	-17.58 (9.23)	-11.08 (11.28)
Employment status		
In education	18.08*** (4.47)	15.57** (4.83)
Inactive	-0.79 (3.41)	-9.92* (4.51)
Employed	-0.34 (3.31)	-1.07 (3.52)
Interactions: Gender x Employment		
Male x In education	0.19 (5.04)	3.55 (5.40)
Male x Inactive	4.30 (4.79)	3.26 (6.02)
Male x Employed	3.54 (4.01)	5.64 (5.17)
Interactions: Migration Status x Education		
1st-generation immigrant x Upper/Post-secondary	13.44* (5.25)	2.46 (9.18)
2nd-generation immigrant x Upper/Post-secondary	-0.39 (4.31)	4.87 (6.95)
1st-generation immigrant x Tertiary	9.17 (5.08)	14.90 (8.70)
2nd-generation immigrant x Tertiary	1.84 (4.59)	-1.89 (7.42)
Interactions: Migration Status x Parental education		
1st-generation immigrant x Maternal medium education	7.63 (6.15)	10.36 (7.75)
2nd-generation immigrant x Maternal medium education	-8.32 (4.66)	4.99 (5.14)
1st-generation immigrant x Maternal high education	4.00 (8.03)	4.70 (7.61)
2nd-generation immigrant x Maternal high education	0.63 (6.17)	7.23 (7.45)
1st-generation immigrant x Paternal medium education	-2.98 (5.42)	-8.21 (7.10)
2nd-generation immigrant x Paternal medium education	4.53 (4.29)	0.05 (4.44)
1st-generation immigrant x Paternal high education	-8.04 (7.31)	-9.64 (7.60)
2nd-generation immigrant x Paternal high education	-1.64 (5.54)	-1.85 (6.44)

10.12 (continued)

	Cycle 1	Cycle 2
	Interactions	Interactions
Predictor	**Estimate**	**Estimate**
Interactions: Migration Status x Employment		
1st-generation immigrant x In education	19.35* (9.59)	24.05* (11.64)
2nd-generation immigrant x In education	6.22 (6.01)	3.15 (8.67)
1st-generation immigrant x Inactive	-4.57 (6.78)	-9.91 (10.87)
2nd-generation immigrant x Inactive	0.38 (6.15)	8.89 (7.98)
1st-generation immigrant x Employed	7.40 (5.90)	-7.38 (7.61)
2nd-generation immigrant x Employed	4.08 (5.62)	11.69 (6.41)
Interactions: Migration Status x Language		
1st-generation immigrant x Not speaking native language	0.39 (10.42)	2.99 (12.07)
2nd-generation immigrant x Not speaking native language	5.36 (10.39)	2.74 (12.08)
R-squared (pooled across PVs)	0.36	0.39

10.13 *France: Base OLS regression model on numeracy scores. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
Predictor	**Estimate**	**Estimate**
Intercept	261.11*** (0.72)	266.09*** (0.89)
Migration status		
Immigrant	-25.56*** (1.73)	-28.96*** (2.09)
R-squared (pooled across PVs)	0.04	0.04

10.14 *France: Main effects & Interactions – OLS regression on numeracy scores. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
	Interactions	Interactions
Predictor	**Estimate**	**Estimate**
Intercept	216.16*** (4.21)	223.33*** (6.15)
Migration status		
Immigrant	-23.98*** (5.34)	-19.04* (9.27)
Age or Gender		
Male	9.34* (4.51)	7.28 (5.55)
25-34	7.12** (2.60)	4.11 (3.06)
35-44	3.58 (2.91)	8.31** (3.09)
45-54	-2.26 (2.82)	-0.62 (3.25)
55-65	-5.83 (2.98)	-9.47** (3.49)
Education		
Upper/Post-secondary	26.05*** (1.83)	19.71*** (3.49)
Tertiary	62.16*** (1.92)	54.91*** (3.69)
Parental education		
Maternal medium education	3.82* (1.67)	6.88*** (1.67)
Maternal high education	9.31*** (2.67)	14.23*** (2.74)
Paternal medium education	5.09*** (1.52)	1.43 (1.74)
Paternal high education	15.55*** (2.34)	10.49*** (2.35)
Country of qualification		
Non-OECD country	-28.52** (9.39)	-47.76*** (6.21)
Language		
Not speaking native language	-21.69* (10.52)	-5.39 (12.63)
Employment status		
In education	20.64*** (4.65)	18.05** (5.86)
Inactive	0.27 (3.72)	-6.92 (5.74)
Employed	4.36 (3.50)	2.56 (4.20)
Interactions: Gender x Employment		
Male x In education	1.30 (5.92)	2.19 (6.98)
Male x Inactive	4.29 (5.61)	8.09 (7.54)
Male x Employed	3.14 (4.74)	6.37 (5.98)
Interactions: Migration Status x Education		
Immigrant x Upper/Post-secondary	11.37*** (3.27)	0.93 (6.74)
Immigrant x Tertiary	8.36* (4.00)	1.80 (7.10)
Interactions: Migration Status x Parental education		
Immigrant x Maternal medium education	-1.43 (4.41)	8.95 (4.91)
Immigrant x Maternal high education	6.78 (5.59)	8.36 (5.50)
Immigrant x Paternal medium education	-0.01 (4.18)	1.91 (4.50)
Immigrant x Paternal high education	-4.82 (4.41)	-3.01 (5.60)
Interactions: Migration Status x Employment		
Immigrant x In education	18.59** (6.75)	3.19 (8.68)
Immigrant x Inactive	-5.27 (5.41)	-2.28 (8.72)
Immigrant x Employed	5.87 (4.74)	2.88 (6.40)
Interactions: Migration Status x Language		
Immigrant x Not speaking native language	-3.87 (11.05)	-4.95 (13.16)
R-squared (pooled across PVs)	0.39	0.34

10.15 *France: Base OLS regression model on numeracy scores by generation of immigrants. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
Predictor	**Estimate**	**Estimate**
Intercept	261.11*** (0.72)	266.09*** (0.89)
Migration status		
1st-generation immigrant	-45.87*** (2.51)	-53.45*** (3.24)
2nd-generation immigrant	-5.79** (2.03)	-8.07*** (2.24)
R-squared (pooled across PVs)	0.07	0.08

10.16 *France: Main effects & Interactions – OLS regression on numeracy scores by generation of immigrants. Cycle 1 vs Cycle 2.*

	Cycle 1	Cycle 2
	Interactions	**Interactions**
Predictor	**Estimate**	**Estimate**
Intercept	214.68*** (4.17)	222.03*** (6.13)
Migration status		
1st-generation immigrant	-36.54*** (7.04)	-22.85 (13.02)
2nd-generation immigrant	-9.00 (7.38)	-20.82* (9.21)
Age or Gender		
Male	9.92* (4.63)	8.50 (5.39)
25-34	7.60** (2.52)	4.61 (3.02)
35-44	4.40 (2.88)	8.94** (3.03)
45-54	-0.61 (2.76)	-0.02 (3.20)
55-65	-3.90 (2.94)	-7.97* (3.35)
Education		
Upper/Post-secondary	26.21*** (1.83)	19.73*** (3.48)
Tertiary	62.35*** (1.92)	54.88*** (3.69)
Parental education		
Maternal medium education	4.17* (1.67)	7.11*** (1.67)
Maternal high education	9.69*** (2.68)	14.51*** (2.71)
Paternal medium education	5.28*** (1.52)	1.48 (1.75)
Paternal high education	15.62*** (2.34)	10.51*** (2.35)
Country of qualification		
Non-OECD country	-19.69* (9.53)	-38.50*** (6.81)
Language		
Not speaking native language	-21.78* (10.49)	-5.45 (12.66)
Employment status		
In education	21.39*** (4.63)	19.12** (5.84)
Inactive	-0.04 (3.79)	-6.78 (5.82)
Employed	4.33 (3.55)	3.09 (4.23)

10.16 (continued)

	Cycle 1	Cycle 2
	Interactions	Interactions
Predictor	**Estimate**	**Estimate**
Interactions: Gender x Employment		
Male x In education	1.08 (6.02)	0.83 (6.90)
Male x Inactive	3.43 (5.80)	6.50 (7.51)
Male x Employed	2.67 (4.83)	5.00 (5.84)
Interactions: Migration Status x Education		
1st-generation immigrant x Upper/Post-secondary	13.76** (4.82)	-2.01 (9.77)
2nd-generation immigrant x Upper/Post-secondary	-0.60 (4.48)	0.07 (7.36)
1st-generation immigrant x Tertiary	8.90 (5.61)	9.22 (9.65)
2nd-generation immigrant x Tertiary	-0.91 (4.51)	-5.71 (7.97)
Interactions: Migration Status x Parental education		
1st-generation immigrant x Maternal medium education	6.97 (6.83)	8.31 (8.13)
2nd-generation immigrant x Maternal medium education	-9.86* (4.84)	4.99 (5.26)
1st-generation immigrant x Maternal high education	6.53 (7.59)	4.44 (7.40)
2nd-generation immigrant x Maternal high education	6.72 (6.38)	9.27 (7.34)
1st-generation immigrant x Paternal medium education	-4.61 (6.36)	4.57 (7.99)
2nd-generation immigrant x Paternal medium education	4.33 (4.59)	-1.84 (4.95)
1st-generation immigrant x Paternal high education	-7.27 (7.59)	-2.98 (7.32)
2nd-generation immigrant x Paternal high education	1.09 (5.46)	2.10 (7.19)
Interactions: Migration Status x Employment		
1st-generation immigrant x In education	30.37** (11.48)	10.17 (13.39)
2nd-generation immigrant x In education	6.41 (6.86)	2.96 (9.49)
1st-generation immigrant x Inactive	-4.81 (7.24)	-13.30 (12.06)
2nd-generation immigrant x Inactive	1.39 (7.17)	9.48 (9.62)
1st-generation immigrant x Employed	7.49 (6.32)	-14.09 (8.52)
2nd-generation immigrant x Employed	5.28 (5.94)	17.99* (7.29)
Interactions: Migration Status x Language		
1st-generation immigrant x Not speaking native language	1.82 (11.53)	3.95 (14.06)
2nd-generation immigrant x Not speaking native language	12.95 (12.13)	4.01 (13.20)
R-squared (pooled across PVs)	0.40	0.35

10.17 *Germany: OLS regression models on literacy scores. Cycle 1 vs Cycle 2.*

	Cycle 1		Cycle 2	
	- Birth Region	Interactions	- Birth Region	Interactions
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Intercept	230.78*** (4.65)	228.85*** (6.83)	229.71*** (6.79)	240.53*** (11.11)
Migration status				
Immigrant	-1.41 (1.83)	2.81 (8.01)	-6.91*** (1.94)	-24.75** (9.37)
Education				
Upper/Post-secondary	24.52*** (2.75)	25.69*** (2.71)	28.19*** (2.79)	26.67*** (3.67)
Tertiary	48.34*** (2.78)	50.08*** (3.09)	56.47*** (3.25)	56.53*** (4.43)
Age or Gender				
Male	1.12 (1.40)	0.93 (6.34)	-6.52*** (1.51)	-8.22 (8.15)
25-34	-0.93 (2.67)	-1.03 (2.74)	-8.03** (3.11)	-8.68** (3.18)
35-44	-2.10 (3.07)	-2.08 (3.11)	-14.98*** (3.40)	-15.41*** (3.49)
45-54	-14.13*** (2.93)	-14.03*** (2.97)	-23.52*** (3.43)	-23.92*** (3.52)
55-65	-20.07*** (2.93)	-19.73*** (2.92)	-30.48*** (3.38)	-30.89*** (3.40)
Parental education				
Maternal medium education	7.35*** (1.87)	8.29*** (2.30)	10.05*** (2.04)	7.15** (2.47)
Maternal high education	12.68*** (2.35)	13.85*** (3.05)	19.83*** (2.56)	17.93*** (3.45)
Paternal medium education	4.87 (2.91)	3.38 (3.34)	10.93*** (2.77)	10.05* (4.27)
Paternal high education	13.83*** (2.97)	13.95*** (3.58)	18.70*** (3.41)	17.85*** (4.97)
Language				
Not speaking native language	-27.14*** (2.95)	-55.76** (16.28)	-45.29*** (2.95)	-8.87 (18.29)
Employment status				
In education	32.12*** (4.63)	33.44*** (6.87)	34.20*** (5.79)	22.24* (9.38)
Inactive	0.52 (4.25)	4.71 (6.02)	9.75 (5.23)	3.07 (9.30)
Employed	11.32** (3.98)	10.98 (5.96)	19.28*** (4.62)	12.93 (8.67)
Interactions: Gender x Employment				
Male x In education		1.81 (7.19)		11.45 (8.44)
Male x Inactive		-8.02 (7.90)		-2.82 (9.22)
Male x Employed		1.38 (6.81)		0.89 (8.39)
Interactions: Migration Status x Education				
Immigrant x Upper/Post-secondary		-1.78 (4.72)		4.56 (5.16)
Immigrant x Tertiary		-3.36 (5.48)		0.14 (6.65)
Interactions: Migration Status x Parental education				
Immigrant x Maternal medium education		-2.29 (3.66)		6.61 (3.56)
Immigrant x Maternal high education		-2.20 (5.21)		2.97 (4.80)
Immigrant x Paternal medium education		4.57 (5.16)		0.61 (5.83)
Immigrant x Paternal high education		-1.74 (6.14)		0.38 (6.69)
Interactions: Migration Status x Employment				
Immigrant x In education		-7.33 (7.82)		10.41 (8.32)
Immigrant x Inactive		-5.30 (8.60)		14.20 (8.81)
Immigrant x Employed		-1.50 (7.57)		10.98 (7.37)
Interactions: Migration Status x Language				
Immigrant x Not speaking native language		28.75 (16.53)		-35.41 (18.07)
R-squared (pooled across PVs)	0.32	0.32	0.42	0.43

10.18 *Germany: OLS regression models on literacy scores by generation of immigrants. Cycle 1 vs Cycle 2.*

	Cycle 1		Cycle 2	
	- Birth Region	Interactions	- Birth Region	Interactions
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Intercept	230.65*** (4.63)	228.41*** (6.75)	229.50*** (6.87)	238.53*** (11.18)
Migration status				
1st-generation immigrant	-13.41** (4.03)	-6.56 (11.58)	-30.00*** (4.02)	-33.14** (11.33)
2nd-generation immigrant	1.03 (1.73)	6.44 (10.47)	-2.17 (1.96)	-21.48 (13.76)
Education				
Upper/Post-secondary	24.28*** (2.71)	25.53*** (2.70)	27.14*** (2.75)	26.22*** (3.67)
Tertiary	47.94*** (2.74)	49.83*** (3.10)	55.25*** (3.26)	55.92*** (4.42)
Age or Gender				
Male	1.25 (1.39)	0.58 (6.34)	-6.54*** (1.47)	-8.86 (8.28)
25-34	-0.19 (2.66)	-0.27 (2.73)	-5.69 (3.20)	-6.38* (3.25)
35-44	-1.63 (3.05)	-1.51 (3.09)	-11.71*** (3.46)	-12.26*** (3.43)
45-54	-13.38*** (2.92)	-13.03*** (2.98)	-20.59*** (3.51)	-20.87*** (3.55)
55-65	-19.45*** (2.92)	-18.88*** (2.96)	-28.31*** (3.43)	-28.25*** (3.51)
Parental education				
Maternal medium education	7.26*** (1.85)	8.41*** (2.30)	9.95*** (2.03)	7.26** (2.49)
Maternal high education	13.04*** (2.33)	14.02*** (3.06)	20.56*** (2.51)	18.11*** (3.45)
Paternal medium education	4.90 (2.84)	3.43 (3.34)	10.51*** (2.77)	10.11* (4.28)
Paternal high education	13.94*** (2.91)	13.99*** (3.58)	18.57*** (3.37)	17.97*** (4.98)
Language				
Not speaking native language	-17.35*** (3.75)	-55.58** (16.30)	-26.13*** (3.82)	-8.62 (18.22)
Employment status				
In education	31.80*** (4.57)	33.78*** (6.81)	33.77*** (5.93)	23.56* (9.49)
Inactive	0.29 (4.19)	4.34 (5.98)	9.13 (5.33)	2.74 (9.35)
Employed	11.03** (3.95)	10.57 (5.94)	18.18*** (4.68)	12.42 (8.75)
Interactions: Gender x Employment				
Male x In education		1.93 (7.15)		12.66 (8.56)
Male x Inactive		-7.46 (7.93)		-2.24 (9.32)
Male x Employed		1.99 (6.77)		1.76 (8.47)
Interactions: Migration Status x Education				
1st-generation immigrant x Upper/Post-secondary		-3.03 (6.80)		-4.13 (6.22)
2nd-generation immigrant x Upper/Post-secondary		-0.79 (5.58)		16.59* (6.51)
1st-generation immigrant x Tertiary		-6.20 (7.50)		-7.58 (7.38)
2nd-generation immigrant x Tertiary		-1.76 (6.46)		12.33 (7.68)
Interactions: Migration Status x Parental education				
1st-generation immigrant x Maternal medium education		-0.59 (6.82)		9.12 (4.89)
2nd-generation immigrant x Maternal medium education		-4.12 (3.89)		6.32 (4.97)
1st-generation immigrant x Maternal high education		2.48 (7.43)		3.82 (5.80)
2nd-generation immigrant x Maternal high education		-3.90 (6.00)		8.83 (7.25)
1st-generation immigrant x Paternal medium education		5.67 (6.92)		6.22 (7.01)
2nd-generation immigrant x Paternal medium education		3.82 (5.38)		-8.98 (6.82)
1st-generation immigrant x Paternal high education		-2.49 (9.24)		6.23 (8.11)
2nd-generation immigrant x Paternal high education		-1.05 (6.02)		-7.92 (7.66)

10.18 (continued)

	Cycle 1		Cycle 2	
	- Birth Region	Interactions	- Birth Region	Interactions
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Interactions: Migration Status x Employment				
1st-generation immigrant x In education		-10.85 (11.36)		5.71 (9.70)
2nd-generation immigrant x In education		-9.60 (10.86)		1.84 (11.96)
1st-generation immigrant x Inactive		-3.58 (11.48)		12.43 (10.57)
2nd-generation immigrant x Inactive		-8.43 (11.68)		11.95 (12.41)
1st-generation immigrant x Employed		-3.03 (10.72)		9.94 (8.73)
2nd-generation immigrant x Employed		-2.26 (9.95)		5.56 (10.97)
Interactions: Migration Status x Language				
1st-generation immigrant x Not speaking native language		35.81 (17.00)		-29.73 (18.08)
2nd-generation immigrant x Not speaking native language		42.60* (17.94)		2.34 (19.01)
R-squared (pooled across PVs)	0.32	0.33	0.43	0.44

10.19 *Germany: OLS regression models on numeracy scores. Cycle 1 vs Cycle 2.*

	Cycle 1		Cycle 2	
	- Birth Region	Interactions	- Birth Region	Interactions
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Intercept	204.94*** (5.35)	206.79*** (7.77)	219.42*** (6.93)	227.65*** (10.99)
Migration status				
Immigrant	1.31 (1.97)	6.05 (7.82)	-7.95*** (1.93)	-18.94 (9.67)
Education				
Upper/Post-secondary	31.17*** (3.02)	31.74*** (2.95)	35.57*** (3.28)	35.96*** (4.28)
Tertiary	59.25*** (3.11)	59.55*** (3.39)	67.45*** (3.69)	69.43*** (4.97)
Age or Gender				
Male	12.45*** (1.66)	6.50 (7.79)	10.29*** (1.72)	6.09 (8.30)
25-34	0.47 (2.91)	0.56 (2.93)	-4.74 (3.16)	-5.44 (3.23)
35-44	2.82 (3.24)	2.95 (3.26)	-10.89** (3.57)	-11.42** (3.67)
45-54	-9.01* (3.48)	-8.89* (3.47)	-16.85*** (3.75)	-17.27*** (3.81)
55-65	-15.21*** (3.45)	-14.96*** (3.41)	-23.03*** (3.63)	-23.30*** (3.69)
Parental education				
Maternal medium education	7.39*** (1.88)	8.18*** (2.27)	7.46** (2.30)	4.99 (2.89)
Maternal high education	12.72*** (2.74)	13.37*** (3.50)	15.50*** (2.91)	13.33*** (3.93)
Paternal medium education	7.86** (3.01)	5.45 (3.45)	8.54** (2.95)	8.96 (4.63)
Paternal high education	16.61*** (3.21)	15.73*** (3.71)	19.99*** (3.67)	20.92*** (5.44)
Language				
Not speaking native language	-30.19*** (3.15)	-72.42** (18.25)	-31.51*** (3.11)	-12.05 (15.96)
Employment status				
In education	42.93*** (5.11)	43.19*** (7.41)	34.38*** (5.95)	21.84* (9.49)
Inactive	6.44 (4.91)	10.04 (6.84)	4.53 (5.43)	-0.95 (9.86)
Employed	21.06*** (4.40)	18.04** (6.80)	16.87** (5.31)	9.29 (9.22)
Interactions: Gender x Employment				
Male x In education		4.40 (8.49)		15.10 (8.58)
Male x Inactive		-2.63 (8.89)		-3.45 (9.54)
Male x Employed		8.32 (8.18)		4.00 (8.70)

10.19 (continued)

	Cycle 1		Cycle 2	
	- Birth Region	Interactions	- Birth Region	Interactions
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Interactions: Migration Status x Education				
Immigrant x Upper/Post-secondary		-1.00 (5.47)		0.87 (5.35)
Immigrant x Tertiary		0.06 (6.30)		-3.50 (6.84)
Interactions: Migration Status x Parental education				
Immigrant x Maternal medium education		-1.85 (3.86)		5.47 (3.94)
Immigrant x Maternal high education		-1.11 (5.80)		4.41 (5.20)
Immigrant x Paternal medium education		5.80 (5.42)		-0.87 (5.89)
Immigrant x Paternal high education		0.03 (6.35)		-2.72 (6.80)
Interactions: Migration Status x Employment				
Immigrant x In education		-8.90 (8.54)		8.11 (8.93)
Immigrant x Inactive		-12.45 (8.69)		11.03 (9.48)
Immigrant x Employed		-5.05 (7.62)		10.12 (7.90)
Interactions: Migration Status x Language				
Immigrant x Not speaking native language		42.58* (18.60)		-18.94 (15.75)
R-squared (pooled across PVs)	0.35	0.35	0.39	0.40

10.20 *Germany: OLS regression models on numeracy scores by generation of immigrants. Cycle 1 vs Cycle 2.*

	Cycle 1		Cycle 2	
	- Birth Region	Interactions	- Birth Region	Interactions
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Intercept	204.80*** (5.34)	206.06*** (7.66)	219.29*** (6.95)	226.54*** (10.93)
Migration status				
1st-generation immigrant	-12.07** (3.97)	-6.10 (12.52)	-22.74*** (3.74)	-21.21 (11.51)
2nd-generation immigrant	4.04* (2.02)	13.76 (10.61)	-4.91* (2.06)	-20.30 (13.60)
Education				
Upper/Post-secondary	30.90*** (2.96)	31.52*** (2.95)	34.90*** (3.27)	35.73*** (4.30)
Tertiary	58.81*** (3.05)	59.19*** (3.40)	66.67*** (3.71)	69.10*** (4.98)
Age or Gender				
Male	12.60*** (1.65)	6.10 (7.70)	10.28*** (1.71)	5.63 (8.43)
25-34	1.30 (2.89)	1.62 (2.91)	-3.24 (3.21)	-4.18 (3.25)
35-44	3.34 (3.19)	3.90 (3.19)	-8.79* (3.58)	-9.60** (3.53)
45-54	-8.17* (3.46)	-7.42* (3.50)	-14.98*** (3.78)	-15.50*** (3.74)
55-65	-14.52*** (3.43)	-13.75*** (3.43)	-21.64*** (3.64)	-21.83*** (3.71)
Parental education				
Maternal medium education	7.29*** (1.88)	8.35*** (2.26)	7.40** (2.28)	5.05 (2.90)
Maternal high education	13.12*** (2.73)	13.61*** (3.49)	15.97*** (2.89)	13.43*** (3.95)
Paternal medium education	7.89** (2.93)	5.53 (3.45)	8.27** (2.96)	8.99 (4.63)
Paternal high education	16.73*** (3.16)	15.80*** (3.71)	19.91*** (3.65)	20.99*** (5.44)
Language				
Not speaking native language	-19.28*** (3.95)	-72.13** (18.25)	-19.24*** (3.90)	-11.88 (15.91)

10.20 (continued)

	Cycle 1		Cycle 2	
	- Birth Region	Interactions	- Birth Region	Interactions
Predictor	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Employment status				
In education	42.57*** (5.05)	43.75*** (7.30)	34.10*** (6.02)	22.42* (9.45)
Inactive	6.19 (4.84)	9.69 (6.75)	4.13 (5.48)	-1.19 (9.86)
Employed	20.73*** (4.37)	17.54* (6.71)	16.16** (5.34)	8.91 (9.29)
Interactions: Gender x Employment				
Male x In education		4.55 (8.36)		16.13 (8.71)
Male x Inactive		-2.23 (8.87)		-2.99 (9.60)
Male x Employed		9.04 (8.04)		4.65 (8.77)
Interactions: Migration Status x Education				
1st-generation immigrant x Upper/Post-secondary		-1.15 (7.15)		-9.40 (6.17)
2nd-generation immigrant x Upper/Post-secondary		-2.28 (6.96)		15.93* (6.48)
1st-generation immigrant x Tertiary		-0.10 (8.69)		-12.47 (7.56)
2nd-generation immigrant x Tertiary		-1.40 (7.82)		11.30 (7.69)
Interactions: Migration Status x Parental education				
1st-generation immigrant x Maternal medium education		0.24 (7.00)		8.62 (5.22)
2nd-generation immigrant x Maternal medium education		-4.05 (4.31)		4.71 (4.84)
1st-generation immigrant x Maternal high education		5.39 (8.86)		4.96 (6.12)
2nd-generation immigrant x Maternal high education		-4.35 (6.63)		8.64 (7.22)
1st-generation immigrant x Paternal medium education		8.17 (6.88)		5.32 (7.05)
2nd-generation immigrant x Paternal medium education		4.23 (6.27)		-11.60 (6.71)
1st-generation immigrant x Paternal high education		-1.89 (9.45)		5.13 (8.14)
2nd-generation immigrant x Paternal high education		1.50 (7.37)		-13.40 (7.68)
Interactions: Migration Status x Employment				
1st-generation immigrant x In education		-13.12 (11.64)		5.02 (10.08)
2nd-generation immigrant x In education		-13.37 (12.06)		3.46 (13.38)
1st-generation immigrant x Inactive		-11.19 (12.13)		7.17 (10.73)
2nd-generation immigrant x Inactive		-15.59 (11.96)		12.73 (13.54)
1st-generation immigrant x Employed		-5.22 (11.04)		8.95 (9.14)
2nd-generation immigrant x Employed		-7.24 (10.22)		7.13 (11.21)
Interactions: Migration Status x Language				
1st-generation immigrant x Not speaking native language		49.10* (18.59)		-17.37 (15.81)
2nd-generation immigrant x Not speaking native language		59.72* (20.74)		8.43 (17.24)
R-squared (pooled across PVs)	0.35	0.36	0.40	0.41

Note: Source: All tables above (Appendix 10) are 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 and numeracy plausible values pooled into a single output.