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# The Impact of Immigrant Peers on Native Students' Academic Achievement in Countries Where Parents of Immigrants Are Relatively Skilled

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# ABSTRACT

# The Impact of Immigrant Peers on Native Students' Academic Achievement in Countries Where Parents of Immigrants Are Relatively Skilled

This study examines how exposure to immigrant students affects the academic achievement of native students in the three largest immigrant-receiving countries – United States, Australia, and Canada. Using a large cross-country dataset, variation in the share of immigrant children between different grade levels within schools is exploited to identify the impact of immigrant peers. I find that exposure to immigrant children has dissimilar effects on native students' achievements across the three countries. While exposure has a positive impact on Australian natives, it has a negative impact on Canadian natives. Exposure has no effect on U.S. natives. More importantly, I find that institutional factors, such as the way in which countries organise their educational systems, have a crucial bearing on how immigrant students affect their peers.

JEL Classification: I21, J15

Keywords: academic achievement, immigrant children, peer effects, within-school estimation

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# 1 INTRODUCTION

Over the past three decades, developed countries have witnessed a dramatic increase in the number of incoming international migrants. A product of this movement has been the rising enrolment of immigrant students and concomitant changes in the ethnic and nativity composition of students in schools and classrooms of the receiving countries (Betts and Fairlie, 2003; Jensen and Rasmussen, 2011; OECD, 2012; Brunello and Rocco, 2013).

One question which is of relevance for the receiving country's education policy is whether the presence of immigrant students has an effect on the academic performance of peers in the same learning environment. Despite the importance of such knowledge for policy-making, research on this issue is scant. The small number of existing studies examining the effects that immigrant students have on the educational outcomes of peers has, until now, been largely based on evidence from countries where the skill composition of immigrants relative to natives is low (Szulkin and Jonsson, 2007; Gould et al., 2009; Neymotin, 2009; Jensen and Rasmussen, 2011; Hardoy and Schøne, 2013; Ohinata and van Ours, 2013; Schneeweis, 2013; Hermansen and Birkelund, 2015). These studies generally find that exposure to immigrant students has either negative or no effects on peers' academic achievement[1]. Apart from a study by Friesen and Krauth (2011), no attempt has been made to examine the effects of such children in countries where migrants are, on average, more skilled than natives (e.g. in Canada, Australia, or New

[1] Exceptions are Neymotin (2009), Ohinata and van Ours (2013), and Hermansen and Birkelund (2015), who find some patchy evidence that exposure to immigrant children have positive impacts on native students' educational outcomes.

Zealand[2])[3]. Yet, one would expect immigrant peer effects to be quite different, possibly even positive, given that the school-going immigrant population in these countries tend to be from more privileged socioeconomic backgrounds.

Results from a study by Schnepf (2006) reveal that the socioeconomic backgrounds of immigrant children in countries that typically attract high-skilled migrants tend to be similar to or even surpass those of native children. Immigrant children in such countries also perform either no differently or only marginally poorer, academically, compared to their native counterparts. By contrast, immigrant children in countries that generally receive less-skilled migrants tend to be markedly less advantaged socioeconomically than native children. They also tend to perform considerably worse in school.

Because the immigrant children who are at the focus of existing studies typically come from less-privileged backgrounds, peer socioeconomic composition and school immigrant concentration are likely to be negatively correlated in these studies (Jensen and Rasmussen, 2011). Since most studies in the immigrant peer effects literature ignore modelling explicitly the effects

[2] Unlike in most other high immigration countries, the average educational level of immigrants in Canada, Australia, and New Zealand stand out as being much higher than that of natives. See, for example, Antecol et al. (2003).

[3] Though Friesen and Krauth (2011) provides some indication on the possible effects of immigrant peers in a country where the migrant population tends to be relatively skilled, the results are not generalisable. There are 2 reasons for this. Firstly, the study focuses only on the effects of 2 specific groups of immigrant students – those that speak Chinese and those that speak Punjabi at home. This hardly covers the universe of immigrant students in their country of study (Canada). Secondly, the evidence is based on student experience in British Columbia and may not be representative of student experience in the other Canadian provinces.

which are due to the socioeconomic backgrounds of immigrant schooling peers, the estimated effects documented in these studies will also include any effects which are due to the unfavourable socioeconomic characteristics of migrant peers. Since the estimates capture a "total treatment effect", the findings may not be generalisable to those countries where immigrant children are, on average, from more-privileged socioeconomic backgrounds.

Given the above considerations, the objective of this study is to fill the gap in the literature by examining whether the negative immigrant peer effects documented in much of the literature still persists when immigrant students have relatively higher-skilled parents than native students.

Specifically, 4 research questions are addressed in this study:

(1) How do first-generation immigrant peers affect the Mathematics and Science achievements of native students if parents of immigrants are, on average, more skilled than those of natives?

(2) How does student achievement vary with the share of immigrant peers?

(3) If immigrant peers indeed have spill-over effects on the academic achievements of natives, what are the mechanisms behind these effects?

(4) Do institutional factors, such as the way in which countries organise their educational systems, have an influence on the peer effects exerted by immigrants?

While there have been a small number of previous studies which have tried to investigate whether academic achievement and the share of immigrant peers varies non-linearly[4], none have attempted to entirely relax the linearity

[4] These include Gould et al. (2009), Schneeweis (2013), Szulkin and Jonsson (2007), and Hardoy and Schøne (2013). Gould et al. (2009) and Schneeweis (2013) allow for a quadratic relationship between the grade share of

assumption by using non-parametric regression methods to recover the underlying functional relationship between these variables. The present study will be the first to model any possible non-linearity this way. Existing studies also rarely investigate how and why immigrant peer effects arise. With the exception of Hardoy and Schøne (2013) and Ohinata and van Ours (2013), no other study I know of has attempted to investigate the mechanisms behind these effects. The present research is among the few which attempts to study whether the peer effects are possibly generated by differences in the language ability of immigrants and educational attainment of their parents. The final research question adds to the literature most appreciably. To my knowledge, no study has yet examined the relationship between immigrant peer effects and educational institutions. Yet, the fact that educational policies and institutions have been found to affect the relative academic achievement of immigrants (Schneeweis, 2011; Cobb-Clark et al., 2012) implies that it may be possible for institutional factors to influence the way in which immigrant students affect others.

In this study, we are interested in examining the peer effects only from *first-generation immigrant students*. Given that differences in attributes (e.g. differences in language ability and/or host-country-specific human capital) are likely to be sharper between native students and first-generation immigrant

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immigrants and student outcomes. On the other hand, Szulkin and Jonsson (2007) and Hardoy and Schøne (2013) first create dummy variables for the shares of immigrant peers by grouping these into arbitrarily-sized bins (e.g. 0-5%, 5-10% immigrants and so on) before regressing student outcomes on these dummies to allow for non-linearities. Both approaches have their disadvantages. The former approach restricts the possible functional relationships analysed to only quadratic and linear forms while the conclusions yielded by the latter approach are sensitive to the base category specified and to the size of the bins used to group the migrant shares.

students than between native students and later generations of immigrant students, these students constitute a particularly interesting group to study. Hence, throughout the rest of this paper, immigrants refer to first-generation migrants – that is, all students not born in the country where the test was conducted[5]. Note also that, throughout the paper, the level of skills possessed by parents is proxied by their educational attainment.

The study proceeds by providing an international comparative study of the peer effects generated by migrants in 3 major immigrant-receiving countries – Australia, Canada, and the United States. Because parents of immigrants in the U.S. are, on average, lower-skilled than parents of natives whilst parents of immigrants in Australia and Canada are, on average, higher-skilled than parents of natives, a comparison of the immigrant peer effects across these 3 countries will provide an indication on whether exposure to immigrant peers is indeed less adverse when the parents of migrants are relatively high-skilled.

The empirical analysis is based on data from the Third International Mathematics and Science Study of 1995. This dataset provides, for all 3 countries, information on the nativity statuses and Math and Science abilities of students from 2 adjacent grades within sampled schools. This allows me to exploit plausibly exogenous variation in the share of immigrants across

[5] I do not further restrict first-generation migrants to those who have at least 1 foreign-born parent because foreign-born children born abroad of 2 native-born parents may also have missed out on certain educational experiences specific to the country during their time of absence. Hence, they are also of interest to this study. In any case, the results do not differ substantively when the definition of first-generation migrant students is restricted to those who were born-abroad and who had at least 1 foreign-born parent.

adjacent grades within schools to identify the causal impact of immigrant peers on natives' academic achievement.

The identification strategy employed is an improvement over a number of those previously used in the literature. Studies in the literature have used within-school between-class variation in the share of immigrant pupils (Ohinata and van Ours, 2013) and instrumental variable (IV) strategies (Jensen and Rasmussen, 2011) to address the potential endogeneity in the variable measuring the degree of exposure to immigrant pupils. However, these approaches face various methodological issues. The former approach requires a strong assumption that students are randomly assigned across classes within schools while the latter approach requires the difficult task of finding a variable which is correlated with the share of immigrant peers but which otherwise is unrelated to student achievement. Jensen and Rasmussen (2011) suggest using immigrant concentration in a larger geographical area as an instrument for immigrant concentration in the school. However, the suggested variable is unlikely to satisfy the requirements needed for an IV since previous studies have shown that it is possible for the characteristics of the larger community to have a direct influence on students' educational outcomes (see, for instance, Ainsworth (2002)). In comparison, the identification strategy used in this paper requires only a relatively weak assumption that variations in the share of immigrants between grades in schools are random.

There are a number of reasons why the presence of immigrant children can have an effect on the academic achievements of native peers. Firstly, coming from a different country and culture, immigrant children may possess different language skills, knowledge, aspirations, and attitudes towards education. Through socialisation within the same learning environment, transmission of skills and educational aspirations between migrants and natives can result (Szulkin and Jonsson, 2007). Since immigrant students may possess more positive attitudes towards learning and/or perform academically

better than native students, this channel allows for immigrants to have a positive impact on peers' learning experiences.

Secondly, immigrant students generally possess a poorer command of the host society's native language. As a result, teachers may slow the pace of instruction more than they otherwise would in order to accommodate them (Hunt, 2012). It is also possible that teachers may alter their pedagogical methods, using less language-intensive methods to deliver their lessons (Betts and Fairlie, 2003). These could either enhance or hinder the learning experiences of those studying with immigrants, though the latter seems more likely. Immigrant students may also divert teaching resources away from other students if teachers allocate a greater amount of class time providing individual assistance to them.

Taken together, it seems unclear whether the presence of immigrant students will have a net beneficial or adverse effect on peers' academic achievement. The overall effect of exposure to immigrant peers is therefore an empirical question.

The results from this study indicate that exposure to immigrant students does have an effect on the academic achievement of peers. In particular, results from both non-parametric regressions and school fixed effects estimations suggest that while exposure to immigrant peers has a positive impact on the Math achievement of Australian natives, it has a negative impact on the Math achievement of Canadian natives. There is no evidence that exposure to immigrant peers has an effect on the academic achievement of U.S. natives. Interestingly, the result for Canada suggests that even if immigrant students have more educated parents than natives, this does not guarantee that immigrants will have non-adverse impacts on the academic achievements of peers. Additional tests to uncover the mechanisms behind the respective peer effects reveal that the peer effects of migrants are more adverse when they are non-native speakers of the test language and when they

have less-educated parents. Hence, within countries, an improvement in the quality of immigrant children (as measured by language proficiency and parental education) will likely mitigate any negative effects or enhance any positive effects which these students may have on the educational outcomes of natives.

Because it is surprising that immigrants in Australia and Canada exert such different impacts (given the similarity in immigrant selection criteria of both countries), I additionally conduct an analysis to examine whether differences in the peer effects of immigrants may be explained by differences in the way educational systems are organised across countries. I find that the peer effects of immigrants are more positive when schools have greater autonomy over the setting of curriculum, when the share of immigrant students who speak the test language frequently at home is higher, and when immigrant children arrive in the host country at younger ages. This finding – that "institutional context matters" – is a novel one in the immigrant peer effects literature.

The findings from this study will be useful for education policy-makers because it enables them to know whether country immigration policies (e.g. policies aimed at increasing the educational attainments of incoming migrants) and educational institutions have an influence on the way migrant students affect their peers.

## 2 DATA

The data used in this paper is from the Third International Mathematics and Science Study (TIMSS 1995)[6]. TIMSS 1995 is an international study

[6] Available online from: http://www.iea.nl/data.html. This study was renamed the "Trends in International Mathematics and Science Study" after 1995.

which was conducted across more than 40 countries in 1995. The aim of the study is to assess the Mathematics and Science achievements of students in 5 grade levels (3rd, 4th, 7th, and 8th grades and the grade constituting the final year of secondary education) of the participating countries.

Because background characteristics are deemed important in explaining academic performance, TIMSS 1995 also fielded questionnaires to students in order to collect contextual information. Among other things, the student questionnaire sought information regarding each student's demographic characteristics (e.g. sex, age, migration status, age at arrival to the country if the child was born abroad) and family background (e.g. educational attainment of each parent, number of books at home, number of people living in the home, whether the test language is frequently spoken at home, whether the child lives with both parents).

Although data on student achievement are available for 5 grade levels, I focus my study on examining student achievement in only the 7th and 8th grades. While the 1995 wave is not the most up-to-date version of TIMSS, it does provide a very unique advantage. In particular, it is the only internationally comparable dataset which provides achievement and migration information on students from 2 different grades of the same school. This makes it well-suited for the identification strategy employed in this paper (this will be discussed in Section 3). No other datasets which I am aware of – not even the subsequent waves of TIMSS[7] – fulfil the strict data requirements needed to implement the empirical strategy proposed.

[7] The other waves of TIMSS (i.e.1999, 2003, 2007, and 2011 waves) assess the academic achievements of students belonging to only 2 grade levels (4th and 8th grade). Students in the 4th and 8th grades are typically not drawn from the same school, making within-school type comparisons infeasible.

TIMSS 1995 employed a two-stage sampling design. In the first stage, schools were sampled with a probability proportional to school size. In the second stage, intact classes of students were randomly selected from within the sampled school. Generally, within each school, one classroom would be randomly selected from the 7th grade and another would be randomly selected from the 8th grade. Because each respondent provides information on his/her nativity status (whether born abroad or born in the country of test), one is able to identify whether a particular observation is an immigrant student. This information allows one to construct the key variable of interest – a variable measuring the share of immigrant students in the 7th and the 8th grade of each school[8]. In all subsequent analyses, I define immigrant students as all those born abroad.

[8] The share of immigrant children in each grade (both 7th and 8th) of a school is calculated as follows: First, each student is weighted by the product of the class weighting factor (inverse of the probability of selection of the classroom within a school), the student weighting factor (inverse of the probability of selection of a student within a classroom), and the student weighting adjustment (adjustment to account for non-participating students in the selected classroom). Next, for each grade in a particular school, the proportion of immigrant students to all students is computed, applying the abovementioned weight. All results are similar if I had instead restricted my sample to only those schools with one class per grade. In this case, the share of immigrant children in the 7th grade class would be akin to the share of immigrant children in the 7th grade of the school. Likewise, the share of immigrant children in the 8th grade class would be akin to the share of immigrant children in the 8th grade of the school. The disadvantage of the latter analysis, though, is that very few schools (and hence, student observations) would remain in the sample, leading to large standard errors in the impact estimates.

## 2.1 Sample

The dataset consists of individual-level student observations. A total of 12,852, 16,581, and 10,973 student observations from 161, 380, and, 183 schools are available respectively for Australia, Canada, and the U.S.. The number of foreign-born observations in each of the 3 countries is sizeable. Of the 12,578 student observations which had non-missing responses on the country of birth in the Australian dataset, 1,401 observations are foreign-born while the rest (11,177) are native-born. Of the 16,232 student observations which had non-missing country of birth information in the Canadian dataset, 1,326 are foreign-born while the rest (14,906) are native-born. Similarly, of the 10,774 student observations in the U.S. dataset which had non-missing responses on the country of birth, 938 are foreign-born while the rest (9,836) are native-born. These figures are consistent with the fact that these 3 countries have been successful in attracting considerable numbers of foreign students.

Since I am mainly interested in investigating whether the exposure to immigrant peers has an effect on the academic achievements of native students, I restrict my analytic sample to those students who reported their country of birth in the background questionnaires. All students who omitted providing a response as to whether or not they were born in the country of test were excluded. Finally, I link each student observation to the share of foreign-born children in his/her grade in school.

## 2.2 Measuring Student Achievement

Student achievement is measured using the subject plausible values (plausible value 1) in TIMSS 1995. To minimise the burden on participating students, each student was only required to complete 1 of 8 possible test booklets. Plausible values are estimates of the achievement scores that

students would have obtained if they had completed an assessment consisting of all the items in the 8 test booklets. They are derived using multiple imputation methods. Throughout this paper, test scores are normalised within each country and subject, to a mean of 0 and a standard deviation of 1 so that the values presented can be interpreted as fractions of a standard deviation.

## 2.3 Parental Education of Immigrant and Native Children

<Insert Table 1 here>

To ascertain if the parents of immigrants in Australia and Canada indeed have higher average educational attainments than those of natives, I compute the share of students having fathers who have not completed secondary education and the share of students having fathers who have at least some university education, separately for the group of immigrant students and native students, by country. These are found in Table 1. As expected, the share of those having fathers with at least some university education is notably larger for immigrant students than for native students in Australia and in Canada, indicating that immigrants in these countries have relatively higher educated parents. As for the United States, although the share of those having fathers with at least some university education is similar for immigrants and natives, a larger proportion of immigrant students have fathers that have not completed secondary education. Therefore, on average, immigrant students in the U.S. have relatively lower educated parents than native students. These findings match those previously found from census data in Antecol et al. (2003).

## 2.4 Preliminary Analysis

Most studies in the immigrant peer effects literature assume the existence of a linear relationship between student test scores and the degree of

exposure to immigrant peers. However, there is no reason *a priori* to believe why a linear relationship should hold. In this section, I relax the linearity assumption entirely and, instead, let the data characterise the functional relationship underlying the variables.

<Insert Figure 1 here>

Figure 1 presents results from non-parametric regressions (locally weighted smoothed scatterplots), showing the relationship between native students' Math test scores and the share of immigrant peers in each of the 3 countries[9]. Panel A of the Figure depicts the relationship between the average Math test scores achieved by native students in a school-grade and the share of immigrant students in the school-grade. For Australia, average Math achievement increases with the share of immigrant grade peers throughout most of the distribution. For Canada, average Math achievement rises initially until the share of immigrant students in the school-grade reaches a non-zero value. Thereafter, it falls as the share of immigrant grade peers increase. For the U.S., average Math achievement falls with the share of immigrant grade peers until the value of this share reaches roughly 0.38. Thereafter, it remains constant as the share of immigrant grade peers increase.

Because the above relationships could be driven by selective enrolment into schools (for example, native students with lower abilities could have a tendency to sort into schools with higher shares of immigrants), I next present results from non-parametric regressions showing the relationships between differences in the share of immigrant students across adjacent grades of a school and differences in grade average native Math test scores. These are provided in Panel B of Figure 1. Because variation in the shares of immigrants

[9] In Figures 1 and 2, grade effects are partialed out semi-parametrically prior to estimation. The bandwidth is set to 0.4 for all regressions. I chose the smallest bandwidth that provided me with a relatively smooth curve.

between adjacent grades of each school are used to identify the peer effects of immigrants, the relationships depicted in this panel account for the non-random sorting of students between schools.

The figures in Panel B of Figure 1 indicate that when school differences are taken into account, average Math achievement of native Australian students still rise with the share of immigrant students in the school-grade. Similarly, for Canada, average native Math achievement still falls with the share of immigrant peers[10]. However, for the U.S., the negative correlation between average native Math achievement and the share of immigrant peers disappears and there now appears to be no relationship between them. This suggests that in the U.S., academically weaker students tend to attend schools with larger shares of immigrants. This comparative exercise highlights the importance of using across-grade variation in immigrant shares within schools to identify the causal effects of immigrant peers. The within transformation plots provide preliminary evidence that while exposure to immigrant peers hurts the Math achievement of Canadian students, it actually benefits the Math achievement of Australian students. Math achievements of American students do not appear to be affected by the presence of immigrant peers.

The results from non-parametric regressions showing the relationships between native students' Science test scores and the share of immigrant peers

[10] Throughout most of the distribution, the relationship between the grade share of immigrants and the grade average Math test scores is negative. The part of the curve to the left of -0.2 and to the right of 0.2 (of the horizontal axis) can, for practical purposes, be ignored since the difference in the shares of immigrants across the 2 grades in the vast majority of schools in the sample does not exceed 0.2 in absolute value. As such, the regression function is likely to be poorly estimated at both tails of the distribution where the absolute difference in the share of immigrants exceeds 0.2.

are displayed in Figure 2. The estimated relationships are very similar to those found in Figure 1. Accordingly, results for Math achievements apply as well to Science.

<Insert Figure 2 here>

Because the relationships between school-grade average test scores and school-grade immigrant shares appear to be reasonably well approximated by a linear function and because the aggregate results presented in this section could mask compositional differences in the student population across both grades, I next turn towards estimating linear models with individual-level data.

## 3 EMPIRICAL STRATEGY

If students were randomly assigned to schools and classes, identifying the causal effect of exposure to immigrant peers would be straightforward. Suppose we were interested to know how the share of immigrant children in a school or class affects the academic performance of peers, we could obtain an estimate of this effect by performing an OLS regression of test scores on the share of immigrant children studying in the school or class. The coefficient on the variable measuring the share of immigrants would then provide an unbiased estimate of the causal effect of exposure to immigrant children.

In practice, however, estimating the causal effect of immigrant students is more challenging. This is because students are neither randomly assigned across schools nor across classrooms within schools. Often, parents choose the neighbourhoods to settle in as well as the schools to send their children to. School administrators may also place students into classes in accordance with their demonstrated academic potential or prior academic achievements.

The potential non-random sorting of immigrant and native students across schools and across classrooms within schools implies that the

unobserved determinants of student achievement may be correlated with the share of immigrant students in schools and classes. As such, OLS estimators of the achievement effect of immigrant peers are likely to be biased.

To address the potential endogeneity arising from the non-random sorting of students *across* schools as well as across classrooms *within* schools, this paper employs a combination of 2 strategies. The first involves aggregating our measure of immigrant concentration to the school-grade level. This eliminates the bias due to the non-random sorting of students, by immigrant status, across classes *within* schools (in any particular grade). The second involves identifying the effect of having immigrant peers in a school-grade by relating variations in the academic performance of students over 2 adjacent grades – grade 7 and grade 8 – of each school to variations in the share of immigrant students over the 2 grades of the school.

To elucidate, consider the educational production function:

$$y_{igs} = \boldsymbol{X}'_{igs}\beta + \delta I_{gs} + (\alpha_g + \alpha_s + \varepsilon_{igs}) \qquad (1)$$

Where $y_{igs}$ denotes the academic performance of student $i$ from grade $g$ of school $s$. $\boldsymbol{X}_{igs}$ denotes a vector of individual and family background characteristics for the student. $I_{gs}$ denotes the share of immigrant children in grade $g$ of school $s$. The error, $(\alpha_g + \alpha_s + \varepsilon_{igs})$, is a composite given by 3 terms: $\alpha_g$ and $\alpha_s$ respectively reflect unobserved grade and school characteristics which are correlated with both $I_{gs}$ and $y_{igs}$ while $\varepsilon_{igs}$ denotes a mean zero random error term. Of interest here is the parameter, $\delta$, which captures the *effect of the share of immigrant peers in a school's grade on the academic performance of students in that school's grade*.

In order to eliminate any bias due to the non-random sorting of students across schools, the unobserved school heterogeneity, $\alpha_s$, has to be removed

prior to estimation. To do this, equation (1) is first averaged over all students in each school, $s$, to yield:

$$\overline{y_s} = \overline{\boldsymbol{X}_s'}\beta + \delta\overline{I_s} + \alpha_s + \overline{\varepsilon_s} \qquad (2)$$

Subtracting (2) from (1) then yields:

$$y_{igs} - \overline{y_s} = \left(\boldsymbol{X}_{igs}' - \overline{\boldsymbol{X}_s'}\right)\beta + \delta\left(I_{gs} - \overline{I_s}\right) + \alpha_g + \left(\varepsilon_{igs} - \overline{\varepsilon_s}\right) \qquad (3)$$

In the transformed equation (3), our parameter of interest remains unchanged: $\delta$. In addition to the interpretation given before, $\delta$ can now also be interpreted as measuring how variations in student test scores around the mean test score for each school are related to variations in immigrant shares around the mean immigrant share for each school. Clearly, for this identification strategy to be implemented, data on student test scores and immigration shares from at least 2 grades of each school are required. The dataset that I use fulfils these unique requirements since it provides me with information on the test scores and nativity statuses of students from the 7$^{th}$ and the 8$^{th}$ grades of each sampled school. The assumption used to identify the effect of immigrant peers is that any variation in the share of immigrants over the 2 grades is due entirely to random demographic differences between age cohorts in schools. This identification strategy is closely related to the one employed by Wößmann and West (2006). In particular, that study also uses variation in educational inputs between grade-levels of a school in order to identify the effects of particular educational inputs on student achievement. Our approaches towards addressing within-school sorting differ, however. While Wößmann and West use an IV strategy to address the potential endogeneity in their main variable of interest (class size) arising from the non-random placement of students across classes within schools, the present study uses a strategy of aggregating the main variable of interest to a level such that the effect estimates are not biased by such sorting patterns. (i.e. immigrant share is measured at the school-grade level).

The empirical strategy used will allow one to capture causal effects as long as parents do not react to a high concentration of immigrant students in a particular grade by moving their children to another school. The estimates would be biased otherwise. The direction of the bias will depend on the types of native students who move. If the natives who move are the higher-achieving ones, then our estimates will be subject to a negative bias (i.e. we will overestimate the negative effects, or alternatively, underestimate the positive effects of immigrant students). On the other hand, if the natives who move are the lower-achieving ones, then our estimates will be positively biased.

# 4 RESULTS

<Insert Table 2 here>

Summary statistics of all variables included in the estimations are presented for the samples of native students in Table 2. There are marked differences in the share of immigrant children which native students are exposed to in the 3 countries. On average, natives in the Australian sample have the highest share of immigrant peers in their grade level in school whilst natives in the Canadian sample have the lowest. The educational attainment of native parents is also quite different across the 3 countries. Canadian natives have the most educated parents, with 35.6% and 33.4% respectively having fathers and mothers who completed university. U.S. natives come next, with corresponding values of 27.2% and 23.7%. Australian natives have the lowest proportion of university educated parents, with only 24.9% and 20.9% respectively having fathers and mothers who completed university.

<Insert Table 3 here>

Table 3 presents results from a variety of regressions showing the estimated effect of the share of immigrant grade peers on the Math and Science achievements of native Australian, Canadian, and U.S. students[11]. For each subject, 3 columns of results are displayed. The first column shows estimates from the most basic specification: an OLS specification that controls only for grade fixed effects. The second column shows the estimates when school fixed effects are included in the regressions. By including school fixed effects, the coefficient on the immigrant share variable is identified on the basis of variation in the exposure to immigrant peers across adjacent grades within schools. Hence, the results in the second column are free from any bias due to the non-random sorting of students across schools. Finally, the third column shows estimates from the most comprehensive specification. This specification controls for student[12] and family background[13] characteristics

[11] The full set of coefficient estimates for the regressions in Table 3 can be found in Appendix Tables A1 and A2.

[12] Included in the set of student characteristics are dummy variables for the student's sex (male or female) and whether the student speaks the test language frequently at home (this dummy is set to 1 if the student reports always or almost always speaking the test language at home). It also includes a continuous variable indicating the student's age (measured in months).

[13] Included in the set of family background characteristics are dummy variables for the highest level of education attained by the student's mother and father, the number of books in the student's home, and whether the student lives with both parents. It also includes a continuous variable indicating the total number of people living in the student's home. Observations may fall into 1 of 6 parental education categories: Father (Mother) had at most primary education or less; Father (Mother) had some secondary education; Father (Mother) completed secondary education; Father (Mother) had some / completed vocational education; Father (Mother) had

(which may be correlated with both the share of immigrant grade peers and subject test scores) in addition to grade and school fixed effects.

In all analyses, I present standard errors which are clustered at the school level to correct for arbitrary correlations in individual error terms within schools[14].

For Australia, the coefficient estimate in column (1) of Table 3 indicates that the Math achievement of native students is positively associated with the share of immigrant peers in the grade. Specifically, a 10 percentage point increase in the grade share of immigrants is associated with a 0.091 standard deviation increase in the Math test score (this relationship is statistically significant at the 5% level). The estimated effect increases slightly in magnitude when school fixed effects are incorporated in the regression, indicating that academically weaker Australian students tend to attend schools with larger concentrations of immigrants. The estimate does not change much when student and family background characteristics are additionally controlled for. The estimate in column (3) suggests that a 10 percentage point rise in the grade share of immigrants increases native Math test scores by about 0.094 standard deviations (significant at the 5% level). Is this effect sizeable? Recall from table 2, that the mean and standard deviation of the share of immigrant students in a grade for Australia are 10.0% and 8.9% respectively. So the values imply that increasing the share of immigrants in a grade by 1 standard

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some university education; Father (Mother) completed university education. Observations may fall into 1 of 5 categories with regards to the number of books owned: 0-10; 11-25; 26-100; 101-200; or more than 200 books at home.

[14] Throughout the paper, all regressions are un-weighted. A comparison reveals that weighting has very little effect on either the point estimates or standard errors.

deviation leads to a 0.084 standard deviation improvement in test scores[15]. So the estimated effects, while non-zero, are arguably small.

For Canada, the coefficient estimate in column (1) of Table 3 indicates that the share of immigrant students in the grade is negatively related to natives' Math test scores (this relationship is statistically significant at the 5% level). A 10 percentage point increase in the grade share of immigrants is associated with a 0.044 standard deviation decrease in natives' Math test score. When across-school sorting is accounted for through inclusion of school fixed effects, the coefficient on the immigrant share variable increases slightly in magnitude. This indicates that, in Canada, academically more-able students tend to sort towards schools with greater concentrations of immigrants. The estimate further increases slightly in magnitude when individual and family background attributes are controlled for. The estimate in column (3) suggests that the share of immigrant grade peers has a negative and statistically significant (at the 10% level) impact on the Math test scores of natives. A 10 percentage point increase in the share of immigrant grade peers is estimated to lead to a 0.056 standard deviation decline in the Math test score of natives.

For the U.S., the coefficient estimate in column (1) indicates that native Math achievement is negatively related to the share of immigrant peers in the grade. However, the estimate in column (2) reveals that this association is

[15] An alternative approach is to consider that the school-grade at the 50$^{th}$ percentile of the immigrant share distribution had 7.4% immigrants while that at the 75$^{th}$ percentile had 14.6% immigrants. This immigrant share difference is 7.2 percentage points or 0.81 (=7.2/8.9) standard deviations. The estimate implies that an increase in the share of immigrants which is sufficient to move a school-grade from the 50$^{th}$ to the 75$^{th}$ percentile of the immigrant share distribution would only result in a 0.068 (=0.81×0.084) standard deviation improvement in Math test score.

actually an artefact of the non-random sorting behaviour of students across schools. Once school differences are accounted for, the statistically significant relationship between the variables disappears and the coefficient falls to essentially zero. This result is unaltered when controls for individual and family background characteristics are added (column (3)).

The above analysis suggests that while exposure to immigrant peers has a positive impact on the Math achievement of Australian students, it has a negative impact on the Math achievement of Canadian students. There is no evidence that exposure to immigrant peers has an effect on the Math achievement of U.S. students. These results are consistent with those from non-parametric regressions.

The estimated peer effects of immigrants on natives' Science test scores are displayed in columns (4) to (6) of Table 3. As can be seen, for all 3 countries, the patterns described for Math achievement apply similarly to Science. Exposure to immigrant peers is shown to have a positive effect on the Science achievement of Australian students and a negative effect on the Science achievement of Canadian students. Here again, exposure to immigrant peers has no impact on the Science achievement of U.S. students. However, the size of the estimated peer effects are much smaller for Science achievement. In fact, none of the estimates from the most comprehensive specification (column (6)) are statistically significant. Hence, at least for the countries considered, immigrant peers appear to have a larger influence on the Math achievements compared to the Science achievements of natives[16].

[16] None of the conclusions described for Table 3 changes even when log-linear or log-log specifications are used.

## 4.1 Mechanisms Explaining Immigrant Peer Effects

In this section, I investigate the possible pathways leading to the observed immigrant peer effects. Could the language deficiencies of Canadian immigrants or the skill deficiencies of their parents be driving the negative achievement effects which these immigrants seem to impose? Similarly, would the positive achievement impacts of Australian immigrants be lower had their parents been lower skilled or had they possessed lower proficiency in the English language? To study whether the quality of immigrant students and their parents (as measured by language ability and parental educational attainment) affects the peer effects that they generate, I split immigrants into dichotomous groups based on skill / adaptation as measured by (1) parental education and (2) native language, before comparing how exposure to immigrants differing on these characteristics affect student achievement. In all cases, I control for individual and family background characteristics as well as school and grade fixed effects.

### *4.1.1 Educational Attainment of Immigrant Parents*

<Insert Table 4 here>

I begin by investigating whether the achievement effects from exposure to immigrants with more-educated parents differ from those of exposure to immigrants with less-educated parents. To do this, I create 2 variables: (1) the share of immigrant grade peers with at least one parent who received some education beyond the secondary level (relatively more-educated parents) and (2) the share of immigrant grade peers with neither parent having any education beyond the secondary level (relatively less-educated parents). I then re-estimate equation (3), incorporating these as explanatory variables instead of the single variable measuring the grade share of immigrants. If parental education contributes positively to the peer effects generated by immigrants,

then the impact from immigrant peers with less-educated parents should be more negative (or less positive) than the impact from immigrant peers with more-educated parents. This is indeed what I find. Panel A of Table 4 shows that for all 3 countries, the share of immigrant peers with less-educated parents has a larger negative impact on natives' Math and Science test scores than the share of immigrant peers with more-educated parents (though effects are only precisely estimated for Australia). Noteworthy are the findings for Australia. For Math, exposure to immigrant peers with more-educated parents has a statistically significant positive impact on the achievement of Australian natives while for Science, exposure to immigrant peers with less-educated parents has a statistically significant negative impact on their achievement.

### *4.1.2 Language Abilities of Immigrant Students*

Next, I investigate whether spill-over effects may be due to the language deficiencies suffered by immigrant students. I create 2 variables for this purpose: (1) the grade share of immigrant peers that are non-native speakers of the test language and (2) the grade share of immigrant peers that are native speakers of the test language[17]. Equation (3) is then re-estimated with these variables instead of the single explanatory variable measuring the grade share of immigrants. The idea is that if language ability contributes positively to peer effects, then any impact from those immigrant peers who are non-native speakers should be more adverse than the impact from those who are native language speakers. This is indeed what I find for Math achievement in Canada. Panel B of Table 4 shows that while the estimated effect (-0.806) of the share of non-native language speaking immigrant peers on natives' Math

[17] A student is classified as a native speaker of the test language if he/she reports always or almost always speaking the language of test at home. He/she is classified as a non-native speaker of the test language otherwise.

test scores is sizeable and statistically significantly negative at the 5% level, the estimated effect of the share of native language speaking immigrant peers is small and non-significant. This provides some support for the idea that the overall negative peer effects documented for Canada are partly driven by the language deficiencies of immigrant students. Little can be said for achievements in the U.S. (and for Science achievement in Canada) because the coefficients on the variables of interest do not reach statistical significance in any of these estimations.

Interestingly, for Australia, we see that the positive peer effects of immigrants come mainly from those immigrants that are non-native speakers. The share of non-native speaking immigrant grade peers is shown to have a sizeable positive impact on the Math achievement of Australian natives (the estimated coefficient of 1.925 is statistically significant at the 1% level). In comparison, the estimated achievement effect of the share of native language speaking immigrant grade peers is much smaller and statistically non-significant. While this seems to suggest that the language deficiencies of immigrants enhance the learning experiences of peers in Australia, we must be careful in making such causal statements. This is because immigrants who are non-native speakers may differ systematically from those who are native speakers. And these differences, which are not accounted for in this analysis, may be creating the illusion that linguistic deficiency makes for better peers. For example, an analysis using TIMSS 1995 reveals that non-native speaking immigrant children in Australia actually outperform native-speaking immigrants and native-born children in Math. While the average Math test scores achieved by native speaking immigrant and native-born children are 0.091 and -0.006 respectively, it is 0.104 for non-native speaking immigrants. Since non-native speaking immigrants seem to perform academically better than their native speaking counterparts, it is not surprising that increased exposure to them has a more positive effect on natives' test scores. However, it is not language deficiency per se that is responsible for the more positive

peer effect. Rather, it is the un-modelled difference in attributes possessed by the two groups of students (i.e. native speaking and non-native speaking immigrant students) which contributes spuriously to this result. Hence, attaching a causal interpretation to the above result would be erroneous.

Overall, the results in sub-sections 4.1.1 – 4.1.2 are in agreement with those from Hardoy and Schøne (2013) and suggest that peer quality is a potential channel through which immigrants affect the achievements of peers.

# 5 DISCUSSION

It seems surprising that the peer effects of immigrants should be so different in Australia and Canada despite the fact that both countries share such similar immigration policies[18] and histories and levels of economic development. In both countries, immigrant students have parents that are, on average, more highly skilled than those of natives. It is therefore puzzling why only immigrant students in Australia should have positive impacts on the achievements of peers (while immigrant students in Canada not only fail to have positive impacts, but even have adverse impacts on peers' achievement). Furthermore, given that the parents of immigrants are relatively less-skilled (than those of natives) in the U.S. than in Canada, one would expect immigrant peer effects to be more adverse in the U.S. than in Canada. Yet, the evidence suggests that U.S. immigrants actually have less adverse impacts on the achievements of natives than Canadian immigrants. How can these counterintuitive findings be explained?

[18] Both countries have a skills-based admissions policy where admission is based on economic criteria such as educational attainment, occupational demand, language ability, and age.

One potential explanation lies in the fact that how immigrant students perform relative to natives (and therefore how immigrant students affect peers' behaviours) is not only influenced by their socioeconomic characteristics but also by institutional factors such as the way in which educational systems are organised (Schneeweis, 2011; Cobb-Clark et al., 2012). This means that even if immigrant students possess better socioeconomic characteristics than native students, any positive influence that this may have on peer effects may still be undone if countries adopt education policies or organise their educational systems in ways that hinder the educational progress of migrants. Because educational systems are inherently differently organised across countries, the impacts from exposure to immigrant students can be different in different countries even if the relative socioeconomic characteristics of immigrant students in these countries are identical.

In fact, I do find some evidence that the way in which educational systems are organised across the 3 countries are quite different. For instance, responses from the TIMSS 1995 school administrator questionnaire reveal that the degree to which schools have the autonomy to make curricular decisions independently of external (i.e. district, regional, or national) entities is lowest for Canada and highest for Australia[19]. While 94% and 86% of the student population respectively in Australia and the U.S. had subject teachers who possessed either "some" or "a lot" of influence in determining curriculum, only 59% of Canadian students had teachers with such influence[20]. Similarly, while 81% and 78% of the student population respectively in Australia and the U.S. had principals who had either "some" or "a lot" of influence in determining curriculum, only 65% of Canadian students had principals with

[19] Data from TIMSS 1995, accessed from: https://nces.ed.gov/timss/idetimss/.

[20] School principals were posed with the following question: "How much influence do teachers of a subject have in determining curriculum?" They could choose among 4 options: "none", "a little", "some", or "a lot".

such influence[21]. The extent to which schools are given the autonomy over curriculum setting is important, because as pointed out by the OECD (2012), "schools with more autonomy over curricular decisions may be better able to cater to the particular needs of immigrant students". They are therefore better able to present immigrants with more educational opportunities. Because of the lower autonomy that Canadian schools possess over curricular decisions, schools there may not be as able as schools in either Australia or the U.S. to cater to the specific needs of immigrant students. Hence, the peer effects exerted by immigrants may be worse in Canada than in the other two countries.

Two other potential explanations lie in age at arrival differences of immigrant children and differences in the extent to which immigrant students are exposed to the test language at home in these countries. Computations using TIMSS 1995 indicate that the average age at arrival of 7$^{th}$ and 8$^{th}$ grade immigrant children is lowest for Australia (5.596 years) and highest for Canada (6.556 years)[22]. They also indicate that the share of immigrant children who speak the test language frequently at home is highest for Australia (64.3% of immigrant children in Australia report "always" or "almost always" speaking the test language at home) and lowest for Canada (only 53.5% of immigrant children in Canada report "always" or "almost always" speaking the test language at home)[23]. Since age at arrival and the extent to which students are exposed to the assessment language at home are

[21] School principals were asked: "How much influence does the Principal/Head of School have in determining curriculum?" Again, they could choose from 4 options: "none", "a little", "some", or "a lot".

[22] In the U.S, the average age at arrival of 7$^{th}$ and 8$^{th}$ grade immigrant children is 6.276 years.

[23] In the U.S., 56.5% of 7$^{th}$ and 8$^{th}$ grade immigrant children report that they either "always" or "almost always" speak the test language at home.

strong predictors of immigrant students' academic performance (see Cobb-Clark et al. (2012) and OECD (2012)), the older ages at which immigrant children arrive in Canada (compared to Australia and the U.S.) and the lower tendency for Canadian immigrant students to speak the test language at home (compared to Australian and American immigrant students) may, to some extent, account for the more adverse effects that these children have on peers' educational achievements.

### 5.1 Immigrant Peer Effects and the Role of Educational Institutions

Is it possible to empirically validate the reasoning above? In other words, is there any evidence to suggest that differences in the peer effects of immigrants are related to differences in the way educational systems are organised across countries? To assess whether and how institutional arrangements affect the peer effects exerted by immigrants, I follow the approach by Schütz et al. (2007) and exploit institutional variation at the country level. Specifically, I pool observations from the 3 countries and estimate the following educational production function:

$$y_{igsc} = \boldsymbol{X}'_{igsc}\beta + \delta I_{gsc} + \gamma\left(I_{gsc} \times R_c\right) + \alpha_c + \alpha_s + \alpha_g + \varepsilon_{igsc} \quad (4)^{24}$$

Where $y_{igsc}$ denotes the academic performance of native student $i$ from grade $g$ of school $s$ in country $c$. $\boldsymbol{X}_{igsc}$ denotes a vector of individual and family background characteristics for the student. $I_{gsc}$ denotes the share of immigrant children in grade $g$ of school $s$ in country $c$. $R_c$ is a measure of the institution of interest for country $c$ and so $I_{gsc} \times R_c$ represents an interaction between the

[24] Institutional variables which vary at the country level cannot be included as main explanatory variables in specification (4) because they would be perfectly collinear with the country fixed effects.

grade share of immigrants and the institutional characteristic. $\alpha_c$, $\alpha_s$, and $\alpha_g$ capture unobserved country, school, and grade heterogeneity respectively and are accounted for in the regressions through a set of country, school, and grade dummy variables. The coefficient of interest here is $\gamma$ for it captures how the effect of the share of immigrant peers on student achievement changes as the institutional feature of interest varies across countries. If the estimate of this coefficient is negative, then this indicates that the influence of the share of immigrants on student achievement becomes smaller (i.e. becomes more negative) as the indicator measuring the institutional feature increases. The converse is true if the estimated coefficient is positive[25].

I concentrate the analysis on 4 indicators measuring national education systems. These measure features relating to schools' autonomy over curriculum and characteristics of the immigrant student population and include specifically: (1) the share of students with subject teachers who possess "some" or "a lot" of influence in determining curriculum, (2) the share of students with principals who possess "some" or "a lot" of influence in determining curriculum, (3) the average age at arrival of ($7^{th}$ and $8^{th}$ grade) immigrant children, and (4) the share of immigrant children who speak the test language frequently at home. As with Schütz et al. (2007), all institutional indicators are measured as averages at the country level. This aggregation is done so as to avoid problems of within-country endogeneity.

<Insert Table 5 here>

[25] More precisely, the marginal effect of the grade share of immigrant peers on student achievement is given by $\frac{\partial y}{\partial I} = \delta + \gamma R$ (subscripts dropped for convenience). Therefore, $\gamma$ captures how the peer effects of immigrants change as $R$ is varied across countries.

Equation (4) is estimated separately for each institutional indicator of interest. Table 5 reports the results from these estimations. For brevity, only estimates of the coefficient on the interaction term between the grade share of immigrant peers and each institutional indicator of interest (i.e. estimates of the parameter $\gamma$ in equation (4)) are reported. These tell us directly how the effect of the share of immigrant peers on native students' test scores changes as the institutional indicator of interest is increased. Statistically significant negative coefficients indicate that the peer effects of immigrants become smaller (more negative) as the institutional indicator is increased. Statistically significant positive coefficients indicate the opposite.

The results in Table 5 support the hypothesis that differences in educational institutional arrangements are, at least, partly responsible for the differential impacts imposed by immigrant students in the 3 countries. In particular, the results for Math achievement indicate that the peer effects of immigrants are more positive when the shares of teachers and principals in the country who possess at least some influence in the setting of curriculum are higher and when the share of immigrant students who speak the test language frequently at home is higher. In addition, the peer effects of immigrants are more negative in countries where immigrant children arrive at older ages. The results for Math achievement apply largely to Science, though for the latter, none of the institutional measures have a significant influence on the peer effects exerted by immigrants.

The results from this exercise provide an explanation for why immigrants in Australia and Canada have such different effects on peers despite the adoption of similar immigration policies by both countries. The fact that schools have less autonomy over curricular decisions and that immigrant children tend to speak the test language less frequently and arrive at older ages in Canada than in Australia possibly accounts for why immigrants in Canada have more adverse achievement impacts. Perhaps more importantly,

they provide a possible explanation for the apparently conflicting findings within the literature. As noted, while most studies have found immigrants to have either adverse or no effects on natives' achievements, a small number do actually find beneficial effects. This analysis shows that the way immigrant students affect their peers is ultimately influenced as well by the educational institutions under which they operate. This is a novel finding in the literature on immigrant peer effects.

# 6 CONCLUSION

Using an internationally comparable dataset which provides achievement and migration information on students from 2 different grades of each school, I estimate the effects that immigrant peers have on the Mathematics and Science achievements of native students in 3 countries – Australia, Canada, and the United States. To derive causal estimates of the impacts of immigrant students on peers' academic achievement, I relate variations in the test scores of students over 2 adjacent grades of each school to variations in the share of immigrant students over the 2 grades of the school.

The results from this study indicate that immigrant students do have an effect on native peers' academic achievement. However, the effects of immigrants are not the same across the 3 countries. While immigrant students in Australia affect the academic achievements of natives positively, immigrant students in Canada affect the academic achievements of natives adversely. However, in both cases, it is only the impacts on natives' Math achievements which are statistically significant. The impacts on natives' Science achievements, though qualitatively similar, do not reach statistical significance. There is no evidence that immigrants in the U.S. affect the academic achievements of natives.

The results from Canada demonstrate that even if immigrant children have better-educated parents than natives, this does not guarantee that they will have non-adverse effects on native peers' academic outcomes. How immigrants affect peers' academic achievement depends also, and perhaps more importantly, on the way a country's educational system is organised. However, within countries, improvements in immigrant quality (as measured by language ability and parental education) may lessen the negative effects or increase the positive effects that immigrants have on the educational achievements of peers.

A unique implication of the findings is that the peer effects of immigrants found in any one country cannot be simply extrapolated to another even if these countries share similar immigration policies. Though immigrants in two countries may share similar socioeconomic positions relative to natives, institutional factors, such as the way in which the countries organise their educational systems, could have an influence on how immigrant students affect the behaviour of others. It would therefore be a mistake if researchers attempt to generalise the peer effects found in one country to others on the basis of similarities in the relative socioeconomic positions of migrants. A reliable assessment of immigrant peer effects would need to be country and context specific and would have to consider both the socioeconomic characteristics of immigrants as well as the institutional arrangements under which these students operate.

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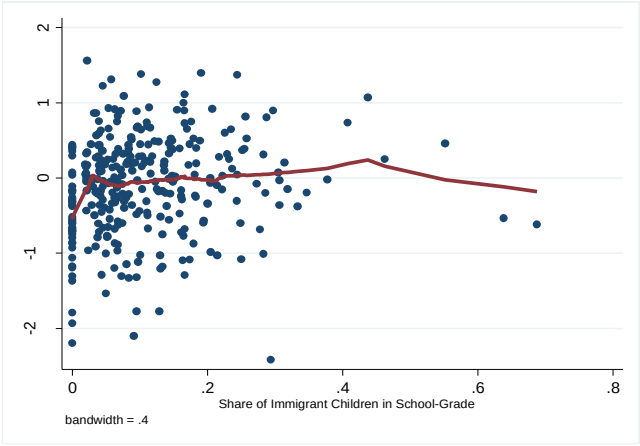
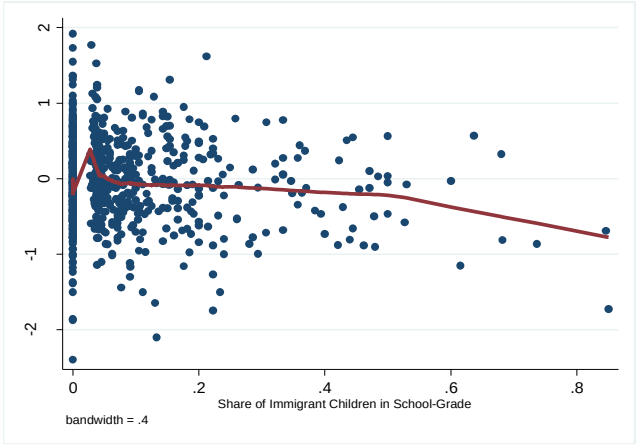
Figure 1: Non-Parametric Estimates of the Effect of School-Grade Immigrant Concentration on Natives' Math Test Scores

Panel A: Relationship between Native Students' Math Test Scores and Share of Immigrant Children at the School-Grade Level

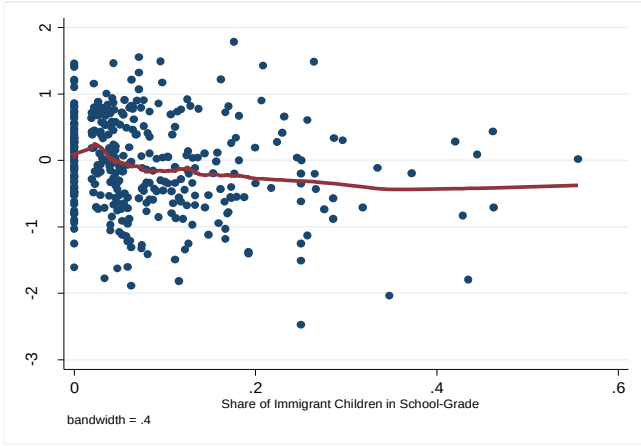
Australia




Canada

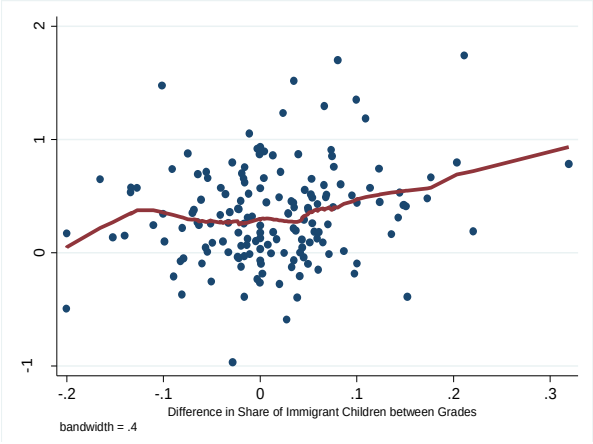



United States

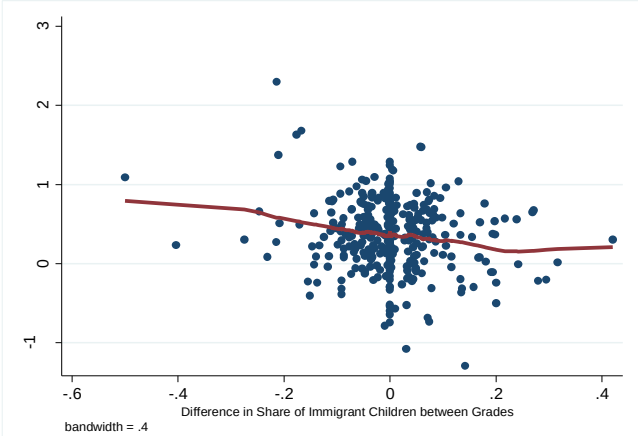



Panel B: Relationship between Differences in the Share of Immigrant Children between 2 Grades of a School and Differences in Native Students' Math Test Scores

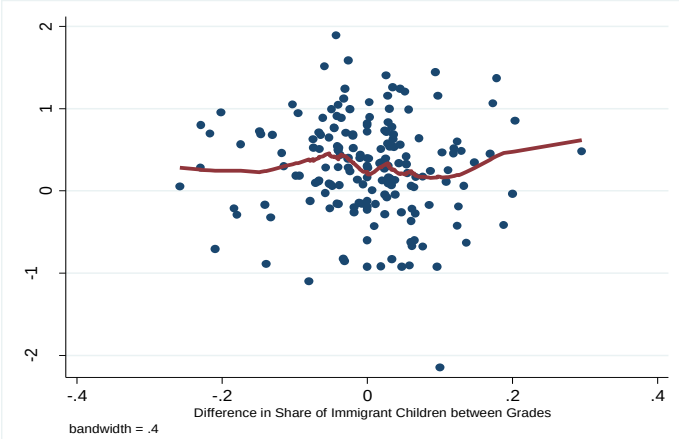
Australia




Canada




United States

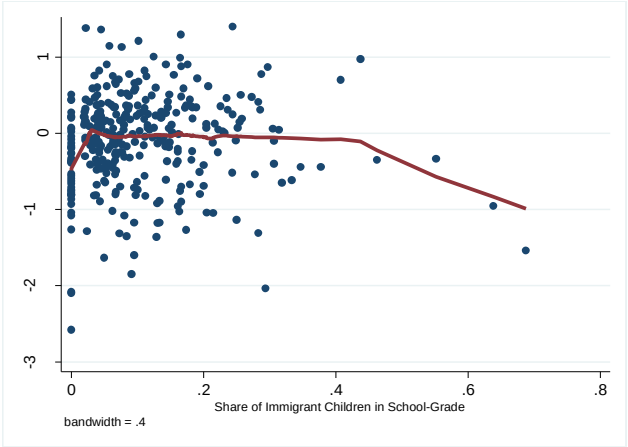



Notes: Data from the Third International Mathematics and Science Study of 1995. Sample weights used in all computations. Grade effects are partialed out semi-parametrically prior to estimation. The bandwidth is set to 0.4 for all regressions.

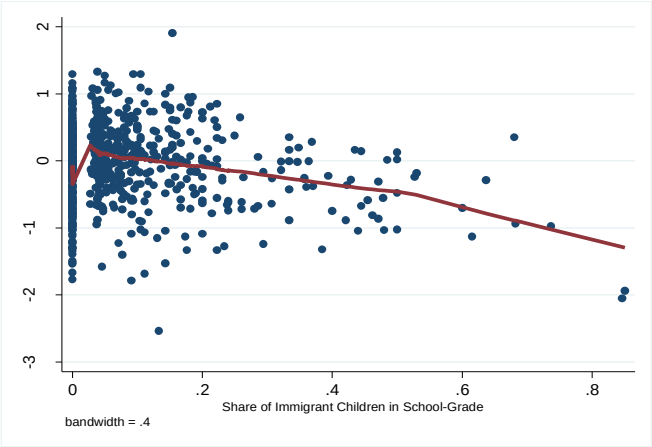
Figure 2: Non-Parametric Estimates of the Effect of School-Grade Immigrant Concentration on Natives' Science Test Scores

Panel A: Relationship between Native Students' Science Test Scores and Share of Immigrant Children at the School-Grade Level

Australia




Canada

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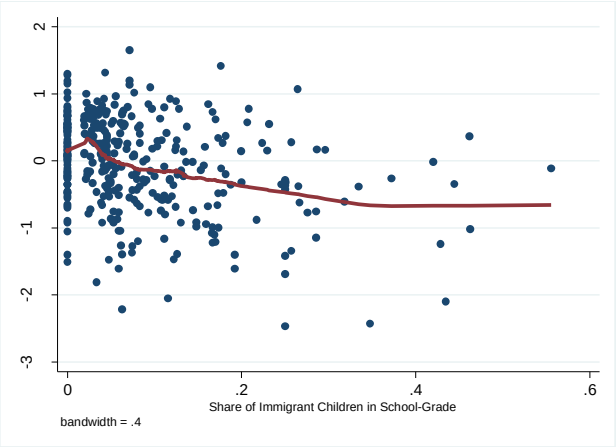
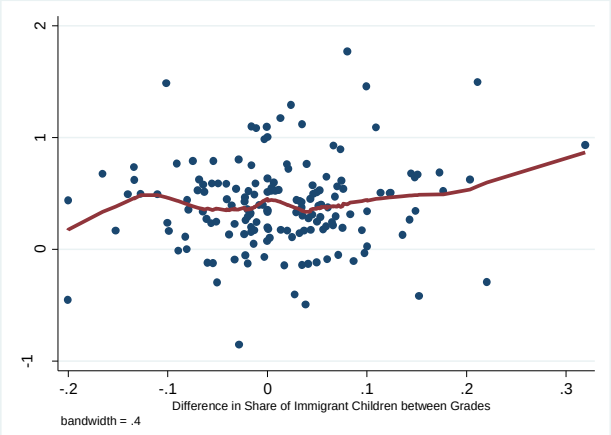
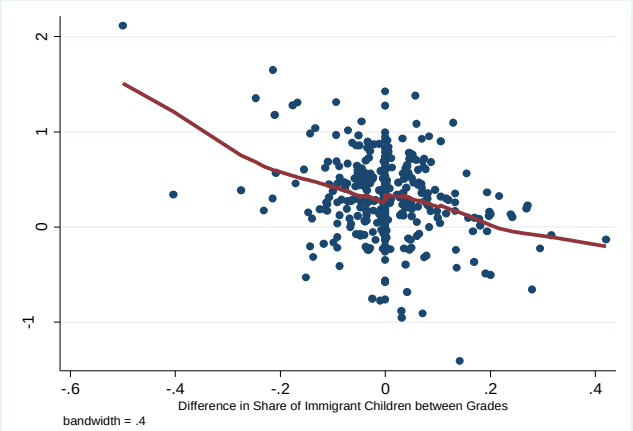



Panel B: Relationship between Differences in the Share of Immigrant Children between 2 Grades of a School and Differences in Native Students' Science Test Scores

Australia




Canada

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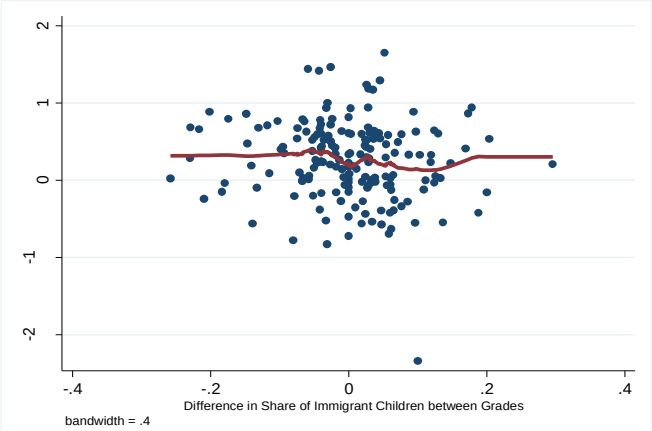


Notes: Data from the Third International Mathematics and Science Study of 1995. Sample weights used in all computations. Grade effects are partialed out semi-parametrically prior to estimation. The bandwidth is set to 0.4 for all regressions.

Table 1: Parental Education of Foreign-Born and Native-Born Children, by Country

| | Australia | | Canada | | United States | |
|---|---|---|---|---|---|---|
| | Foreign | Native | Foreign | Native | Foreign | Native |
| Father Did Not Complete Secondary Education | 0.225* | 0.360 | 0.180* | 0.248 | 0.176* | 0.131 |
| Father Had Some / Completed University Education | 0.473* | 0.299 | 0.557* | 0.447 | 0.520 | 0.506 |
| Sample Size | 1,401 | 11,177 | 1,326 | 14,906 | 938 | 9,836 |

Notes: Data from the Third International Mathematics and Science Study of 1995. Sample weights used in all computations so that mean values are nationally representative. Values are proportions. * indicates that the mean value is significantly different at the 5% level between native and immigrant students.

Table 2: Summary Statistics of Variables Used in Estimations (for the Sample of Native Students)

| | Australia | | Canada | | U.S. | |
|---|---|---|---|---|---|---|
| Variable | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| Standardised Math Test Score | -0.003 | 0.999 | 0.026 | 0.986 | 0.032 | 0.981 |
| Standardised Science Test Score | 0.015 | 0.991 | 0.043 | 0.979 | 0.052 | 0.978 |
| Share of Immigrant Students in Grade | 0.100 | 0.089 | 0.066 | 0.097 | 0.078 | 0.084 |
| Share of Immigrant Students in Grade with More Educated Parents | 0.066 | 0.069 | 0.048 | 0.079 | 0.054 | 0.066 |
| Share of Immigrant Students in Grade with Less Educated Parents | 0.034 | 0.044 | 0.017 | 0.044 | 0.019 | 0.036 |
| Share of Immigrant Students in Grade who are Non-Native Speakers | 0.032 | 0.055 | 0.030 | 0.065 | 0.037 | 0.057 |
| Share of Immigrant Students in Grade who are Native Speakers | 0.074 | 0.060 | 0.036 | 0.052 | 0.041 | 0.048 |
| 8th Grade (0/1) | 0.558 | 0.497 | 0.503 | 0.500 | 0.646 | 0.478 |
| Female (0/1) | 0.529 | 0.499 | 0.495 | 0.500 | 0.510 | 0.500 |
| Age | 13.889 | 0.648 | 13.540 | 0.701 | 13.865 | 0.704 |
| Speak Test Language at Home (0/1) | 0.956 | 0.205 | 0.857 | 0.350 | 0.906 | 0.292 |
| Living with Both Parents (0/1) | 0.749 | 0.434 | 0.733 | 0.442 | 0.624 | 0.484 |
| Household Size | 4.660 | 1.272 | 4.508 | 1.208 | 4.746 | 1.741 |
| Mother's Highest Edu – Primary Education or Less (0/1) | 0.020 | 0.139 | 0.065 | 0.246 | 0.030 | 0.170 |
| Mother's Highest Edu – Some Secondary Education (0/1) | 0.385 | 0.487 | 0.141 | 0.348 | 0.110 | 0.313 |
| Mother's Highest Edu – Completed Secondary Education (0/1) | 0.233 | 0.423 | 0.239 | 0.426 | 0.260 | 0.439 |
| Mother's Highest Edu – Some/Completed Vocational Edu (0/1) | 0.091 | 0.288 | 0.104 | 0.305 | 0.092 | 0.289 |
| Mother's Highest Edu – Some University Education (0/1) | 0.061 | 0.240 | 0.118 | 0.323 | 0.271 | 0.444 |
| Mother Completed University Education (0/1) | 0.209 | 0.407 | 0.334 | 0.471 | 0.237 | 0.425 |
| Father's Highest Edu – Primary Education or Less (0/1) | 0.030 | 0.170 | 0.079 | 0.269 | 0.032 | 0.176 |
| Father's Highest Edu – Some Secondary Education (0/1) | 0.325 | 0.468 | 0.164 | 0.370 | 0.118 | 0.323 |
| Father's Highest Edu – Completed Secondary Education (0/1) | 0.173 | 0.378 | 0.192 | 0.394 | 0.246 | 0.430 |
| Father's Highest Edu – Some/Completed Vocational Edu (0/1) | 0.174 | 0.379 | 0.113 | 0.316 | 0.121 | 0.326 |
| Father's Highest Edu – Some University Education (0/1) | 0.050 | 0.219 | 0.097 | 0.296 | 0.211 | 0.408 |
| Father Completed University Education (0/1) | 0.249 | 0.432 | 0.356 | 0.479 | 0.272 | 0.445 |
| Has 0-10 Books at Home (0/1) | 0.020 | 0.141 | 0.036 | 0.185 | 0.086 | 0.281 |
| Has 11-25 Books at Home (0/1) | 0.056 | 0.230 | 0.100 | 0.300 | 0.131 | 0.338 |
| Has 26-100 Books at Home (0/1) | 0.231 | 0.421 | 0.282 | 0.450 | 0.284 | 0.451 |
| Has 101-200 Books at Home (0/1) | 0.260 | 0.439 | 0.244 | 0.430 | 0.203 | 0.403 |
| Has more than 200 Books at Home (0/1) | 0.433 | 0.496 | 0.338 | 0.473 | 0.296 | 0.456 |
| Number of Students | 11,177 | | 14,906 | | 9,836 | |

Notes: Unweighted means and standard deviations of all variables included in the estimations, for the sample of native students.

Table 3: Estimated Effect of the Share of Immigrant Peers on Native Students' Test Scores

| | Math | | | Science | | |
|---|---|---|---|---|---|---|
| | OLS | OLS (w/School FE) | | OLS | OLS (w/School FE) | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | No Controls | No Controls | Controls for Student & Family Characteristics | No Controls | No Controls | Controls for Student & Family Characteristics |
| Australia | | | | | | |
| Share of Immigrant Students in Grade | 0.910** | 1.095*** | 0.935** | 0.440 | 0.563 | 0.263 |
| | (0.383) | (0.390) | (0.375) | (0.382) | (0.404) | (0.397) |
| Observations | 11,177 | 11,177 | 7,488 | 11,177 | 11,177 | 7,488 |
| R-Squared | 0.025 | 0.323 | 0.385 | 0.026 | 0.280 | 0.371 |
| Canada | | | | | | |
| Share of Immigrant Students in Grade | -0.435** | -0.494* | -0.557* | -0.226 | -0.411 | -0.205 |
| | (0.206) | (0.284) | (0.289) | (0.221) | (0.253) | (0.264) |
| Observations | 14,906 | 14,906 | 9,882 | 14,906 | 14,906 | 9,882 |
| R-Squared | 0.041 | 0.270 | 0.346 | 0.026 | 0.285 | 0.375 |
| U.S. | | | | | | |
| Share of Immigrant Students in Grade | -1.669*** | -0.006 | -0.035 | -2.612*** | -0.280 | -0.089 |
| | (0.510) | (0.530) | (0.466) | (0.497) | (0.413) | (0.369) |
| Observations | 9,836 | 9,836 | 7,855 | 9,836 | 9,836 | 7,855 |
| R-Squared | 0.037 | 0.404 | 0.459 | 0.065 | 0.412 | 0.473 |

Notes: Grade fixed effects are included in all regressions. The student and family background variables control for students' sex, age, whether or not they speak the test language frequently at home, household size, mothers' and fathers' highest level of education, number of books at home, and whether or not they live with both parents. Standard errors in parentheses are cluster-robust standard errors that allow for correlation in individual error terms within schools. *** p-value<0.01, ** p-value<0.05, * p-value<0.1.

Table 4: Estimated Effects of the Shares of Immigrant Peers in the High Skill Group and in the Low Skill Group on Native Students' Test Scores

| | | Math | | Science | |
|---|---|---|---|---|---|
| | Skill/Adaptation Measured by: | Share of Immigrant Peers in High Skill/Adapted Group | Share of Immigrant Peers in Low Skill/Adapted Group | Share of Immigrant Peers in High Skill/Adapted Group | Share of Immigrant Peers in Low Skill/Adapted Group |
| Panel A | | | | | |
| Australia | | 1.225*** | -0.662 | 0.564 | -1.296** |
| | | (0.401) | (0.558) | (0.385) | (0.639) |
| Canada | Parental Education | -0.242 | -1.117 | 0.024 | -0.847 |
| | | (0.302) | (0.723) | (0.282) | (0.560) |
| U.S. | | 0.211 | -0.948 | 0.166 | -0.656 |
| | | (0.614) | (0.970) | (0.426) | (0.757) |
| Panel B | | | | | |
| Australia | | 0.214 | 1.925*** | -0.103 | 0.784 |
| | | (0.422) | (0.724) | (0.397) | (0.644) |
| Canada | Language Use | -0.157 | -0.806** | -0.243 | -0.128 |
| | | (0.424) | (0.351) | (0.413) | (0.316) |
| U.S. | | -0.170 | 0.072 | -0.109 | -0.070 |
| | | (0.683) | (0.738) | (0.577) | (0.602) |

Notes: This table presents estimates from various regressions, showing the impact of immigrant peers in the high skill/adapted group and the impact of immigrant peers in the low skill/adapted group. Skill/adaptation is measured by: (1) parental education and (2) language use. Immigrant students are defined as low skilled/adapted when skill is measured by parental education and if neither of the student's parents have an education above the secondary level. When adaptation is measured by language use, immigrant students are low skilled/adapted if they are non-native speakers of the test language. In each case, the number of observations from Australia, Canada, and the U.S. is 7,488, 9,882, and 7,855 respectively. All regressions control for the grade, sex, age, and household size of students, the number of books the student has at home, whether the student frequently speaks the test language at home, whether the student lives with both parents, and the highest education attained by both parents. All regressions also include school fixed effects. Standard errors in parentheses are cluster-robust standard errors that allow for correlation in individual error terms within schools. *** p-value<0.01, ** p-value<0.05, * p-value<0.1.

Table 5: Estimated Impacts of Various Institutional Arrangements on the Peer Effects Exerted by Immigrants

| | Math | Science |
|---|---|---|
| Institutional Indicator 1 | | |
| Share of Students with Teachers who Possess Influence in Curriculum Setting | 3.712*** | 1.488 |
| | (1.315) | (1.267) |
| Full Set of Controls? | Yes | Yes |
| Observations | 25,225 | 25,225 |
| R-Squared | 0.387 | 0.399 |
| Institutional Indicator 2 | | |
| Share of Students with Principals who Possess Influence in Curriculum Setting | 7.829*** | 3.098 |
| | (2.841) | (2.711) |
| Full Set of Controls? | Yes | Yes |
| Observations | 25,225 | 25,225 |
| R-Squared | 0.387 | 0.399 |
| Institutional Indicator 3 | | |
| Average Age at Arrival of Immigrant Students | -1.582*** | -0.721 |
| | (0.508) | (0.526) |
| Full Set of Controls? | Yes | Yes |
| Observations | 25,225 | 25,225 |
| R-Squared | 0.387 | 0.399 |
| Institutional Indicator 4 | | |
| Share of Immigrant Students who Speak the Test Language Frequently at Home | 14.012*** | 6.403 |
| | (4.513) | (4.670) |
| Full Set of Controls? | Yes | Yes |
| Observations | 25,225 | 25,225 |
| R-Squared | 0.387 | 0.399 |

Notes: The coefficients in this table represent estimates of the parameter in equation (4). Each is derived from a separate regression. Negative coefficients imply that the peer effects of immigrants become smaller (more negative) as the institutional indicator is increased. Positive coefficients imply that the peer effects of immigrants become larger (more positive) as the institutional indicator is increased. All regressions control for the grade, sex, age, and household size of students, the number of books the student has at home, whether the student frequently speaks the test language at home, whether the student lives with both parents, and the highest education attained by both parents. All regressions also include country and school fixed effects. Standard errors in parentheses are cluster-robust standard errors that allow for correlation in individual error terms within schools. *** p-value<0.01, ** p-value<0.05, * p-value<0.1.

Appendix Table A1: Full Set of Coefficient Estimates for Table 3 Regressions – Math Achievement

| | Australia | | | Canada | | | United States | | |
|---|---|---|---|---|---|---|---|---|---|
| | OLS | OLS (w/School FE) | | OLS | OLS (w/School FE) | | OLS | OLS (w/School FE) | |
| Regressor | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| | No Controls | No Controls | Controls for Student and Family Charac | No Controls | No Controls | Controls for Student and Family Charac | No Controls | No Controls | Controls for Student and Family Charac |
| Share of Immigrant Students in Grade | 0.910** | 1.095*** | 0.935** | -0.435** | -0.494* | -0.557** | -1.669*** | -0.006 | -0.035 |
| | (0.383) | (0.390) | (0.375) | (0.206) | (0.284) | (0.289) | (0.510) | (0.530) | (0.466) |
| 8th Grade | 0.261*** | 0.320*** | 0.451*** | 0.389*** | 0.374*** | 0.583*** | 0.272*** | 0.299*** | 0.523*** |
| | (0.034) | (0.033) | (0.042) | (0.023) | (0.023) | (0.032) | (0.050) | (0.045) | (0.044) |
| Female | – | – | -0.077*** | – | – | -0.061*** | – | – | -0.156*** |
| | | | (0.022) | | | (0.018) | | | (0.018) |
| Age | – | – | -0.130*** | – | – | -0.230*** | – | – | -0.249*** |
| | | | (0.026) | | | (0.022) | | | (0.022) |
| Speak Test Language at Home | – | – | 0.291*** | – | – | 0.121*** | – | – | 0.123*** |
| | | | (0.057) | | | (0.037) | | | (0.043) |
| Living with Both Parents | – | – | 0.096*** | – | – | 0.137*** | – | – | 0.094*** |
| | | | (0.024) | | | (0.021) | | | (0.019) |
| Household Size | – | – | -0.025** | – | – | -0.028*** | – | – | -0.029*** |
| | | | (0.010) | | | (0.007) | | | (0.006) |
| Mother had Some Secondary Education | – | – | 0.231*** | – | – | 0.126** | – | – | 0.123* |
| | | | (0.078) | | | (0.049) | | | (0.072) |
| Mother Completed Secondary Education | – | – | 0.169** | – | – | 0.183*** | – | – | 0.123* |
| | | | (0.083) | | | (0.052) | | | (0.073) |
| Mother had Vocational Education | – | – | 0.286*** | – | – | 0.247*** | – | – | 0.085 |
| | | | (0.086) | | | (0.053) | | | (0.075) |
| Mother had Some University Education | – | – | 0.262*** | – | – | 0.268*** | – | – | 0.120 |
| | | | (0.086) | | | (0.053) | | | (0.074) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Mother Completed University Education | – | – | 0.381*** | – | – | 0.275*** | – | – | 0.156** |
| | | | (0.086) | | | (0.049) | | | (0.072) |
| Father had Some Secondary Education | – | – | 0.156*** | – | – | 0.179*** | – | – | -0.071 |
| | | | (0.059) | | | (0.044) | | | (0.055) |
| Father Completed Secondary Education | – | – | 0.159** | – | – | 0.234*** | – | – | -0.030 |
| | | | (0.061) | | | (0.045) | | | (0.052) |
| Father had Vocational Education | – | – | 0.290*** | – | – | 0.330*** | – | – | 0.001 |
| | | | (0.058) | | | (0.048) | | | (0.056) |
| Father had Some University Education | – | – | 0.205*** | – | – | 0.293*** | – | – | 0.042 |
| | | | (0.069) | | | (0.046) | | | (0.057) |
| Father Completed University Education | – | – | 0.377*** | – | – | 0.408*** | – | – | 0.091 |
| | | | (0.062) | | | (0.044) | | | (0.058) |
| Has 11-25 Books at Home | – | – | 0.223** | – | – | 0.067 | – | – | 0.082* |
| | | | (0.089) | | | (0.055) | | | (0.042) |
| Has 26-100 Books at Home | – | – | 0.497*** | – | – | 0.288*** | – | – | 0.319*** |
| | | | (0.081) | | | (0.054) | | | (0.040) |
| Has 101-200 Books at Home | – | – | 0.644*** | – | – | 0.397*** | – | – | 0.446*** |
| | | | (0.081) | | | (0.054) | | | (0.041) |
| Has more than 200 Books at Home | – | – | 0.762*** | – | – | 0.417*** | – | – | 0.506*** |
| | | | (0.080) | | | (0.054) | | | (0.043) |
| Observations | 11,177 | 11,177 | 7,488 | 14,906 | 14,906 | 9,882 | 9,836 | 9,836 | 7,855 |
| R-Squared | 0.025 | 0.323 | 0.385 | 0.041 | 0.270 | 0.346 | 0.037 | 0.404 | 0.459 |

Notes: Grade fixed effects are included in all regressions. Standard errors in parentheses are cluster-robust standard errors that allow for correlation in individual error terms within schools. *** denotes a coefficient significant at the 1% level, ** denotes a coefficient significant at the 5% level, * denotes a coefficient significant at the 10% level.

Appendix Table A2: Full Set of Coefficient Estimates for Table 3 Regressions – Science Achievement

| | Australia | | | Canada | | | United States | | |
|---|---|---|---|---|---|---|---|---|---|
| | OLS | OLS (w/School FE) | | OLS | OLS (w/School FE) | | OLS | OLS (w/School FE) | |
| Regressor | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| | No Controls | No Controls | Controls for Student and Family Charac | No Controls | No Controls | Controls for Student and Family Charac | No Controls | No Controls | Controls for Student and Family Charac |
| Share of Immigrant Students in Grade | 0.440 | 0.563 | 0.263 | -0.226 | -0.411 | -0.205 | -2.612*** | -0.280 | -0.089 |
| | (0.382) | (0.404) | (0.397) | (0.221) | (0.253) | (0.264) | (0.497) | (0.413) | (0.369) |
| 8th Grade | 0.309*** | 0.376*** | 0.434*** | 0.311*** | 0.305*** | 0.433*** | 0.258*** | 0.281*** | 0.453*** |
| | (0.030) | (0.029) | (0.038) | (0.022) | (0.021) | (0.028) | (0.043) | (0.037) | (0.035) |
| Female | – | – | -0.194*** | – | – | -0.219*** | – | – | -0.238*** |
| | | | (0.024) | | | (0.017) | | | (0.017) |
| Age | – | – | -0.063** | – | – | -0.144*** | – | – | -0.188*** |
| | | | (0.026) | | | (0.020) | | | (0.017) |
| Speak Test Language at Home | – | – | 0.422*** | – | – | 0.235*** | – | – | 0.268*** |
| | | | (0.057) | | | (0.034) | | | (0.040) |
| Living with Both Parents | – | – | 0.084*** | – | – | 0.110*** | – | – | 0.055*** |
| | | | (0.024) | | | (0.021) | | | (0.019) |
| Household Size | – | – | -0.045*** | – | – | -0.064*** | – | – | -0.042*** |
| | | | (0.009) | | | (0.007) | | | (0.006) |
| Mother had Some Secondary Education | – | – | 0.276*** | – | – | 0.164*** | – | – | -0.063 |
| | | | (0.083) | | | (0.047) | | | (0.071) |
| Mother Completed Secondary Education | – | – | 0.255*** | – | – | 0.274*** | – | – | -0.010 |
| | | | (0.083) | | | (0.047) | | | (0.069) |
| Mother had Vocational Education | – | – | 0.333*** | – | – | 0.299*** | – | – | -0.037 |
| | | | (0.088) | | | (0.050) | | | (0.072) |
| Mother had Some University Education | – | – | 0.291*** | – | – | 0.313*** | – | – | 0.041 |
| | | | (0.090) | | | (0.049) | | | (0.069) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Mother Completed University Education | – | – | 0.444*** | – | – | 0.337*** | – | – | 0.035 |
| | | | (0.086) | | | (0.045) | | | (0.070) |
| Father had Some Secondary Education | – | – | 0.157*** | – | – | 0.081* | – | – | 0.043 |
| | | | (0.060) | | | (0.042) | | | (0.055) |
| Father Completed Secondary Education | – | – | 0.143** | – | – | 0.113*** | – | – | 0.084 |
| | | | (0.062) | | | (0.043) | | | (0.051) |
| Father had Vocational Education | – | – | 0.318*** | – | – | 0.283*** | – | – | 0.116** |
| | | | (0.057) | | | (0.045) | | | (0.053) |
| Father had Some University Education | – | – | 0.225*** | – | – | 0.154*** | – | – | 0.144** |
| | | | (0.073) | | | (0.045) | | | (0.056) |
| Father Completed University Education | – | – | 0.372*** | – | – | 0.295*** | – | – | 0.194*** |
| | | | (0.062) | | | (0.043) | | | (0.057) |
| Has 11-25 Books at Home | – | – | 0.141 | – | – | 0.048 | – | – | 0.115** |
| | | | (0.093) | | | (0.051) | | | (0.045) |
| Has 26-100 Books at Home | – | – | 0.398*** | – | – | 0.279*** | – | – | 0.343*** |
| | | | (0.087) | | | (0.050) | | | (0.042) |
| Has 101-200 Books at Home | – | – | 0.566*** | – | – | 0.460*** | – | – | 0.477*** |
| | | | (0.084) | | | (0.052) | | | (0.045) |
| Has more than 200 Books at Home | – | – | 0.723*** | – | – | 0.534*** | – | – | 0.553*** |
| | | | (0.087) | | | (0.051) | | | (0.046) |
| Observations | 11,177 | 11,177 | 7,488 | 14,906 | 14,906 | 9,882 | 9,836 | 9,836 | 7,855 |
| R-Squared | 0.026 | 0.280 | 0.371 | 0.026 | 0.285 | 0.375 | 0.065 | 0.412 | 0.473 |

Notes: Grade fixed effects are included in all regressions. Standard errors in parentheses are cluster-robust standard errors that allow for correlation in individual error terms within schools. *** denotes a coefficient significant at the 1% level, ** denotes a coefficient significant at the 5% level, * denotes a coefficient significant at the 10% level.