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Exploring the skills gap between migrants and natives in Europe Trends among first- and second-generation immigrants over time

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1. INTRODUCTION

In the context of international migration[1], immigrants' socioeconomic integration is one of the most debated issues. This topic 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 one hand, migration contributes to population and socioeconomic growth favoring both destination and origin country. Concerning the consequences of immigration on the receiving country, recent 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). Overall, this impact may be either positive or negative, depending on various socio-economic factors including immigrant's competencies and age of immigration. Among the benefits to the host society, for instance, immigration is discussed to provide labor force and, to some extent, tackle labor shortages, hence, encouraging productivity and economic progress (Luz, 2025). Additionally, immigration is often claimed to counterbalance the drawbacks of an ageing population. More specifically, since immigrants tend to leave their home countries at their working age, they can contribute to reducing the financial consequences of ageing population on pension systems, through tax contribution (Christl et al., 2022). According to Christl, high-skilled immigrants have positive fiscal impact. To enable the potential of migration and, particularly, the benefits of high-skilled immigrants, interventions in removing the barriers to the access to the labor market are necessary, starting from guaranteeing the correct recognition of their qualifications. In addition to the positive consequences of immigration, it is relevant to note that the fusion of individuals from inside and outside the host country with different socio-economic and cultural backgrounds often provokes tension. This tension mainly derives from the perception around the quantity of new arrivals who may be, subsequently, seen as a threat to national identity and social security (Rindermann & Thompson, 2014). To alleviate the concerns, consistent progress in migration knowledge, data collection and research is required.

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. A crucial role in shaping the integration pathways and the often-resulting difficulties immigrants face once they enter the destination country is played by their skills, particularly cognitive skills. Literacy, numeracy and problem-solving skills are foundational as they enable participation in society and the successful

[1] In this work, international migration refers to the general concept of migration.

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.

1.1 SKILL MISMATCH AND SKILL RECOGNITION

Despite not being the focus of this work, in addition to the specific proficiency gap between immigrant and native subpopulations, measuring immigrants' skills makes it possible to cover the concept of skill mismatch and achieve potential solutions to implement to alleviate the issue. 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, together with late access to the labor market and limited social networks (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). As a result, tension rises between immigrant and native subpopulations, therefore undermining the balance in the host society and country that would, otherwise, enhance development.

The effect that immigration may have on the social and economic growth of the host country highly depends on the composition of the immigrant group in terms of their qualifications and level of their skills. The distinction between high-skilled and low-skilled immigrants is widely discussed in the academic literature as well as in policy debates. Attracting the first group is often discussed as an effective approach to incentivize the positive fiscal impact of immigrants and reap the benefits of immigration for the host society. Nevertheless, the distinction between low and high skilled loses a defined frame in the context of policymaking and governmental decisions. A relevant example is Japan, as described by Liu-Farrer. Immigration policies in Japan have always been based on skills with the main goal of the access to the country to high-skilled immigrants. Since 2010, to face and solve the increasing issue of labor shortages, the definition of highly skilled was extended to encompass also what academic literature would define as low skilled occupations (Liu-Farrer, 2023). In other words, barrier to immigration of medium- and low-skilled were lifted by changing the definition, thus allowing Japanese policymakers to maintain the discourse of selective, high-skilled immigration. Fuzzy definitions can, however, complicate the measurement of low and high-skilled migration flows.

1.2 SKILLS ACROSS GENERATIONS OF IMMIGRANTS

Measuring skills and considering their predictors can be the key to a comprehensive analysis of immigrants' integration once they arrive in the host country. Evaluating which dimensions mostly affect these skills can be the tool to, for instance, assess how skills evolve, ensure their high level or causes their low level. Doing so, it is possible to understand if and how immigrants' skills can be best utilized and developed from low to high and, subsequently, determine the focus of policies. A successful skill-related policy will reduce the gap within the population and, concerning the focus of this thesis, particularly, between immigrants and natives, ensuring a smooth fusion of the two. Nevertheless, it can be a particularly challenging task. 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). This crucial point enables us to introduce the importance of considering and including the generational perspective in the examination of skills gap. 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. For instance, it is essential to take into consideration the differences across generations of immigrants to assess whether those who have had access to the educational system of the host country are more advantaged than those who received most of their education in the origin country and whether their performance more closely resembles that of natives than that of those who did not.

First-generation immigrants (G1) who migrated as adults, after the age of 18 or so, find themselves catapulted directly into the dynamics of integration into the receiving society and labor market (Levels et al., 2017). On one hand, part of this group leaves voluntarily their country of origin and 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. Instead, second-generation immigrants (G2), i.e. the descendants of immigrant parents who were born in the host country, have more time to integrate themselves into the new social and cultural environment as they enter it at a younger age (Levels et al., 2017). For instance, they have entered the local educational system, have obtained qualifications directly in the country of residence and have had more time to learn the language of the country. The latter is, instead, a bigger barrier for first-generation immigrants who reveal often an insufficient language proficiency (Eurostat, 2023).

In this thesis, 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). In this thesis I have considered the G1 and G1.5 distinction, however, the sample sizes did not allow it, therefore, I limit the analysis to G1 and G2.

Additionally, the role of language is also crucial to the determination of immigrants' and natives' skills, impacting, consequently, on individuals' access to health, social and economic services and benefits. The language barrier is observable in the context of the distinction between first and second generation of immigrants. More precisely, lacking proficiency in the language of the host country particularly affects G1, undermining, above all, their access to the labor market, as well as to social integration. 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. Nonetheless, education influences the language proficiency of the G2. For instance, the educational system and the specific schools G2 enter, as a consequence of their parents' decisions and aspirations, can contribute to widening or narrowing the language barrier.

1.3 CONTRIBUTION AND NOVEL ASPECTS OF THE STUDY

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 and deepen the relationship between immigrants' cognitive skills and their socio-demographic characteristics already widely discussed in the existing literature, as reported in the literature review (Chapter 3). This thesis intends to provide novel evidence and knowledge on the skills and integration of immigrants in order to inform policies addressed to improve these individuals' qualifications and, consequently, guarantee them a smoother and more successful integration into the host society. 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, I could not find any study that uses both cycles and focuses on temporal shifts. Therefore, I am addressing these missing pieces of the complex puzzle which is crucial for understanding the dynamics of migrants' skills. Consequently, the results can support effective management of skilled migration and provide crucial evidence for maximizing its benefits for both immigrant and receiving populations.

In addition to the existing research and papers, this work covers two cycles of PIAAC data, instead of one, in order to look at the temporal trends of the skills gap. In other words, a new perspective is included by analyzing how the immigrant-native skills discrepancy has evolved over time. For the purpose of the study, a cross-national analysis is required as countries differ in immigration and integration policies (OECD, 2018). This can help identify the variety of the skills gap determined by the characteristics of migrant subgroups and define more solid evidence of its existence. Evaluating the skills of immigrants and how they differ from those of natives and across migrant generations is crucial to properly recognize their skills, reduce prejudice and widespread stereotypes resulting in discrimination and support their integration into the receiving labor market. This would enable immigrants to fully benefit from their new lives and opportunities in the destination country while allowing the host country to maximize the contributions of immigrants to its labor force.

This first introduction aims to provide a comprehensive overview of the complex concept of migrant-native skills gaps and their root causes. Next, this thesis proceeds as follows. In the next Chapter 2, I 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 I 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, I 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, I acknowledge the limitations of the study in both data collection and methodology.

2. OBJECTIVES AND RESEARCH QUESTIONS

This work develops around four main research questions, moving from broader to narrower perspectives. First of all, it starts from analyzing whether a gap in immigrants' and natives' skills exists or not. These skills are restricted to functional literacy and numeracy. Moreover, the migrant-native gap has been at the center of several existing discussions confirming it. Therefore, this research aims to elaborate the answer to:

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

Next, I specifically focus on:

RQ2: "How has this gap evolved over time, specifically from Cycle 1 (between 2011 and 2018) to Cycle 2 (2022-23)?",

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

RQ4: "What are the variables that most affect the migrant-native literacy and numeracy skill gap? And how?"

The purpose is to examine whether the skills gap decreases or increases as immigrants settle in the receiving country and whether it varies between first-generation immigrants and second-generation immigrants. To do so and, therefore, to answer the first three research questions, a descriptive analysis will be implemented, by covering the demographic composition of both immigrant and native subpopulations and the temporal distribution of their skills – expressed in literacy and numeracy scores and levels. To answer these three questions, I perform regression analysis to investigate the existence and the magnitude of the skill gaps and their temporal trends.

Finally, the fourth question will also be addressed by applying regression methods to investigate the effect of specific independent variables on the migrant-native skills gap. In other words, multiple models will be attempted to explore the socio-economic and demographic variables that influence migrant-native gap and the direction and magnitude of their effects.

3. LITERATURE REVIEW AND STATE OF THE ART

Literature on immigrants' skills is widely published. The skills gap to natives has often been at the core of discussion and research. However, this topic is more 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.

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 in various ways in literature. Among the most discussed definitions, the distinction between hard or cognitive skills and soft or non-cognitive skills is particularly relevant to mention in support 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 consist in personality traits, whereas cognitive skills are technical abilities (OECD, 2025). This literature overview will focus on cognitive skills, as measured in the Survey of Adult Skills (PIAAC) from the OECD. More specifically, the OECD considers cognitive skills as a tool for measuring the capacity of individuals to interact with professional and social contexts.

Despite not being deepened in this work, an insightful concept in the context of skill differentials among immigrants is skill mismatch. Both migrant-native skill gap and skill mismatch refer to the moment individuals access or try to access the host labor market and both have long-term and multidimensional impact on individuals. "Multidimensional" indicates how the effect expands to various aspects in the individual's life, from their social interactions to their economic benefits and services. *Skill mismatch* refers more precisely 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 provoking discrepancy in how these two subgroups enter the labor market and, consequently, the society and their privileges in it. Measuring both gap and mismatch can provide an overall analysis of the immigrant disadvantage and the imbalance within the host society resulting from an imbalance between the immigrant and native subpopulations. The skill mismatch can be considered a result of an existing skill gap. In their paper, Pivovarova and Powers recall the human capital theory, according to which education and competencies cannot be straightforwardly transferred from the sending to the receiving labor market, as a consequence of differences in, for

instance, the educational system or the language proficiency. As evidenced by the results found by Pivovarova and Powers on PIAAC data, immigrants in the United States are more inclined to be overmatched for their jobs in this country than natives, meaning that they usually have higher and stronger skills than what their job requires (Pivovarova & Powers, 2022). More specifically, 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 predictable, this mechanism can have a relevant and sustained impact on the individual's opportunities in the receiving country and, more generally, on their social and economic advancements. Along with the individual effect, as a consequence of the role that remittances play in supporting the development of the sending country, their home countries will also suffer from the underutilization of their skills. Likewise, immigrants' limited productivity will slow and damage the receiving economy (Pivovarova & Powers, 2022). This issue mainly affects the first generation, as second-generation immigrants obtain their education in the country and face immediately its educational, working and societal environment. As stated by Pivovarova and Powers, in other words, second-generation immigrants have more access to 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.

Despite the prevalence of grey literature discussing migrant-native skills gaps, the existing peer-reviewed literature provides relevant insights to reach a complete comprehensive analysis of the topic. If, on one hand, a modest collection of peer-reviewed papers can be a limitation, on the other hand, it allows to enrich the study of skills gap, extending it to multiple and innovative perspectives. The studies this paper will mention refer either to the specific use of PIAAC data or to the theoretical concept of skills gap, along with different material or analytical methods.

The existing peer-reviewed literature mainly focuses on measuring immigrants' skills and how these are influenced by socio-demographic factors (Batalova & Fix, 2015). The resulting findings are used to define the gap between immigrants and natives. Most previous works concentrate on either a single or more countries. 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 thesis, conversely to the majority of existing literature exploring kids at the school age of 15 (Levels et al., 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, such as Levels et al. who provided theoretical explanations for the skills gap between natives and immigrants in Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, the United Kingdom, and the United States (Levels et al., 2017). The widest gap is between the first-generation immigrants and natives and, according to Levels, 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.

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). In other words, children's education and future socio-economic status are highly correlated to their parents' education and socio-economic status, as parents reflect their aspirations on children's educational choices investing in them. 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 second-generation immigrants tend to have high educational aspirations, as a consequence of their immigrant parents' high aspirations (Heisig & Schaeffer, 2020). Heisig states that the immigration process requires motivation, aspiration and risk tolerance, subsequently, transmitted to the next generation. Furthermore, Richwine reports 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 mainly consist in the lack of a unique definition of skills, combined with the lack of unique migration definitions. Most of the existing literature focuses on specific variables that are potentially playing a relevant role in shaping the skills gap between natives and immigrants in order to restrict the complex analysis to a concise aspect. For instance, to overcome these complications, education is often chosen as core factor to examine the migrant-native gap and the widely discussed disadvantage of the former (Schnepf, 2006). Schnepf explores the gap through educational differentials and, in particular, through the discrepancies in educational achievements. In other words, these authors concentrate their study of the skills gap on the gap in achievements at school. Therefore, the age range of the target population is lower and restricted to young individuals. Like Schnepf (2006), authors like Azzolini, Schnell and Palmer (2012) or Levels and Dronkers (2008) focus their attention on individuals' scholastic achievements.

Azzolini and Levels include the generational detail in their studies (Azzolini et al., 2012; Levels et al., 2008). Similarly to this thesis, both comparisons between natives and immigrants and between first and second generations of immigrants are emphasized, however, the focus is not on adults but on 15-year-olds. These studies report different findings, suggesting the existence of multiple factors that affect the performance of the populations under study. 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 to affirm. In fact, the direction and magnitude of this gap vary with the social, cultural and economic context. Azzolini narrows the analysis to Italy and Spain and concludes that the gap is particularly evident if the first generation of immigrant pupils is considered, whereas the second generation reveals a consistent disadvantage relative to natives but a better performance relative to the first generation (Azzolini et al., 2012).

Levels follows a wider cross-national perspective 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, and which country of destination or country of origin is taken into consideration (Levels & Dronkers, 2008). After this study, in 2017, Levels with Dronkers and Jencks deepened the previous investigation by shifting the target population to older ages (16 to 64) and including both literacy and numeracy skills, along with non-European countries. Once again, the gap is confirmed to vary depending on various factors. For instance, the language plays a crucial role considering that surveys like PIAAC are administered in the language of the country of the interview. Despite a non-unique conclusion about migrant-native skill gap, first-generation immigrants often seem to report a disadvantage compared to natives, although moderate (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 moment in time, without considering the evolution of skills and the gap between native and immigrant populations over time.

4. DATA & METHODS

4.1 DATA

To examine the skills gap between immigrants and natives and between first- and second- generation of immigrants, the data from the OECD's cyclical *Programme for International Assessment of Adult Competencies* (PIAAC), which provides the *Survey of Adults Skills*, are utilized. More specifically, the data is retrieved from available microdata files, called PUFs (Public-Use Files). PIAAC data contributes to the analysis of adults' skills by measuring functional literacy, numeracy and problem-solving skills through test scores and questions on family or educational background. These three domains are recognized by the OECD as crucial for the complete integration into the 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. Aside from the decision to have a more precise and targeted focus, another reason for excluding the problem-solving proficiency is the difference between the measurement and assessment of this skill 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.

The PIAAC survey consists in two cycles, and this thesis 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. Only the European countries with sizeable immigrant populations were selected for the purpose of the study. These countries are Belgium (the Flemish Region only), Finland, France, Germany, Ireland, Spain, Italy and

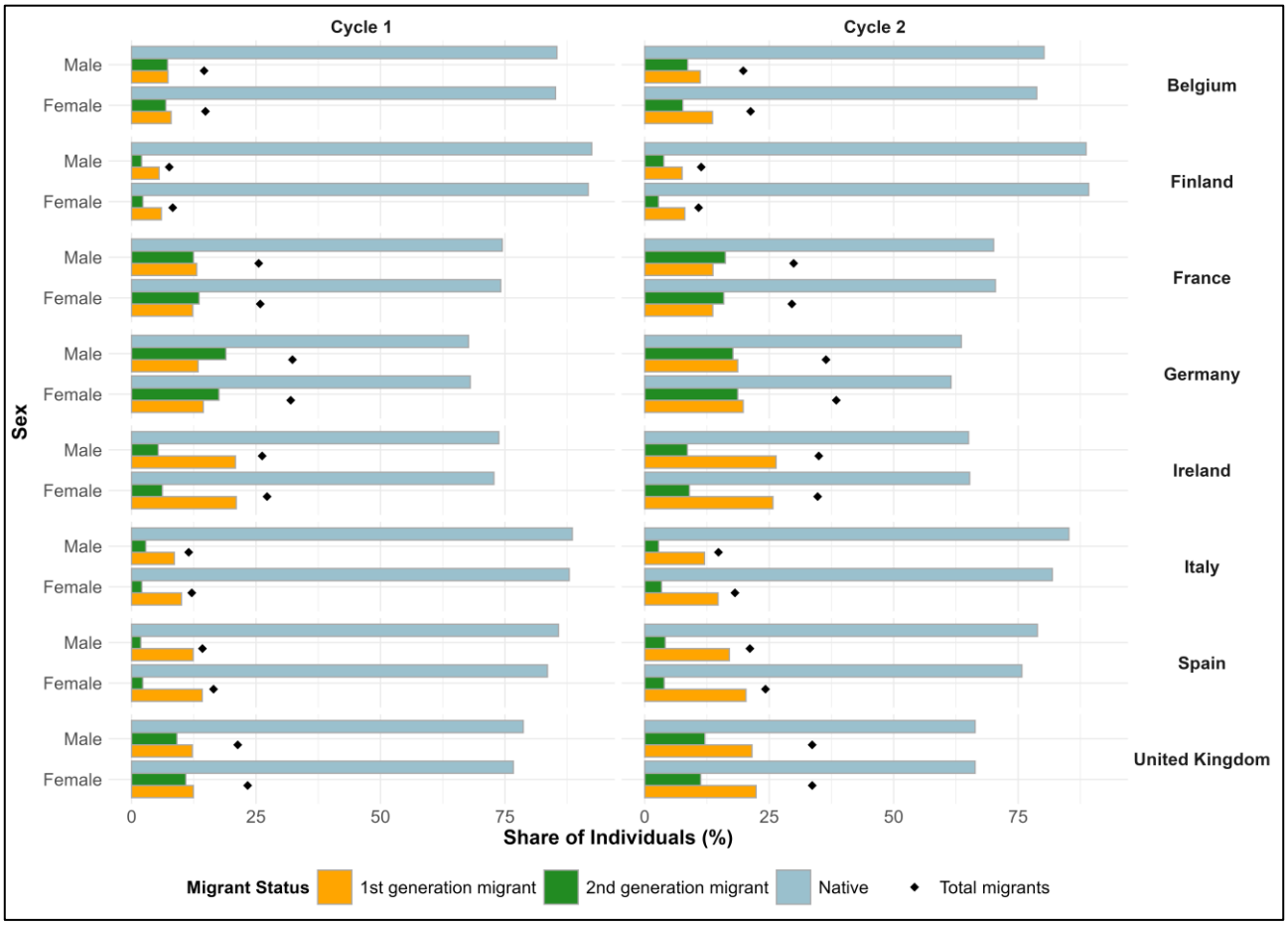
United Kingdom (England only). All the countries selected participated in Cycle 1 of the *Survey of Adults Skills* in 2011-12 and in Cycle 2 in 2022-23. The target sample consists of adults aged 16-65.

4.1.1 – Immigrant-native demographic composition

Literacy and numeracy scores and levels, which the Section 4.2 of Chapter 4 will discuss, are the focus of the analysis in order to investigate immigrants' and natives' skills in comparison. However, prior to addressing the core of the study, it is relevant to discuss the demographic characteristics of these two groups and how these are represented by the sample under study – the illustrated results were calculated as weighted shares of individuals. This will allow for a more comprehensive overview of the topic. Gender and age are the characteristics being examined in this section. As aforementioned, these two were available in the PIAAC PUFs as categorical variables, which categories were subsequently converted into "Male" and "Female" for gender and the three broader groups "16-24", "25-44" and "45-65" for age. Firstly, Figure 1 shows the percentage of individuals in each country by migrant status (the *migrant* variable distinguishing immigrants by generation and natives), sex and survey cycle. Overall, the migrant component – whose total is represented by the black point – is more prevalent in France, with an increase from 25% in the first cycle of the survey to 30% in the second cycle, Germany from 33% to 37% and Ireland from 26% to 34%, approximately for both sexes. 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 with very little discrepancy. In the second cycle, this prevalence is emphasized. Finland and France have a quite even distribution. Additionally, the Irish trend reverses with a slight overtaking of male immigrants. Despite the consistent gap between natives (in the light blue bar) and immigrants, the former seem to have decreased in the second cycle in all countries. On the contrary, the size of the migrant component has increased. To have a look at the intergenerational trend, the yellow and green bars represent, respectively, the first- and second-generation immigrants. First generation immigrants predominate, particularly in Ireland, Italy, Spain and United Kingdom. France and Germany show very little difference with the exception of a majority of second-generation immigrants in Germany in the first cycle. Furthermore, if sex disaggregation is considered, the first generation of immigrants reflects more clearly a potential discrepancy between female and male immigrants in terms of their migration decisions and patterns. From the chart, a prevalence of women migrating can be observed. Nevertheless, this conclusion and, hence, the direction of this discrepancy, i.e. whether immigrant women prevail over immigrant men or not, cannot be stated. In fact, in the existing evidence, among G1, men are commonly more likely to migrate, for instance, as a consequence of their economic role in the family in some of the origin cultures. According to Eurostat,

in 2023, 55.0% of men migrated to EU countries, opposed to 45.0% of women (Eurostat, 2025). In addition to this, regardless, the gender pattern depends on the origin country, and a unique conclusion is not achievable. The controversial finding in Figure 1 may suggest a bias in the sampling and weighting process that often occurs with immigrants. Immigrants are difficult to track and gather, as it is addressed in Chapter 7 on the limitations of the study. This may also be due to an evidenced greater participation of women in surveys. Furthermore, the language barrier contributes to underrepresenting and underestimating the immigrant population, given the limited access to the survey and its tasks administered in the native language (OECD, 2024). The detailed overview of the limitations for PIAAC data and, overall, migration data shown in Chapter 7, explains the consequences of small samples for immigrant population and the complications with individuals not proficient in the test language.

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

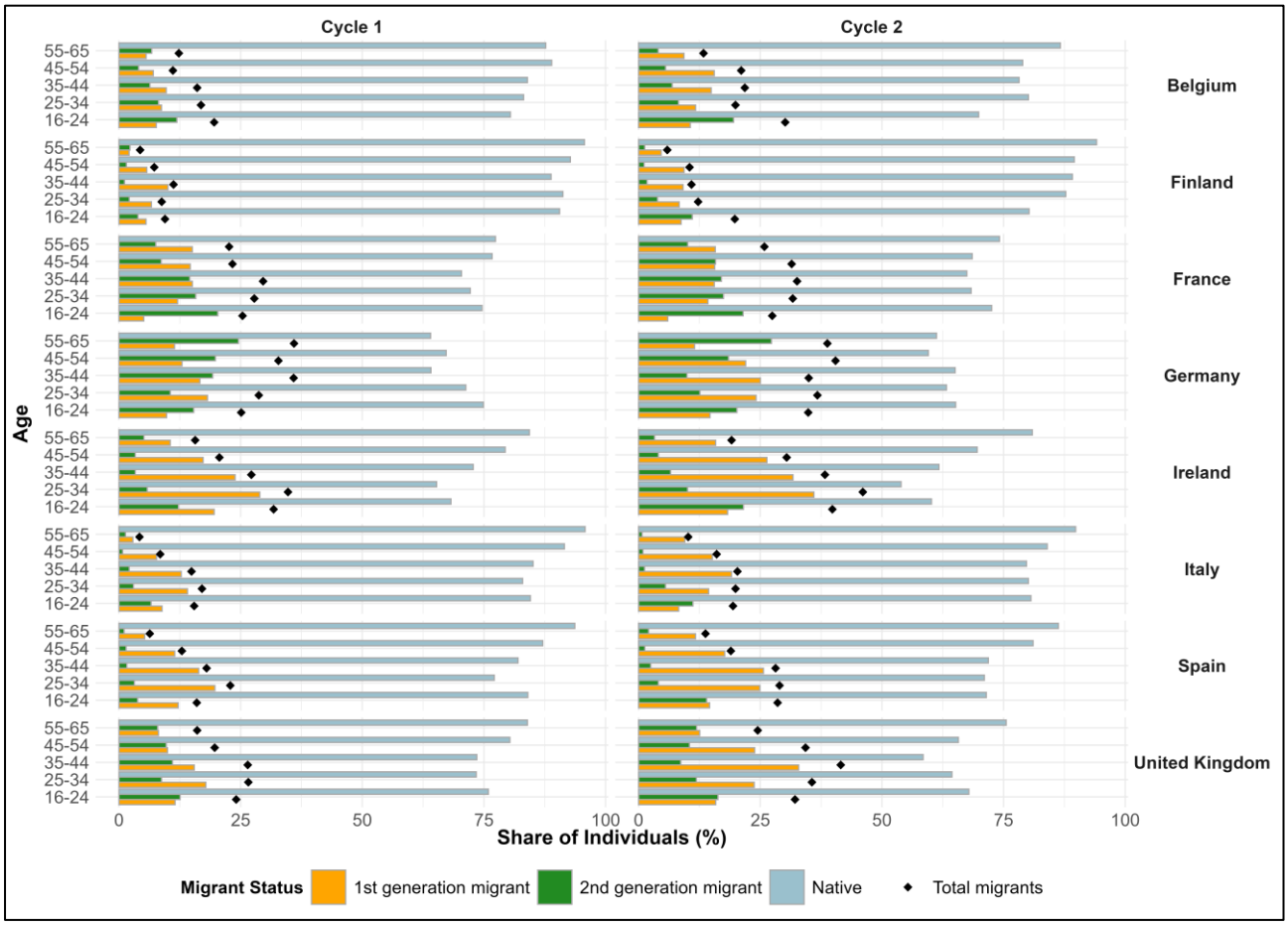


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23).

As displayed in Figure 2, overall, the distribution of immigrants across age groups is right-skewed with a majority of younger individuals, regardless the generation. Conversely, the native component shows a higher concentration in older age groups. This conclusion is commonly confirmed by existing

evidence and statistics. Following family reunification, one of the main reasons why immigrants leave their country and move to European countries is to seek job opportunities to ensure themselves and their family back home greater standards of living, suggesting 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. 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). 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 2. Share of individuals by age, migrant status and cycle.

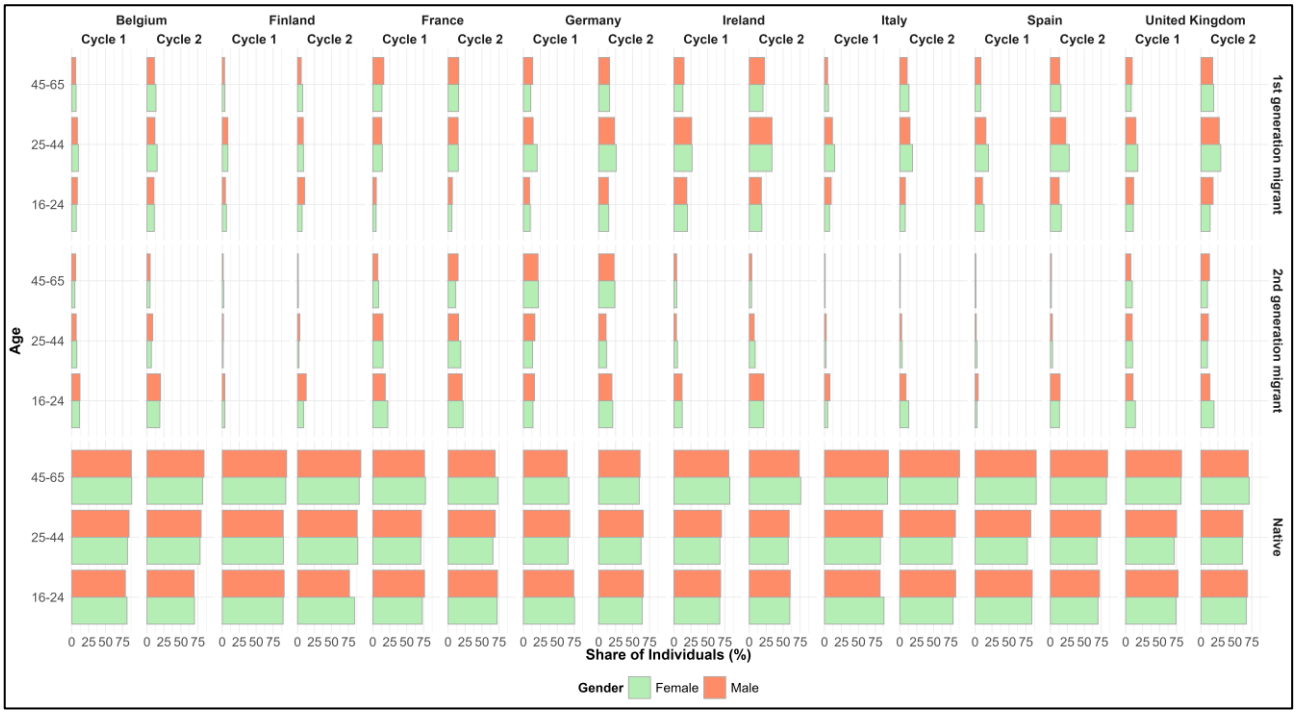


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23).

Figure 3 displays the gender disaggregation of immigrants and natives by age, after grouping the range 16-65 into three: 16-24, 25-44, 45-65. Taken as a whole, the differences between the distribution of women and the distribution of men are not significant and the concentration of both sexes in the three age groups has decreased over time. Concerning first-generation immigrants, all countries have maintained similar distributions across gender and age groups. In Cycle 1, both women and men were mainly concentrated in the groups 25-44 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 UK. Among these countries, men dominate the 16-24 age group in Belgium, Italy and UK. Finland, Ireland, Germany and France have experienced moderate change. Particularly, Ireland shows men prevailing in 45-65 conversely to average trends.

Moving to second-generation immigrants, 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 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 particular, 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 second-generation immigrants are more concentrated in younger age groups as a consequence of having been born in the current country. The distribution by sex is nearly even, resembling the native. 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 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.

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).

4.2 METHODS

4.2.1 – Variables

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 denominations 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 respondents 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. In this work, conversely to immigrants, 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", to include the generation detail to the study. Starting from the classification between immigrants and natives, immigrants were clustered, in turn, by generation. Addressing first-generation and second-generation immigrants, this work distinguishes them by country of birth. More precisely, first-generation immigrants are classified as individuals born in a different country than the country of the interview where they immigrated, whereas second-generation immigrants 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_R** for the gender dimension. This variable was originally binary with categories 0 and 1, consequently converted into "Male" and "Female".
- **AGEG10LFS** for the age dimension. It presents five categories from 1 to 5, consequently converted into five ten-year interval age groups ("24 or less", "25-34", "35-44", "45-54", "55 plus"). For the purpose of the study, these groups were aggregated into three broader groups ("16-24", "25-44", "45-65").
- **educ_3** for the education dimension. This variable was constructed from EDCAT6 in Cycle 1 and EDCAT6_TC1 in Cycle 2, indicating the highest level of formal education obtained with the ISCED 97 classification. The original categories go from 1 to 6 ("Lower secondary or less" (ISCED 1,2, 3C short or less), "Upper secondary" (ISCED 3A-B, C long), "Post-secondary, non-tertiary" (ISCED 4A-B-C), "Tertiary - professional degree" (ISCED 5B), "Tertiary - bachelor degree" (ISCED 5A), "Tertiary - master/research degree" (ISCED 5A/6)). These six categories were aggregated into three categories and renamed as "Lower secondary or less", "Upper secondary/Post-secondary", which includes "Upper secondary" and "Post-secondary, non-tertiary", and "Tertiary", which includes "Tertiary - professional degree", "Tertiary - bachelor degree" and "Tertiary - master/research degree".
- **J2_Q04c** and **J2_Q05c** to respectively integrate the mother's highest qualification, and the father's highest qualification (respectively, J_Q06b and J_Q07b in Cycle 1). The two cycles

have three similar but different categories that, in this work, are assumed to be classified as low, medium and high education.

- **employment_status** for the employment dimension. The employment predictor was formerly in the PUFs under the name C2_Q07_T (C_Q07_T for Cycle 1) and represents the current work situation. It originally had six categories – 1 to 6 ("Employed or self-employed", "Retired", "Not working and looking for work", "Student (including work programs)", "Doing unpaid household work", "Other"). For the purpose of the study, these categories were grouped into "Employed", "Unemployed", "In education" and "Inactive", which combines "Retired", "Doing unpaid household work" and "Other".
- **bornlang_simple** for the language dimension. In this work, the language barrier was included aggregating the four categories of the variable BORNLANG with categories, from 1 to 4 ("Native-born and native-language", "Native-born and foreign-language", "Foreign-born and native-language", "Foreign-born and foreign-language") indicating the interactions between place of birth and language status. A simplified version of BORNLANG was constructed and renamed bornlang_simple with categories "native_language" and "foreign_language", after grouping the former categories by language proficiency. The reason behind this conversion is to reduce the issue of small samples of first-generation and second-generation immigrants across the categories.
- **BIRTHRGN** with categories 1 to 9 ("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") represents the region of birth.
- **CTRYQUAL_simple**, indicating the country where the highest qualification was obtained, was created from CTRYQUAL (with the same categories as BIRTHRGN) by aggregating the original categories into only two to simplify the regression analysis and make it more intelligible. These two new categories are "OECD" and "Non-OECD", distinguishing individuals who obtained their highest qualification in a member of the OECD and those that did not.
- **country_name**, the country of the interview, i.e. the countries under study, were taken from the country codes in the PIAAC dataset (CNTRYID) to which all the names were associated and renamed.

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 – From scores to proficiency levels

As stated in Chapter 2, the central point of this study is to explore and compare immigrants' and natives' cognitive skills. To do so, attention is directed to literacy and numeracy test scores and the corresponding levels to which this section is addressed. The proficiency levels contribute to having better transparency in the population's distribution across cognitive skills. The OECD defines functional literacy and numeracy levels as groups of score ranges. Nevertheless, the PIAAC dataset solely provides public access to the test scores, each of them presented as ten plausible values. These plausible values are variables labelled PVLIT1 to PVLIT10 for literacy and PVNUM1 to PVNUM10 for numeracy and can be defined as ten different guesses from each respondent's performance. In other words, given that each respondent answers only a subset of all possible tasks, the respondent will not receive a single exact test score, but ten plausible scores used to estimate how well that respondent would have done if they had taken the full test. 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). Before delving into the methods implemented, it is crucial to clarify how the skill levels were inferred from the test scores. The strategy was to group the scores between 0 and 500 into 6 proficiency levels of score ranges. First of all, the scale of 500 points indicates both the proficiency of the respondent, depending on their assessment outcomes, and the difficulty of the tasks (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, as carefully described in the Survey of Adult Skills reader's Companion by OECD. Concerning the levels, they correspond to increasing levels of difficulty and represent what the respondent is able to do depending on within which range their score falls into. More specifically, the ranges are: Below Level 1 includes scores from 0 to 176, Level 1 from 176 to 226, Level 2 from 226 to 276, Level 3 from 276 to 326, Level 4 from 326 to 376 and Level 5 from 376 to 500. The definitions of the five levels are different for literacy and numeracy, according to Insights and Interpretations published by the OECD in 2024. As for literacy, conversely to individuals below Level 1 who are able to only comprehend simple sentences, 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. On the contrary, individuals at Level 4 and 5 can handle more complex calculations with rates and ratios, assess charts and statistical statements. The first two groups 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

For the purpose of the study, both descriptive analysis and regression analysis were performed. In particular, the descriptive analysis addresses the first three research questions – "What is the skills gap between immigrants and natives starting from literacy and numeracy skills in European destination countries?", "How has this gap evolved over time, specifically from Cycle 1 to Cycle 2?", "Is there a difference in pattern when we distinguish between first-generation immigrants and second-generation immigrants?".

The descriptive analysis addresses both socio-demographic dimensions and the distribution of literacy and numeracy skills focusing on education and temporal trends. More precisely, a first section concentrates on the weighted distribution of immigrants (first, as a whole and, later, as first and second generation) and natives, in comparison, by education, age and cycle of the survey. This section examines 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 deriving from this analysis and the correspondent bar charts emphasize the differences in the performance between the subpopulations starting from their level of education. In the second section, the distributions of scores and levels by education and cycle of the survey are explored, to comprehend and visualize the correlation between education and literacy and numeracy performance. Taken together, the descriptive statistics enable the assessment of the existence and evolution of the skills gap between immigrants and natives from Cycle 1 to Cycle 2 in the selected eight European countries.

To do so, in the descriptive analysis, immigrants' and natives' cognitive skills were explored and illustrated over time by comparing the straightforward and simple weighted mean between the 10 plausible values for each domain. For this purpose, to account for the individual weights provided in the PUFs, both *survey* and *srvyr* R packages were utilized.

4.2.4 – Regression analysis

The second part of the analysis consists in implementing a linear regression model to supplement the descriptive outcomes by evaluating the effect that relevant factors (variables) have on the determination of skills and the migrant-native cognitive skills gap. More precisely, 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?". In the regression analysis, multiple models were implemented separating 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.

4.2.4.1 – Specification of the models

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:

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

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:

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

At this stage, the interaction terms were incorporated into model *(2)*. More precisely, a first 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, as explained in detail in Section 4.3. In other words, 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. Nevertheless, the effects of the interactions repeatedly resulted to be non-significant. This conclusion was attained after several attempts and confirmed by testing the regression models with different packages – *intsvy*, *Rrepest* and *mitools*. Despite the non-significance of the interactions, the coefficients were logical 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.

$$
\begin{aligned}
score = \ & \beta_0 + migrant\beta_1 \\
& + educ\_3\beta_2 + GENDER\_R\beta_3 + AGEG10LFS\beta_4 + J2\_Q04c\beta_5 \\
& + J2\_Q05c\beta_6 + CTRYQUAL\_simple\beta_7 + bornlang\_simple\beta_8 \\
& + employment\_status\beta_9 + country\_name\beta_{10} \\
& + GENDER\_R \times employment\_status\beta_{11} + migrant \times educ\_3\beta_{12} \\
& + migrant \times J2\_Q04c\beta_{13} + migrant \times J2\_Q05c\beta_{14} \\
& + migrant \times bornlang\_simple\beta_{15} \\
& + migrant \times employment\_status\beta_{16} + migrant \times country\_name\beta_{17} \\
& + \varepsilon
\end{aligned}
\qquad (3)
$$

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.

4.2.4.2 – Dependent variable

To keep the analysis at the individual level, the model was constructed by choosing the initial scores (ten plausible values PVLIT1 to PVLIT10 and PVNUM1 to PVNUM10) as dependent variable. Unlike the common practice in existing literature of using the first literacy and numeracy plausible values or the simple weighted mean between all ten values used in the descriptive analysis, the regression analysis follows the approach provided by the OECD in the *Survey of Adult Skills 2023 Technical Report* (OECD, 2025). The OECD suggests that users execute a separate model for each plausible value and pool the ten models using Rubin's rules to achieve a unique result. The OECD explains this method as a solution to increase the accuracy in estimating proficiency distribution, regression and, therefore, the effects under study, given the estimation of plausible values from respondents' answers to both tasks and background questionnaire. To do so, the *mitools* package in R was utilized. *mitools* helps 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. Following the OECD approach (2024) and other studies such as that of Heisig (2020), 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. 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.

4.2.4.3 – Independent variables

The regression analysis includes the following variables: migrant or migrant_generation, GENDER_R, AGEG10LFS, educ_3, J2_Q04c, J2_Q05c, CTRYQUAL_simple, bornlang_simple, employment_status, country_name. Two groups can be delineated. The first group focuses on the demographic predictors of skill score. Doing so, the measurement of the impact of socio-demographic characteristics on performance can be achieved. These variables are gender and age. Additionally, as anticipated in Section 4.2.4.1, an interaction between gender and employment was explored among the reference group. The second group of predictors work on both immigrant and native subpopulations and encompasses, in turn, two different clusters. A first cluster is incorporated into the model through an interaction with migration background in order to examine the gap between

immigrants and natives. This cluster consists in the highest qualification attained by the respondent and their parents, the proficiency in the test language, employment and country of the interview (country under study). A second cluster consists of the region of birth and the country where the highest qualification was attained. 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 may provide noteworthy results. In particular, the country of highest qualification may highlight the differences in the respondents' literacy and numeracy skills, more specifically between immigrants and natives. In other words, the differences in educational systems may be a proxy for the differences in the socio-economic condition of a given country. In fact, educational systems and the overall education 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.

Insightful information derives from employment status which may also shed light on the skill mismatch and, therefore, the correlation between the individual's competencies and their access to the labor market. Being aware of which category (employment categories) benefits more in terms of cognitive skills by clustering individuals can help address specific group of people, conditions and environments at the time of implementing and improving policies. Additionally, this classification can contribute to examining potential disadvantages or advantages between immigrant and native subpopulations.

Moreover, as anticipated in the theoretical introduction, 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).

4.2.4.4 – Weighting

The management of the weights was a crucial stage of the analysis. Specifically, to perform the regression models, a survey design was created including both 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). The regression analysis encountered various obstacles, and the replication weighting was one of these.

For PIAAC survey, different replication methods were applied in each country, and these discrepancies need to be accounted for at the stage of implementing regression, given the connection between replicate weights, variance and standard errors. The countries included in the study – France, Belgium, Finland, Germany, Ireland, Italy, Spain, United Kingdom – also experience this discrepancy. While, in the first cycle, the paired jackknife (JK2) replication method was implemented in all these countries, except for JK1 in Germany, in the second cycle, France is consistent with JK2, whereas the rest switches to Fay method. 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). For this reason, some adjustments and specifications were required. First of all, the selection of packages to use 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,

United Kingdom, As for France- and Germany-specific models, 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.

4.2.4.5 – Country selection and the cases of France and Germany

Conversely to the descriptive analysis, the regression models were decided to be implemented on a restrained selection of countries: Belgium, Finland, Ireland, Italy, Spain, UK. As for France and Germany, these two countries were excluded from the full models, and their regression models were run separately, removing *country_name* variable. The France-specific regression is discussed in the text as a concrete example on immigrant-native skills gap. More specifically, the broader model without the generation detail is displayed within the text, whereas the detailed models by generation of immigrants are reported in the Appendix. The models for France follow the specifications *(1)*, *(2)* and *(3)* reported in Section 4.1. The decision to exclude this country was taken after acknowledging the different replication method used in Cycle 2. While all the countries under study use the JK2 replication method in Cycle 1, France is the only country using JK2 consistently in Cycle 2, conversely to the Fay method used by the rest of the countries. As a consequence, to have a more comprehensive and smooth analysis, France was examined as a single case. Doing so, it is possible to zoom on the within-country migrant-native skill gap and explore its evolution over time, from Cycle 1 to Cycle 2, through a more detailed approach.

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

As for Germany, the case is not discussed, although still illustrated in the Appendix. The main reason behind this decision was the different replication methods Germany used (JK1 in Cycle 1 and Fay in Cycle 2). Additionally, Germany was not considered together with the other countries due to data availability. More specifically, in the PIAAC Public-Use Files for Germany, data on birth region and

the country where the highest qualification was attained were missing. 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:

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

5. RESULTS

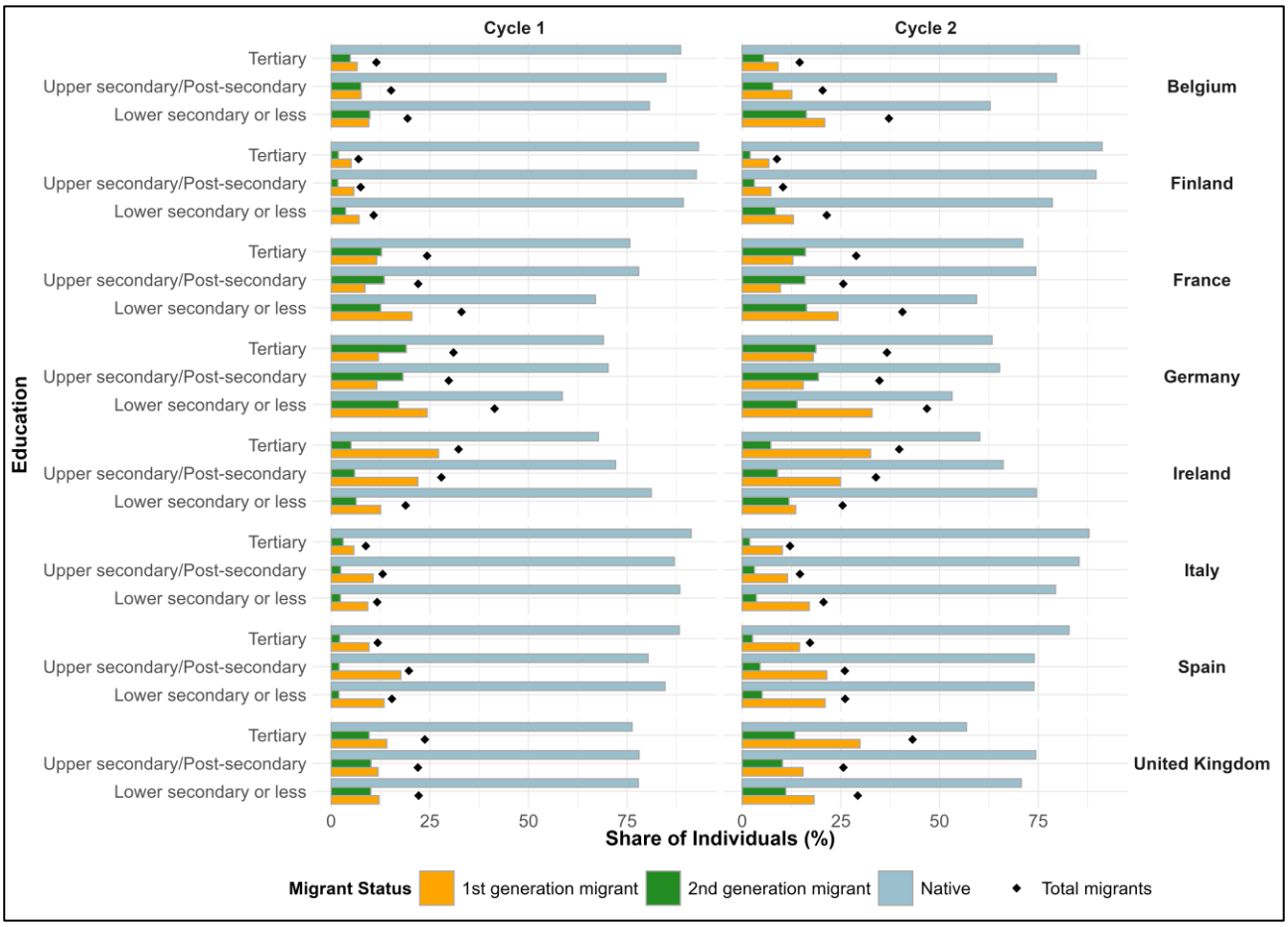
5.1 DESCRIPTIVE ANALYSIS

5.1.1 – Migrant-native gap in educational attainment

This chapter illustrates the main results of the descriptive analysis. Central focus is placed on education, given the direct role in determining individuals' skills. More specifically, this first section of the descriptive analysis aims to investigate and highlight the existence of a migrant-native gap prior to the context of literacy and numeracy skills. Understanding a gap in the distribution of these two subpopulations across educational levels provide insights and plausible interpretations of the migrant-native skills gap. Therefore, before exploring the actual gap between immigrants' and natives' literacy and numeracy mean scores over time, these individuals' educational compositions are compared.

In Figure 4, the populations under study are displayed by education level, country and cycle where education is grouped into lower education which refers to lower secondary education or less, medium education which includes upper secondary and post-secondary education (non-tertiary), and higher education which refers to tertiary education (professional, bachelor's and master's degrees). On the whole, immigrants and natives reveal opposite distributions. 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 United Kingdom. In particular, the UK, together with Ireland, present a completely reversed trend where immigrants are more highly educated than natives. Considering the intergenerational perspective, while the first generation of immigrants confirms the opposing trend with a low-education prevalence compared to natives, second-generation immigrants are more equally distributed across the education levels in all countries.

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

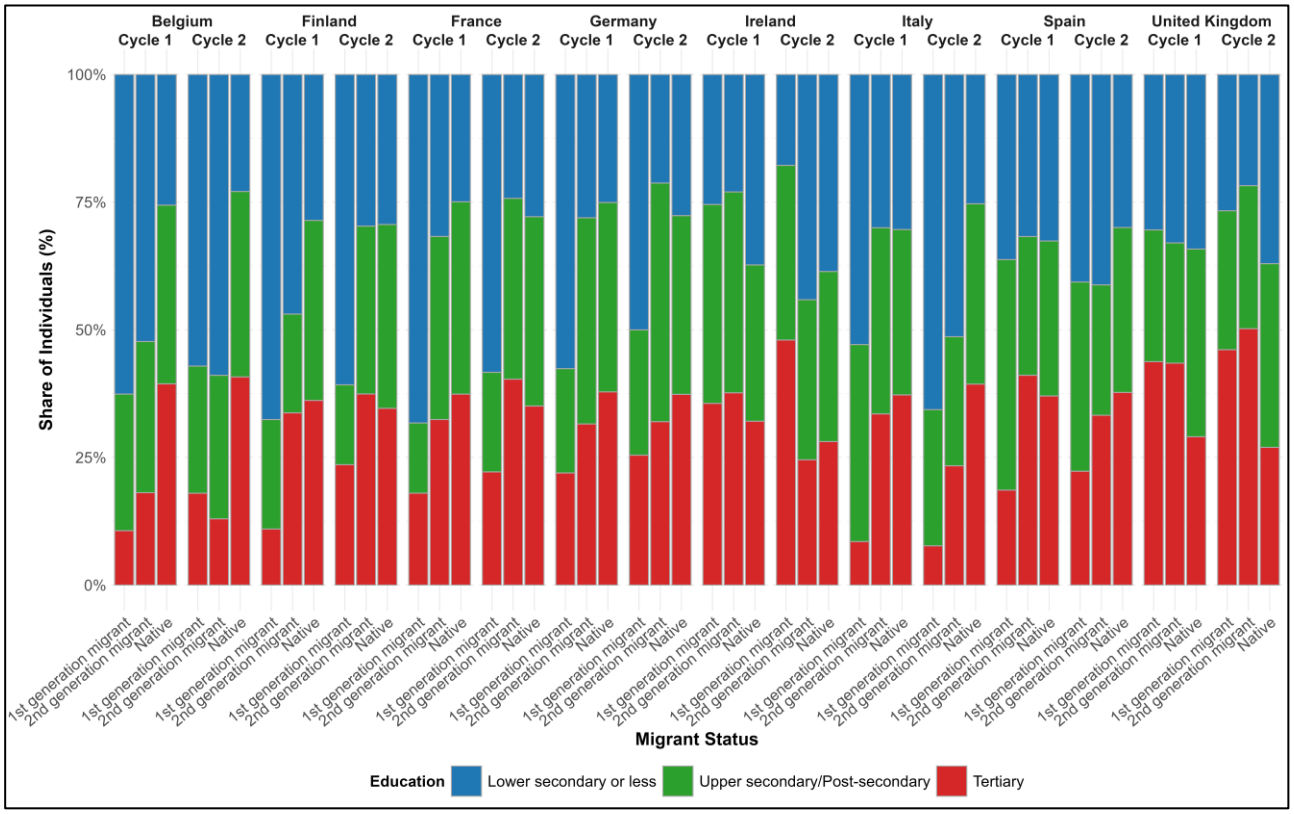


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23).

Given the high concentration of immigrants in the 25-34 age group and the relevance of individuals this age's role in the society and labor market, focusing on them can provide an interesting perspective. The highest education level immigrants aged 25-34 have attained can contribute to a more comprehensive analysis of who is actually migrating, how they are perceived and, hence, integrated into the receiving labor market and, more broadly, into the society. The 100% stacked bar chart in Figure 5 allows us to emphasize the opposing trends for immigrants and natives with, overall, a higher density in the lowest education level for the former and a less noticeable pattern for the latter. Overall, in all countries, the share of natives in the highest education level remained the same from Cycle 1 to Cycle 2. 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 particular, in Finland and France, G2 immigrants surpass natives in Cycle 2, while, in Spain, the share of G2 immigrants at the highest-level regresses below natives. These results suggest an upward mobility of immigrants in education in some of the countries under study. Belgium, Finland, France, Germany and Italy show the most significant gap between generations of immigrants with the second generation reaching higher levels. 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. An interesting result is the predominance of first-generation immigrants in Ireland and both generations in United Kingdom among the highest level compared to natives. 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.

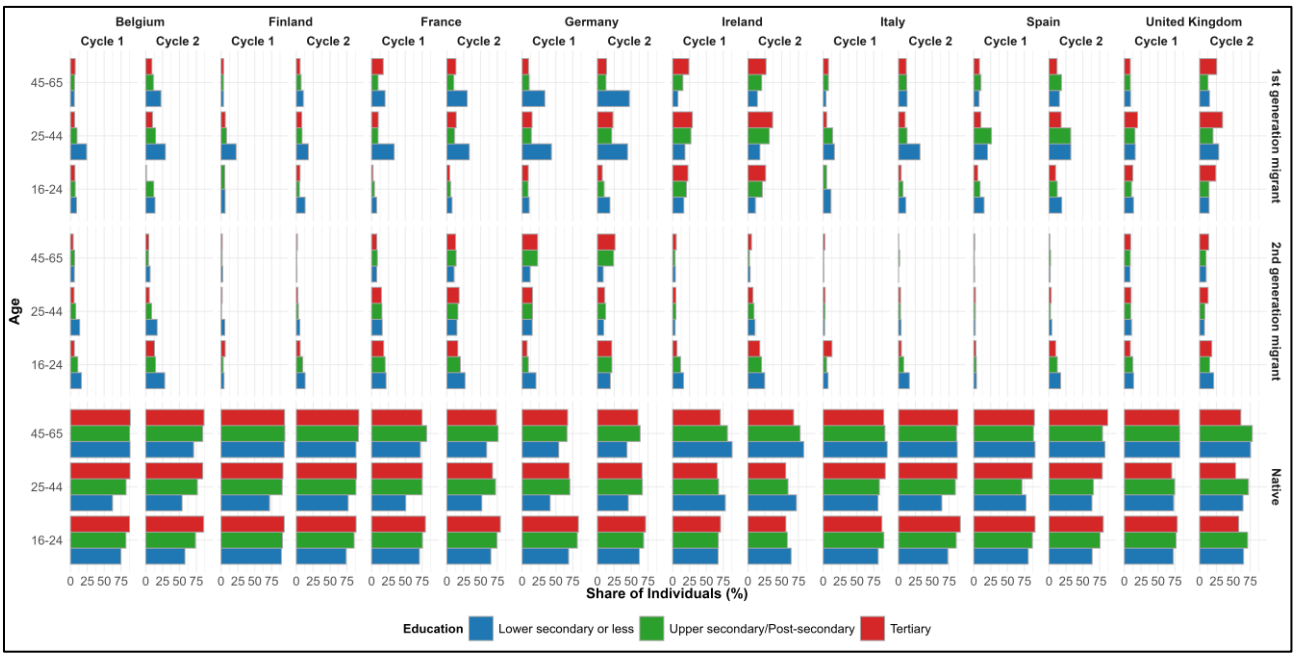


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23).

Moreover, the five initial age groups can be aggregated into three broader groups, as done earlier with the disaggregation by age and sex: 16-24, 25-44 and 45-65. This way it is possible to analyze whether younger and older individuals differ in their education depending on their migration background. This perspective will anticipate interesting consequences for immigrants' participation in the receiving labor market and society. A noticeable pattern from Figure 6 is that, in countries such as Ireland and Germany, younger immigrants seem to be observed more in higher levels, while older immigrants fall more into lower levels. This suggests increasing access to education over time. Additionally, second-generation immigrants have a less clear gap across education levels and age groups, similarly to natives but at a much lower density. 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, 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. 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. Shifting the focus to the second generation, the change from Cycle 1 to Cycle 2 is little. The most relevant results are the progressing trend for individuals aged 16-24 in Ireland and Belgium, despite the increase in the share of low-educated, and the regressing trend for the same age group in Italy. Overall, the second generation is more educated at younger ages. Conversely, the first generation is more educated at older ages. Germany and United Kingdom for both generation, Ireland for the first and France for the second present instead an even distribution across age groups.

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



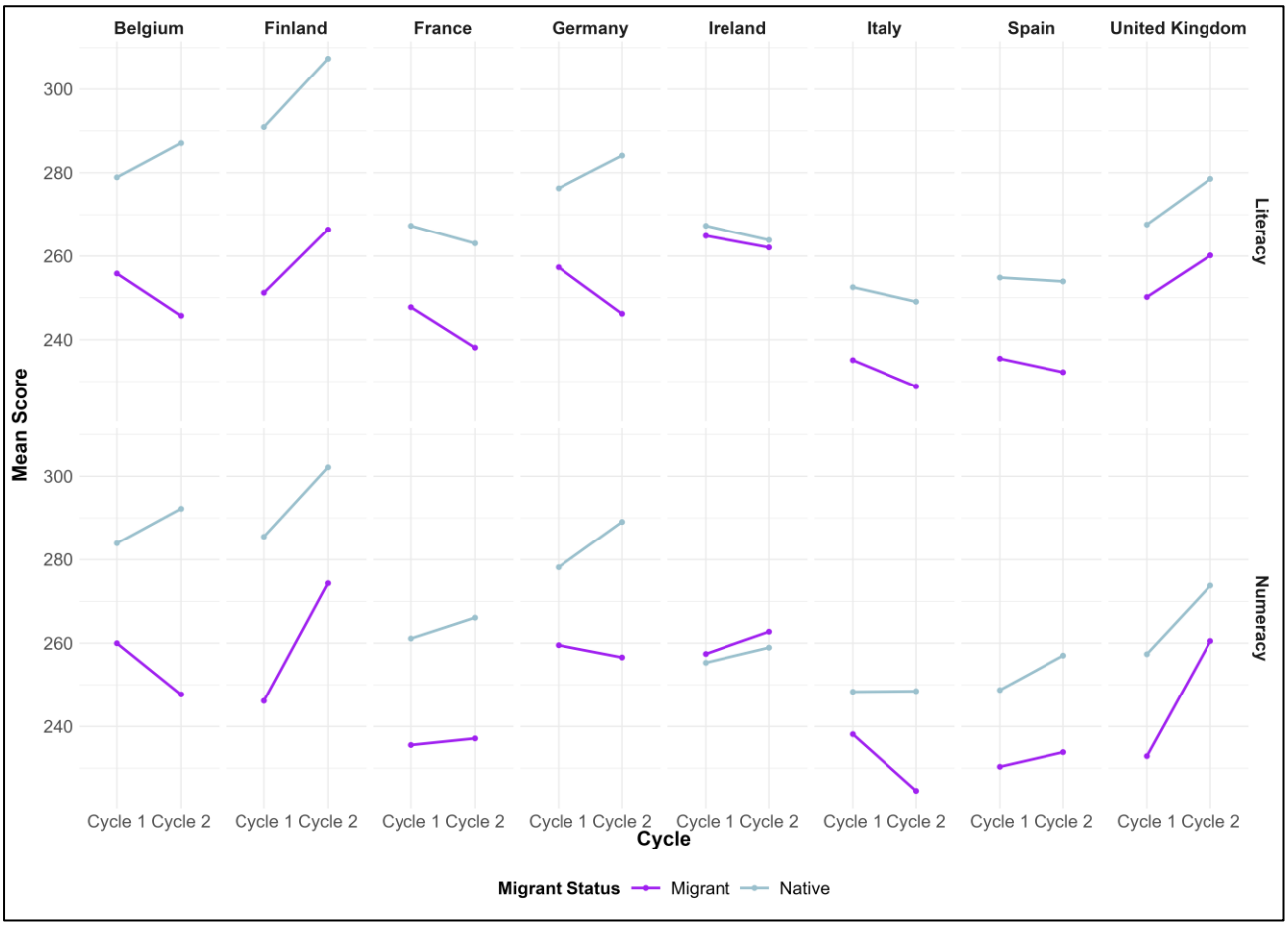
Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23).

5.1.2 – Migrant-native skills gap in scores and levels

Once the differences in the distributions of immigrants and natives across educational levels are assessed, this section proceeds to the differences in terms of skills, exploring both mean scores and proficiency levels. Along with the trends by generation, cycle and domain, the educational attainment is included. Doing so, the results in Section 5.1.1 can be deepened and supported by investigating the relationship between immigrants' and natives' education and their relative literacy and numeracy.

The line chart in Figure 7 illustrates the comparison in mean literacy and numeracy scores between natives and immigrants, respectively in light blue and purple, from Cycle 1 to Cycle 2. as described in the methods (Section 4.2, Chapter 4), 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 United Kingdom, both immigrants and natives have improved over time, while in France, Ireland, Italy and Spain both have regressed. Belgium and Germany reveal two opposite trends for the two groups, an increase for natives and a decrease for immigrants. The widest gap between the two populations is presented in Finland, followed by Belgium in Cycle 2. Conversely, Ireland has the smallest gap. As for numeracy represented in the bottom chart, in Finland, France, Ireland, Spain and United Kingdom, both natives and immigrants have improved in their scores. In Belgium, Germany and Italy, immigrants' scores have declined, in opposition to natives' progress. Immigrants residing in Belgium, Germany and Italy are the only groups showing a deteriorating trend, respectively from an average of 260 to 248, 260 to 257, 238 to 225 points. Taken together, the main result is that a gap between immigrants and natives does exist. More specifically, within each domain, natives outperform immigrants, except for Ireland. Ireland is the only country with greater performance in numeracy tests for immigrants scoring 263 in Cycle 2 against 260 for natives and, additionally, with overall little gap. Regardless of the consistent advantage of natives, improvements over time are more noticeable among immigrants, mainly in Finland and United Kingdom. Lastly, Finland reveals the steepest improvement for both groups and domains, along with immigrants' mean numeracy score in the UK.

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

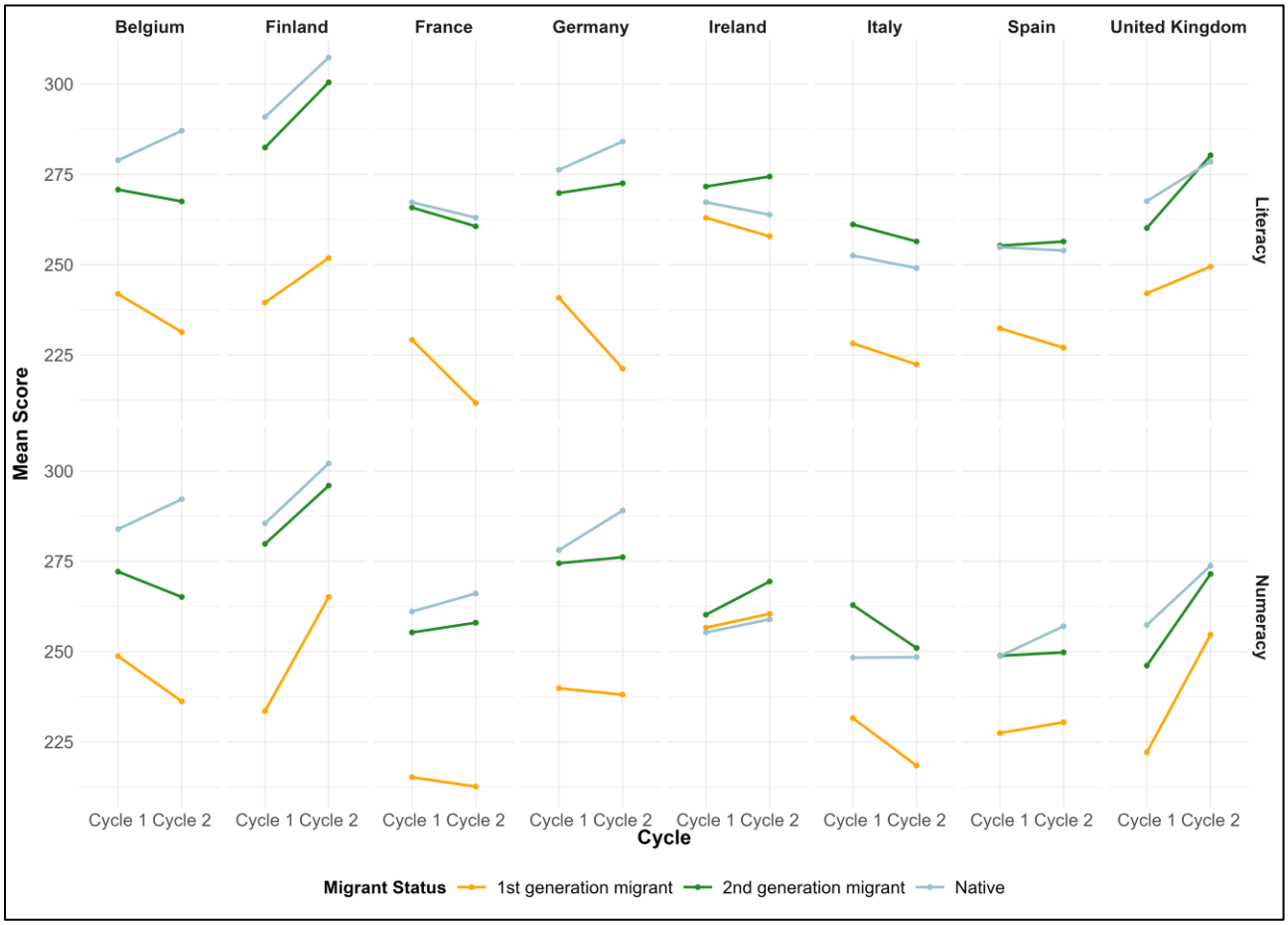


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23).

When plotted by generation, as shown in Figure 8, the gap in literacy and numeracy scores is mostly explained by the low performance of first-generation 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, in France, Spain and United Kingdom only in Cycle 2, second-generation immigrants have the smallest gap with natives. However, in Spain, G2 immigrants outperform natives over time as their scores increase compared to the decrease in native averages. Along with Spain, also in Ireland and Italy, G2 immigrants achieve higher scores than natives. 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. In terms of numeracy, the trends within immigrants are often confirmed. An interesting result is the steep pace for first-generation immigrants in Finland that explains the overall progress among immigrants. Furthermore, Ireland and Italy present an outperformance of second-generation immigrants that is decreasing for Italy. However, G2 immigrants' higher scores are not sufficient to counterbalance G1 immigrants' low scores. This is also due to the very small second-generation immigrant sample under study that likely do not well

represent the true population. Conversely to literacy, in Spain, natives have surpassed second-generation immigrants from Cycle 1 to Cycle 2.

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

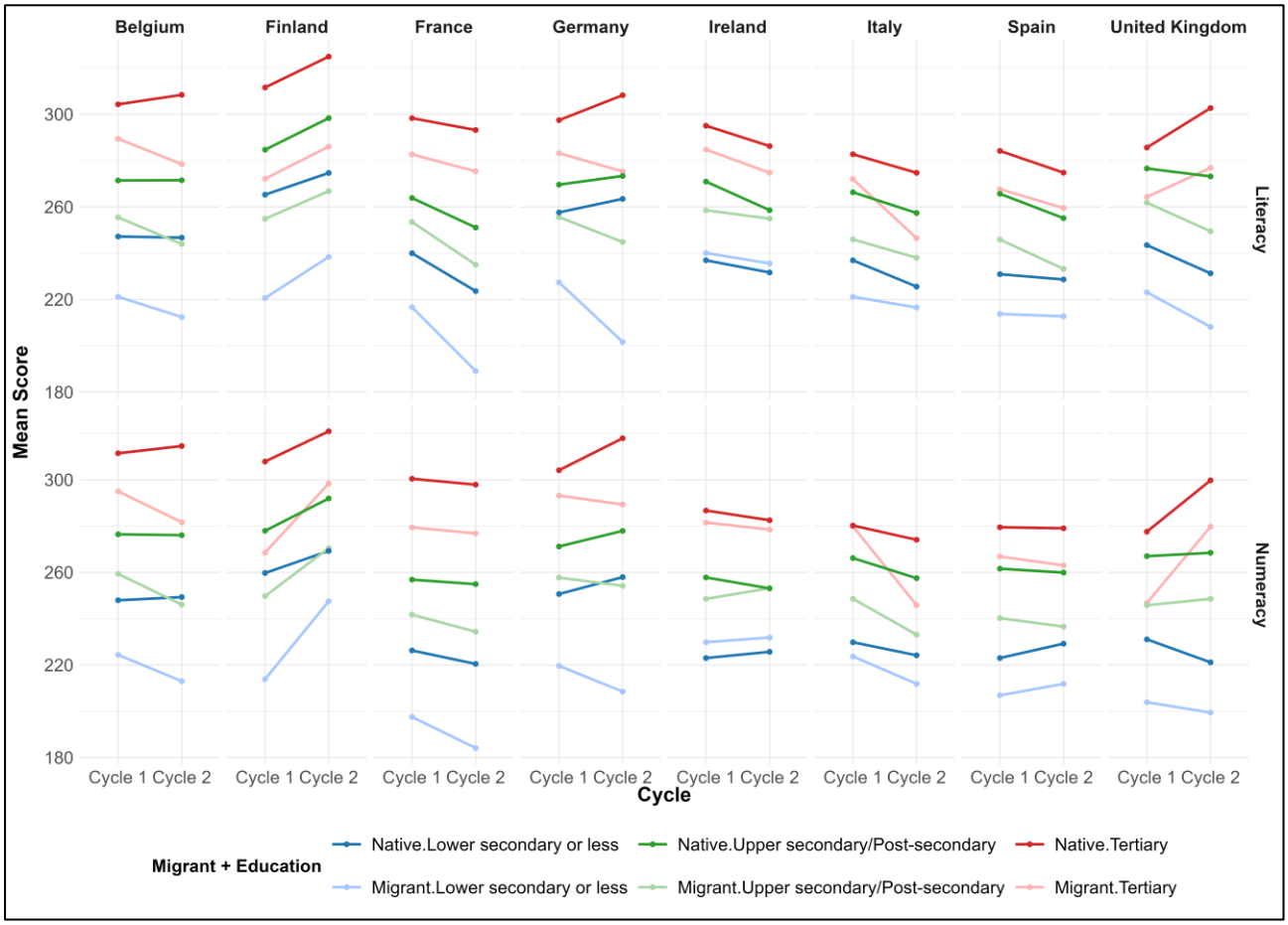


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23).

The trends mentioned in Figures 7 and 8 can be examined, including the educational dimension, in order to offer a more detailed explanation of the variations across countries and target groups. This is displayed in Figure 9. As expected, the main observation from the chart is that higher mean scores are reached by higher-educated individuals. The native line is in most of the countries constantly above the migrant line, with the exception of Ireland for the lowest education level. The literacy and numeracy outperformance of immigrants in Ireland is due to the outperformance of low-educated immigrants compared to natives. Both populations are progressing over time in Finland, whereas they are regressing in France, Ireland, Italy with a steep decline for high-educated immigrants and a steadier decline for lower-educated immigrants, and Spain. In Belgium, at every level, natives and immigrants have undergone, respectively, an upward and a downward trend. Lastly, as for United Kingdom, the two subgroups follow the same pattern with a disadvantage for immigrants. An

interesting observation is that low-educated individuals have attained better results from Cycle 1 to Cycle 2, while secondary and tertiary-educated individuals have attained worse results.

Figure 9. Mean literacy and numeracy scores by educational attainment, migrant status and cycle.

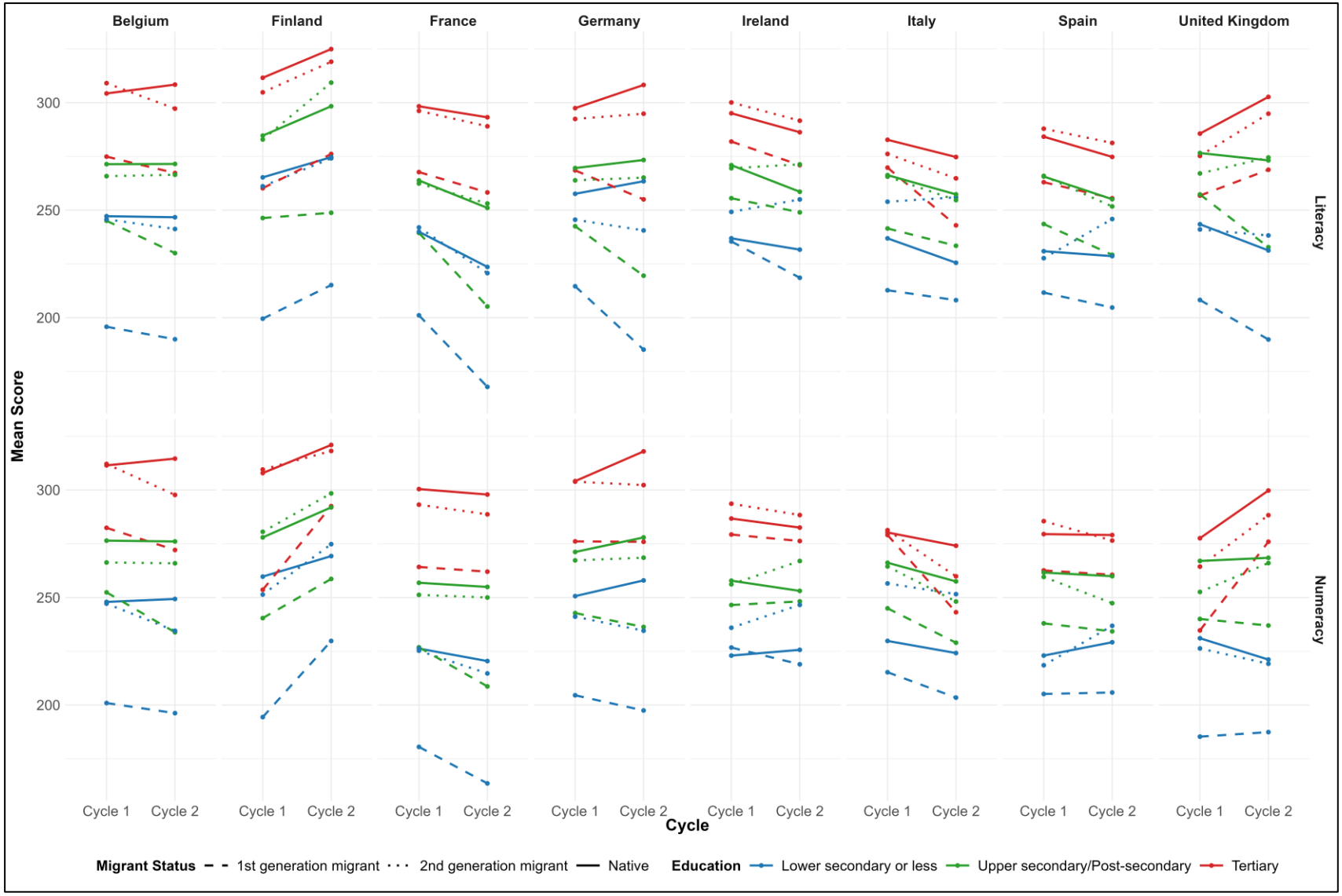


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23).

Figure 10 includes the intergenerational detail to the distribution of mean skill scores. The solid line, the dashed line and the dotted line denote natives, first-generation and second-generation immigrants, respectively. Overall, natives and G2 immigrants follow the same pattern and pace. Finland shows the clearest progress over time, and the United Kingdom follows the high performance, despite the increasing scores among high-educated individuals and the decreasing scores among medium-low educated. France, Ireland, Italy and Spain have experienced deterioration with the exception of lower-educated G2 immigrants. 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. Concerning literacy, in Finland, all three groups have improved their scores from Cycle 1 to Cycle 2 across all education levels, with G2 immigrants approaching native scores, while, in France, all three groups have worsened. Italy and Spain have the

same downward trend for the populations under study except for low-educated G1 immigrants. Belgium and Germany have a progressive native population and a regressive G1 population. As for G2 immigrants, in Belgium, they follow the natives, excluding those high-educated. Conversely in Germany, low-educated G2 immigrants' scores are the ones declining in opposition to natives' and the higher-educated immigrants. 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. Here, second-generation immigrants witness a reversed trend with an increase for medium- and high-educated individuals and a decline for low-educated. Relevant result are the low-educated second-generation immigrants surpassing natives in Cycle 2 and low-educated ones reaching the native level in Finland. Moreover, medium-educated second-generation immigrants in the UK have reached the native level in Cycle 2. The most significant gap between these two groups and first-generation immigrants is observed in Belgium, Finland, France, Germany, i.e. countries where high-educated natives' scores are generally higher. Concerning numeracy, the trends are nearly confirmed. The greatest gap is between first-generation immigrants and the other two. In Finland, both immigrants and natives have improved at every education level, while, in Italy and France, both have worsened their performance. Belgium and Germany again follow the same pattern with an increase among natives for all three educations and among G2 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 first-generation immigrants can be attributed to both the differences between the sending and the receiving educational systems and the limited access to the second one. Despite the often gap with first-generation immigrants, they do show improving trends across all educational categories.

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

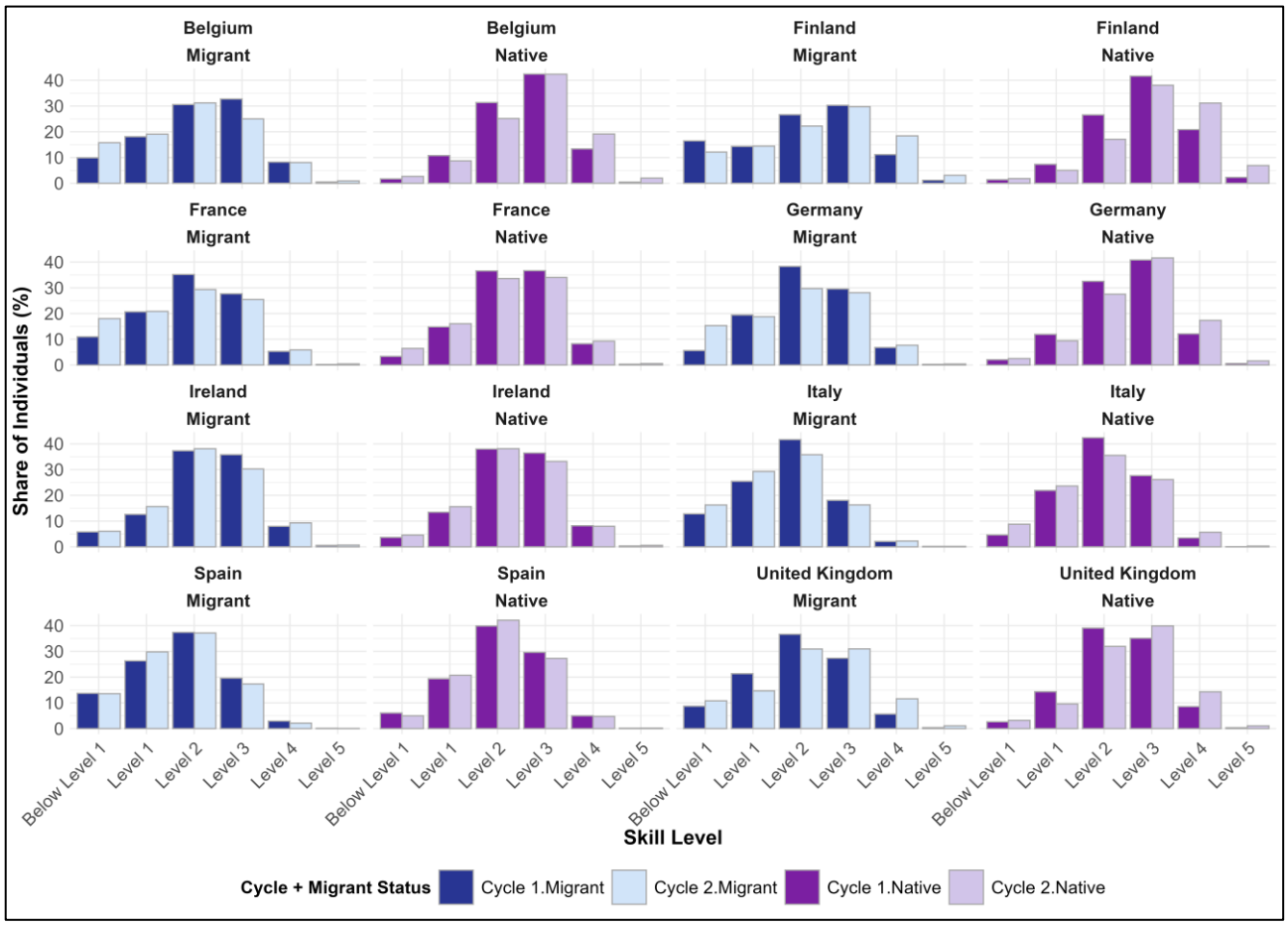


Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23).

Figure 11 and Figure 12 show 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. Specifically, the blue ones indicate the percentages of immigrants who have reached a given level, whereas the purple ones indicate the corresponding percentage among natives.

According to Figure 11, overall, modest change from Cycle 1 to Cycle 2 has occurred. Among the two populations, immigrants have shown greater progress. 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. On the contrary, Italy and, less discouragingly, Spain have showed a downward trend and an overall low performance. 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. Focusing on the migrant-native gap in literacy, 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. By contrast, 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 under study is not particularly pronounced in Ireland. However, the improvement is clearer among immigrants whose share at Level 4 exceeds the native share in Cycle 2. Despite the overall underperformance of both immigrants and natives compared to the other countries, in Spain, the gap between the two at lower and higher levels is still substantially observable. 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.

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



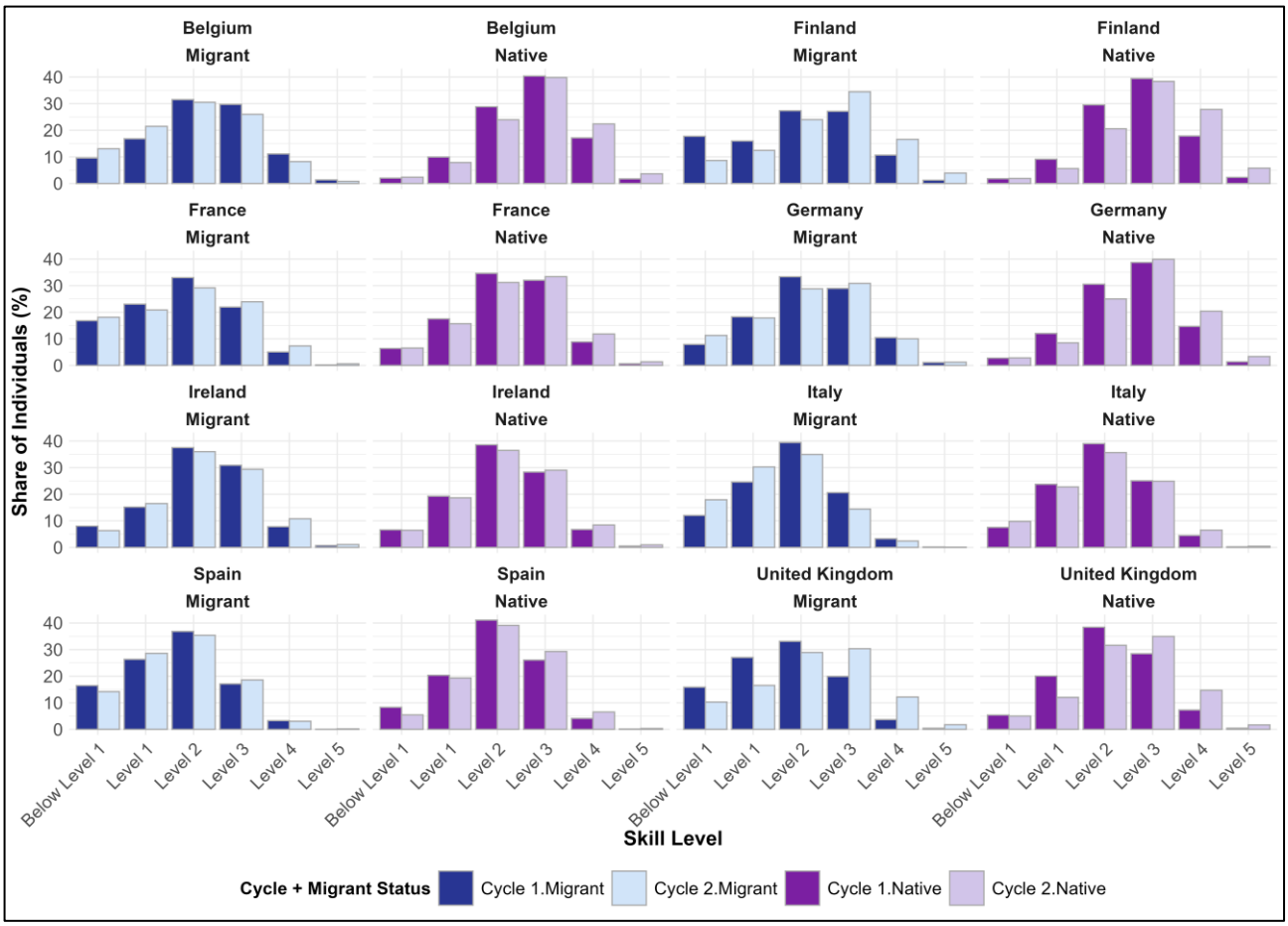
Source: Own elaborations on PIAAC data in Cycle 1 (2011-12) and Cycle 2 (2022-23).

Proceeding to numeracy in Figure 12, the trends 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.

All things considered, a normal distribution for all the countries results from both literacy and numeracy charts. 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 ANALYSIS

This chapter delineates the outcomes of the regression analysis. The regression analysis was performed with the purpose to examine how relevant variables affect the skills gap between immigrants and natives. After a descriptive overview of this gap, it is crucial to explore the factors

that most explain the discrepancy in the performance of these two subpopulations. The potential results can help suggest responses to the existence of this gap and solutions aimed at reducing it. Different attempts were made, and the independent variables were taken into account one by one in order to reach the most efficient model. All models illustrated revealed an R^2 of about 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 women born in Belgium, unemployed, low-educated, 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 first final model includes main effects only. The two columns for each cycle in Table 1 display the model with the birth region detail and the model without. The exclusion of birth region was decided after acknowledging a noticeable loss of significance for the independent variable *migrant*, which indicates the distinction between immigrants and natives. According to the coefficient of the intercept, meaning the average score when all other predictors are at their base level, the reference group averagely scored 238.5 points in Cycle 1. The most relevant result concerns the migration status as it indicates the adjusted literacy skill gap between immigrants and natives. The negative and statistically significant coefficient can be interpreted as a disadvantage for the immigrant subgroup. More specifically, immigrants averagely scored 12.0 points less than their native counterparts in Cycle 1.

Moving to the predictors of literacy performance, education appears to have the strongest effect. Additionally, higher education explains better performance, aligning with the importance of education discussed in literature. More specifically, tertiary-educated individuals scored 41.0 points higher than lower-secondary-educated and less and about 20 points higher than upper/post-secondary-educated. Likewise, parental education has a beneficial effect with lower magnitude. Both parents' education affects positively their children's literacy performance. Individuals with highly educated mothers and fathers scored, respectively, 12.1 and 10.2 points higher.

As for gender, the effect is particularly small and non-significant. Similarly, younger age groups do not have 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 suggests two reasons behind it. On one hand, ageing damages cognitive skills and, on the other hand, the cohort of respondents aged 16-24

and the cohort of respondent aged 55-65 experienced different educational systems, advancements and policies.

Although not statistically significant, the country where the highest qualification was attained reveals interesting results. Respondents who received their highest education in a non-OECD country are at a disadvantage of 15.8 points, showing remarkable insights of the differences in educational systems of different countries. This is a conclusion for first-generation immigrants as most of the immigrant sample falls in the non-OECD category. Along with the differences in the educational systems, the obstacles deriving from not speaking the test language, i.e. the native language of the country of the interview, are confirmed by this regression output. A lacking proficiency in the test language causes a worse performance by 16.9, supported by high significance.

The employment status results to be considerably significant, with the exception of inactivity. Individuals in education and employment benefit more than those unemployed in terms of literacy skills. Those in education outperform with a gap of 21.4 from unemployed, followed by those in employment with 8.0 points.

With regard to the cross-national patterns, Finland confirms the best scores already observed in the descriptive results, with 11.6 points higher than Belgium. Italy and Spain have the worst 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. Nevertheless, the significant and wide gap in the previous model is no longer confirmed. The gap is narrow and non-significant, with a moderate disadvantage for immigrants (-2.7). The remaining effects undergo no changes. All the birth regions are associated with a worse performance compared to Northern America and Western Europe. This is more 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 the estimates for Cycle 2 shows similar patterns to Cycle 1, although with greater or smaller magnitude. The reference group of natives scored averagely 233.3 points, all other predictors being at their base level (a decrease of about 5.0 points). The literacy skill gap between natives and immigrants also narrowed, revealing a slight convergence between the two. The latter appear to score 8.5 points worse than natives (compared to -12.0 in Cycle1). This disadvantage loses certainty and reaches a level of zero when birth region is included.

The effect and benefit of the individual's education on skills remained particularly stable over time. Regarding parental education, the benefit of having higher-educated mother increased over time, whereas it deteriorated for paternal high education. The 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 paternal education decreased.

Focusing on demographics, gender did not vary considerably. As for age, apart from the most significant coefficient, i.e. the oldest age group, that remained nearly the same, the ages between 25 and 44 underwent an inversion of direction, though non-significant, meaning that performance would deteriorate starting already from 25 years compared to the 16-24 age group. The 45-54 age group gained significance by the second cycle, and its negative coefficient indicates that individuals in that group score 6.6 points less than those in 16-24 and about 4.0 points higher than those in 55-65.

Further significant outcomes are observed for the country of highest education and test-language proficiency. The trend is similar to Cycle 1 but with an increased significant disadvantage for individuals who received their highest qualification in a non-OECD country and for individuals who do not speak the test language (both by about 2.0 points).

An insightful result is the increase in the positive effect deriving from being employed. In Cycle 1, being in education would provide the strongest benefit. This still occurs in Cycle 2, however, employment gains magnitude (19.9 points higher than unemployment) and slightly approaches the effect of education. Inactivity is strongly significant, conversely to the first cycle, and individuals in this group perform better than unemployed by 8.8 points.

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

Table 1.Main effects - OLS regression on literacy scores. Cycle 1 vs Cycle 2.
(Reference: 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)

	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.

5.2.1.1 – Literacy main effects by generation of immigrants

When the distinction between first generation and second generation of immigrants is examined, interesting results are observed. To have correct analysis of the skill gap between natives and the generations of immigrants, it is crucial to take into account the limitation resulting from working on small samples that may affect the outcome. Therefore, uncertainty needs to be accounted for.

Table 2 displays the output of the linear regression on plausible values for literacy under the intergenerational perspective. According to the results, the reference group – female, low-educated and unemployed native individuals born in Belgium, aged 24 or less, with low-educated parents, proficiency in the test language and with highest qualification attained in an OECD country – scored averagely 238.0 points in the first cycle. Before including the information of the respondent's birth region, the coefficient for the first generation of immigrants reveals high significance scoring 17.3 scores lower than natives, whereas the second generation was consistently non-significant across the regression attempts. Despite the non-significance, the discrepancy between natives and second-generation immigrants is very little (1.9), confirming the convergence of their patterns as discussed in the literature.

Regarding the control variables, both 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 outcome observed in the descriptive analysis is confirmed with higher scores in Finland and lower scores in Italy and Spain.

The inclusion of the information of birth region explains the loss of significance in the coefficient for the first generation of immigrants. The gap between this group and the native becomes smaller, converging to the gap with second-generation immigrants. As for the effect of birth region, all the significant coefficients are negative and of a considerable magnitude, suggesting the advantage among European individuals. Since almost all natives and G2 immigrants were born in the reference region, Northern America and Western Europe, the coefficient of birth region is assumed to refer to G1 immigrants. Therefore, the negative coefficients reveal that, among G1 immigrants, individuals whose origin region differs from North 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).

In Cycle 2, all the trends are confirmed, in terms of direction of the effects. Nevertheless, the magnitude and the significance varied. The reference group averagely scored 232.5 points, which is

slightly lower than the first cycle. The same downward trend occurred for the gap itself, along with the effect of the respondent's education, age and gender. More specifically, the literacy gap between natives and first-generation immigrants witnesses a reduction, although small (from 17.3 to 15.6 of disadvantage for the latter).

Similarly to the broader migrant-native regression output in Section 5.2.1, paternal education has a lower impact on the respondent's score compared to the first cycle by about 5.0 points, whereas maternal education has a higher impact by the same amount.

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

Moreover, employment status, followed by language proficiency and the country where the highest qualification was attained, experienced an upward trend. Being in education and employment would contribute more considerably to better performance. The coefficient for inactivity earned significance and magnitude from Cycle 1 to Cycle 2, being less damaging than unemployment by 8.5 points.

As for the linguistic barrier, the disadvantage of not speaking the test language is confirmed and slightly emphasized. A similar disadvantage is experienced by individuals who obtained their highest education in a non-OECD country.

Focusing on how the countries under study impact differently on literacy skills, the direction of the coefficients for each country is aligned to Cycle 1. Finland maintains the lead, whereas Ireland, Italy and Spain show the lowest results. When the birth region is included, its coefficients are consistent from Cycle 1 with first-generation 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 scoring 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 in Belgium, aged 16-24 with both low-educated parents, with proficiency in the test language and 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 relevant control variables were considered to explore what factors affect most the migrant-native skill gap. Nevertheless, after various attempts, a consistent non-significance of the interaction effects was observed. Overall, the main effects appear to absorb all the significance when influencing literacy and numeracy performance, maintaining similar magnitude and direction to previous models. Conversely, non-significant and small interaction effects reveal that the selected control variables do not contribute to explaining and influencing the gap. In other words, little evidence that the migrant-native skill gap varies across levels of each control variable is observed, despite assessing the gap 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, the issue of non-significance is mainly encountered in Cycle 1, conversely to the various statistically significant interactions in Cycle 2. All the models with interaction terms omit the detail of birth region as not particularly significant.

To better delineate the results, the full tables with both main effects and interactions are illustrated in the Appendix (Table 10.3.2), whereas the individual interactions are displayed in plots, indicating coefficients and confidence intervals, and discussed throughout the text. The main effects will not be the focus in the text.

In literacy, before examining the interactions, it is relevant to note that, only in Cycle 1, the inclusion of interactions absorbs the significance of the migration effect. More precisely, although not significantly, immigrants score 6.6 points less 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 displayed 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 10.3.2), the purpose of this interaction was to investigate whether this discrepancy changes if the employment status of individuals is considered. Nevertheless, the effects have weak significance, indicating a bigger male advantage in education and employment, relative to unemployment.

Moving to how the migrant-native skills gap varies within each category, an interesting observation is, despite the strong impact of education on scores, the small and non-significant interaction with migration status indicates that little evidence of changes in the gap across educational levels is shown.

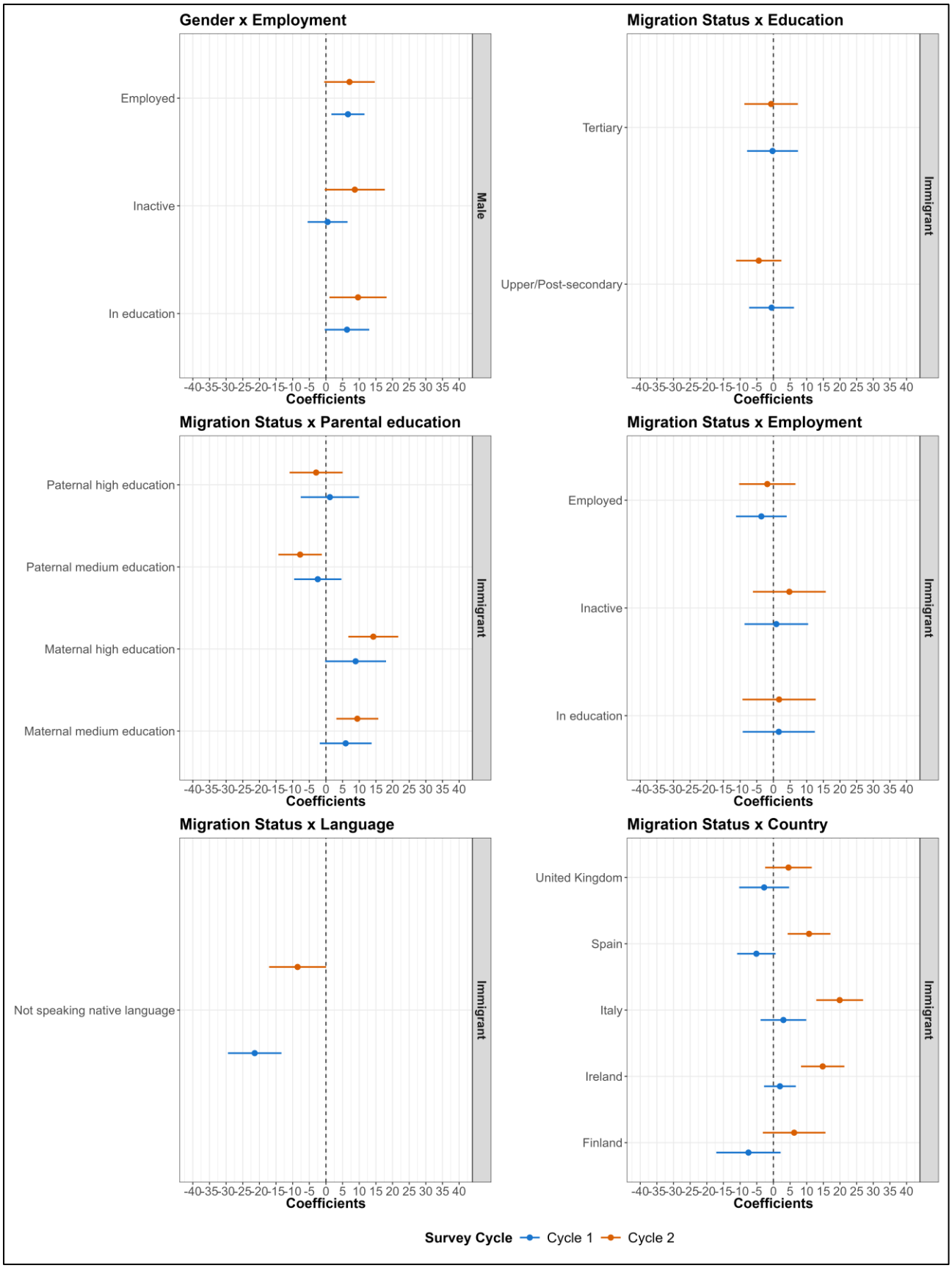
Education does not have a significant role in widening or narrowing the gap. According to the direction of the coefficient, the gap between the two subpopulations widens at increasingly higher levels of education. Proceeding with parental education, the focus will be on maternal education in Cycle 2 as it is particularly significant. Maternal education results to reduce significantly the immigrant-native gap, conversely to paternal education that seems to have no significant impact. The gap between immigrants and natives with higher-educated parents is smaller than the gap among individuals with low-educated parents. Summing 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 non-significantly and to a moderate extent. While education and inactivity have 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 means that the gap between employed immigrants and natives is increasingly wider than the gap between unemployed immigrants and natives.

Among considerably significant results, the gap between immigrants and natives not speaking the test language is noticeably wider than the gap between immigrants and natives speaking the test language (21.4 points wider). In particular, immigrants with no proficiency in the test language score 28.0 points less than natives with no proficiency (summing the main effect of migration status and the interaction with language). Not speaking the test language is a disadvantage for both subpopulations, yet more pronounced among immigrants, although it slightly and not significantly improves over time.

Lastly, among the significant effects, cross-national discrepancies in Cycle 2 are relevant to delineate. In Cycle 2, the coefficients for the countries under study are positive, showing an improvement in the gap, in comparison with the gap in Belgium. This is mainly the case of Italy, followed by Ireland and Spain with strongly significant progress (respectively, by 19.9, 14.8 and 10.7). Across countries, immigrants still perform lower than their native counterparts except for Italy where immigrants experience a small benefit of 1.9 points. Finland and United Kingdom have little and non-significant decrease in the gap. In Cycle 1, the immigrant-native gap widens in Finland, Spain and United Kingdom and narrows in Ireland and Italy in Cycle 1, not significantly. Overall, in both cycles, Finland and the UK have the most extensive gap, whereas Ireland and Italy have the smallest gap.

Figure 13. Interactions - OLS regression on literacy scores. Cycle 1 vs Cycle 2.
(Reference: 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)



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.

5.2.2.1 – Literacy interactions by generation of immigrants

The literacy regression model by generation of immigrants with both main effects and interaction terms does not vary in most of the coefficients, as shown in the Appendix (Table 10.3.4). Education, age and gender are consistent with the direction and magnitude of previous models. The first generation of immigrants maintains high significance, whereas the second generation maintains no significance across cycles. According to the coefficients of these two categories, first-generation immigrants averagely scored 17.7 points, in Cycle 1, and 28.3 points, in Cycle 2, lower than natives. Particularly, in the second cycle, the gap between this group and natives is emphasized by interactions. With regard to the second generation, the gap is narrower and non-significant, suggesting a smaller disadvantage than the first generation. Not significantly, second-generation immigrants scored averagely 3.3 (Cycle 1) and 7.9 points (Cycle 2) lower than natives.

Focusing on the effects of control variables on the literacy skill gap illustrated in Figure 14, despite being mostly non-significant, the direction is aligned with previous conclusions and the literature. The gap between G1 immigrants and natives seems to undergo minimal change at both upper/post-secondary and tertiary levels, relative to low secondary and less. As for G2, the gap also does not reveal significant variations from lower secondary education and less. The magnitude of the effect is slightly wider for the second generation, suggesting an increase at each higher educational category, nearly to the same extent regardless of the 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 first-generation immigrants with high-educated mother in Cycle 2. Here, the gap narrows by 16.9 points compared to those with low-educated mothers. 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.

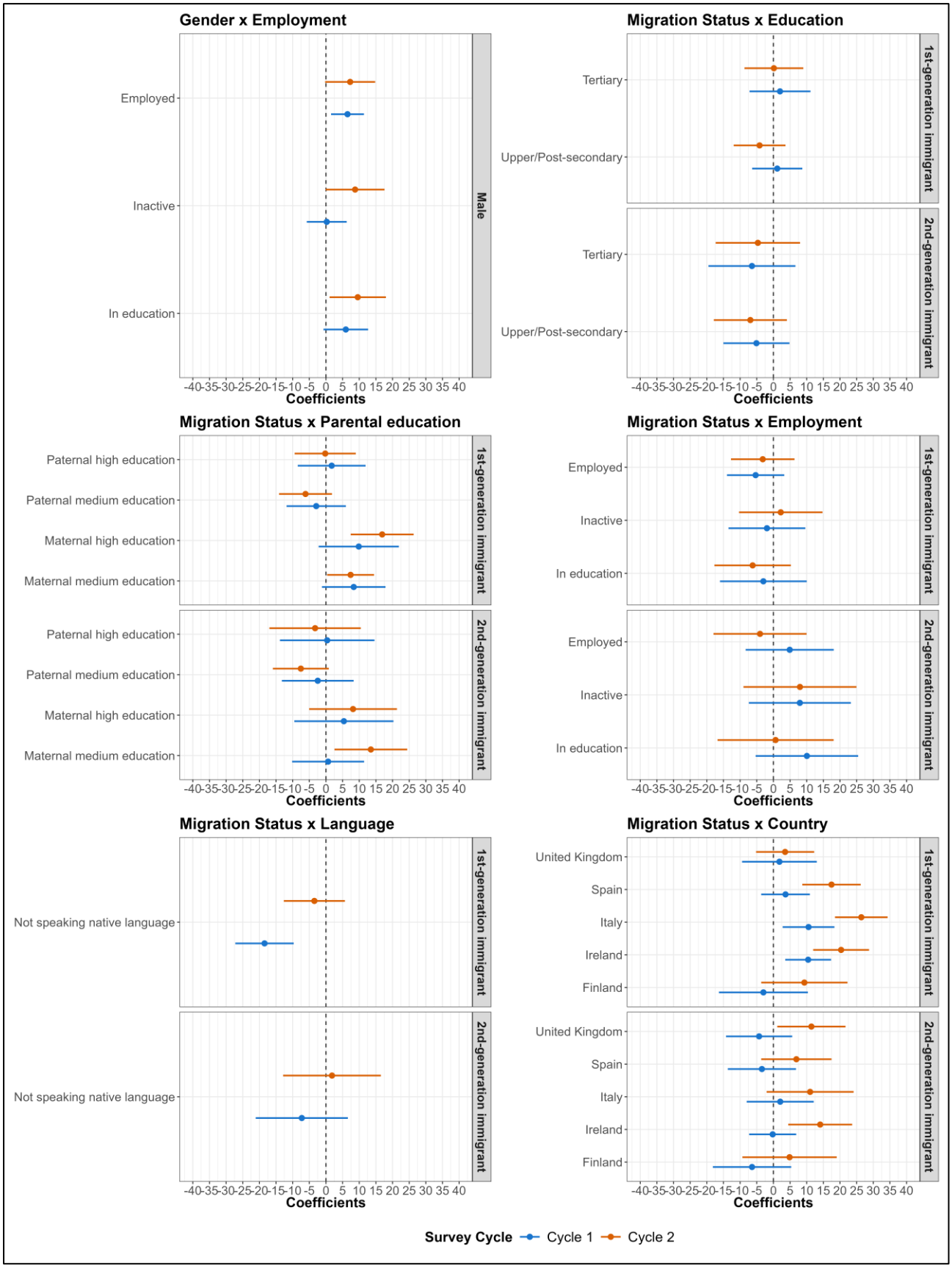
Relative to unemployment, the gap between natives and the two generations of immigrants stays roughly the same when individuals in education, inactivity and employment are considered.

Regarding the language barrier, not speaking the test language widens the gap across generations. This is significantly pronounced for the gap between G1 immigrants and natives in Cycle 1, with an expansion of 18.5 points. Additionally, this result means 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 particularly an obstacle for the first generation. The negative effect decreases over time for both gaps.

The last observation concerns the differences in the gap between the countries under study. In the first cycle, Italy and Ireland are the only countries to reveal a significant decrease in the gap between G1 and natives, by 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 first generation, 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. Relatively, in these countries, G2 immigrants score 6.2, 3.5 and 3.1 points less than natives.

Figure 14. Interactions - OLS regression on literacy scores by generation of immigrants. Cycle 1 vs Cycle 2. (Reference: 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)



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.

5.2.3 – Numeracy main effects

Having examined the output of the survey-weighted linear regression on literacy plausible values, the chapter proceeds with the analysis of the second domain, numeracy. Table 3 illustrates the estimates. The intercept and the effect of migrant status that determines the migrant-native gap under study have a lower intensity compared to literacy. 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 scored averagely 229.2 points in Cycle 1, all other regressors being at their base level. The numeracy skill gap between immigrants and natives, when all the regressors are controlled for, is nearly the same as for literacy with immigrants performing worse than their native counterparts by 10.3 points (about 2.0 points less than in literacy).

Regarding education, the upward trend with increasing educational level discussed in the context of literacy is observed for numeracy skills. Tertiary-educated individuals score significantly 43.8 points higher than those with lower secondary education and less and about 20 points higher than those with upper/post-secondary education. The qualification of both parents affects positively their children's numeracy performance to a similar extent (about 11.0 higher for those with high-educated parents).

Conversely to literacy where gender did not have a statistically significant and wide effect, Table 3 reveals a particularly significant advantage for men in numeracy scores by 10.8 points, in opposition to their female counterparts, although this discrepancy will be almost completely absorbed when interaction terms are included (Appendix, Section 10.3). An anomalous pattern in comparison with literacy concerns age. The previously significant and wide discrepancy between the youngest and the oldest age groups no longer is. Instead, the gap between the youngest age group and the clustered 25-44 one gained significance with better numeracy results for the latter by about 8.0 points.

Country of highest qualification, language proficiency and employment status report similar results to literacy regression. 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 who have no proficiency in the language of the test underperform 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 deriving from employment is more pronounced for numeracy (12.1 vs 8.0 for literacy).

Shifting the focus to the countries under study, a further difference from the regression on plausible literacy values is observed. The leading position of Finland is no longer significant and wide, and the coefficient for United Kingdom increased in significance and in negative direction. The latter, along with the remaining countries, reports a low performance relative to the reference country, Belgium. Spain has the worst results (20.0 lower than Belgium), followed by Ireland (-18.1), United Kingdom (-15.5) and Italy (-14.7).

The information about birth regions does reduce the significance and magnitude of the migrant-native numeracy skill gap that is almost absent in the new model. All other effects remained stable. As for the additional independent variable, the disadvantage for Arab States, South and West Asia, Latin America and the Caribbean, Sub-Saharan Africa, Central and Eastern Europe resembles the results for literacy, with worst-performing individuals born in South and West Asia (-44.6) and Sub-Saharan Africa (-20.8).

Addressing Cycle 2 and the evolution of the effects on numeracy scores over time, the reference group scored averagely 224.7 points, meaning slightly lower than Cycle 1. The migrant-native gap is nearly confirmed with a disadvantage of 9.6 points for the immigrant subpopulation. Education maintains its strong role in contributing to greater numeracy skills, with an increasing benefit when maternal education is considered (from 11.6 to 19.5 between high- and low-educated) and a decreasing benefit when paternal education is considered (from 11.1 to 6.3). This reversed outcome by the second cycle already emerged in the literacy regression. Additionally, along with being in education and employment, being inactive results to be more advantageous than being unemployed by 10.4 points, with strong significance.

Gender confirms its significance and the male outperformance. On the contrary, age loses significance across the groups and resembles more literacy patterns with worsening results at older ages.

Moreover, having received 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 shown in the first cycle but with a reduced intensity (from 15.3 to 10.8), compared to literacy.

One last observation concerns the country of the interview. In Cycle 2, Finland regained the best performance, similarly to literacy, with a statistically significant coefficient of 11.9. United Kingdom underwent progress, despite still scoring less than Belgium (-9.1), whereas all other countries confirm

the results in the first cycle. As noted above, the inclusion of birth regions explains the loss of significance for migrant status. As for the other regressors, the only differences are in the country of highest qualification and proficiency in the test language. The former shows a reduction in the disadvantage deriving from a non-OECD educational system and, slightly, in the significance (from -21.7 to -11.1), all other things being constant. This occurs for the language variable and more intensively. The negative impact of not knowing the test language is narrower and non-significant (from -10.8 to 4.5). Focusing on the role of the birth region, the results in South and West Asia and Sub-Saharan Africa, with the worst performance in Cycle 1 and across all previous models, slightly improved by Cycle 2. Although not significant and certain, an interesting pattern is experienced by individuals born in the Arab States as they underwent a noticeable improvement over time, going from 26.7 points less than those born in Northern America and Western America to 9.9 less.

Table 3. Main effects - OLS regression on numeracy scores. Cycle 1 vs Cycle 2.
(Reference: 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)

	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

The model in Section 5.2.3 provided insights on the numeracy skill gap between the native and the immigrant subpopulations. Nevertheless, as explored for the literacy domain, the immigrant subpopulation aggregates within itself, in turn, two big subgroups, first-generation and second-generation immigrants. As discussed for the literacy models, the distinction between the two generations causes a considerable decrease in the sample size, leading to less certain results when the gap is examined. Therefore, the significance of the effect of migration status on numeracy scores, i.e. what indicates the migrant-native numeracy skill gap, falls entirely into the first generation, due to the small size of the second generation when all the predictors are taken into account. In other words, as reported in Table 4, in Cycle 1, while G1 immigrants significantly scored 15.1 points lower than natives, the coefficient for G2 is not significant. However, the small disadvantage (-1.1) nearly aligns with the concept of convergence between the relative patterns of natives and G2 immigrants, as a consequence of being raised in the same country, social and educational environment, discussed earlier in the literature. On the contrary, the first generation confirms the most pronounced disadvantage due to greater differences and challenges during the integration process, explaining the wide overall gap between natives and immigrants in Table 3.

Despite the non-significance of the second generation, all other coefficients are stable from Table 3 to Table 4 with all other effects maintaining similar magnitude and direction. Comparing the results with literacy models, the reference group averagely scored worse in numeracy than in literacy with 228.6 points in the former.

Cycle 2 presents differences from Cycle 1 in the context of numeracy, like in the overall model in Table 3. The gap between natives and first-generation immigrants narrows by about 2.0 points significantly, whereas the gap with the second generation widens by about 3.0 points, though not significantly. On the contrary, in literacy, the second gap narrowed approaching zero. Additionally, in the column with the information on birth region, an unexpected result is the increase in significance for the gap between second-generation immigrants and natives, with the former scoring 5.3 points less (downward trend from Cycle 1).

Given the analogous pattern across cycles, the focus shifts on the main discrepancies. Among these, age totally loses its significance in each group. Similarly to literacy, conversely to the advantage of individuals aged 25-44 on those aged 16-24 in Cycle 1, in the second cycle, the performance deteriorates with age, despite being non-significant in numeracy.

Moving to 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, following the earlier models.

As anticipated above, the coefficient for Finland considerably gains significance in the second cycle revealing an average score of 12.1 points higher than Belgium. Furthermore, the gap between the United Kingdom and Belgium narrowed with individuals living in the UK scoring better points than Cycle 1. Additionally, Spain also underwent an improvement by about 3.0 points, surpassed by Italy and, mainly, Ireland in low performance.

As for the differences in origins, the worst-performing South and West Asia and Sub-Saharan Africa experienced little progress, conversely to these two regions from Cycle 1 to Cycle 2 in literacy. Along with these two regions, the Arab States achieved better points than in the first cycle, with individuals scoring 14.2 points lower than those born in Northern America and Western Europe (about 12.0 points better than 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 in Belgium, aged 16-24 with both low-educated parents, with proficiency in the test language and 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.

5.2.4 – Numeracy interactions

Shifting the focus to the model with main effects and interactions, the plots in Figure 15 report the interaction coefficients and confidence intervals for numeracy. Like with literacy, this model does not consider the impact of birth region. Additionally, the migration variable loses significance in Cycle 1 and, similarly, the interaction effects are mostly non-significant in both cycles. According to the intercept, the reference group, consisting in low-educated unemployed female Belgian natives aged 16-24 with low-educated parents, proficiency in the test language who attained their highest qualification in an OECD-country, score averagely 234.1 in Cycle 1 to 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, when all other regressors are held constant, in the first cycle. In Cycle 2, the gap widens considerably reaching a statistically significant disadvantage of 21.9 points for immigrants.

As for literacy, the main effects can be observed in detail in the Appendix (Table 10.3.6). The main difference from the model with main effects only concerns gender which effect narrowed and lost significance in both cycles. To deepen this effect, the interaction between gender and employment status was integrated, resulting in more significant results. Overall, the outperformance of men is confirmed across categories. In other words, the male advantage increases if individuals in education, inactivity and employment are considered, by respectively 10.2, 7.5, 11.0 in Cycle 1 and 9.2, 12.5, 10.0 in Cycle 2. Focusing on the most significant coefficients and summing the main effects to the interactions, men in education score (+2.1) + (+10.2) = 12.2 points higher than women in education in the first cycle and (+2.5) + (+9.2) = 11.7 higher in the second cycle. As for employment, employed men score (+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 over time, yet moderately.

Moving to education, 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. Summing the main effect of education and the interaction, immigrants' performance improves with higher levels of education. Nevertheless, taken together, the benefit is stronger for natives, and the gap widens at higher levels of education with a peak at upper/post-secondary education. When the parental education is considered, the mother's highest qualification is the most impactful and significant, especially in the second cycle, like for literacy. Maternal education is beneficial for both subgroups. The gap narrows at higher levels of the mother's education. Focusing on the significant estimates of Cycle 2, immigrants with medium-educated mother score (-

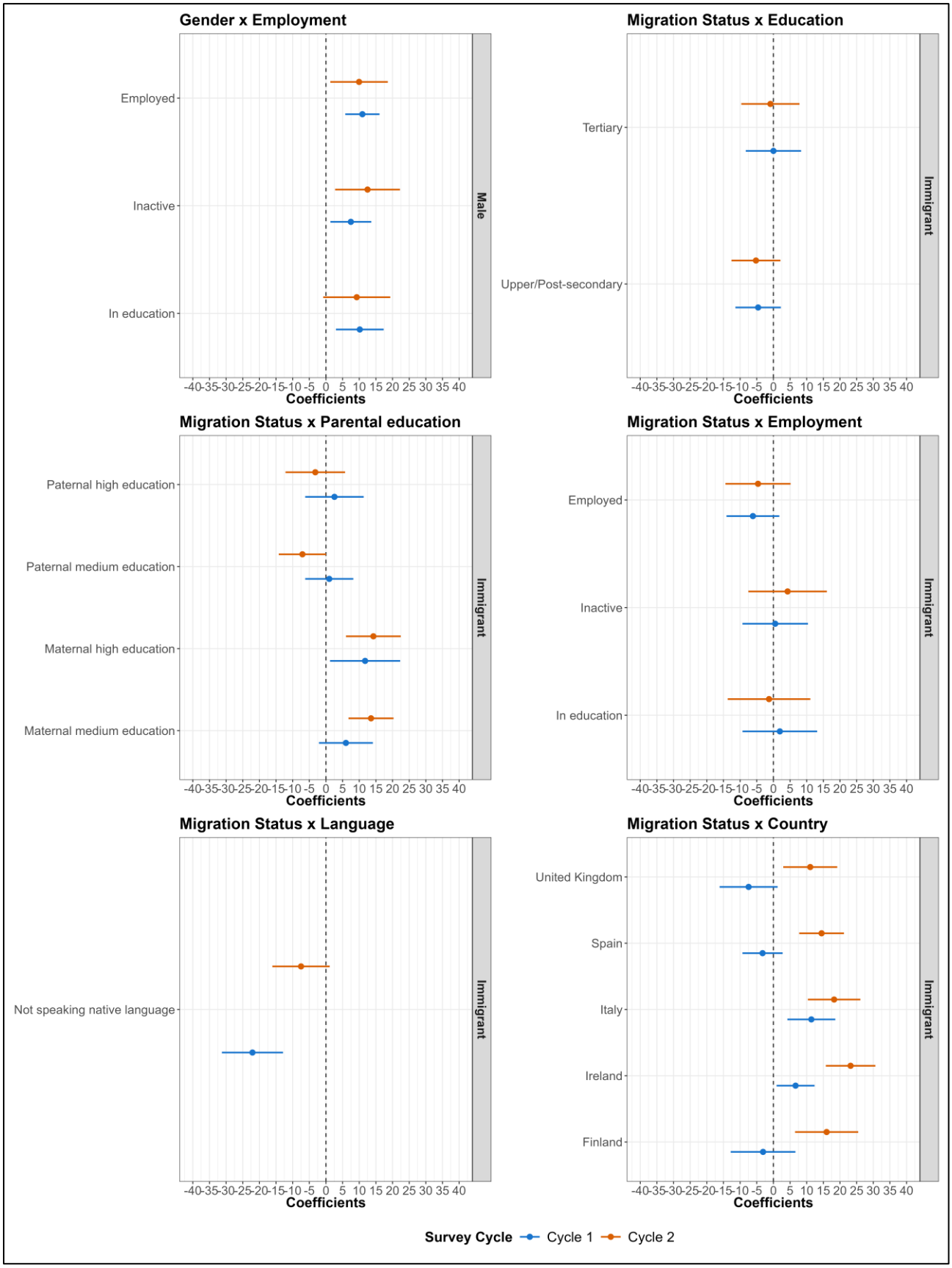
21.9) + (+13.5) = -8.4 points lower than natives with medium-educated mother. Immigrants with high-educated mother score (-21.9) + (+14.2) = -7.7 lower than natives with high-educated mothers. This suggests that, anew, parental education contributes to better performance among natives and immigrants. However, the latter still experience a disadvantage, more pronounced at the medium level.

Concerning employment status, the strongest effects derive from employment which slightly widens the gap relative to unemployment. In particular, employed immigrants averagely 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. Natives are increasingly more advantaged than immigrants over time.

Focusing on language, the barrier of not speaking the test language is significant only in the first cycle with an increased gap between immigrants and natives who do not have proficiency in the language by 22.1, similarly to literacy. Among individuals with no proficiency in the test language, immigrants score (-6.0) + (-22.1) = -28.1 less than natives in Cycle 1. Although not significantly, the coefficient in Cycle 2 confirms the direction of the effect and the interpretation and suggests a smaller barrier.

Lastly, the gap in numeracy varies cross-nationally. Relative to Belgium, the gap particularly decreases in Finland, Ireland, Italy, Spain and United Kingdom in Cycle 2. Ireland is the only country with a slight immigrant advantage (+1.3). Conversely, in the United Kingdom, immigrants score 10.8 points lower than natives, followed by Spain (7.4 points less), Finland (5.9 points less) and Italy (3.7 points less).

Figure 15. Interactions - OLS regression on numeracy scores. Cycle 1 vs Cycle 2.
(Reference: 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)



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

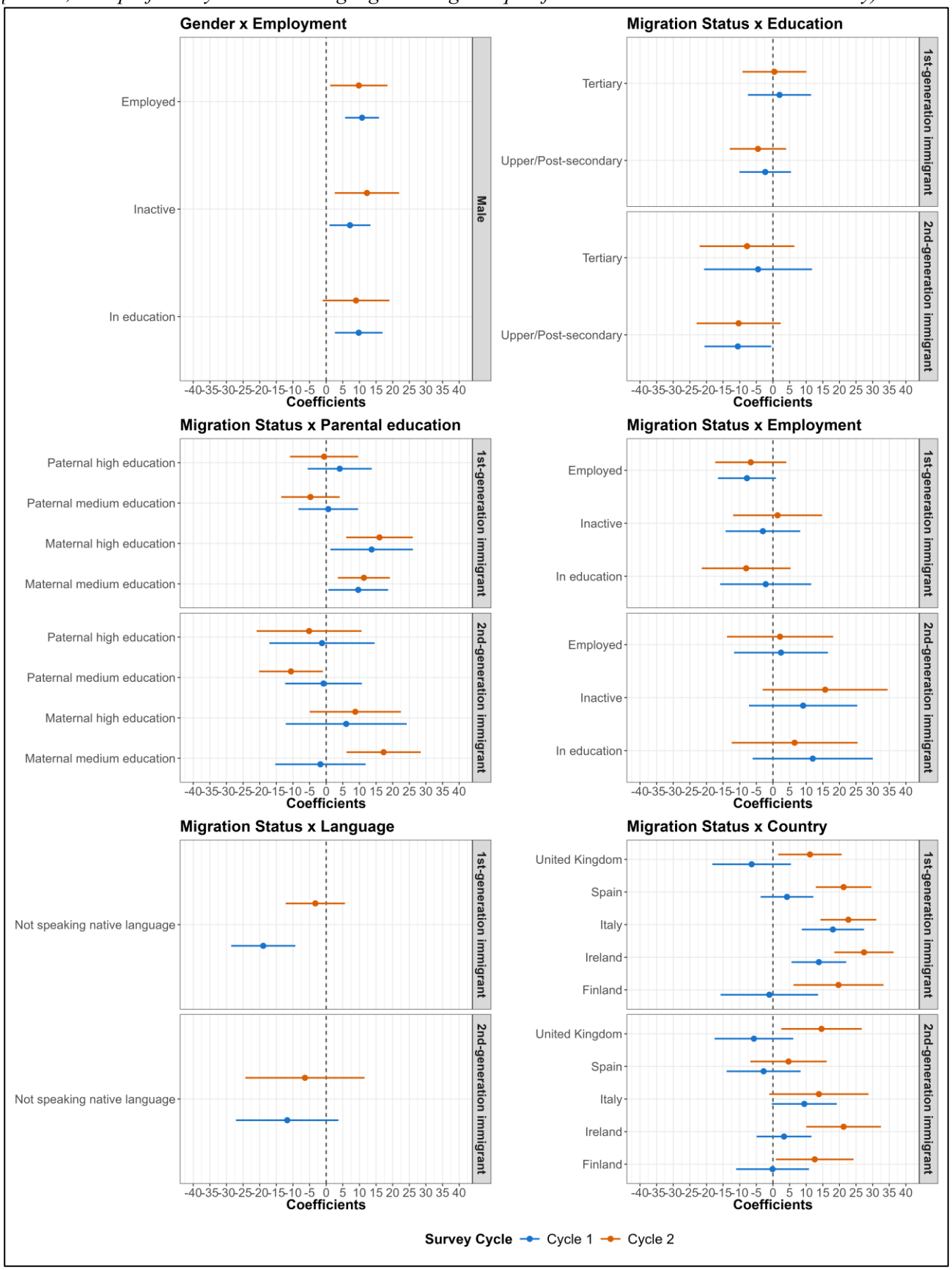
Once the interaction terms are integrated into the model with main effects only and without the birth region detail by generation of immigrants, similarly to literacy, both generations of immigrants confirm the disadvantage relative to natives. In Cycle 1, conversely to the moderate magnitude and no significance of the second generation, the first generation scores significantly 16.3 points, in Cycle 1, and 24.2 points, in Cycle 2, lower than natives (Appendix, Table 10.3.8). Regardless of the significance, both magnitude and direction support the idea of second generation and natives converging in their trends, both outperforming the first generation. Nevertheless, in Cycle 2, although not significantly, second-generation immigrants also score averagely 16.8 points lower.

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

Focusing on the effectiveness of speaking the test language, both gaps between G1 immigrants and natives and between G2 immigrants and natives expand among non-proficient individuals, by 18.9, significantly, 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. Interpreting the within category perspective, first-generation immigrants are the most disadvantaged group.

Lastly, the differences in the gap between countries are aligned with literacy results. In Cycle 1, the cross-national gap does not report significant differences compared to Belgium. In Cycle 2, all countries witness a narrowing trend in their gaps compared to Belgium. The biggest change is with Ireland by 27.4 for the first generation and by 21.3 for the second, followed by Italy by, respectively, 22.7 and 13.8, Spain by 21.3 and 4.7, Finland by 19.7 and 12.6 and UK by 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 of a G2-immigrant advantage. Lastly, in UK and Finland with G1 immigrants scoring, respectively, (-29.6) + (+11.1) = -18.5 and (-29.6) + (+19.7) = -9.9 points lower than natives, report the widest gap between first-generation immigrants and 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 in Belgium, aged 16-24 with both low-educated parents, with proficiency in the test language and 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 – France-specific regression

The regression analysis above enables us to explore the migrant-native skills gap over time. The country variable provides insights on how the country impacts on the average score and how the gap between the two subpopulations varies across countries. Due to discrepancies in the replication methods, France and Germany were decided to work on separately by implementing country-specific linear regressions. Particularly, since modelling for Germany encountered data unavailability, France was selected as specific example to assess the evolution of the gap and the effects of individual predictors on skills over time more precisely. Detailed regression outputs by generation of immigrants in France are illustrated in Section 10.3 of the Appendix to ensure a complete and transparent documentation., together with all the Germany-specific tables that are not discussed in the text.

5.2.5.1 – Literacy

Table 5 reports the outcomes of the survey-weighted linear regression on literacy plausible values in France. First, the reference group – low-educated unemployed native women aged 16-24, with low-educated parents, highest qualification attained in an OECD country, speaking the test language – scored averagely 236.0 points in Cycle 1 and 232.2 in Cycle 2, if birth region is not included in the model and if all other predictors are at their base level. The gap in this country adjusted for the other predictors sees the immigrant population at a disadvantage confirming 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 skills at higher levels of education. More specifically, tertiary education provides a benefit of about 50.0 points compared to lower secondary education and less in both Cycles. At a lower magnitude and same direction, parental education has a significant impact. Overall, the highlighted trend of a decreasing positive effect of the father's education and an increasing positive effect of the mother's education in the models across countries is confirmed for France.

The gender effect is not significant and the discrepancy between women's and men's skills is moderate with a little disadvantage for the latter in Cycle 2. As for age, the deteriorating pattern with age is confirmed, reaching 11.3 and 16.8 points less for individuals aged 55-65 relative to those aged 16-24 in, respectively, Cycle 1 and Cycle 2.

Table 5. France: Main effects - OLS regression on literacy scores. Cycle 1 vs Cycle 2.
(Reference: 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)

	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.

Having attained the highest qualification in an OECD country benefited individuals increasingly over time, shifting from 30.1 points higher than having attained it in a non-OECD country 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 are particularly significant.

With regard to employment status, while in the models across countries employment was also beneficial and significant, in the France-specific model being in education has the strongest effect, contributing to 22.3 points more than those unemployed in Cycle 1 and 19.2 in Cycle 2.

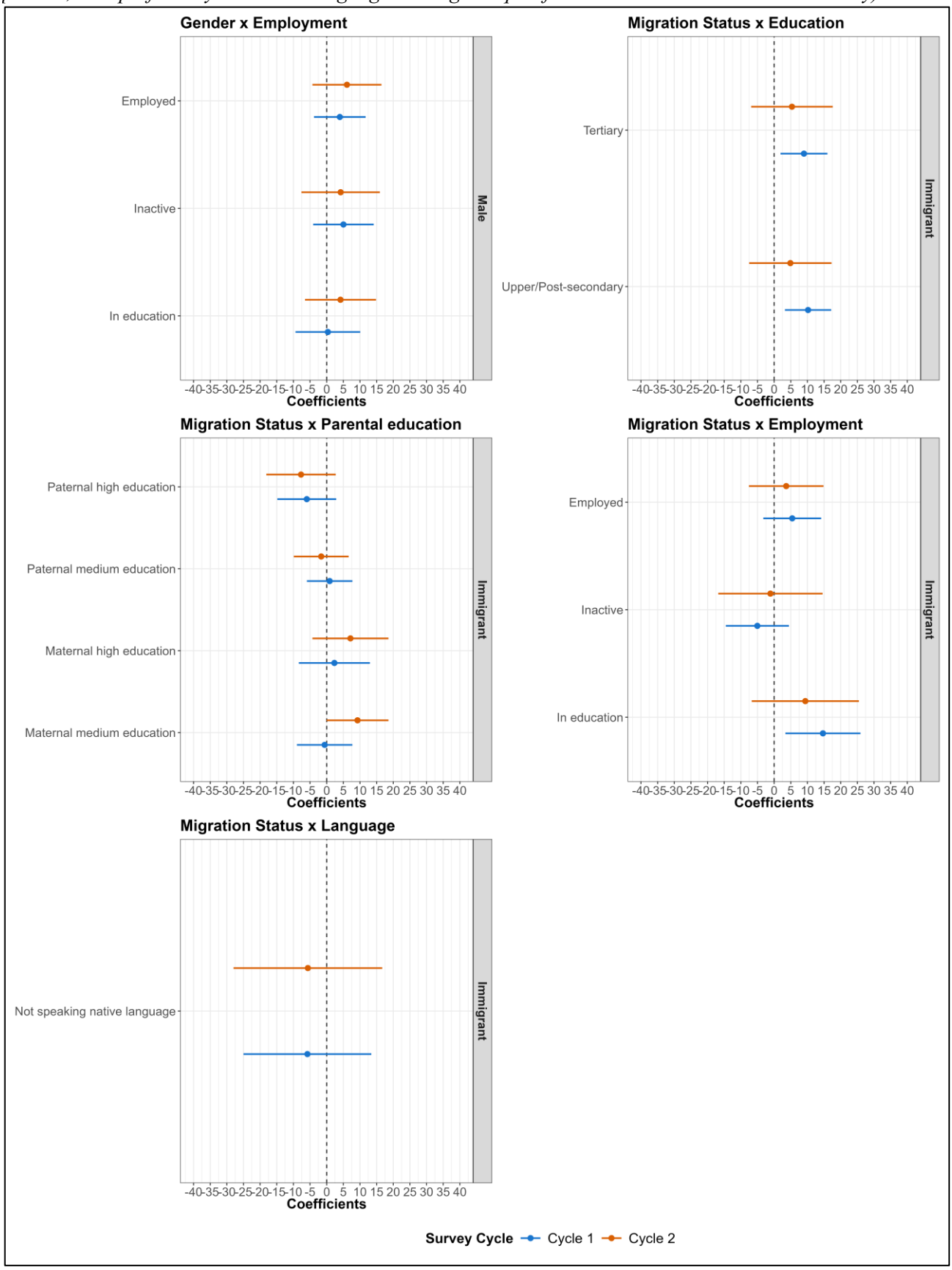
Lastly, the model with birth region reveals different patterns from previous models. More specifically, in the first cycle, Central and Eastern Europe, followed by poorer countries in east Asia and Pacific and Sub-Saharan Africa have the worst performance. However, the most critical performance returns to South and West Asia and Sub-Saharan Africa by the second cycle.

In the France-specific regression, the inclusion of interactions leads to higher average score among the reference group of low-educated unemployed female natives aged 16-24 with low-educated parents, proficiency in the test language and highest qualification in an OECD-country. More specifically, this group scores 241.3 in Cycle 1 and 238.3 in Cycle 2, all other regressors being at their baseline. Focusing on the actual literacy gap between immigrants and natives in France, immigrants significantly score 18.5 points less than their native counterparts, all other things being equal. Although not significantly, similar pattern is consistent in Cycle 2 with an immigrant disadvantage of 15.7. As done for the cross-national models with interactions, the focus will be on the interaction effects, illustrated in Figure 17. Little effects are statistically significant, meaning that the migrant-native gap does not vary across levels of the control variables. This is consistent with cross-national models.

First, education does not play a strong role in widening or narrowing the gap across educational levels. Nonetheless, the magnitude of the effect and its weak significance, particularly for Cycle 1, reveal a decrease in the gap when higher-educated immigrants and natives are compared. As for parental education, the effectiveness of both parents' qualifications lacks significance, meaning little evidence of variations in the gap. Nevertheless, in Cycle 2, the magnitude of maternal education suggests a narrowing gap at higher levels. conversely to paternal education. With regard now to employment status, with weak significance, education confirms narrowing 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 undergo considerable change from the gap among unemployed.

Given the non-significance of the language effect, it is not possible to directly and strongly reach a conclusion. Nonetheless, the results are consistent with the disadvantage discussed in literature and in previous interpretations.

Figure 17. France: Interactions - OLS regression on literacy scores. Cycle 1 vs Cycle 2.
(Reference: 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)



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.

5.2.5.2 - Numeracy

Having explored the literacy regression output, the focus shifts now to the numeracy regression output shown in Table 6. The patterns across countries are nearly confirmed. In Cycle 1 and Cycle 2, the overall average score among the reference group is respectively 210.6 and 217.7, lower than literacy. An interesting difference from the cross-national models is that the immigrant literacy disadvantage was wider than the immigrant numeracy disadvantage in Cycle 1 and slightly narrower in Cycle 2, whereas in the single case of France immigrants experience higher disadvantage in numeracy skills 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 of a more rapid improvement in the migrant-native literacy skill gap over time observed in the cross-national models, in opposition to a slower pace in numeracy, is validated through the case of France.

The positive effect of the respondent's and the parents' education is stronger for numeracy, especially the former, similarly to previous models. As for gender, the advantage for men who score higher than 12.0 points in both cycles recalls the numeracy models across countries.

Regarding where the respondents attained their highest qualification, literacy and numeracy follows similar patterns, showing a negative impact on the average score of about 30.0 points in Cycle 1 that worsens by Cycle 2. Conversely, the disadvantage of not speaking French (test language) narrows over time shifting from 27.0 points scored less than those with French proficiency in Cycle 1 to 10.8 points less in Cycle 2. This progress appears to be more pronounced for numeracy than literacy.

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

Lastly, when the information on birth region was included, Cycle 1 presented lower results among 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 in South and West Asia and Sub-Saharan Africa.

Table 6. France: Main effects - OLS regression on numeracy scores. Cycle 1 vs Cycle 2. (Reference: 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)

	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.

In the regression on numeracy plausible values in France with both main effects and interactions, the migration variable, meaning the gap between immigrants and natives, maintains solid significance. Immigrants scored 24.0 points less than natives in Cycle 1 and 19.0 points less in Cycle 2, holding all other regressors constant. Furthermore, the gap is more pronounced in the model with interactions, compared to the ones with main effects only.

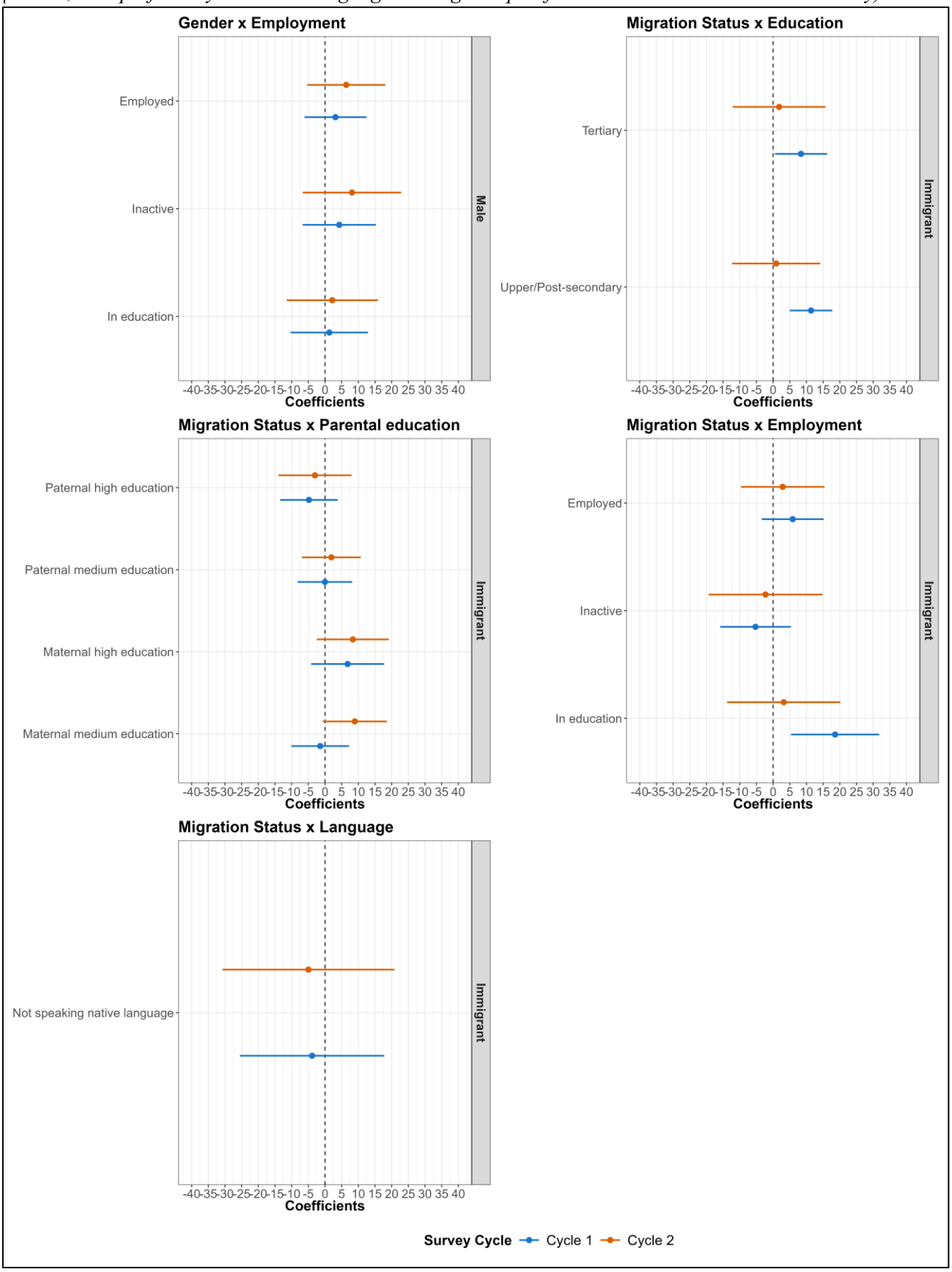
Figure 18 reports the interaction coefficients. An interesting result concerns the impact of education on the migrant-native gap. The significant coefficient of 11.4 for upper/post-secondary education in Cycle 1 indicates a noticeable decrease in the gap, relative to the gap at lower secondary level and less. A decrease occurs at the tertiary level, although to a lesser extent (8.4). Conversely, Cycle 2 shows little and non-significant change from lower education.

As for employment status, education confirms the positive effect in narrowing the gap with natives outperforming in Cycle 1. As for employment and inactivity, no significant change from a situation of unemployment is observed. Similarly, both non-significance and small size 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 generation of immigrants are illustrated in the Appendix (Section 10.3), as the patterns resemble overall the broader perspective of migrant-native skill gap and the cross-national models which are the focus of the study. Generally, like the cross-national models, the inclusion of the intergenerational detail undermines the significance of migration status, resulting in a strongly significant effect of being first-generation immigrant and a non-significant effect, in literacy, and weakly significant effect, in numeracy, of being second-generation immigrant. The wide gap between natives and first-generation immigrants and the convergence between natives and second-generation immigrants is confirmed by the France-specific outcome, despite a considerable gap for both in Cycle 2.

In literacy, when the interaction terms are incorporated, the main effect of migration background reveals a disadvantage of 30.5 points in Cycle 1 and 24.3 in Cycle 2 for first-generation immigrants and a disadvantage of 5.0 in Cycle 1 and 13.5 in Cycle 2 for second-generation immigrants. In numeracy, the first generation of immigrants scored 36.5, in Cycle 1, and 22.9, in Cycle 2, points less than natives, whereas the second scored 9.0 and 20.8 points less than natives. A further interpretation is that first-generation immigrants experience an improvement over time, compared to second-generation immigrants.

Figure 18. France: Interactions - OLS regression on numeracy scores. Cycle 1 vs Cycle 2. (Reference: 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)



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

Both literacy and numeracy interaction coefficients have weak or no statistical significance, recalling previous models. Two are the exceptions. First, among upper-/post-secondary-educated individuals, the gap between G1 immigrants and natives becomes smaller, relative to low secondary education and less. 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.

6. DISCUSSION

6.1 DESCRIPTIVE RESULTS

Taking all results together, this thesis provides support to existing evidence. It embeds previous findings with an innovative perspective, extending the analysis to recent years (two survey cycles) and to a wider range of individuals aged 16-64. The descriptive analysis illustrates important insights reflecting the past dynamics of immigration to European countries. It sheds light on the socio-demographic composition and human capital of immigrants in comparison to natives allowing the comprehension of migration itself and the origin of the migrant-native gap before it becomes skill-related. Further, the analysis narrows the focus on the skills gap in numeracy and literacy test scores providing a comprehensive overview of it and change over time. In sum, 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). Nevertheless, before discussing the perspective by generation of immigrants, it is necessary to explore the trends that characterize the overall immigrant population and its comparison to the native.

In the context of skills, figures in Section 5.1 of Chapter 5 show that 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 United Kingdom, in opposition to an improvement in immigrants' performance in Finland and 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 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 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 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. Therefore, the analysis in this work incorporates a cross-temporal perspective which may help investigate the evolution of skills and their drivers and, hence, intervene on the gap.

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. Not only is a purpose of it to highlight the skill discrepancy between first- and second-generation immigrants but also how differently the skills of these two generations are in comparison to natives. Overall, 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.

6.2 REGRESSION RESULTS

The survey-weighted regression on literacy and numeracy plausible values aims to explore 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. The regression analysis recalls the approach used by OECD in terms of examining and comparing the unadjusted and adjusted gaps (2024). The main difference in approaches consists in investigating the cross-national discrepancies within one model, instead of implementing each country-specific model, along with the inclusion of interactions. 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. Once the gap is assessed, the interaction terms provide insights on how a specific predictor, such as own education, parental education, employment status, proficiency in the test language and country of the interview, influences the gap itself. Despite the non-consistent significance across the interaction effects, it is relevant to interpret and discuss the coefficients.

Before including the non-significant interaction effects, the models with main effects only reveal insightful and statistically significant results. The first research question addressed in this work is "What is the skills gap between immigrants and natives starting from literacy and numeracy skills in European destination countries?". This question can be rephrased as "Does a gap between immigrants' and natives' skills exist?". The descriptive analysis already shed light on an actual difference between these two groups, when either literacy and numeracy scores and levels are considered. To confirm or reject the descriptive results, the regression models represent solid support to the former. Considering the descriptive charts and regression tables together, a skills gap between immigrants and natives does exist. Additionally, the migrant-native skills gap depends on the domain and varies over time, from Cycle 1 to Cycle 2. Nevertheless, these changes are not consistently substantial, and the main patterns are nearly confirmed across both domains and cycles. On the whole, 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 cross-national 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 still positive. Once the disaggregation of immigrant population by generation is included, the gap between first-generation immigrants 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). In addition to this, the literacy gap narrows over time for both generations. Conversely, the numeracy gap narrows for the first generation and widens, though not significantly, for the second generation, from Cycle 1 to Cycle 2. Overall, like the broad models, the literacy gap is wider than the numeracy gap.

From each regression model, regardless of the skill domain, the cycle or the subpopulation under study, all results emphasize education and its leading role 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 et al., 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 et al. (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). Regarding age, insightful results that differ across domains and cycles are observed. 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, 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 results. 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. More specifically, 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 contrasts the result in the descriptive analysis of a narrowing numeracy proficiency gap in Finland and 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 first-generation immigrants and natives is considered. Regarding the gap between natives and second-generation immigrants, 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.

Focusing on education, little change occurs from low secondary education and less to tertiary education. Combining the direction of the coefficients and the descriptive charts, both immigrants and natives benefit from education, meaning that these subgroups score higher at higher levels of education. Nevertheless, immigrants score generally lower at each level. Despite this conclusion, education reveals the strongest positive effect on the determination of skills observed in the main effect. Parental education has a more pronounced role in determining the gap, especially in the case of numeracy and the mother's highest qualification. 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.

Shifting the focus on employment status, education and employment results to have a strong positive effect 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.

Lastly, in Cycle 1, Finland, Spain and 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, 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. United Kingdom presents the widest gap, followed by Spain and then, Finland. Taken together, Finland, Spain and 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.

When the generation detail is considered, most trends are consistent across domains. The most relevant results are discussed. First, the significant coefficient of maternal education confirms its positive impact qualifications that expands by Cycle 2 for both generations of immigrants and domains. Regarding employment status, both literacy and numeracy are characterized by a negative effect of being in education for the gap between natives and G1 immigrants and a positive effect for the gap with G2 immigrants. Both effects experience a deteriorating trend from Cycle 1 to Cycle 2, expanding the gap. Furthermore, employment has a similar effect to education, by widening the gap with the first generation and narrowing the one with the second generation, except for the reversed trend for the latter in literacy by Cycle 2.

As for the language barrier, 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, the cross-national trends between literacy and numeracy do not particularly differ. Over time, a significant improvement for both gaps (with first and second generation) occurs across all countries, compared to Belgium. Italy, followed less significantly by Ireland and Spain, presents the most noticeable improvement in the gap, relative to Belgium, across domains and cycles. Strong evidence

of this result occurs for the gap between G1 immigrants and natives. 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 first-generation immigrants. The base models for both literacy and numeracy, meaning the models with migration variable only, displayed in the Appendix (Section 10.3), 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 first-generation immigrants, 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. As shown in Figure 4, immigrants in Ireland are mostly high educated, compared to other countries under study. Conversely to other countries and the widely discussed disadvantage of first-generation immigrants relative to second-generation immigrants, in this country, the first generation shows greater shares at higher educational levels. 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 challenging obstacles. Starting from the various definitions that develop around this demographic phenomenon, it is challenging to include representative samples of immigrant population in sample 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 the respondents are confronted with. As previously mentioned, 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 under pressure or may fear the level of difficulty, leading them to a non-response. In addition to this, the 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. Immigrant individuals, particularly the first generation, are disadvantaged and the lack of language proficiency often do not allow them to go through the background questions and, subsequently, through the literacy and numeracy tasks. The non-response bias is defined as the result of a discrepancy between individuals who decide to take part in the survey and individuals who do not. The outcome is a sample that does not represent correctly the target population, complicating the interpretation of the latter and its patterns. In other words, the immigrant population and its subgroups risk to be over- or under-represented. This limitation was mainly an issue 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, Belgium (only the Flemish region) revealed over 5.0% of adults not participating, similarly 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 the so-called doorstep interview for those with language barriers. This section of the survey consists of self-administered questions in 43 different languages about socio-demographic background information of the respondents, such as age, gender and education. From these answers, it was possible to make estimations about the skills of the respondents.

Overall, many new tools and improvements were implemented in the second cycle, to considerably reduce the risk of non-response bias. Nevertheless, in this work, the limitation persists given the cross-time perspective, i.e. the comparison between the first and the second cycles. 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, in this work, doorstep-

interview variables were not considered. The already missing observations from Cycle 1 due to non-response and the excluded observations who answered to the doorstep interview in Cycle 2 with the purpose of harmonizing and comparing the two cycles explain the small size of the immigrant sample. The sample size reduces as various dimensions are included. In addition to the non-response bias, the samples under study in this thesis are small due to scarce data availability from European country to European country. 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 the variables, limiting the study to less perspectives than originally planned. PIAAC Public-Use Files are prepared for, as the name itself clarify, public uses. Therefore, these files are strictly anonymized, explaining the noticeable missing information.

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

The methodological limitations mainly concern two types of incomparability. The first incomparability occurs in the cross-national and within-cycle perspectives of the regression analysis. The discrepancies in the weighting replication methods used across countries under study 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. 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 different scales, it is not possible to compare scores across domains but only within domains. More precisely, it is not possible to state if immigrants perform higher or lower in literacy than in numeracy but solely if, within literacy, they perform higher or lower than natives or than immigrants in a different country or cycle. For this reason, proficiency levels were created, enabling cross-domain

comparisons. Similarly, one of the reasons behind excluding problem-solving skills from the study was the change in the assessment approach from Cycle 1 to Cycle 2. Extending the analysis to problem-solving skills would have incorporated an additional point of view and outcome.

Because of data availability and, more specifically, not all the variables investigated in the survey being public, a selection had to be made. A restricted list of variables may limit the perspective of study. The selection of variables in this work is highly insightful and relevant. Nevertheless, additional variables may support the analysis with interesting perspectives. Among these, for instance, PIAAC survey investigates different perspectives of language proficiency, including the proficiency in native language and the language spoken at home. Nonetheless, most of these variables are not public for all countries under study. Therefore, the interaction between the country of birth and the language was taken into consideration in this work, which may simplify the distinction between natives and immigrants within the linguistic aspect. In future research, it would be interesting to explore the specific effects of all these PIAAC variables on the migrant-native skill gap, to assess, for instance, potential differences in various levels of language proficiency.

Furthermore, the date of arrival and the age of immigration may also provide meaningful details. For instance, the duration of stay can be derived, helping examine the differences between less and more recent immigrants and how the opportunity to develop or utilize skills changes between immigrants and natives over time and with age.

Lastly, PIAAC investigates whether the respondent took or is currently taking part in a training program. This aspect offers insight into the process of development of skills over time, meaning whether training improves cognitive skills or not and how, along with increasing the respondents' access to the labor market and the opportunity of integration. However, training variables were also not available for all the countries under study and, additionally, this aspect is not the primary focus of this thesis.

The complications deriving from data collection and availability represent a markable issue in migration research. It is important to acknowledge these limitations and consistently keep them in mind to execute the analysis and correctly interpret the outcomes. The more improved and precise data and analytical tools are, the easier and better making conclusions about a complex phenomenon like migration will be.

8. CONCLUSIONS

Immigration has a strongly debated impact on both origin and destination countries. In host societies, new arrivals cause fear of not being able to control them and tension deriving from the fusion between individuals with different backgrounds (Rindermann & Thompson, 2014). On the other hand, a proper integration of immigrants into the host society facilitates these individuals' contribution to socioeconomic growth in the sending and receiving countries. A successful integration benefits immigrants by providing them with job opportunities and more favorable standards of living. In turn, home countries benefit from immigrants' remittances and overall economic advancement. Lastly, the host country mainly benefits from the expanded labor force contributing to productivity and an efficient economy.

Given the role that cognitive skills play in guaranteeing immigrants' access to the receiving labor market, this work aim to explore the gap between immigrants' and natives' skills, specifically literacy and numeracy. Not only does a skills gap between the two considerable and diverse subpopulations affect immigrants' work prospects, but it also increases tension within the social and interpersonal context. Once the existence of the gap and its properties have been assessed, measures to narrow it can be advanced, facilitating integration. This work is based on the idea that literacy and numeracy skills can be representative of individuals' abilities to interact with the surrounding social and economic environment (Batalova & Fix, 2015). Using PIAAC data provided by OECD which evaluates the respondent's skills through tasks in addition to a background questionnaire, the purpose of this study was 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 United Kingdom (England only).

The research questions this thesis aimed to answer were: "What is the skills gap between immigrants and natives starting from literacy and numeracy skills in European destination countries?", "How has this gap evolved over time, specifically from Cycle 1 to Cycle 2?", "Is there a difference in pattern when we distinguish between first-generation immigrants and second-generation immigrants?" and "What are the variables that most affect the migrant-native literacy and numeracy skill gap? And how?". Answering the first three questions, first, the results of descriptive and regression analyses confirm the existence of a skills gap between immigrants and natives. 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) who also integrate PISA data. However, the contribution of this thesis to the referred previous studies consists in expanding the target population of the analysis to older ages.

Second, I find a consistent immigrant disadvantage across domains, cycles and countries. Third, focusing on the shifts over time (between two PIAAC cycles) represents the most innovative perspective in the context of skills research promoted by this work. No existing papers were found that address skills and migrant-native skills gap over time. According to the results, immigrants and natives seem to follow similar trends in most countries (the performance of both either improves or deteriorates). Belgium and Germany are the exception to this trend. More specifically, in these two countries, natives' literacy and numeracy scores improve from Cycle 1 to Cycle 2, whereas those of immigrants deteriorate. A fourth result is that, despite the small samples, the disaggregation of immigrants by generation reveals a narrower gap between natives and second-generation immigrants. In other words, while first-generation immigrants report a significantly lower performance in literacy and numeracy than natives, a converging pattern concerns second-generation immigrants and natives in most countries under study, in terms of test outcomes and evolution over time. Once more, these findings recall studies on PISA and PIAAC Cycle 1 that had previously assessed a smaller disadvantage for G2 immigrants compared to G1 and the convergence of their skills with those of their native counterparts (Cathles et al., 2021; Azzolini et al., 2012). These results align with the discussed idea that having been 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, first-generation immigrants tend to experience a more rapid and noticeable progressing evolution from Cycle 1 to Cycle 2, in opposition to a slower pace among natives and second-generation immigrants. Additionally, Ireland reports the narrowest gap with immigrants, particularly the second generation, performing better than natives in numeracy.

The fourth question was mainly addressed through 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 et al. (2008). Nevertheless, existing studies focus on young individuals at school age. This thesis integrates the perspective of education on adults' performance, shedding light on the long-term effect of education in determining skills and 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. The negative effect of having attained the highest qualification in a non-OECD country may be a further explanation for this conclusion, given the differences in educational systems across countries, as previously discussed by Richwine (2022). Moreover, at each educational level, the gap is consistent. This suggests that,

despite the benefit for both immigrants and natives from education, other factors maintain immigrants' performance low. Among these, a relevant influence derives from the linguistic barrier. Not speaking the native language considerably affects individuals' results, confirming patterns explored for PIAAC Cycle 1 and PISA (Cathles et al., 2021). Lastly, along with being in education, employment reduces the gap. In conclusion, policies aimed at narrowing the skills gap between immigrants and natives should address the linguistic barrier, enable immigrants' access to the receiving educational system and labor market, for instance, through 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 that involves 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 migration data collection and in skills measurement is encouraged for promoting more solid and efficient research.

Due to data availability and incomparability, 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, within the European, non-European and global contexts, could be included. Furthermore, the analysis of what affects the gap could be extended to further variables. For instance, throughout this work, the effect of offering a training course to immigrants at the time of entering the receiving country was mentioned. This perspective suggests a central focus of integration policies aimed at optimizing benefits for both immigrants and natives. Additionally, as Levels (2017) discussed, the inclusion of 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. It would have been insightful to include this disaggregation in this thesis to comprehend 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 from either one or both foreign-born parents. Given the impact parents and their background have on children, distinguishing the second generation between those with one foreign-born parent only or both could provide insights into the resulting advantages and disadvantages. For instance, the outcome could emphasize and elucidate the evidence of a linguistic barrier during skill assessment and during the overall integration process.

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

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Use of AI: While writing this thesis, the author used the support of ChatGPT for suggestions on wording, grammar checks and assistance with bugs and certain functions in R. All content is the author's own work.

10. APPENDIX

10.1 Abstract

The integration of immigrants into host societies is a widely debated issue with significant implications for population and economic growth in both sending and receiving countries. Nevertheless, this potential depends on the successful integration of immigrants and their children into the labor market. 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 thesis 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 thesis 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 thesis provides useful insights to inform policies aimed at reducing disparities with natives and promoting development in destination and origin countries.

10.2 Kurzfassung

Die Integration von Einwander:innen in die Aufnahmegesellschaften ist ein viel diskutiertes Thema mit erheblichen Auswirkungen auf das Bevölkerungs- und Wirtschaftswachstum, sowohl in den Herkunfts- als auch in den Aufnahmeländern. Das Potenzial von Migration für Herkunfts- und Ankunftsländer hängt jedoch von der erfolgreichen Integration der Einwander:innen und ihrer Kinder in den Arbeitsmarkt ab. Die Qualifikationsunterschied zwischen Einwander:innen und Einheimischen, einschließlich der Unterschiede in Bezug auf Qualifikationen und Grundkenntnisse, behindert oft die Integration und schränkt die Möglichkeiten der Einwander:innen ein. Anhand von Daten aus dem ersten und zweiten PIAAC-Zyklus untersucht diese Arbeit die Qualifikationsunterschied in europäischen Ländern und konzentriert sich dabei auf deren Fortbestehen, Verringerung oder Ausweitung im Zeitverlauf, sowie zwischen Einwander:innen der ersten und zweiten Generation. Insbesondere befasst sie sich mit Lese-, Schreib- und Rechenkompetenzen als Maßstab für die Teilhabe von Einwander:innen am sozialen und wirtschaftlichen Leben ihres Aufnahmelandes. Diese Arbeit untersucht den Einfluss von Faktoren wie der eigenen Bildung oder der Bildung der Eltern und Sprachbarrieren auf die Lese-, Schreib- und Rechenkompetenzen sowie deren Auswirkungen auf die Kluft zwischen Migrant:innen und Einheimischen. Die Arbeit zeigt, dass eine Kluft zwischen den Kompetenzen von Einwander:innen und Einheimischen besteht, wobei Einwander:innen benachteiligt sind, was bei der ersten Generation stärker ausgeprägt ist und sich bei der zweiten Generation dem Niveau der Einheimischen annähert. Diese Trends variieren jedoch im Laufe der Zeit, je nach Bereich und Land. Diese Arbeit liefert nützliche Erkenntnisse für politische Maßnahmen, die darauf abzielen, die Ungleichheiten gegenüber Einheimischen zu verringern, und die Entwicklung in den Ziel- und Herkunftsländern zu fördern.

10.3 Additional tables

10.3.1 *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

10.3.2 *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)

10.3.2 (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

10.3.3 *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

10.3.4 *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)

10.3.4 (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

10.3.5 *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

10.3.6 *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)

10.3.6 (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

10.3.7 *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

10.3.8 *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)

10.3.8 (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

10.3.9 *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

10.3.10 *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)

10.3.10 (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

10.3.11 *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

10.3.12 *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)

10.3.12 (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

10.3.13 *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

10.3.14 *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

10.3.15 *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

10.3.16 *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)

10.3.16 (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

10.3.17 *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

10.3.18 *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)

10.3.18 (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

10.3.19 *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)

10.3.19 (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

10.3.20 *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)

10.3.20 (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 10.3) 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.