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Abstract

This paper documents the change in educational achievement differences between native and foreign background students between the ages of 10 and 15, as they progress from primary to secondary education. We examine three cohorts of students in a number of Western European and traditional English-speaking immigration countries using combinations of PIRLS, TIMSS and PISA survey data. While the performance of students with mixed parents is not markedly different from native students', foreign background children—both first- and second-generation—exhibit a large achievement gap at age 10 in continental Europe, even when accounting for observable differences in socio-economic characteristics. The gap tends to narrow down by age 15 in reading, but no catching up is observed in mathematics. By contrast, we do not find significant differences between the academic achievements of immigrant children and their native-born peers in traditional immigration countries.

Keywords: Achievement gap, foreign-born students, primary education, secondary education, test scores comparability, Europe, Traditional Immigration Countries, TIMSS, PIRLS, PISA

JEL Code: I24, D63, C14

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1 Introduction

The inflow of migrants over the last decade is rapidly changing classroom compositions in many host countries of Europe, as well as in traditional English-speaking immigration countries. Between 2006 and 2015, the share of 15 years old with a migratory background grew steadily in all OECD countries, driven by country-specific changes in the shares of first- and second-generation migrant children. In particular, second-generation immigrant students accounted for most of these changes in Austria, Luxembourg, Switzerland, New Zealand and the US while first-generation became the fastest growing segment in the UK and Australia. At the same time, Norway, Sweden, and more particularly Ireland, have witnessed a significant increase from both groups (OECD, 2016).

In Europe, many of these children originate from less developed countries and typically grow up in poorly educated households with parents working in low-paid occupations. The unprecedented and poorly controlled influx of asylum seekers over the past few years is likely to further accelerate the changing face of its classrooms. According to recent data, the number of first-time asylum seekers under 14 year old has grown by more than five times between 2010 and 2016, from roughly 53,000 to almost 290,000 (EUROSTAT, 2017). Immigrant children in Europe are up to three times more at risk of living in a poor household than their native counterparts, even among those living with highly educated parents (OECD/EU, 2015a). In many OECD countries, these children are also less likely to attend early childhood (pre-school) programs (OECD/EU, 2015b) despite robust evidence of their benefits on future educational outcomes (Biroli et al., 2017, Klein and Becker, 2017, OECD/EU, 2015b).[1] Moreover, many immigrant children grow up without speaking the host country language at home (Alba et al., 2011), another critical factor of academic success.[2]

It is therefore not surprising that foreign background children in Europe demonstrate lower educational achievement than natives in various assessment tests. This achievement gap – traditionally defined as the difference in average test scores between the children of native-born parents and immigrant children – triggered interest among academics in better understanding the underlining risk factors driving these lackluster educational performances; see recent contributions by Algan et al. (2010), Ammermüller (2013), Cobb-Clark et al. (2012), Dustmann et al. (2012), Hillmert (2013), Krause et al. (2015), Levels et al. (2008), Luedemann and

[1] Evidence suggest that students who attended pre-school programs scored up to 15 percentage points higher in Programme for International Student Assessment (PISA) in countries including the US, France, Israel and Finland (OECD/EU, 2015b).

[2] Recent evidence from PISA data reveals that the existence of a significant language penalty in Luxembourg, Northern Europe, France and Switzerland (OECD/EU, 2015b).

Schwerdt (2013), Schneeweis (2011), Schnepf (2007), Riederer and Verwiebe (2015).

Previous studies have mainly examined the achievement gap of foreign background children in either primary or secondary schools by exploiting available comparative assessment studies such as the Progress in International Reading Literacy Study (PIRLS), the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) data (Ammermüller, 2013, Cobb-Clark et al., 2012, Schneeweis, 2011). At the same time, a few cross-country studies have also explored more explicitly the academic progress of specific student cohorts between primary and secondary schools (Schubert and Becker (2010), Jakubowski and Pokropek (2015)). None of these contributions, however, specifically focused on the scholastic *progress* of foreign background children.

To the best of our knowledge, very little is known about the academic progress of immigrant children as measured by the change in the achievement gap over time ("the achievement-gap change"), which arguably provides a more informative measure of educational progress.[3] This question is particularly relevant given that, over the last decades, many European countries committed significant resources to address the educational needs of economically vulnerable children including foreign background students (see Anderson et al. (2015), Klein and Becker (2017), Riederer and Verwiebe (2015)).

Our study attempts to shed further light on this question by documenting the change in academic disparities between native and immigrant children between the ages of 10 and 15 using synthetic cohort data for twelve Western European countries and three traditional immigration countries. In contrast to Europe, traditional immigration countries actively select their migrants and therefore provide interesting benchmark cases. We address the potential pitfalls of comparing standardized test scores across groups and countries by considering both a cardinal and an ordinal measure of achievement gap. This allows us to assess the sensitivity of standard test score based results to the identifying assumption of cardinal comparability between test scores drawn from independent surveys.

Our findings reveal comparable academic trajectories between immigrant children and their native peers in traditional immigration countries in both reading and mathematics. By contrast, immigrant children in Europe generally exhibit substantially larger achievement gaps in primary school which only narrows down over time in reading. Our results are not sensitive to the measure of achievement gap considered. Perhaps not surprisingly, our results also reveal a great deal of heterogeneity, not only between countries, but also across student cohorts within countries.

[3] Andon et al. (2014) is an exception.

2 Background

A literature closely related to our contribution has explored racial disparities in educational achievement in the US, originally motivated by the resurgence of growing disparities between Black and White children as they progressed from kindergarten to elementary school in the late 1980s, early 1990s. The compositional changes in environmental factors between Black and White children, the reappearance of segregation – not across, but within districts (Fiel, 2013) – and the lower school quality attended by Black students have been identified as important risk factors forging the racial achievement gap in the US (Hanushek and Rivkin, 2006, 2009). By the age of 5, chronic exposure to poverty together with poor home environment account for up to 80 percent of the cognitive gap between Black and White children (Brooks-Gunn et al., 1996). More recent contributions of neuroscience corroborate the hazardous impact of living in poverty on the cognitive development of young children and its long-term impact on language acquisition, memory and socio-emotional processing (Evans and Kim, 2012, Evans and Schamberg, 2009, Maholmes and King, 2012, Noble et al., 2005, 2007, 2015). These findings underscore the importance of inequality of opportunities at birth in shaping cognitive deficits before the start of formal schooling and fostering educational disparities over time and across groups.

Evidence of racial disparities in educational achievement in the US are not confined to Black students. Hispanic children exhibit lower test scores in reading and mathematics upon entering kindergarten compared to both Blacks and Whites (Fryer and Levitt, 2004, Reardon and Galindo, 2009). This is not fully surprising as a large proportion of Hispanic children also face poor environmental factors from a very early age due to weaker socio-economic position. Furthermore, Hispanics arguably form a more heterogeneous group than Blacks, with a large proportion of children with a recent immigration background who often do not speak English at home (Reardon and Galindo, 2009). It is well documented that language capital significantly fosters the academic success of foreign-born children (Dustmann et al., 2012, Entorf and Minoiu, 2005, Strobel, 2016, Vedder and Virta, 2005). This literature identifies the age at migration and enrollment into pre-school programs as key factors which help narrow educational disparities in secondary schools by strengthening the acquisition and command of the host country language of instruction (Ammermüller, 2013, Cobb-Clark et al., 2012, Entorf and Minoiu, 2005, Klein and Becker, 2017, Klein et al., 2014, Schneeweis, 2011, Strobel, 2016).

Interestingly, the academic trajectory of Hispanic children improves throughout kindergarten and grade schools, whereas that of Blacks continues to deteriorate (Fryer and Levitt, 2004, 2006). Overall, the achievement gap between Hispanic and White children narrows significantly during the first two years of elementary school but flattens thereafter (Fryer and Levitt, 2006, Reardon and Galindo, 2009). By contrast, the achievement gap of Black students continues to widen throughout grade school (Fryer and Levitt, 2006, Reardon and Galindo, 2009) revealing the existence of heterogeneous academic trajectories in elementary schools between different groups of children sharing vulnerable socio-economic backgrounds.

3 Data and Methods

Our study documents the academic trajectories of foreign background children between primary and secondary schools in twelve European countries and three traditional immigration countries – Australia, Canada and New Zealand.

3.1 Data

Educational progress over time is best measured with longitudinal data. The academic trajectories of ethnic minorities between kindergarten and elementary school is well-documented in the US owing to the availability of a rich collection of educational surveys.

To the best of our knowledge, no comparable data are available to explore the academic trajectories of foreign background children between primary and secondary schools in other traditional immigration countries or in Western Europe. The Children of Immigrants Longitudinal Study (CILS) in the US and the Children of Immigrants Longitudinal Survey in Four European Countries (CILS4EU), its European equivalent, could potentially be exploited to explore the academic progress of immigrant children between 14 and 17 years old across five countries. Unfortunately, no measure of scholastic achievement is collected before the age of 14 in these surveys.

We therefore follow Hanushek and Woessmann (2006) and build synthetic cohort datasets by pooling independent cross-sections from PIRLS, PISA and TIMSS—three widely used international surveys in educational research—to circumvent the absence of longitudinal data.[4] Pooling surveys allows us to follow the academic trajectories in reading and mathematics of pupils drawn from three different cohorts in a cross-country setting. Earlier studies by Schubert and Becker (2010), Jakubowski and Pokropek (2015) have exploited a similar strategy. None of these contributions, however, focused on the change in the immigrant achievement gap

[4]PIRLS, TIMSS and PISA data and data documentation are available online at http://timssandpirls.bc.edu/ and at http://www.oecd.org/pisa/.

between primary and secondary schools.

PIRLS and TIMSS target pupils attending the grade corresponding to 4 years of formal elementary education (Grade 4), that is, around the age of 10.[5] PIRLS provides a measure of scholastic achievement in reading. TIMSS assesses achievement in mathematics and science. Both surveys cover nationally representative samples of pupils over a large number of countries. TIMSS started in 1995 and is run every four years. PIRLS started in 2001 and is run every five years. PISA targets older students. It provides a measure of academic achievement at age 15 (without targeting a specific grade) in reading, mathematics and science. PISA started in 2000 and is run every three years.

By design, the population of students targeted in TIMSS and PIRLS in year t is approximately the population that is targeted in PISA in year $t+5$. So, tracking the performance of children in TIMSS/PIRLS in year t and in PISA in year $t+5$ informs us of the academic trajectory of one particular cohort of children (born around year $t-10$). We take advantage of this design to study the academic progress between the ages of 10 and 15 for three separate cohorts of pupils.[6] Cohort 1 uses data from PIRLS 2001 and PISA 2006, which include students born in 1990 or 1991. Cohort 2 uses data from PIRLS 2006 and PISA 2012. It is the most recent cohort which can be constructed with survey data currently available. However this second cohort is not perfectly aligned since there is a 6 years period between PIRLS and PISA: PIRLS 2006 covers students born in 1995–96 while PISA 2012 covers students born in 1996–97. We assume here that the performance of the latter provides a good approximation of the performance of children born one year earlier. These two cohorts track the change in reading performance. Cohort 3 uses data from TIMSS 2007 and PISA 2012, which include students born in 1996 or 1997 and allows us to track the change in performance in mathematics.

Table 1 presents the countries included in each of those three cohorts. Students from a particular country are included if the country took part in the study in both years used to construct the synthetic cohort datasets.

We focus on three distinct groups of foreign background children. First-generation immigrants (1G) include all children from a cohort born abroad. Second-generation immigrants (2G) include all children of foreign-born parents born in the host country. We treat children of *mixed* background parents—one native-born and one foreign-born—as a distinct group. This

[5] TIMSS also assesses skills in Grade 8, but we do not use those data.

[6] Note that, because TIMSS and PIRLS target Grade 4 (and not necessarily children aged 10), we restrict our elementary school samples to children born in the expected year to attend Grade 4. That excludes kids having already repeated a grade by age 10 or having started elementary school early. We only exclude a small number of cases and our estimation results are not sensitive to this sample selection criteria. Results on the unrestricted sample are available upon request.

last grouping is motivated by evidence that intermarried immigrants tend to integrate better into host society's labour market, making their children an interesting pivotal group between foreign- and native-born (Meng and Gregory, 2005, Meng and Meurs, 2009, Furtado and Song, 2015, Elwert and Tegunimataka, 2016). With intermarriage becoming more common, mixed background children make a sizeable group in each country of this study. Note that the cohort population is fixed at Grade 4: we exclude from the PISA samples all migrant children who settled in the host country after the age of 10. Tables 2 and 3 present sample sizes and the percentage of students with a migratory background included in our analytical samples. The share of foreign background students varies greatly across countries. Reassuringly, the share is generally similar in both PIRLS/TIMSS and in PISA samples in each cohort—as they should be given our definition of the samples. Caution is however warranted for the Mixed background students whose share appears to differ more systematically across surveys.

PIRLS, TIMSS and PISA provide individual measures of student performance in the form of standardized test scores (in reading and/or mathematics). In each survey, standardized student-level test scores have a mean of 500 and a standard deviation of 100 over the whole set of participating children across all countries. These scores were drawn from an estimated latent-ability distribution based on a subset of test items answered by individual respondents. Their computation follows a series of steps involving Item Response Theory modeling (Mislevy and Sheehan, 1989) and Rubin (1987)'s multiple imputation method (Adams et al., 2007, Monseur and Adams, 2009, Wu, 2005). The availability of standardized test scores makes it easy to compare performance across different academic disciplines and levels of schooling. Because the universe of students covered varies over time and across surveys (because different countries are taking part), re-normalization of test scores is however required. Since we focus on achievement gap and progress *within* countries, we rescale all standardized test scores to have a mean of 500 and a standard deviation of 100 at each academic stage within each country separately.

As with previous related studies, the reliability of our approach rests on the assumption that the cognitive tests of PIRLS, PISA, and TIMSS are quantitatively comparable; see Ammermüller (2013), Hanushek and Woessmann (2006), Ruhose and Schwerdt (2016), Schnepf (2007), among others. While PIRLS, PISA and TIMSS are all designed to provide reliable aggregate measures of students' performance for major subpopulations, they were not explicitly designed to be compared to each other. These surveys share, however, many similar features. Analysis of the equivalence of item difficulty report 80 per cent commonality of the total variance in item difficulties in PIRLS and PISA, and also a high correlation between national results (Grisay et al., 2007, 2009). Some differences are found in performance between TIMSS and PISA in mathematics. However, they are not large enough to cause significant concerns over the robustness of comparative results (Wu, 2010). Brown et al. (2007) reach a similar conclusion while outlining that these differences are also sensitive to the survey years considered.

3.2 Measuring the Achievement Gap

We aim to describe differences in test scores within each country across students with different migration background—the achievement gap—and the evolution of these differences as students progress from primary to secondary education. To do so, we rely on two indicators of the achievement gap in any given country/year.

The simplest measure is the difference in *average* test score between native-born children and children with a migration background (1G-, 2G-, or mixed children)

$$\text{Diff} = \mu(F^n) - \mu(F^f)$$

where F^n and F^f are the (cumulative) distributions of test scores of native-born and foreign-background children respectively. This measure has two drawbacks. First, focusing on the average score hides heterogeneity in the performance of students. Second, the average test score is only meaningful if one accepts the 'cardinality' of test scores as a measure of academic achievement; i.e. the scaling of scores have the same interpretation across different surveys, and/or time periods. We must accept that a difference of, say, 50 in two different surveys represents the same gap in performance. Although this is common practice, this is a strong assumption. US studies have raised concerns about the inter-temporal comparability of test scores when the achievement measures are inherently ordinal (Bond and Lang, 2013, Ho and Reardon, 2012, Reardon, 2008). For example, Bond and Lang (2013) find that up to 13% of the widening of the Black-White test gap between school entry and grade three can be due to test score sensitivity to scale transformation, raising questions about the reliability of the information conveyed in test score gap changes between grades. We address this cardinality assumption issue by considering a second measure of (change in) achievement gap using the Gastwirth index (Gastwirth, 1975).

The Gastwirth index provides an ordinal measure of the achievement gap by comparing the relative *ranking* of students from distinct groups in the distribution of tests scores. The index measures the probability that a randomly selected student with migration background has a higher score than a randomly selected native student. If there were no systematic deviation in the test scores of the two groups, this probability would be 0.5 (a random foreign background student would be equally likely to do better or worse than a random native student). On the other hand, if *all* foreign background pupils did worse than *all* native pupils, the probability would be 0. It would be 1 in the other extreme case of seeing all foreign background students doing better than all native students.

Formally, the index Prob can be written

$$\text{Prob} = 1 - \int F^n(s) f^f(s) ds$$

where F^n is the cumulative probability distribution of scores among native pupils and f^f is the probability density function of scores among foreign-background pupils; see Gastwirth (1975) for methodological details and Le Breton et al. (2012) for a more recent discussion.[7] Unlike Diff, this measure of achievement gap between native and foreign background pupils is no longer plagued by the potential cardinal comparability bias.

Whatever index is considered (Diff or Prob), the change in achievement gap over time for a cohort of children is given by the change between measurements at age 10 (in primary school) and at age 15 (in secondary school)

$$\Delta_D = \text{Diff}^{15} - \text{Diff}^{10}$$

or

$$\Delta_P = \text{Prob}^{15} - \text{Prob}^{10}.$$

$\Delta_D > 0 \text{or} \Delta_P > 0$ indicates that the academic performance of foreign background students is deteriorating over time compared to their native-born peers.

[7] With individual data on test scores for N students, Prob can effectively be calculated as

$$\widehat{\text{Prob}} = 1 - \frac{1}{N^f} \sum_{i=1}^{N} I_i \, \hat{F}^n(s_i)$$

where s_i and I_i are student i's test score and migration backround (I_i is 1 for foreign background and 0 otherwise), $N^f = \sum_{i=1}^{N} I_i$ is the number of foreign background students, and $\hat{F}^n(s_i) = \frac{1}{N^n} \sum_k^N (1 - I_k) \mathbb{1}(s_k \leq s_i)$ is the share of native students with a score lower than s_i.

3.3 Adjusting for differences in socio-economic background

Differences in achievement between the group of foreign background and native pupils reflect, at least in part, differences in socio-economic background. For a discussion of the impact of migration background on academic achievement, there is therefore interest in examining measures that are adjusted for those differences, that is, measures that compare the achievement of pupils with migration background to the achievement of native pupils with similar socio-economic background.

With access to individual data on test scores and socio-economic characteristics, reweighting or 'direct standardization' methods offer an easy way to achieve this (DiNardo et al., 1996, Fortin et al., 2011). To calculate adjusted Diff or Prob measures, we need estimates of a counterfactual cumulative distribution of test scores among natives if they had the characteristics of foreign background students, which we denote F^c. A direct standardization approach to constructing the latter involves reweighting native pupils in such a way that the socio-economic characteristics of the reweighted sample of native pupils has the same characteristics as the sample of foreign background pupils. Formally, F^c is defined as follows:

$$F^c(s) = \int_{\Xi} F^n(s|X = x)h^f(x)dx$$

where $F^n(s|X = x)$ is the cumulative probability distribution of test scores among native children with characteristics x and $h^f(x)$ is the probability density of observing characteristics x among foreign background children. The reweighting argument is that F^c can be expressed as

$$F^c(s) = \int_{\Xi} \Psi(x)F^n(s|X = x)h^n(x)dx$$

with the reweighting function $\Psi(x) = \frac{h^f(x)}{h^n(x)}$ defined as the ratio of densities of characteristics in the two groups. The counterfactual distribution is then easily estimated from the sample data as

$$\hat{F}^c(s) = \frac{1}{N^c}\sum_{i=1}^{N^n} \Psi(x_i)\mathbb{1}(s_i \leq s)$$

where $N^c = \sum_i^{N^n} \Psi(x_i)$.[8] The intuition is that characteristics x relatively more common among foreign background children receive a weight larger than 1 while characteristics relatively rare receive a weight closer to 0. At one extreme, characteristics absent among foreign

[8] DiNardo et al. (1996) show that, by applying Bayes' rule, $\Psi(x)$ can be calculated as $\frac{\Pr(f|X=x)}{1-\Pr(f|X=x)}\frac{1-\Pr(f)}{\Pr(f)}$ with $\Pr(f|X = x)$ being the probability that a pupil with characteristics x has foreign background and $\Pr(f)$ the share of foreign background students in the sample. Each term can be estimated using, e.g., logistic regression models. See Hildebrand et al. (2017) for an application to analysis of deprivation levels of immigrants.

background pupils, namely with $h^f(x) = 0$, receive a weight of zero and native students with those characteristics are effectively discarded in the reweighted sample of native children.

Note that we 'reweight' native pupils towards foreign background students and not the other way round. There are two reasons for this. The first is notional: we are interested in the progress of foreign-background students against native pupils with similar characteristics. Reweighting them to the native pupils characteristics would lose representativity of our group of interest. The second is technical: the reweighting technique requires that all possible patterns of characteristics found in the target group of interest are also found in the reference (reweighted) group—otherwise it is not possible to match the target population characteristics by reweighting. This condition is more often satisfied when the larger and more heterogenous population—here the natives—is reweighted 'down' to the smaller population (Hildebrand et al., 2017).

We estimate the adjustment weights using a set of commonly used student and family background characteristics available in both PIRLS/TIMSS and PISA: student's gender, the highest level of education of parents, the number of books at home and whether students have a computer and a desk to study on.[9] Table 4 and 5 show summary statistics on those variables in the pooled samples: foreign background students are more likely to have parents with the lowest level of education, have less books at home, and are less likely to have their own computer.

We denote the adjusted difference in average test score and the Gastwirth index calculated from F^f and F^c by Diff^U and Prob^U where the U superscript indicates that they measure an achievement gap that is 'unexplained' by differences in socio-economic background. Diff^U measured at age 15 ($\text{Diff}^{U,15}$) is comparable to the measure of educational *integration* of Schneeweis (2011): the distance separating the educational performance of immigrant children from that of native-born that is not explained by differences in student characteristics and family background. Our measures of progress adjusted for socio-economic background are then

$$\Delta_D^U = \text{Diff}^{U,15} - \text{Diff}^{U,10}$$

and

$$\Delta_P^U = \text{Prob}^{U,15} - \text{Prob}^{U,10}.$$

[9]The level of parent's education is not available in the grade 4 sample of TIMSS 2007 and therefore omitted from the analysis for Cohort 3. The number of books at home is nonetheless considered a good proxy measure for the educational and cultural capital of the household (see, Pedro et al., 2013, Woessmann, 2008, Ammermueller and Pischke, 2009, among others).

and each measure captures the change in the immigrant achievement gap between 10 and 15 years old that cannot be explained by student and family characteristics. A narrowing of the unexplained part over time would suggest that the return to endowment of migrants are converging to that of natives. It can be viewed as a measure of educational assimilation.

4 Results

We contended that measures of academic progress from standardized test scores, drawn from independent surveys such as PIRLS (TIMSS) and PISA, may simply reflect the lack of cardinal comparability between test scores in these surveys.[10] We explored this concern by contrasting test score gap estimates with those obtained with our ordinal measure of academic progress using the Gastwirth index. For all countries, we found that the direction and the magnitude of the changes in the achievement gap implied by either measure of academic progress yield analogous results. This observation provides convincing supporting evidence that the change in the difference in *average* test score between native and foreign background children does not appear to suffer significant scale misspecification bias in our study. All estimation results are reported in Appendix – Tables A.1 to A.4 for reading and Tables B.5 to B.8 for mathematics.[11]

Henceforth, with this in mind, we largely focus the rest of our discussion to the Gastwirth index results, conveniently summarized graphically in Figures 1 to 4 for reading, and in Figures 5 to 8 for mathematics. Both unadjusted (observed) and adjusted gap results are displayed on the left and the right plots of each figure, respectively. As a reminder, the adjusted gap measures the portion of the achievement gap unaccounted for by between-group differences in observable characteristics.

The *x-axis* of each plot marks the achievement gap in Grade 4 (primary school), while the *y-axis* reflects the achievement gap at age 15 (secondary school).[12] Countries where migrant-origin children perform as well as their native peers in both, primary and secondary school, are clustered at the center of the plot. In countries located in the lower left quadrant (below the horizontal dashed line and to the left of the vertical dashed line), migrant-origin children demonstrate lower educational achievement than their native peers in *both* primary and secondary school. If the size of the achievement gap in primary school remains unchanged by age

[10]Note that any effect size statistics commonly used in educational research (i.e. Cohen's q) implicitly assume cardinal comparability. See Nielsen (2015) for a recent comprehensive discussion.

[11]Each table reports the observed (Raw) and adjusted (Adj) gaps in Grade 4 (primary school), at age 15 (secondary school) and the resulting change in gaps over time (ΔGap) using our two measures of achievement – normalized standardized test scores and the Gastwirth index.

[12]Individual countries are identified by their "ISO Alpha-2" code.

15, the point falls on the 45-degree line; if the achievement gap declines over time, the point will fall above the main diagonal. To help visualise progress, the magnitude of the change in the achievement gap between secondary and primary school for each country is represented by a vertical line which displays the distance to the 45-degree line.

Overall, regardless of the academic subject considered, Figures 1, 2, 5 and 6 reveal that European countries are generally located in the bottom left quadrant of each plot. This finding corroborates numerous studies which have consistently documented that 1G and 2G children lag behind their native peers (in both reading and mathematics); see Schneeweis (2011), Riederer and Verwiebe (2015), among many others. The vast majority of these studies, however, do not measure academic progress over time.[13] By contrast, in traditional immigration countries – Australia, Canada, New Zealand– migrant-origin children appear to perform at least as well as their native peers by the age of 15.

Accounting for differences in student characteristics generally narrows the achievement gap in almost all countries, evidenced by a rightward shift upward for most countries in the "Adjusted gap" plots. A sizeable portion, however, often remains unaccounted for and the size of these unexplained differences – at either level of schooling – greatly varies across countries, and cohorts within countries. This observation underscores the existence of a large diversity between immigrant populations across receiving countries.

Academic Progress in Reading

In traditional immigration countries (Canada and New Zealand in our reading sample), 1G and 2G pupils perform generally at least as well as their native counterparts by age 15 depending on the cohort considered (see Figures 1 and 2). Note the existence of a large gap among 1G fourth graders in Canada, in the 2001 cohort. This gap, however, disappears in secondary school demonstrating significant academic progress between the age of 10 and 15. By contrast, our Figures reveal more modest academic progress in reading, among both 1G and 2G pupils, in European countries.

1G pupils in Europe generally exhibit large achievement gaps in Grade 4, which are never fully absorbed by age 15. This translates graphically by vertical lines above the 45 degree-line in the bottom left quadrant which never cross the vertical dashed line (see Figure 1).[14]

The positive educational outcomes of 1G children in traditional immigration countries is

[13] Jakubowski and Pokropek (2015), Schnepf (2007) are a notable exception. However, unlike this contribution, no attempt is made to follow the educational progress of a particular cohort over time.

[14] Cohort 1 from Denmark is a notable exception with a large and significant increase in the achievement gap of 1G-pupils over time ($\Delta_P^U = -0.10$).

often attributed to their selective migration policies, which explicitly target high skilled parents (Claudia Buchmann, 2006, Entorf and Minoiu, 2005, Levels et al., 2008). Cattaneo and Wolter (2015) provide further evidence supporting this view in a recent study which reported a significant increase in test scores among immigrant children in Switzerland, following a policy change in the mid-1990s, which triggered a large exogenous increase in its share of high-skilled migrants. This finding support the view that students' socio-economic capital at the time of migration (the initial endowment) is an important determining factor of future academic success into the host country school system.

Similarly, our finding of more modest academic progress among 1G pupils in Europe are not fully surprising, given that immigrant children in Europe are usually drawn from families of unskilled labour or refugees, in absence of selective migration policies. The substantial educational disparities with their native peers may therefore be a mere reflection of the additional difficulties faced by foreign-background pupils from families with weak socio-economic background to smoothly integrate into the host country's school system (Levels et al., 2008, Cattaneo and Wolter, 2015). Country specific obstacles inherent to their school systems, which are also perhaps less prepared (or less willing) to meet the needs of increasing (and unplanned) flows of immigrant children, may also be at play. Levels et al. (2008), however, do not find robust evidence supporting this hypothesis.

Comparing results from countries in which we observe two cohorts of children reveals that the size of the achievement gap is sensitive to cohorts. For instance, while 1G children from Cohort 1 in Germany, Norway and France no longer show significant differences in achievement with observationally comparable natives by the age of 15, their counterparts from the Cohort 2 still experience a significant gap. This finding may be indicative of deteriorating academic progress for the most recent cohort of 1G children in these countries.[15]

[Figure 1 about here]

Likewise, the estimated academic progress of 2G children in Europe is equally mediocre. 2G children are expected to better transition to primary education than their 1G peers as a result of having experienced from the onset the benefits of early education programs in their parent's destination country.[16] Yet, unlike in traditional immigration countries, we also find significant educational disparities between 2G children and their native peers and unremarkable academic progress between ages 10 and 15 (see Figure 2).

[15] One cannot draw definite conclusions strictly comparing results from Cohort 1 and 2 as pointed out in section 3.1

[16] Remember that our sample only considers 1G children who migrated before the age of 10.

[Figure 2 about here]

We further examine the academic progress of 2G pupils by contrasting their scholastic achievement with their 1G peers. For this exercise, countries in which 2G consistently outperform their 1G peers in primary schools are displayed in the bottom-left quadrant (see Figure 3 and Table A.3). Consistent with prior expectations, 2G fourth graders from Cohort 1 perform significantly better than their 1G peers in almost all European countries.[17] Surprisingly, however, their educational advantage tends to narrow in secondary school, suggesting that 1G pupils are closing the gap with their native counterparts faster than their 2G peers.

We find broadly similar results for Cohort 2, but gaps and changes in gaps (regardless of their magnitude) are often statistically insignificant (Table A.3). The lack of statistical significance may be due to the modest size of our immigrant samples. Despite this caveat, we view our results as providing little supporting evidence of significant educational progress of 2G children compared to their 1G peers in many European countries in our sample, both within and across cohorts.

[Figure 3 about here]

We now turn to results for mixed migrant children. Consistent with prior expectations, mixed migrant pupils outperform their 1G and 2G peers, evidenced by a smaller (or insignificant) achievement gap in Grade 4, which fully disappears by the age of 15 in almost all countries (see Figure 4). These results are in line with evidence that children of intermarried parents have more social contacts with natives, better language skills and information about local institutions and customs than their 1G and 2G counterparts (Kalmijn, 2015). Information on the educational achievement of mixed migrant children is scarce. Available evidence shows that their educational achievement lays somewhere in between immigrant children (1G or 2G) and natives (Levels et al., 2008, Kalmijn, 2015). Our results show that in most countries the reading proficiency of mixed-migrant pupils at age 15 does not differ significantly from that of native-born in all but four countries: Germany in both cohorts and Belgium, France and the Netherlands for Cohort 2. Our results for Germany and the Netherlands corroborate Kalmijn (2015).

[Figure 4 about here]

[17] Except for the Netherlands where first-generation 4th graders outperform second-generation.

Academic Progress in Mathematics

Results in mathematics reveal even more striking differences between Europe and traditional immigration countries than in reading, with the exception of the UK where the experience of migrant-origin children appears more comparable to their peers in traditional immigration countries (see Figures 5 to 8). To a lesser extent, this observation also held for reading. In what follows, we group the UK together with traditional immigration countries when referring to English-speaking countries.

Foreign background children in English-speaking countries do not show any significant disparities in achievement with their native-born peers even at age 10, sometimes outperforming them significantly by age 15.[18] 1G children in all traditional immigration countries show significantly better educational progress over time than natives.

By contrast, 1G and 2G children in continental Europe exhibit large and persistent achievement gaps, evidenced graphically by their positioning along the 45-degree line in the bottom left quadrants of Figures 5 and 6. Among 1G children, we only find a statistically significant narrowing of the gap in Austria and the Netherlands. Likewise, we find very little evidence of academic progress among 2G migrant children in any country but the Netherlands and Italy (see Figure 6).

[Figure 5 about here]

[Figure 6 about here]

To further investigate these results, we again contrast the achievement of 2G children with their 1G peers (see Figure 7 and Table B.7). Consistent with prior expectation, 2G children perform better at age 10 than their 1G peers in all European countries. However, as for reading, their (adjusted) educational advantage tends to narrow by age 15 in all countries but Denmark and Italy. While the estimated changes are not always statistically significant, they provide additional evidence suggesting a slower rate of educational progress among 2G immigrant children. To some extent, these children appear to hit some achievement glass ceiling. These lackluster results in mathematics may reflect, in part, the cumulative effect of poor reading skills in early grades (Andon et al., 2014).

[Figure 7 about here]

[18] 1G fourth graders in the UK is an exception. However, the adjusted achievement gap completely disappears at age 15.

Interestingly, the progress in mathematics of mixed-migrant children in continental Europe is similar to pupils from Cohort 2 in reading. We find evidence of significant gaps at age 10 (of varying magnitude depending on the country), which tend to disappear and/or become insignificant by the age of 15 in all countries but Germany and the Netherlands.[19]

[Figure 8 about here]

5 Conclusion and Discussion

We inferred the academic progress of three cohorts of foreign background children between the age of 10 and 15 in reading and mathematics by exploiting independent cross-sections from PIRLS 2001 and 2006, TIMSS 2007 and PISA 2006 and 2012. Past contributions have predominantly used these data to document the immigrant achievement gap cross-sectionally.[20] One important contribution of this study is to apply a synthetic cohort approach to document the change in the gap over time, which arguably provides a more comprehensive picture of educational assimilation. Our second contribution is the use of an ordinal measure of achievement gap in addition to average test scores. The ordinal measure does not rely on the implicit assumption of cardinal comparability of test scores across surveys and countries. Interestingly, we find that our results are robust to either measure of achievement gap.

Overall, our results show a clear and consistent pattern. The academic achievement of foreign background children in traditional immigration countries converge to that of natives in reading, and even surpass them in mathematics. This finding is in sharp contrast with the academic progress of migrant-origin children in our sample of continental European countries—the UK exhibits assimilation profiles closer to traditional immigration countries. In continental Europe, we find that, while immigrant children appear to close some of the gap with their native peers between primary and secondary school in reading, both 1G and 2G migrant children show stalled academic progress in mathematics.

The time dimension of our study contributes to emphasize the importance of parental background at the time of migration (country of origin, parental socio-economic background) to genuinely understand the educational trajectories of foreign background children in the destination countries. Previous studies have identified the importance of parental background to explain differences in scholastic achievement between various ethnic groups, within and be-

[19] Both cohorts (Cohort 2 and Cohort 3) follow students over a broadly comparable time period: 2006–2012 and 2007–2012.

[20] Andon et al. (2014) is a notable exception.

tween countries (Azzolini and Barone, 2013, Bygren and Szulkin, 2010, Jackson et al., 2012, Jonsson and Rudolphi, 2011, Levels et al., 2008). These factors include linguistic, cultural and religious distance between immigrant and native groups (Fleischmann and Dronkers, 2010, Isphording, 2014, Isphording et al., 2016, Jonsson and Rudolphi, 2011, Levels and Dronkers, 2008), pre-migration context (measured through political stability and democratic tradition), economic prosperity in the country of origin (Levels et al., 2008), community concentration and residential segregation in the host country (Bygren and Szulkin, 2010). A natural and valuable extension of our study would be to document the academic progress of foreign-background children according to their parents' country of origin as well as the differences in academic progress of particular groups across different destination countries.[21]

A selective migration policy can be viewed as a valuable quasi-experiment to gauge the effect of parental background (children initial educational endowment) at the time of migration on the achievement gap. With this in mind, the diverging educational progress of foreign background children in traditional immigration countries and Western European countries may mirror the differences in scholastic readiness of their migrant populations at the time of migration (Ammermüller, 2007, Levels et al., 2008, Cattaneo and Wolter, 2015) rather than being a by-product of European school systems' inabilities to accommodate their idiosyncratic needs.

Many European countries engaged in major investments over the last decade to address the educational needs of economically vulnerable children including foreign background students. For instance, Germany improved access to quality Kindergarten programs, provided additional language support to immigrant children and their parents (Anderson et al., 2015, Klein and Becker, 2017), as well as began offering more flexible possibilities to move between school tracks (Riederer and Verwiebe, 2015). Likewise, Austria, Belgium, Denmark, Ireland, the Netherlands, Norway, and Sweden introduced several measures to address the specific needs of immigrant children including language skills screening among preschoolers, compulsory kindergarten enrollment, additional school teaching time, training about intercultural pedagogy, language support throughout school, and provided extra funding to schools with a higher concentration of immigrant children (see Nusche et al., 2009, 2010, Riederer and Verwiebe, 2015, Shewbridge et al., 2010, Taguma et al., 2009, 2010, for further details).

Yet, while evaluating these policies is beyond the scope of this paper, our results do not reveal significant improvements between the academic progress of Cohorts 1 and 2 in reading. This observation is in line with Levels et al. (2008) who did not find evidence supporting that the better educational achievement of migrant children in traditional immigration countries

[21] Unfortunately, parents' country of origin is not collected in PIRLS/TIMSS.

could be explained by educational policies specifically targeting the needs of immigrant children using data from PISA 2003. Anderson et al. (2015) find some evidence that the reforms in Germany improved the equality of opportunities of the targeted population at the bottom of the achievement spectrum over the 2003-2009 period. However, they did not implicitly address the impact of these reforms on the educational trajectories of immigrant children. Further research with richer longitudinal data, would help address these important questions more rigorously in future studies.

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6 Tables & Figures

Table 1: Age-Cohort–Data Summary

	Cohort 1	**Cohort 2**	**Cohort 3**
Primary Secondary	PIRLS 2001- PISA 2006	PIRLS 2006- PISA 2012	TIMSS 2007- PISA 2012
Denmark		x	x
Norway	x	x	x
Sweden	x	x	x
Austria		x	x
Germany	x	x	x
Luxembourg		x	
Netherlands	x	x	x
Belgium		x	
France	x	x	
Italy	x	x	x
Spain		x	
United Kingdom	x	x	x
Australia			x
Canada	x	x	x
New Zealand	x	x	x

Table 2: Percentage of Students with a Migratory Background (Reading Test Cohorts)

	N		1G		2G		Mixed	
Cohort 1 (2001-2006)	PIRLS	PISA	PIRLS	PISA	PIRLS	PISA	PIRLS	PISA
Scandinavia								
Norway	3246	4379	2.3	2.0	2.9	2.7	12.2	8.0
Sweden	5574	4185	4.4	3.4	5.7	5.6	12.8	10.3
Mid./C. Eur.								
Germany	6165	4269	7.0	4.3	6.5	6.3	9.6	4.8
Netherlands	3778	4604	3.4	2.9	5.8	7.2	10.7	8.2
France	3048	4406	3.3	2.0	11.4	8.9	15.4	12.3
Southern Eur.								
Italy	3140	20434	2.7	1.4	1.3	0.6	7.8	5.0
English speaking								
United Kingdom	5072	12271	4.7	1.8	7.6	4.7	20.0	8.8
Canada	14228	20827	10.7	6.4	11.1	11.2	18.3	11.4
New Zealand	1450	4227	10.7	9.0	9.7	7.1	21.3	16.0
Cohort 2 (2006-2012)	PIRLS	PISA	PIRLS	PISA	PIRLS	PISA	PIRLS	PISA
Scandinavia								
Denmark	3112	6570	1.7	1.9	6.1	5.2	12.6	7.7
Norway	3361	4315	1.7	3.1	3.8	4.4	12.0	9.2
Sweden	3993	4196	2.2	3.3	9.4	7.4	14.4	11.5
Mid./C. Eur.								
Austria	4011	4315	3.4	3.7	11.4	8.7	11.2	8.0
Germany	6299	3813	3.1	1.9	11.4	9.4	13.0	7.1
Luxembourg	2494	4381	7.3	12.2	27.4	27.8	21.4	16.7
Netherlands	3793	4177	2.0	2.0	8.9	7.0	11.4	8.4
Belgium	7917	7696	4.1	3.8	7.7	7.2	17.2	13.1
France	3828	4260	2.6	3.2	10.5	9.1	18.9	11.4
Southern Eur.								
Italy	3362	28973	3.0	3.3	2.9	1.7	8.2	6.5
Spain	3731	23704	7.6	5.9	2.6	1.5	8.3	6.5
English speaking								
United Kingdom	7025	11628	5.3	4.2	6.4	5.7	16.5	11.0
Canada	17752	19411	7.9	8.8	20.0	16.8	17.5	10.6
New Zealand	5351	3804	10.8	11.3	9.6	10.1	23.4	16.9

Notes: All proportions are weighted using individual student weights. 1G=First-generation migrants,2G=Second-generation migrants, Mixed=One native-born parent.

Table 3: Percentage of Students with a Migratory Background (Math Test Cohort)

	N		1G		2G		Mixed	
Cohort 3 (2007-2012)	TIMSS	PISA	TIMSS	PISA	TIMSS	PISA	TIMSS	PISA
Scandinavia								
Denmark	2760	6570	3.1	1.9	5.5	5.2	7.9	7.7
Norway	3742	4315	2.6	3.1	2.6	4.4	9.5	9.2
Sweden	4386	4196	4.2	3.3	8.6	7.4	11.8	11.5
Mid./C. Eur.								
Austria	4499	4315	5.9	3.7	9.4	8.7	10.3	8.0
Germany	4093	3813	4.5	1.9	11.7	9.4	11.5	7.1
Netherlands	3007	4177	5.9	2.0	6.2	7.0	11.1	8.4
Southern Eur.								
Italy	4060	28973	2.5	3.3	2.9	1.7	8.1	6.5
English speaking								
United Kingdom	7564	11628	5.5	4.2	4.9	5.7	14.9	11.0
Australia	3907	12627	7.4	6.8	13.7	12.5	21.2	16.5
Canada	14594	19411	11.2	8.8	13.8	16.8	15.0	10.6
New Zealand	4666	3804	12.4	11.3	7.9	10.1	19.7	16.9

Notes: All proportions are weighted using individual student weights. 1G=First-generation migrants,2G=Second-generation migrants, Mixed=One native-born parent.

Table 4: Descriptive Characteristics of Reading Sample by Cohorts

	Natives		1G		2G		Mixed	
Cohort 1 (2001-2006)	PIRLS	PISA	PIRLS	PISA	PIRLS	PISA	PIRLS	PISA
Boys	0.50	0.50	0.52	0.50	0.49	0.50	0.50	0.50
Age	10.17	15.77	10.26	15.81	10.19	15.79	10.17	15.76
Grade	4.17	9.87	4.16	9.56	4.19	9.72	4.27	9.91
Birthyear	1990.7	1990.1	1990.6	1990.1	1990.7	1990.1	1990.7	1990.1
Education of Parents								
Primary or less	0.04	0.01	0.05	0.07	0.13	0.12	0.07	0.01
Secondary	0.51	0.53	0.44	0.36	0.46	0.47	0.45	0.43
Tertiary	0.45	0.46	0.51	0.57	0.41	0.41	0.48	0.56
Books at Home								
0-10	0.07	0.09	0.18	0.17	0.14	0.18	0.07	0.08
11-25	0.20	0.14	0.29	0.23	0.24	0.21	0.18	0.13
26-100	0.35	0.31	0.27	0.32	0.35	0.31	0.33	0.27
101-200	0.20	0.20	0.12	0.14	0.16	0.15	0.20	0.20
>200	0.19	0.26	0.13	0.14	0.12	0.15	0.21	0.32
Own computer	0.84	0.93	0.78	0.90	0.80	0.93	0.83	0.92
Own Desk	0.87	0.94	0.83	0.95	0.85	0.95	0.87	0.94
Cohort 2 (2006-2012)								
Boys	0.51	0.50	0.50	0.50	0.49	0.47	0.50	0.49
Age	10.07	15.79	10.18	15.79	10.14	15.81	10.11	15.80
Grade	4.01	9.88	4.04	9.74	4.02	9.76	4.02	9.91
Birthyear	1995.8	1996.1	1995.7	1996.1	1995.7	1996.1	1995.7	1996.1
Education of Parents								
Primary or less	0.02	0.01	0.07	0.06	0.08	0.06	0.03	0.01
Secondary	0.56	0.44	0.40	0.37	0.54	0.46	0.50	0.39
Tertiary	0.42	0.55	0.53	0.57	0.38	0.48	0.47	0.60
Books at Home								
0-10	0.08	0.11	0.20	0.22	0.15	0.19	0.09	0.12
11-25	0.19	0.15	0.28	0.25	0.28	0.23	0.20	0.15
26-100	0.33	0.30	0.30	0.30	0.31	0.30	0.32	0.29
101-200	0.20	0.20	0.10	0.11	0.14	0.15	0.19	0.19
>200	0.20	0.25	0.12	0.12	0.12	0.12	0.21	0.26
Own computer	0.90	0.98	0.83	0.97	0.88	0.98	0.91	0.97
Own Desk	0.86	0.94	0.81	0.94	0.85	0.94	0.85	0.93

Notes: Own calculations on PIRLS waves 2001 and 2006 and PISA 2006 and 2012 data. 1G=First-generation migrants, 2G=Second-generation migrants, Mixed=One native-born parent. All proportions are weighted using individual student weights.

Table 5: Descriptive Characteristics of Mathematic Sample

	Natives		1G		2G		Mixed	
Cohort 3 (2007-2012)	TIMSS	PISA	TIMSS	PISA	TIMSS	PISA	TIMSS	PISA
Boys	0.51	0.50	0.54	0.50	0.48	0.48	0.49	0.49
Age	10.14	15.77	10.16	15.77	10.17	15.79	10.14	15.77
Grade	4.00	9.96	4.00	9.99	4.00	9.88	4.00	10.05
Birthyear	1996.7	1996.2	1996.6	1996.2	1996.6	1996.2	1996.6	1996.2
Books at Home								
0-10	0.08	0.11	0.20	0.18	0.14	0.16	0.10	0.10
11-25	0.21	0.14	0.30	0.22	0.29	0.21	0.20	0.13
26-100	0.36	0.30	0.29	0.32	0.33	0.33	0.33	0.29
101-200	0.19	0.20	0.12	0.13	0.14	0.16	0.20	0.20
>200	0.17	0.26	0.09	0.15	0.10	0.15	0.17	0.28
Own computer	0.94	0.98	0.90	0.97	0.93	0.98	0.93	0.98
Own Desk	0.85	0.92	0.86	0.93	0.91	0.93	0.87	0.92

Notes: Own calculations on TIMSS 2007 and PISA 2006 and 2012 data. 1G=First-generation migrants, 2G=Second-generation migrants, Mixed=One native-born parent. All proportions are weighted using individual student weights.

Figure 1: First-generation migrants vs. Natives; Gastwirth Index

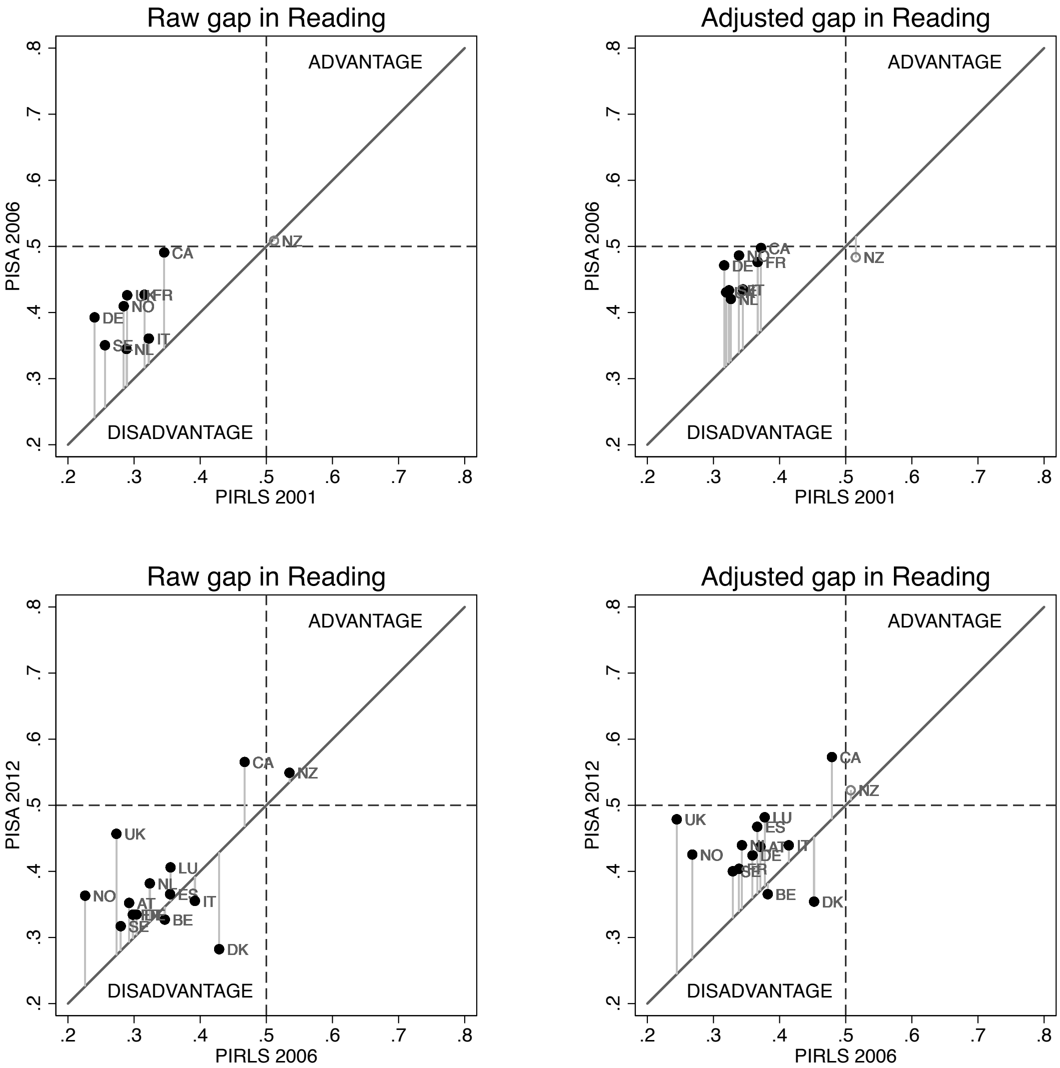


Figure 2: Second-generation migrants vs. Natives; Gastwirth Index

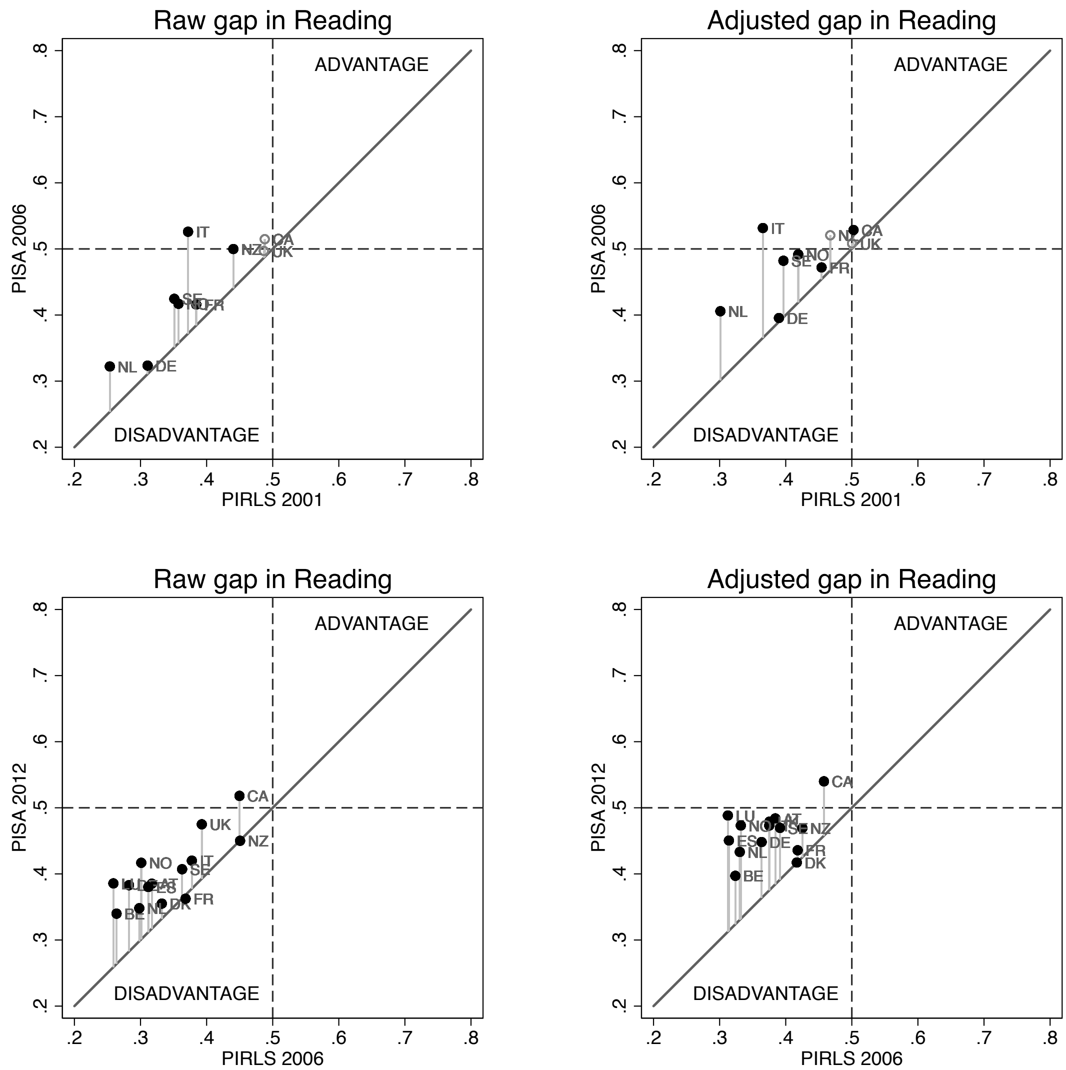


Figure 3: First-generation vs. Second-generation migrants; Gastwirth Index

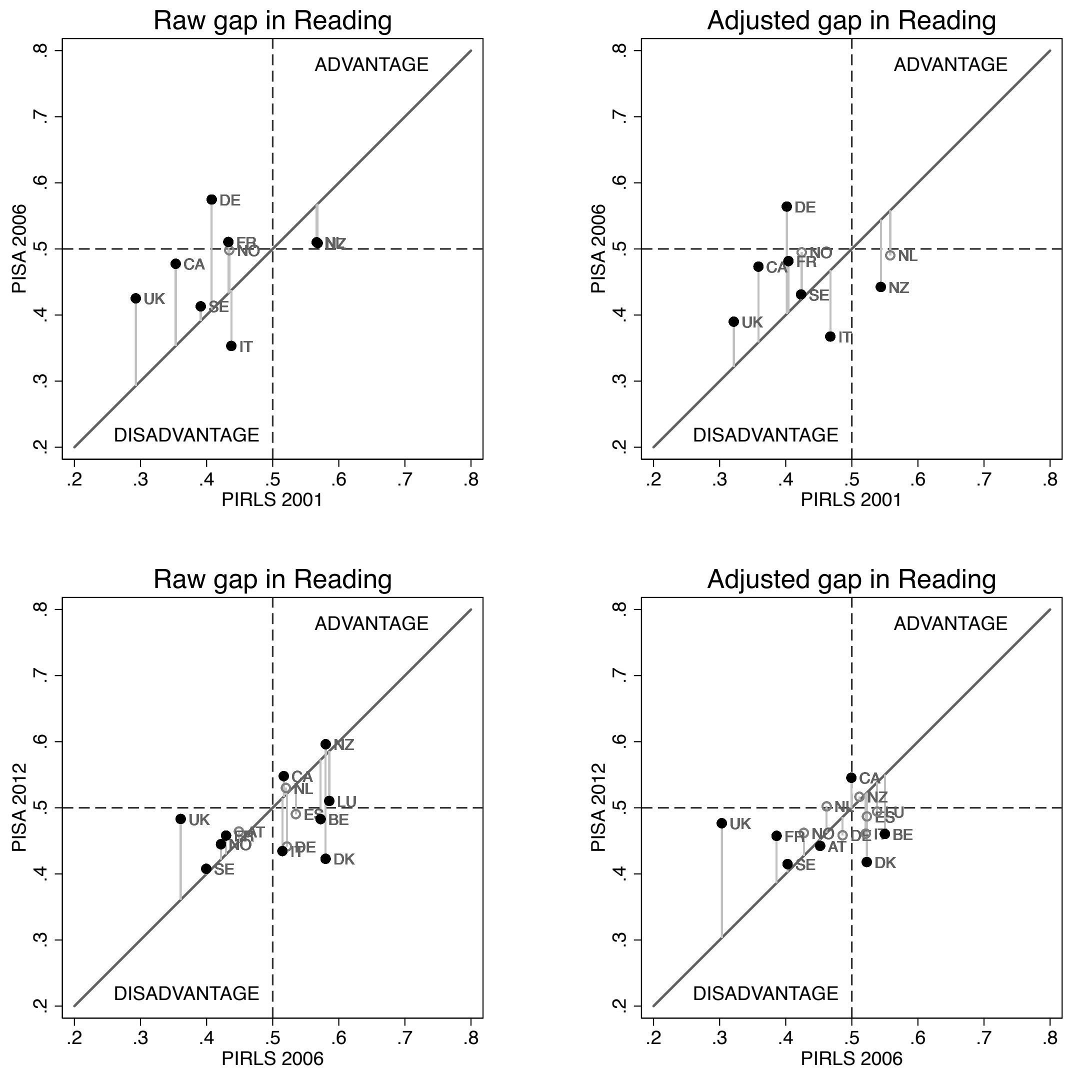


Figure 4: Mixed migrants vs. Natives; Gastwirth Index

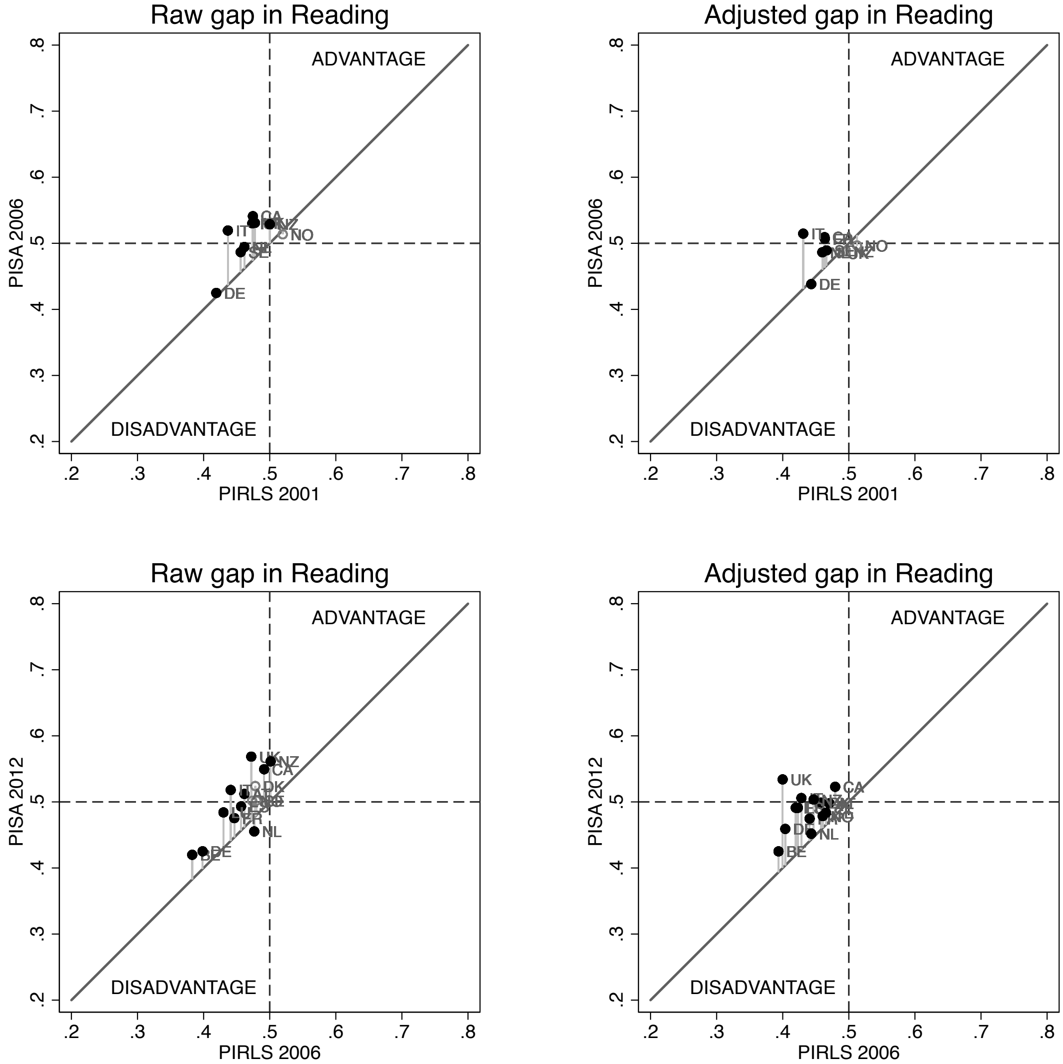


Figure 5: First-generation migrants vs. Natives; Gastwirth Index

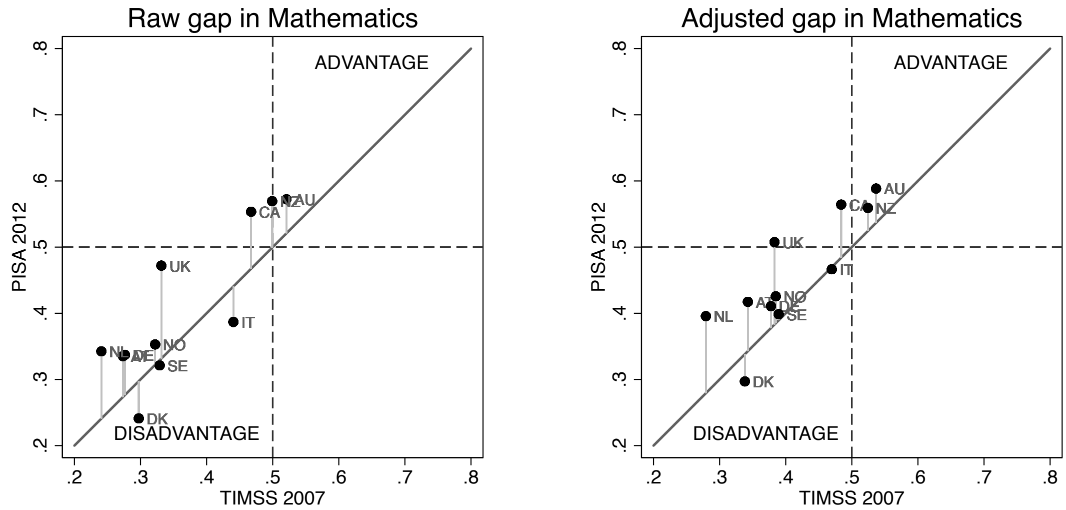


Figure 6: Second-generation migrants vs. Natives; Gastwirth Index

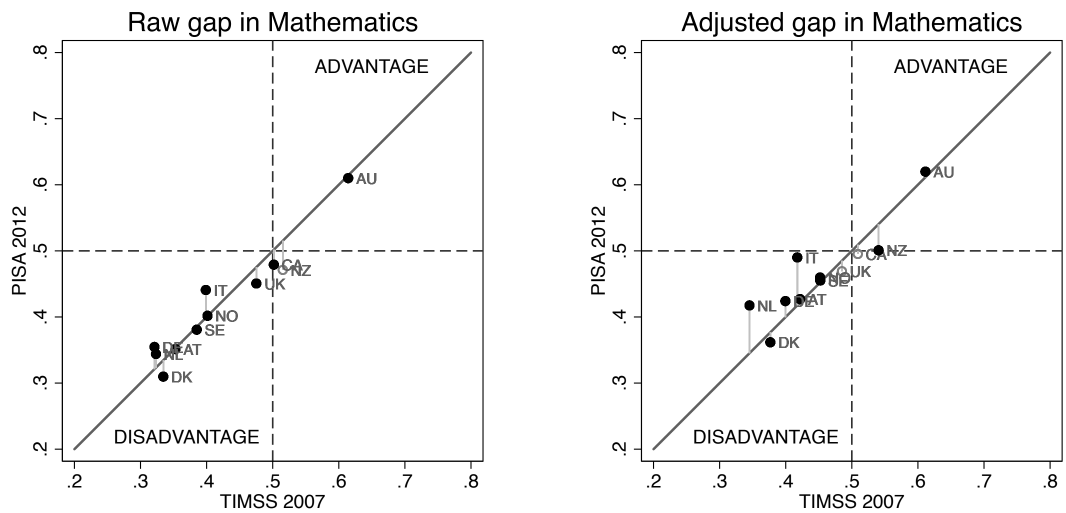


Figure 7: First-generation vs. Second-generation migrants; Gastwirth Index

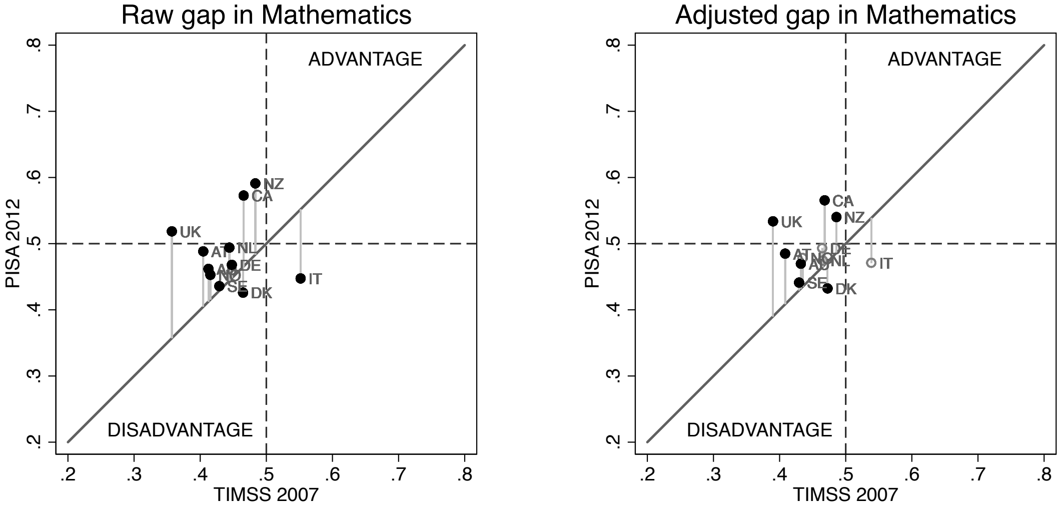
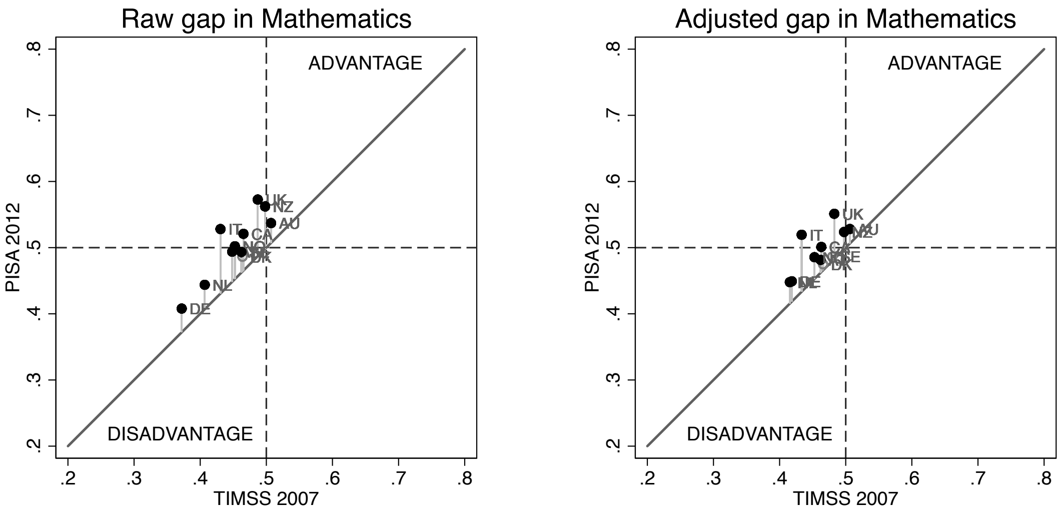


Figure 8: Mixed migrants vs. Natives; Gastwirth Index



Appendices

Appendix A Results in Reading

Table A.1: Achievement Gap in Reading of First Generation Migrants

	Normalized Score						Gastwirth Index					
	PIRLS		PISA		Δ Gap		PIRLS		PISA		Δ Gap	
	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj
2001-2006												
New Zealand	-2	-4	-2	7	0	10	0.51	0.52	0.51	0.48	0.00	-0.03
Canada	57 *	47 *	5	2	-52 *	-44 *	0.35 *	0.37 *	0.49	0.50	0.15 *	0.13 *
Italy	63 *	54 *	57 *	29 †	-6	-25	0.32 *	0.34 *	0.36 *	0.43 †	0.04	0.09 †
France	63 *	45 *	26 †	8	-38 †	-37 †	0.32 *	0.37 *	0.43 †	0.48	0.11 *	0.11 †
Netherlands	68 *	55 *	61 *	30 *	-8	-24	0.29 *	0.33 *	0.34 *	0.42 †	0.06	0.09 †
United Kingdom	76 *	65 *	29 †	28 †	-47 *	-37 *	0.29 *	0.32 *	0.43 †	0.43 †	0.14 *	0.11 *
Norway	83 *	62 *	31 *	3	-52 *	-59 *	0.28 *	0.34 *	0.41 *	0.49	0.13 *	0.15 *
Sweden	92 *	64 *	54 *	25 *	-37 *	-39 *	0.26 *	0.32 *	0.35 *	0.43 †	0.09 *	0.11 *
Germany	103 *	72 *	39 *	10	-64 *	-62 *	0.24 *	0.32 *	0.39 *	0.47	0.15 *	0.16 *
2006-2012												
New Zealand	-11 †	0	-16 *	-6	-5	-7	0.54 †	0.51	0.55 *	0.52	0.01	0.02
Canada	10 †	6	-23 *	-26 *	-33 *	-32 *	0.47 †	0.48	0.57 *	0.57 *	0.10 *	0.09 *
Denmark	29 ‡	19	79 *	51 *	50 *	33 ‡	0.43	0.45	0.28 *	0.35 *	-0.15 *	-0.10 ‡
Italy	38 *	30 †	54 *	23 *	16	-7	0.39 *	0.41 †	0.36 *	0.44 *	-0.04	0.03
Luxembourg	51 *	43 *	33 *	7	-18 ‡	-36 *	0.36 *	0.38 *	0.41 *	0.48	0.05 ‡	0.10 *
Spain	55 *	52 *	46 *	11 †	-9	-41 *	0.35 *	0.37 *	0.37 *	0.47 †	0.01	0.10 *
Belgium	58 *	45 *	65 *	51 *	7	6	0.35 *	0.38 *	0.33 *	0.37 *	-0.02	-0.02
Netherlands	70 *	62 *	49 *	28 †	-21	-34	0.32 *	0.34 *	0.38 *	0.44	0.06	0.10 ‡
Germany	71 *	47 *	67 *	34 †	-4	-14	0.30 *	0.36 *	0.33 *	0.42 †	0.03	0.07
France	71 *	58 *	62 *	36 *	-9	-22	0.30 *	0.34 *	0.33 *	0.40 *	0.04	0.07 ‡
Austria	82 *	49 *	52 *	21 ‡	-30 †	-27 ‡	0.29 *	0.37 *	0.35 *	0.44 †	0.06	0.07
United Kingdom	87 *	99 *	15 ‡	8	-73 *	-91 *	0.27 *	0.24 *	0.46 ‡	0.48	0.18 *	0.23 *
Sweden	90 *	71 *	63 *	33 *	-27	-38 †	0.28 *	0.33 *	0.32 *	0.40 *	0.04	0.07
Norway	109 *	91 *	45 *	23 †	-64 *	-68 *	0.23 *	0.27 *	0.36 *	0.43 *	0.14 *	0.16 *

Notes: Achievement gap measures based on normalized scores are rounded to the nearest integer ∗, † and ‡ indicate achievement gap and achievement gap changes significance at 1, 5 and 10 percent levels, respectively.

Table A.2: Achievement Gap in Reading of Second Generation Migrants

	Normalized Score						Gastwirth Index					
	PIRLS		PISA		Δ Gap		PIRLS		PISA		Δ Gap	
	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj
2001-2006												
Canada	2	-3	-5	-10 †	-7	-7	0.49	0.50	0.51	0.53 †	0.03	0.03
United Kingdom	4	-1	0	-3	-4	-2	0.49	0.50	0.50	0.51	0.01	0.01
New Zealand	19 †	10	1	-7	-18	-17	0.44 †	0.47	0.50	0.52	0.06 ‡	0.05
France	41 *	17 †	29 *	11 ‡	-12	-6	0.38 *	0.45 †	0.42 *	0.47	0.03	0.02
Italy	45 *	47 *	-10	-13	-55 †	-60 †	0.37 *	0.37 *	0.53	0.53	0.15 †	0.17 †
Sweden	54 *	38 *	23 *	6	-30 *	-32 *	0.35 *	0.40 *	0.42 *	0.48	0.07 *	0.09 *
Norway	56 *	33 *	31 *	3	-26	-30 ‡	0.36 *	0.42 †	0.42 *	0.49	0.06	0.07
Germany	67 *	39 *	64 *	35 *	-3	-4	0.31 *	0.39 *	0.32 *	0.40 *	0.01	0.01
Netherlands	91 *	71 *	65 *	34 *	-26 †	-38 *	0.25 *	0.30 *	0.32 *	0.41 *	0.07 *	0.10 *
2006-2012												
New Zealand	16 *	26 *	17 *	10	1	-16 ‡	0.45 *	0.43 *	0.45 *	0.47 ‡	0.00	0.04 ‡
Canada	18 *	15 *	-7 †	-15 *	-25 *	-30 *	0.45 *	0.46 *	0.52 ‡	0.54 *	0.07 *	0.08 *
United Kingdom	36 *	41 *	5	5	-30 *	-37 *	0.39 *	0.38 *	0.47	0.48	0.08 *	0.10 *
Italy	41 *	42 *	30 *	11	-11	-31 †	0.38 *	0.38 *	0.42 *	0.47	0.04	0.10 *
Sweden	45 *	35 *	35 *	14 †	-11	-21 †	0.36 *	0.39 *	0.41 *	0.47	0.04 ‡	0.08 *
France	47 *	30 *	46 *	21 *	-1	-10	0.37 *	0.42 *	0.36 *	0.44 *	-0.01	0.02
Denmark	58 *	27 *	51 *	28 *	-7	1	0.33 *	0.42 *	0.36 *	0.42 *	0.02	0.00
Spain	61 *	62 *	42 *	17 ‡	-19	-45 *	0.31 *	0.31 *	0.38 *	0.45 ‡	0.07 ‡	0.14 *
Austria	66 *	42 *	40 *	6	-26 *	-36 *	0.32 *	0.38 *	0.39 *	0.48	0.07 *	0.10 *
Netherlands	70 *	58 *	55 *	25 *	-15	-33 *	0.30 *	0.33 *	0.35 *	0.43 *	0.05 †	0.10 *
Germany	77 *	45 *	41 *	19 *	-37 *	-26 †	0.28 *	0.36 *	0.38 *	0.45 *	0.10 *	0.08 *
Norway	78 *	65 *	28 *	8	-50 *	-57 *	0.30 *	0.33 *	0.42 *	0.47	0.12 *	0.14 *
Belgium	82 *	60 *	58 *	37 *	-24 *	-23 *	0.26 *	0.32 *	0.34 *	0.40 *	0.08 *	0.07 *
Luxembourg	83 *	63 *	39 *	7	-44 *	-56 *	0.26 *	0.31 *	0.39 *	0.49	0.13 *	0.18 *

Notes: Achievement gap measures based on normalized scores are rounded to the nearest integer ∗, † and ‡ indicate achievement gap and achievement gap changes significance at 1, 5 and 10 percent levels, respectively.

Table A.3: Achievement Gap in Reading: Second vs First Generation Migrants

	Normalized Score						Gastwirth Index					
	PIRLS		**PISA**		**Δ Gap**		**PIRLS**		**PISA**		**Δ Gap**	
	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj
2001-2006												
Netherlands	-23 ‡	-22 ‡	-5	2	18	24	0.57 ‡	0.56	0.51	0.49	-0.06	-0.07
New Zealand	-21	-12	-3	23 *	18	35 †	0.57 ‡	0.54	0.51	0.44 †	-0.06	-0.10 †
Italy	18	6	67 *	58 †	49 ‡	52	0.44	0.47	0.35 *	0.37 †	-0.08	-0.10
France	22 †	32 *	-4	7	-26	-25	0.43 †	0.40 *	0.51	0.48	0.08	0.08
Norway	27	31 ‡	0	-1	-26	-32	0.43	0.42	0.50	0.49	0.06	0.07
Germany	36 *	38 *	-25 †	-21 †	-61 *	-59 *	0.41 *	0.40 *	0.57 *	0.56 †	0.17 *	0.16 *
Sweden	38 *	27 †	31 *	25 †	-7	-2	0.39 *	0.42 †	0.41 *	0.43 †	0.02	0.01
Canada	55 *	52 *	9	11 ‡	-46 *	-41 *	0.35 *	0.36 *	0.48	0.47	0.12 *	0.11 *
United Kingdom	72 *	63 *	29 †	43 *	-43 *	-19	0.29 *	0.32 *	0.43 †	0.39 *	0.13 *	0.07
2006-2012												
Luxembourg	-32 *	-13	-6	1	26 †	14	0.59 *	0.54	0.51	0.49	-0.08 *	-0.04
Denmark	-29	-7	28 *	29 *	57 *	37 ‡	0.58	0.52	0.42 *	0.42 *	-0.16 *	-0.10
New Zealand	-26 *	-3	-33 *	-4	-7	-1	0.58 *	0.51	0.60 *	0.52	0.02	0.01
Belgium	-24 *	-15 †	7	16 ‡	31 *	32 *	0.57 *	0.55 †	0.48	0.46 ‡	-0.09 *	-0.09 *
Canada	-8	-1	-16 *	-15 *	-8	-13 ‡	0.52	0.50	0.55 *	0.55 *	0.03	0.05 †
Germany	-6	6	26 ‡	21	33 ‡	14	0.52	0.49	0.44	0.46	-0.08	-0.03
Spain	-6	-15	4	5	10	20	0.54	0.52	0.49	0.49	-0.04	-0.04
Italy	-3	-5	24 †	13	27	18	0.51	0.52	0.43 *	0.46	-0.08	-0.06
Netherlands	-0	19	-6	3	-6	-16	0.52	0.46	0.53	0.50	0.01	0.04
Austria	16	15	11	20	-4	5	0.45	0.45	0.46	0.44 ‡	0.02	-0.01
France	24 †	40 *	16	15	-8	-24	0.43 †	0.39 *	0.46	0.46	0.03	0.07
Norway	31 ‡	29	18	11	-14	-18	0.42 ‡	0.43	0.44 ‡	0.46	0.02	0.03
Sweden	44 *	44 *	28 *	26 †	-16	-18	0.40 †	0.40 †	0.41 *	0.41 *	0.01	0.01
United Kingdom	52 *	76 *	9	12	-42 *	-64 *	0.36 *	0.30 *	0.48	0.48	0.12 *	0.17 *

Notes: Achievement gap measures based on normalized scores are rounded to the nearest integer. $*$, † and ‡ indicate achievement gap and achievement gap changes significance at 1, 5 and 10 percent levels, respectively.

Table A.4: Achievement Gap in Reading of Mixed Migrants

	Normalized Score						Gastwirth Index					
	PIRLS		PISA		Δ Gap		PIRLS		PISA		Δ Gap	
	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj
2001-2006												
Norway	-6	-4	-5	1	1	5	0.52	0.51	0.51	0.50	-0.01	-0.02
New Zealand	-0	2	-11 *	3	-11	1	0.50	0.50	0.53 †	0.49	0.03	-0.01
United Kingdom	6	3	-10 †	5	-16 †	3	0.48	0.49	0.53 †	0.49	0.05 *	0.00
Canada	8 †	12 *	-16 *	-5	-24 *	-16 *	0.47 †	0.46 *	0.54 *	0.51	0.07 *	0.05 *
France	9	13 †	-9 ‡	-1	-18 †	-14 ‡	0.47	0.46 †	0.53 †	0.51	0.06 *	0.04 †
Netherlands	13 †	14 †	3	6	-10	-8	0.46 †	0.46 †	0.49	0.49	0.03	0.03
Sweden	14 *	11 †	3	2	-11	-8	0.46 *	0.47 †	0.49	0.49	0.03	0.02
Italy	25 *	27 *	-6	-4	-31 *	-32 *	0.44 *	0.43 *	0.52	0.51	0.08 *	0.08 *
Germany	29 *	20 *	25 *	20 *	-4	-0	0.42 *	0.44 *	0.42 *	0.44 *	0.01	0.00
2006-2012												
New Zealand	-1	19 *	-22 *	-2	-21 *	-20 *	0.50	0.45 *	0.56 *	0.50	0.06 *	0.06 *
Canada	2	7 ‡	-18 *	-9 †	-20 *	-15 *	0.49	0.48 †	0.55 *	0.52 †	0.06 *	0.04 *
Norway	7	11 †	0	9	-6	-2	0.47	0.46 †	0.50	0.48	0.03	0.02
Denmark	7	14 †	-7	2	-15 ‡	-12	0.48	0.46 †	0.52	0.50	0.05 ‡	0.04 ‡
Netherlands	8	20 *	17 *	18 *	8	-2	0.48	0.44 *	0.46 *	0.45 *	-0.02	0.01
Sweden	9	14 †	-1	6	-10	-8	0.48	0.47 †	0.50	0.48	0.02	0.02
United Kingdom	10 †	34 *	-25 *	-12 †	-35 *	-46 *	0.47 †	0.40 *	0.57 *	0.53 †	0.10 *	0.13 *
Austria	14 †	11 ‡	-4	0	-18 †	-10	0.46 †	0.47 ‡	0.51	0.50	0.05 †	0.03
Spain	17 †	30 *	4	4	-13	-26 *	0.46 †	0.42 *	0.49	0.49	0.04	0.07 *
France	17 *	19 *	8	8	-10	-11 ‡	0.45 *	0.44 *	0.48 ‡	0.47 ‡	0.03	0.03 ‡
Italy	21 *	26 *	-6 †	-2	-27 *	-28 *	0.44 *	0.43 *	0.52 ‡	0.51	0.08 *	0.08 *
Luxembourg	24 *	26 *	2	1	-21 *	-25 *	0.43 *	0.42 *	0.48	0.49	0.05 *	0.07 *
Germany	34 *	31 *	25 *	14 †	-8	-17 †	0.40 *	0.40 *	0.43 *	0.46 †	0.03	0.06 †
Belgium	42 *	39 *	27 *	26 *	-15 *	-13 †	0.38 *	0.39 *	0.42 *	0.43 *	0.04 *	0.03 †

Notes: Achievement gap measures based on normalized scores are rounded to the nearest integer ∗, † and ‡ indicate achievement gap and achievement gap changes significance at 1, 5 and 10 percent levels, respectively.

Appendix B Results in Mathematics

Table B.5: Achievement Gap in Math of First Generation Migrants

	Normalized Score						Gastwirth Index					
	TIMSS		PISA		Δ Gap		TIMSS		PISA		Δ Gap	
	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj
2007-2012												
Australia	-8	-14 ‡	-27 *	-32 *	-19 †	-18 †	0.52	0.54	0.57 *	0.59 *	0.05 ‡	0.05 ‡
New Zealand	1	-9	-26 *	-22 *	-27 *	-13	0.50	0.52	0.57 *	0.56 *	0.07 *	0.03
Canada	11 †	5	-19 *	-23 *	-30 *	-28 *	0.47 †	0.48	0.55 *	0.56 *	0.09 *	0.08 *
Italy	20 †	11	40 *	11 †	20 ‡	0	0.44 †	0.47	0.39 *	0.47 †	-0.05 ‡	0.00
Sweden	60 *	37 *	63 *	35 *	3	-2	0.33 *	0.39 *	0.32 *	0.40 *	-0.01	0.01
Norway	61 *	39 *	47 *	20 †	-14	-19	0.32 *	0.38 *	0.35 *	0.43 *	0.03	0.04
United Kingdom	64 *	43 *	11	-2	-53 *	-45 *	0.33 *	0.38 *	0.47	0.51	0.14 *	0.12 *
Denmark	77 *	60 *	93 *	70 *	17	10	0.30 *	0.34 *	0.24 *	0.30 *	-0.06	-0.04
Germany	79 *	38 *	63 *	35 †	-16	-2	0.28 *	0.38 *	0.34 *	0.41 †	0.06	0.03
Austria	82 *	55 *	57 *	28 *	-25 †	-27 †	0.27 *	0.34 *	0.34 *	0.42 *	0.06 †	0.07 †
Netherlands	94 *	80 *	57 *	37 *	-37 †	-42 *	0.24 *	0.28 *	0.34 *	0.40 *	0.10 *	0.12 *

Notes: Achievement gap measures based on normalized scores are rounded to the nearest integer ∗, † and ‡ indicate achievement gap and achievement gap changes significance at 1, 5 and 10 percent levels, respectively.

Table B.6: Achievement Gap in Math of Second Generation Migrants

	Normalized Score						Gastwirth Index					
	TIMSS		PISA		Δ Gap		TIMSS		PISA		Δ Gap	
	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj
2007-2012												
Australia	-40 *	-38 *	-42 *	-46 *	-2	-7	0.61 *	0.61 *	0.61 *	0.62 *	0.00	0.01
New Zealand	-8	-18 *	9	-2	17 †	16 ‡	0.52	0.54 †	0.47	0.50	-0.04 ‡	-0.04
Canada	-2	-5	7 †	1	9 ‡	6	0.50	0.51	0.48 †	0.50	-0.02	-0.01
United Kingdom	9	6	16 †	9	6	3	0.48	0.49	0.45 †	0.47	-0.02	-0.02
Norway	31 *	13	35 *	13 ‡	4	-0	0.40 *	0.45 ‡	0.40 *	0.46 ‡	0.00	0.01
Italy	36 *	29 *	21 *	3	-14	-25 †	0.40 *	0.42 *	0.44 *	0.49	0.04	0.07 †
Sweden	37 *	13 †	44 *	19 *	7	5	0.39 *	0.45 †	0.38 *	0.46 †	0.00	0.00
Austria	51 *	27 *	55 *	28 *	4	1	0.35 *	0.42 *	0.35 *	0.43 *	0.00	0.01
Germany	61 *	31 *	50 *	26 *	-11	-5	0.32 *	0.40 *	0.35 *	0.42 *	0.03 ‡	0.02
Denmark	62 *	45 *	68 *	47 *	6	2	0.33 *	0.38 *	0.31 *	0.36 *	-0.02	-0.02
Netherlands	68 *	58 *	56 *	30 *	-12	-29 †	0.32 *	0.35 *	0.34 *	0.42 *	0.02	0.07 †

Notes: Achievement gap measures based on normalized scores are rounded to the nearest integer ∗, † and ‡ indicate achievement gap and achievement gap changes significance at 1, 5 and 10 percent levels, respectively.

Table B.7: Achievement Gap in Math: Second vs First Generation Migrants

	Normalized Score						Gastwirth Index					
	TIMSS		**PISA**		**Δ Gap**		**TIMSS**		**PISA**		**Δ Gap**	
	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj
2007-2012												
Italy	-15	-11	19 †	9	34 †	20	0.55	0.54	0.45 †	0.47	-0.10 †	-0.07
New Zealand	9	8	-35 *	-15 ‡	-44 *	-23 †	0.48	0.49	0.59 *	0.54 ‡	0.11 *	0.05 ‡
Canada	13 †	12 †	-25 *	-23 *	-39 *	-35 *	0.47 †	0.47 †	0.57 *	0.57 *	0.11 *	0.10 *
Denmark	14	12	25 *	24 *	11	12	0.46	0.47	0.43 *	0.43 *	-0.04	-0.04
Germany	19 †	12	13	4	-6	-8	0.45 †	0.46	0.47	0.49	0.02	0.03
Sweden	23 †	23 †	19 †	18 ‡	-4	-5	0.43 †	0.43 †	0.44 †	0.44 †	0.01	0.01
Netherlands	26 †	17	2	8	-25	-9	0.44 ‡	0.47	0.49	0.47	0.05	0.01
Norway	30 †	24	12	2	-18	-22	0.42 †	0.43	0.45	0.48	0.04	0.04
Austria	31 *	29 *	2	4	-29 †	-26 ‡	0.40 *	0.41 *	0.49	0.48	0.08 †	0.08 †
Australia	32 *	24 †	15 *	13 †	-17	-11	0.41 *	0.43 †	0.46 *	0.47 †	0.05 ‡	0.04
United Kingdom	54 *	42 *	-5	-11	-59 *	-53 *	0.36 *	0.39 *	0.52	0.53	0.16 *	0.14 *

Notes: Achievement gap measures based on normalized scores are rounded to the nearest integer. $*$, $\dagger$ and $\ddagger$ indicate achievement gap and achievement gap changes significance at 1, 5 and 10 percent levels, respectively.

Table B.8: Achievement Gap in Math of Mixed Migrants

	Normalized Score						Gastwirth Index					
	TIMSS		PISA		Δ Gap		TIMSS		PISA		Δ Gap	
	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj	Raw	Adj
2007-2012												
Australia	-2	-2	-15 *	-12 *	-12 †	-10	0.51	0.51	0.54 *	0.53 *	0.03 ‡	0.02
New Zealand	2	2	-21 *	-8 ‡	-23 *	-11 ‡	0.50	0.50	0.56 *	0.52 ‡	0.06 *	0.03
United Kingdom	5	6	-24 *	-16 *	-29 *	-22 *	0.49	0.48	0.57 *	0.55 *	0.09 *	0.07 *
Canada	12 *	12 *	-9 †	-2	-20 *	-14 *	0.47 *	0.46 *	0.52 †	0.50	0.06 *	0.04 *
Denmark	12	11	6	11 ‡	-5	-1	0.46	0.47	0.49	0.47	0.02	0.01
Sweden	13 †	6	3	6	-9	-1	0.46 †	0.48	0.49	0.49	0.03	0.01
Norway	16 †	16 †	0	6	-16 ‡	-10	0.45 †	0.45 †	0.50	0.49	0.05 †	0.03
Austria	21 *	16 *	6	9	-15 ‡	-6	0.45 *	0.46 †	0.49	0.48	0.05 ‡	0.02
Italy	28 *	27 *	-9 *	-6 ‡	-36 *	-32 *	0.43 *	0.43 *	0.53 *	0.52 †	0.10 *	0.09 *
Netherlands	31 *	28 *	22 *	20 *	-10	-8	0.41 *	0.42 *	0.44 *	0.45 *	0.04	0.03
Germany	43 *	26 *	32 *	18 *	-11	-8	0.37 *	0.42 *	0.41 *	0.45 *	0.04	0.03

Notes: Achievement gap measures based on normalized scores are rounded to the nearest integer ∗, † and ‡ indicate achievement gap and achievement gap changes significance at 1, 5 and 10 percent levels, respectively.

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