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Race and the Income-Achievement Gap

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Race and the Income-Achievement Gap

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Abstract

We study whether racial disparities in economic opportunity appear at an early age. Using administrative education data linked to tax records, we study the income-achievement gap across different races and find important variation. The income-achievement gap is small for East Asian children while it is close to twice as large for Indigenous children. Sorting by income into schools accounts for a large portion of the variation in the income-achievement gap across all student groups. In addition, our results suggest that the large income-achievement gap for Indigenous students may be rooted in inequality in health outcomes and poor housing conditions. Our findings on income-achievement gaps across race could partially explain the different intergenerational mobility outcomes by race documented by others.

Keywords: test scores, income-achievement gaps, race

JEL: I20, I24, J15.

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1. Introduction

It is clear that there are achievement gaps based on family socioeconomic status (SES): children from families with higher income or higher education perform better in school.[1] While the gap in test scores by socioeconomic status has been widely studied, little work to date has touched on how the link between test scores and income varies by race. In this paper, we show that there are large differences in the income-achievement gap across race, and study what factors explain such variation.

Our work ties into a wider literature documenting disparities in outcomes across race. Recently, work by Chetty et al. (2020) shows that there are large differences in intergenerational mobility of income across race.[2] For instance, conditional on having parents in the same income percentile, White children earn higher income than American Indian and Black children (Chetty et al., 2020). Our findings show that there are different relationships between test scores and parental income across races. Since the early cognitive skills of children are associated with their future labour market outcomes (Chetty et al., 2011; Heckman et al., 2006; Heckman et al., 2010), unequal income-achievement gaps could play a role in the different intergenerational mobility of income across racial groups.

Our work uses administrative education data linked to tax records from the Canadian province of British Columbia. This data covers (nearly) the population of students in the province.[3] Our primary measure of the income achievement gap is the average difference in test scores for students from families in the top before-tax household income decile versus the bottom decile, which we refer to as the P90-P10 gap, as in Reardon (2011). Following Chetty et al. (2020), income deciles are calculated across all racial groups. Our main measure of achievement is performance on standardized tests when students are in Grade 4 (age nine) and Grade 7 (age twelve). Student records are linked to the tax records of their parents, allowing us to construct measures of parental household income. We study outcomes for three groups of visible minority students: East Asian, South Asian, and Indigenous. These three racial groups are the most populated ones in British Columbia.

We highlight two key sets of results. First, there is important variation in P90-P10 gaps across race when children are young. For children who are aged nine in 2009 - 2013, Indigenous students have the highest P90-P10 gap at 0.7 standard deviations. The gap for East Asian

[1] For example, see Carneiro et al. (2003), Heckman et al. (2005), Reardon (2011), Magnuson et al. (2012), Hanushek et al. (2019), and Hanushek et al. (2020) for the U.S., and Currie et al. (2001) and Bradbury et al. (2019) for the United Kingdom. For a cross-country comparison see Chmielewski et al. (2016) and Bradbury et al., 2019.

[2] See also Bhattacharya et al. (2011) and Akee et al. (2019).

[3] We do not see Indigenous students who attend on-reserve schools. See Section 3 for further discussion.

students is the lowest, at around 0.45 standard deviations. Furthermore, there is heterogeneity in the P90-P10 gap within race by subject. For instance, the raw P90-P10 gap for East Asians is noticeably lower in math than in reading. On the contrary, Indigenous students have large P90-P10 gaps in both subjects. We also show that the patterns across race that we find at age nine are consistent three years later: in fact, they narrow for East Asian students and widen for Indigenous students.

Second, the richness of our education data allows us to study several factors that could contribute to variation in the P90-P10 gap. We find that controlling for school fixed effects explains about 20-30% of the P90-P10 gap across all groups. This suggests strong sorting patterns by income and average school performance, whereby lower income students are more likely to attend schools with lower performance on standardized tests. The education data we use also identifies whether a student has a special needs or was ever an English as a Second Language (ESL) learner [4]. We find that controlling for ESL status reduces the East Asian P90-P10 gap by 43% while it reduces the South Asian P90-P10 gap by around 25%. In our population of interest, lower income East Asian and South Asian students are more likely to be ESL, thus explaining why ESL status contributes so much to the P90-P10 gap. In fact, the income-achievement gaps for both East Asian and South Asian students narrow from age nine to age twelve, possibly because those who are ESL have had more time to get comfortable with English.

On the other hand, we find that for Indigenous students, both ESL status and special needs status are important factors in understanding their income-achievement gap. In fact, we find a stark pattern between income and the probability of having a special need for Indigenous students. This result builds on previous work in the literature that has documented a large health gap between Indigenous and non-Indigenous Canadians, of which income can be an important mediator (Booth et al., 2008; Frohlich et al., 2006). Furthermore, within the one fifth of our sample that is linked to the Census, we can also look at certain household variables of the student. For instance, we find that Indigenous students are significantly more likely to live in housing needing major repairs and to live with single parents than non-Indigenous students, conditional on being in the same income quintile.

While identifying Indigenous students in our data is straightforward, for East Asian and South Asian students we use two different classification methods. Our first method utilizes our administrative education data, which asks students what language they speak at home. Students who speak an East (South) Asian language at home are classified as East (South) Asian. For a

[4]By students with special needs we mean students with behavioural, learning, or physical needs. We do not include gifted students.

robustness test, we use another classification method. A fifth of our administrative education dataset is linked to the Census, which explicitly asks students which visible minority group they identify with. Our results are robust to using visible minority status from the Census to identify East Asian and South Asian students instead of the language at home. Furthermore, while our main estimates use before-tax household income, we also find similar estimates when using after-tax household income, and after-tax household income scaled by family size.

In summary, our findings show that there are different relationships between test scores and parental income across race. At age nine, East Asian students have the highest "achievement mobility", with a small income-achievement gap across math and reading. In contrast, the income-achievement gap for Indigenous students is almost twice as high. Since the academic performance of children is correlated with their labour earnings(Chetty et al., 2011; Heckman et al., 2006; Heckman et al., 2010), we can compare the income-achievement gaps we observe across race to the intergenerational mobility of income documented across race by Chetty et al., 2020. They find that Asian Americans have high upward income mobility while we show that East Asians especially do very well academically, independent of parental income. In addition, just as we find that Indigenous students have large income-achievement gaps, Chetty et al., 2020 show that American Indians have low mobility outcomes.

Our work has several policy implications that could improve the disparity in income-achievement gaps. To start, school quality explains a large portion of the income-achievement gap across all groups, indicating that sorting into schools is an important source of inequality. School funding in British Columbia is at the provincial level and so differences in school quality do not arise due to differences in property tax funding as in the United States.[5] Nevertheless, school sorting on income still occurs as British Columbia has catchment areas and school zone boundaries implying that the quality of schools is capitalized into property prices (Black, 1999).

In addition, we point to several factors that contribute to the large income-achievement gap we see among Indigenous students. While school factors explain thirty percent of the Indigenous income-achievement gap, almost as important is special needs status. Indigenous students are more than twice as likely than non-Indigenous students to have a special needs diagnosis and the prevalence of special needs among this subpopulation declines with income. Furthermore, we show that Indigenous students are a lot more likely to live in unsuitable housing conditions than non-Indigenous students, conditional on being at the same income quintile. Therefore, a clear policy intervention that could help close the Indigenous income-achievement gap is better access

[5]The literature on inequality and education has shown that the United States' decentralized funding system has negative effects on opportunity and intergenerational mobility as district resources are tied to the socioeconomic status of residents. For example, see Durlauf et al. (1993), Durlauf (1996), Fernandez et al. (1996), Fernandez et al. (1998), Biasi (2022), Jackson et al. (2016), Eckert et al. (2019), and Zheng et al. (2020).

to health care and safe housing. Several works have documented the severity of the Indigenous health gap[6] and our work highlights how the link between health and income worsen educational outcomes for low-income Indigenous students.

2. Literature Review

Our work is related to three strands of literature: research on achievement gaps, research on education inequality in Canada, and research on socioeconomic status and opportunity across race.

There are several works studying achievement gaps among students. In the United States, a wealth of research has studied the test score gap between Black and White students (see Jencks et al. (2011) and Magnuson et al. (2006) for a comprehensive review). Most estimates of the Black-White gap range from 0.5-1 standard deviations (Magnuson et al., 2006). Fryer Jr et al. (2004) show that school quality plays an important role in the development of the Black-White test score gap, while Card et al. (2007) emphasize the importance of neighborhood segregation by race. More closely related to our work, Rothstein et al., 2013 study the gap in black and white test scores for students with the same permanent family income.

The achievement gap between students of high and low socioeconomic status has also been extensively researched. Michelmore et al. (2017) use information on free and reduced meals as a measure of socioeconomic background and find large achievement gaps. Often, studies have used survey data without reliable family income information. Instead, these works have constructed an index of socioeconomic status from parental education and durables at home (for example, see Hanushek et al., 2019) or number of books at home (Hanushek et al., 2011; Jerrim et al., 2012). Previous work has found pronounced achievement gaps based on number of books at home, and this finding is consistent across multiple countries (Jerrim et al., 2012). Other studies have used parental occupation as a measure of SES. For example, Haeck et al. (2021) study achievement gaps in Canada for high school students who take the Programme for International Student Assessment.

When using parental income as a measure of socioeconomic status, studies have also found large achievement gaps (for example, see Carneiro et al., 2003). Reardon (2011) estimates that the P90-P10 test score gap is 1.25 standard deviations for children born in 2001 in the U.S. and that the gap grew when compared to earlier cohorts. Magnuson et al. (2012) finds gaps between the top and bottom quintile of around one standard deviation for the U.S., and 0.8-1.0 standard deviations for England. In a cross-country comparison of multiple countries, Chmielewski et al.

[6]For example, see King et al., 2009; Smylie, 2012; Shapiro et al., 2021.

(2016) find that the P90-P10 income gap is larger in the U.S. than in other OECD countries. More recently, Sandsør et al. (2021) calculates the P90-P10 income gap for Norway to be 0.55-0.93 standard deviations. Just like our paper, these works are descriptive, documenting the correlations between income and achievement. For causal effects of income on achievement, see Dahl et al. (2012), who find that changes in the Earned Income Tax Credit led to improvements in test scores in the United States.

One of our key findings is large income-achievement gaps for Indigenous students. This result is tied to a broad literature documenting inequalities within the Indigenous population in Canada. Friesen et al. (2010) study the achievement gaps between Indigenous and non-Indigenous students in British Columbia. They find that there is significant sorting of Indigenous students into lower-performing schools. Similarly, Richards et al. (2010) show that school quality explains an important component of the Indigenous test score gap in British Columbia as well. Across Canada, Barber et al. (2021) use a national sample of students and find an Indigenous gap of around 0.31 standard deviations that has stayed consistent from 1996 to 2008.

Our work also ties into the literature on economic outcomes by race. Recent work on intergenerational mobility by Chetty et al. (2020) has highlighted that economic opportunity in the United States varies, with Black Americans and American Indians having worse outcomes than White and Asian Americans. In related work, Collins et al. (2017) look at historical intergenerational mobility outcomes between Black and White Americans, while Abramitzky et al. (2021) study intergenerational mobility of immigrants to the United States. In addition to studying intergenerational mobility, Akee et al. (2019) also study income shares and income inequality by race. Overall, these findings suggest that the importance of parental background for child prosperity varies by race. One difference between our work and the literature is that we are not able to speak to outcomes for Black students as they are a small minority in British Columbia. Instead, we shed light on outcomes for East Asian, South Asian, and Indigenous students.

The rest of the paper is structured as follows. In Section 3 we discuss the education system in British Columbia and Section 4 presents the data. Section 5 goes over the empirical framework and Section 6 presents the results. We do several robustness exercises in Section 7 and Section 8 concludes.

3. Institutional Background

Our data is for the province of British Columbia (BC), the third most populous province in Canada. BC is a diverse province; at the time of the 2006 Census, it had a visible minority

share of 25 percent. Table A.1 in the Appendix lists demographic characteristics from the 2006 Canadian Census of BC in comparison to Canada. The racial composition of BC differs from Canada in a few key ways. First, the province has a large share of Asian residents. Ten percent of the British Columbia population are Chinese, compared to only four percent nationwide. In addition, six percent in the province are South Asian. Second, five percent of the province's population is Indigenous, which in turn implies that almost seventeen percent of the Indigenous population of Canada resides in British Columbia. Finally, the Black population is significantly under-represented in British Columbia: less than one percent of residents identify as Black, compared to two and a half percent in Canada overall. In this paper, we focus on studying income-achievement gaps among BC's three largest minority groups: Indigenous, East Asian and South Asian.

We now discuss education policy, which in Canada is set at the provincial level. British Columbia has a traditional public school system: students are guaranteed a seat in a school based on their catchment area. Since 2003, the province has had an open-enrolment policy in which children can attend school outside their catchment area, given available seats.[7] The school financing system in British Columbia is centralized, with roughly 94 % of the budgeted revenue for school boards coming from provincial grants (Ministry of Education British Columbia, 2015). Additional funds are provided for Indigenous students, students with special needs, adult learners, and English/French Language Learners (Independent Funding Model Review Panel, 2018). This financing system is in contrast with the U.S., where in 2013-14, funding at the district level still made up 45% of per-pupil revenue with 81% of district funding raised from local property taxes (U.S. Department of Education, 2016). Furthermore, British Columbia has a system of independent (private) schools. These schools must hire teachers certified by the province and adhere to the provincial curriculum. Some independent schools are funded at 35-50% of their local public school rate.[8]

One of the student groups we focus on is Indigenous children. In BC, education for Indigenous students can take place in two forms. Students living on Indigenous reserves can attend an on-reserve school, which are funded by the federal Canadian government. This is a small proportion of the Indigenous student population though; for instance Friesen et al. (2010) estimate that only seven percent of Grade 7 (age twelve) BC Indigenous students attend a school operated by a First Nations band. Unfortunately, we have no data on students in these types of schools. We can only see Indigenous students who attend traditional public schools run by the province.

[7] See Friesen et al. (2015) for an analysis of the impact of the open-enrolment policy.
[8] See the B.C. Ministry of Education website.

Drawing on the literature, we can get a sense of how the lack of on-reserve school data would affect our estimates of the Indigenous income-achievement gap. Previous findings have shown that education quality and income on reserves are lower than those of Indigenous people off-reserve (McMahon, 2014).[9] This suggests that if we had data for on-reserve students, our estimates of the income-achievement gap for Indigenous students would be higher.

4. Data

We use a unique dataset that links the achievement data of students in British Columbia to parental information that includes income tax data and demographic information from the Census. We go through each of these data sources in turn.

Education Data

Our education dataset is from the British Columbia Minister of Education and covers the universe of students who attend public or independent schools in the province. It consists of student-year level observations documenting student demographics including age, Indigenous status, gender, language spoken at home, special needs status, and school attended. Special needs students are those with physical, behavioural, or learning needs. For the purposes of our analysis, we do not include gifted students in our classification of special needs. We only consider school-aged learners and drop adult learners from our sample.

During the year that students are in Grade 4 (age nine) and Grade 7 (age twelve), performance on provincial wide standardized exams are recorded. The test score performance is from the Foundation Skills Assessment (FSA), which is available starting from the 2000-01 school year. This is a provincial-wide test given annually to all students (in both public and independent schools) in Grade 4 and Grade 7, and tests their skills in literacy and numeracy. Students are graded in the form of a percentage score, which we standardize within a grade, subject, and cohort. If a student repeats a grade and retakes the FSA, we use their first attempt.

Note that while in principle, all students should take the FSA, there are some exceptions. Students can miss an exam due to illness or an emergency, and exceptions are given to students with serious disabilities and for students who are not yet at a proficiency level of English that would allow them to take the test. Moreover, recently there has been a push by the teacher's union to have parents opt their children out of the FSA (Boynton, 2019). This movement has had some success with participation rates falling the past few years. For example, in 2017, the participation rate was 79% whereas in 2007 it was around 89%.

[9] See also https://www150.statcan.gc.ca/n1/daily-quotidien/210921/cg-d001-eng.htm

We focus on the cohort of students who were in Grade 4 from the academic years 2008/09 to 2012/13 and who were thus in Grade 7 from 2011/12 to 2015/16. The reason we do this is twofold. First, a fifth of our sample is linked to the 2016 Census, meaning that the census information from 2016 covers students when they are age 12 to 16 and still in school. If we use older cohorts, the census linkage will no longer capture demographics of our sample during school years. Second, we do not want to use cohorts that are too recent due to the falling participation discussed above. In Section 6 we discuss how changing participation may bias our estimates.

Tax Return Data

Children in the BC education dataset are linked to the tax return data of their parents through the T1FF datafile from Statistics Canada. The tax return data covers the parents of children in the education dataset who file an income tax return, in addition to individuals who claim child benefits from the federal government. Our main definition of income is before-tax income at the household level. In robustness checks we also use household income after tax, and household income after tax scaled by family size. Income is defined as the sum of employment income, business income, income from agriculture, self-employment income, and benefits. We define a household as the two parents of a child. To get a sense of the household finances during the child's early years, we take averages of total household income in the five years leading up to when the child is in Grade 4. We are able to match 96% of our students of interest to tax records. Of these matches, 92% of the linkages have the full five years of income available. All income values are normalized to real Canadian dollars using the Consumer Price Index from Statistics Canada.

Data on Race

As mentioned in Section 3, the most populous minority groups in British Columbia are Indigenous, East Asian, and South Asian. These are the racialized groups we focus on.

The data from the Ministry of Education asks students whether they are Indigenous. We classify a student as Indigenous if a student ever answers as being so during the years observed. For other minority groups, the administrative data does not explicitly ask for a student's race. We do however, have information on the language a student speaks at home. To start with, we use language spoken at home as a coarse proxy for race. We classify students who speak Chinese or Korean at home as "East Asian", and students who speak Punjabi or another South Asian language as "South Asian". For comparison, we look at students who speaks English at home and are not Indigenous; we classify these students into our "Baseline Group".

Our classification system is subject to some measurement error. While our classifications for

East Asian and South Asian minorities are likely to be accurate, students who speak English at home may be White or belong to a visible minority group. Note that our classification of Indigenous students is accurate to the extent that Indigenous students will self-identify as being such.

Census Data

To get a more accurate measure of race, we can restrict our sample to the twenty percent that is linked to the 2016 census. The census has a question explicitly asking for the visible minority group that a student belongs to. We find that while over eighty percent of our "Baseline Group" are white, around four percent identify as South Asian whereas another four percent identify as South Korean or Chinese. We recalculate our income-achievement gaps using racial groups based on the census definition, but do not find large differences in our results. In fact, whether we define our Baseline group as "speaking English at home" or as White per the census, we find that the income-achievement gaps are very similar. Given the similarity in our findings between the administrative data and the census, for most of our analyses we elect to use the home language proxy as we have the entire universe of students in that sample.

In addition, the census data provides us with additional demographic information that can allow us to understand variation in the income-achievement gap. The linkage of the census is done based on the child's identifier, so we do not have information on parental individual variables such as education attainment. We are however, able to use variables at the household level and we study how family composition and quality of housing may relate to income-achievement gaps.

5. Empirical Framework

We use a standard OLS regression to document the test score-income gap. Our baseline model is a regression of standardized student test scores for child i on their household before-tax income. To start, we focus on the achievement gap between the top and bottom income decile. We use deciles so that we can compare our estimates to those of Reardon (2011) for the U.S. and Sandsør et al. (2021) for Norway. We run the following regression separately for each of our four student groups, Baseline, Indigenous, East Asian and South Asian:

$$y_i = \alpha + \sum_{q=2}^{10} \beta_q \mathbb{1}income_{i,q} + \epsilon_i \tag{1}$$

where y_i is the average test score across reading and math of individual i in standard deviations, and $\mathbb{1}income_{i,q}$ is an indicator variable that equals one if the child's household income is in decile

q. The bottom income decile is the reference level.

We calculate income deciles across all families and not within racial groups, as in Chetty et al., 2020. The coefficient β_q represents the average test score for those in income decile q relative to the bottom income decile. Standard errors are clustered at the school level to account for families sorting into schools. We call β_{10} the P90-P10 achievement gap. In certain specifications, we augment Equation (1) with controls and/or school fixed effects.

6. Results

In this section we discuss results using the student population data from the BC Minister of Education, where, except for Indigenous students, home language is used as a proxy for race. As discussed above, when we refer to East Asian or South Asian students, we mean those who speak an East Asian or South Asian language at home. For comparison, our Baseline group is those who speak English at home. In Section 6.5, we show that using race information from the twenty percent of the dataset linked to the Census does not change our findings significantly.

6.1. Summary Statistics

To start we present summary statistics for three samples of our students. Column (1) of Table 1 is for the entire sample of students in our cohort of interest: those in Grade 4 from 2008/09 to 2012/13. Column (2) is the sample of students for which we have at least one Grade 4 FSA score in either reading or numeracy. Lastly, Column (3) is the sample of students for which we have at least one Grade 4 FSA score and one Grade 7 FSA score. We present information on the total number of students, average before-tax household income, and share of minority students. Note that per data-release guidelines, all counts are rounded to the nearest tenth and average income values are rounded to the nearest hundredth.

In the full sample, we have 191,880 Grade 4 students over the five years with an average household income before taxes of $67,100. Sixty-five percent of students speak English at home. The percentage of students identifying as Indigenous is thirteen percent. Six percent of students speak an East Asian language at home while seven percent of students speak a South Asian language at home. Around 17% were diagnosed with a special needs disorder and about 19% were English as Second Language (ESL) students.[10] Recall that we group students as ESL and special needs students based on if they were ever classified in the data as being in one of these groups.

[10]While these ESL rates may seem high, note that populous regions in British Columbia have a significant immigrant population. For example, reporting from the Vancouver Sun in 2014 stated that ESL students make up more than 50% of their school's population in over 60 schools in Vancouver (Skelton, 2014).

Table 1: Summary Statistics

	Full Sample	Grade 4 FSA	Grade 4 and 7 FSA
	(1)	(2)	(3)
Number of Students	191,880	165,270	142,260
Average Household Income	$ 67,100	$ 69,000	$70,300
% English Language	65	66	66
% Indigenous	13	12	12
% East Asian	6.3	6.0	6.1
% South Asian	7.2	7.4	7.7
% Special Needs	17	13	12
% English as Second Language	19	17	17

Notes: Column (1) contains summary statistics for the cohort of students in Grade 4 from 2008 to 2012. Column (2) is the subset of the full sample who have at least one non-missing FSA score from Grade 4. Column (3) is the subset of students who have at least one non-missing FSA score in both Grade 4 and Grade 7.

Column (2) presents summary statistics for our cohort of students who are in Grade 4 and took at least one of the Reading or Math FSA exams. Out of all the students in Grade 4 during 2009-2013, 165,270 or roughly 86%, wrote at least one FSA subject exam. Students who write the FSA have parents with around $2,000 higher household income. There are lower participation rates among Indigenous, ESL, and special needs students: the percent of Indigenous students drops to twelve, the percent of ESL is at seventeen, while the percent of special needs students falls to thirteen. In Column (3), we highlight the sample of students who have both Grade 4 and Grade 7 FSA scores. Participation does drop from Grade 4 to Grade 7: we now have a sample of 142,260 students. The average income is higher, now at $70,300.

Table 1 shows that there is selection into exam participation, which could cause our P90-P10 gaps could be biased. From the summary statistics, we see that children who do not participate are likely to be from lower-income families, since average household income rises as we condition on participation. Furthermore, we are missing students who are likely to be of lower ability since special needs students are less likely to write the exams. Therefore, the estimates of the P90-P10 gap that we calculate should be downwards biased.

6.2. Raw Income-Achievement Gaps

We now present estimates of the raw-income achievement gap across race. Figure 1 presents a binscatter of the P90-P10 gap for students in Grade 4 across our four groups of interest: Baseline, Indigenous, East Asian, and South Asian. Each dot on the graph is the average test score from reading and math for students from a group in a certain income decile. Recall that income deciles are calculated across *all* students, and not within each group.

The first thing to note is that there are stark differences in the level of achievement among the different groups. As previously documented (see Friesen et al. (2010), Richards et al. (2010), and Barber et al. (2021)), Indigenous students perform worse on standardized tests: their test scores range from -0.6 to around 0.1 standard deviations (σ). On the other hand, students in the baseline group have a minimum average performance of -0.2σ. South Asian students perform slightly worse while East Asian students perform very well: from around 0.4 to 0.8σ.[11]

Next, we present our novel findings on how the income-achievement gap varies by race by looking at how the slope between parental income and test scores differs among our groups of students. In particular ,we look at the difference in outcomes between an average student whose family income is in the top income decile versus one whose family income is in the bottom decile (P90-P10 gap). For the Baseline group this is 0.51σ and South Asians have a similar value, at 0.55σ. The difference for East Asian students is smaller, at roughly 0.45σ . For Indigenous students though, the P90-P10 gap is noticeably larger, close to 0.71σ. Thus, we find that in Grade 4, East Asians have the flattest relationship between income and test scores while income is the strongest predictor of test scores for Indigenous students.

Figure 2 shows that the above patterns stay consistent when students are three years older, in Grade 7. The P90-P10 gap widens to around 0.75σ for Indigenous students while it narrows for East Asian students to around 0.35σ. For our Baseline group of students, the gap is similar at around 0.6σ, while the South Asian gap is closer to 0.5σ.

We now discuss how to interpret these achievement gaps. Our findings indicate gaps ranging from around 0.35σ for East Asian students to 0.75σ for Indigenous students in Grade 7. In absolute terms, we can compare these to the average P90-P10 gap in the United States which Reardon (2011) documented to be around 1.5σ. For Norway, Sandsør et al., 2021 find that the P90-P10 gap is much smaller, around 0.6σ. Our results indicate first that among all groups of students in BC, the income-achievement gaps are substantially lower than that in the United States. This difference between Canada and the US is in line with other works that have found

[11] In related work for Australia, Jerrim (2015) document that East Asian students perform better than Australian-born students in school.

higher intergenerational mobility of income in Canada compared to the US (Connolly et al., 2019).

Nevertheless, there is important heterogeneity across different student groups. Looking at outcomes in Grade 7, the P90-P10 gaps are similar for English-Speaking and South Asian students and close to what has been documented in Norway. However, the gap for Indigenous students is noticeably larger, at 0.75σ. In contrast, East Asian students perform pretty similarly, regardless of where there parents are in the income distribution; their P90-P10 gap is only around 0.35σ.

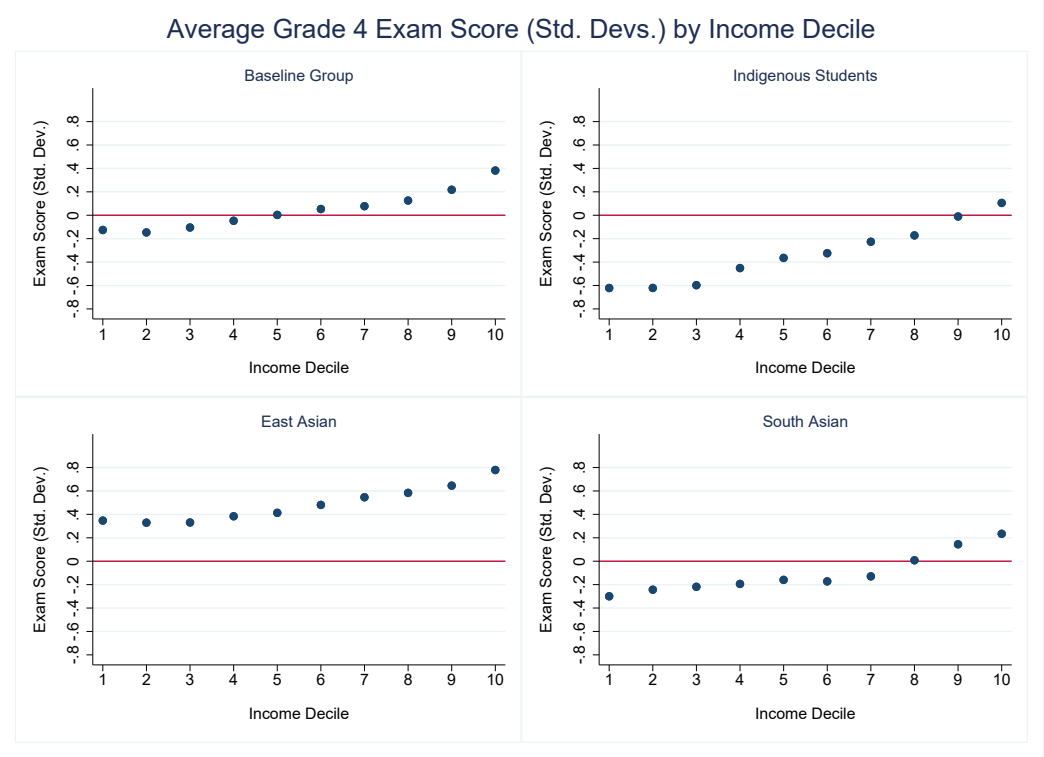
More broadly, our findings can also be linked to work on economic opportunity and race. Here, we show that even when children are as young as nine, there are already patterns between test scores and parental income that vary across race and that are suggestive of the future relationships in child income and parental income documented by Chetty et al., 2020. Just like they find that Asians have higher relative economic mobility, we find that East Asians specifically, have lower income-achievement gaps. Furthermore, Chetty et al., 2020 find worse intergenerational mobility outcomes for American Indians. In a similar vein, we find that Indigenous students have the largest P90-P10 gap, at around 0.75σ. Therefore, even at childhood, we already see the existence of the disparities that Chetty et al., 2020 document between parental income and child outcomes across racial groups.

6.3. Mechanisms

The next step is to understand what factors explain the income-achievement gap across the four groups of students. To do so we utilize the richness of our administrative dataset and include different controls such as: school characteristics, peer characteristics, and individual student information. Table 2 presents the results for the Grade 4 exams. For reference, Column (1) contains the estimates for the raw P90-P10 achievement gaps, which were presented in the discussion of Figure 1 above. In Column (2), we include school fixed effects and the P90-P10 achievement gaps fall by around 20-30% across all student groups. Thus, the sorting of high income parents into good quality schools explains a significant proportion of the raw P90-P10 achievement gap. As discussed in Section 2, British Columbia has a traditional public school system with catchment schools. Given that school quality is capitalized into house prices (Black, 1999), it is higher income families who can afford to live in catchment areas with good schools. While British Columbia does have an open-enrolment policy, Friesen et al. (2015) showed that in 2006, the majority of students still attended their in-catchment school.

Notice as well that the inclusion of school fixed effects reduces the P90-P10 gap for Indige-

Figure 1: Income-Achievement Gaps in Grade 4

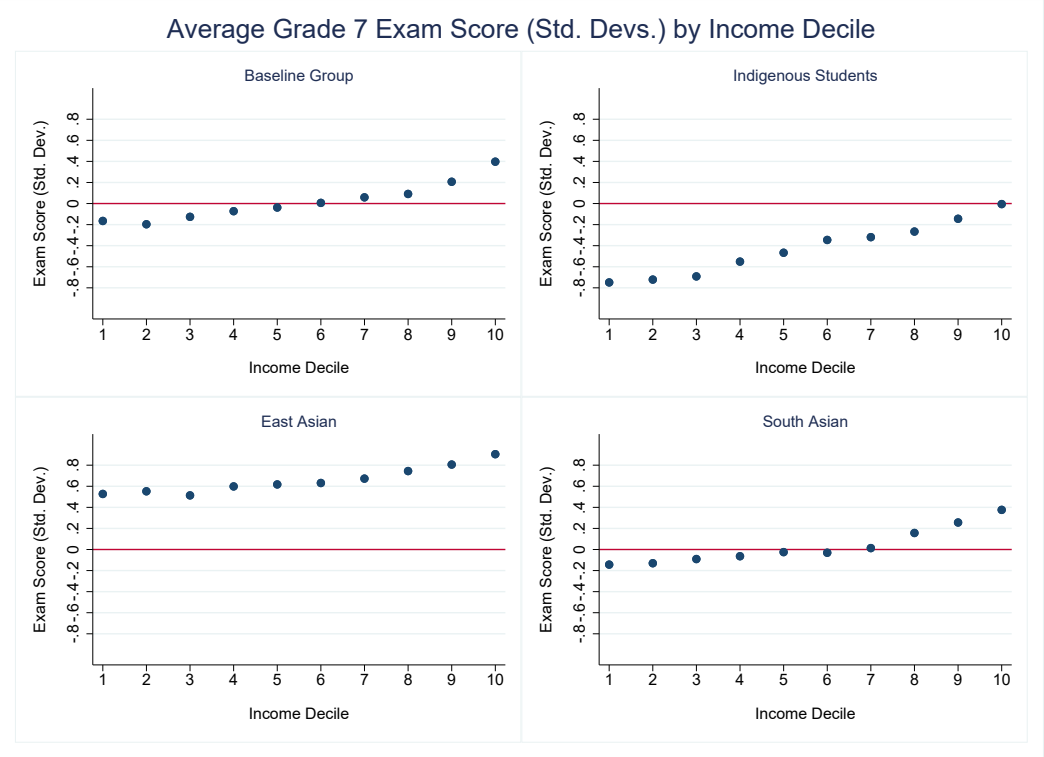


Notes: Each figure plots the average Grade 4 FSA score across both reading and numeracy by each income decile. Top left figure is for the baseline group of students, who speak English at home. Top right figure is for Indigenous students. Bottom left figure is for students speaking Chinese or Korean at home. Bottom right figure is for students speaking a South Asian language at home. Income deciles are calculated from before-tax household income and the deciles are calculated across the entire cohort of students.
Source: Author's own calculations using data from B.C. Minister of Education, Statistics Canada.

nous students from 0.71 to 0.51, a drop of almost 30 percent. Thus, a key reason for the large P90-P10 gap in Indigenous students is that low-income Indigenous students attend low-quality schools. This finding is in line with work by Friesen et al. (2010) who study the test score gap between Indigenous and non-Indigenous students. They show that school characteristics accounts for around half of the raw difference in the Indigenous and non-Indigenous test score gap.

Another factor that may be correlated with both parental income and test scores is peer composition. In Column (3) we keep school fixed effects and then include three variables to capture peer effects: the percentage of Indigenous students, East Asian students, and South Asian students in a grade-school-year. Note that we cannot see the classroom assignments of students and therefore, our peer effects capture interactions among students of the same grade in a school, including those in the same classroom. Comparing Column (3) to Column (2), we see that adding peer fixed effects explains very little of the P90-P10 gap above what school fixed effects did. The coefficients do not change. This could be because there is little fluctuation in

Figure 2: Income-Achievement Gaps in Grade 7



Notes: Each figure plots the average Grade 7 FSA score across both reading and numeracy by each income decile. Top left figure is for the baseline group of students, who speak English at home. Top right figure is for Indigenous students. Bottom left figure is for students speaking Chinese or Korean at home. Bottom right figure is for students speaking a South Asian language at home. Income deciles are calculated from before-tax household income and the deciles are calculated across the entire cohort of students.
Source: Author's own calculations using data from B.C. Minister of Education, Statistics Canada.

the composition of peers from year to year within a school-grade, and so school fixed effects essentially capture peer effects as well. Also on peer effects, Friesen et al. (2010) do not find that peer composition is an important factor in explaining the Indigenous test score gap. However, Friesen et al. (2011) do find that having more Chinese speaking peers raises the test scores of Chinese students, while having more Punjabi speaking peers lowers the test scores of Punjabi students. For our findings, the P90-P10 gap for East Asian and South Asian students does not change with the inclusion of peer effects, suggesting that peer composition does not affect these students differently by income.

In Column (4) we keep school fixed effects as a control, but add in an indicator variable for if a student is ESL. Recall that we define a student as ESL if they were *ever* listed as being so in the school records. Since our student population includes those who speak a language besides English at home, many of them may be immigrants who are learning English for the first time. As expected, ESL status does little to explain the income-achievement gap for English-Language students. However, ESL status explains about ten percent of the P90-P10 Indigenous

gap, reducing it from 0.51 to 0.45σ. More striking, for East Asian students, including a control for ESL reduces the P90-P10 gap from 0.35 to 0.20σ. Thus, a big factor in the income gradient of achievement among East Asians is that low-income families tend to be immigrants and are still learning English. Conditional on knowledge of English, the P90-P10 gap for East Asian students is quite small, at 0.2σ. Similarly, including an ESL indicator also reduces the P90-P10 gap for South Asian students, from 0.38 to 0.27σ.

To get a deeper understanding of how ESL status affects income-achievement gaps, we present the visual relationship between ESl status in Grade 4 and income for our four student groups in Figure 3. We show the percentage of ESL students by income quintile for each student group.[12] As expected, for our baseline group of students, very few are ESL since they speak English at home. For the rest of the students, there is a clear link between ESL status and income. Twenty percent of Indigenous students from families in the bottom income quintile are ESL compared to around five percent in the top income decile. For East Asian speaking and South Asian speaking students, the relationship is even starker. We see that the majority of both groups in the bottom income quintile are ESL students, with a higher percentage for South Asian than for East Asian. Thus, the relationship between income and ESL explains why when controlling for ESL status as done in Column (4) of Table 2, the income-achievement gap falls substantially. The importance of ESL status for the income-achievement gap of East and South Asian students is related to the work by Chetty et al. (2020). They hypothesize that one reason for the high intergenerational mobility of Asians is that many are high skilled immigrants but earn low-income due to their lack of local labour market experience. This hypothesis is also echoed in recent work on the intergenerational mobility of immigrants (Abramitzky et al., 2021).

Lastly, in Column (5) of Table 2 we add an indicator for special needs status. Controlling for special needs has little effect on the P90-P10 achievement gap (comparing Columns (3) and (5)) except for Indigenous students. For them, the gap falls from 0.51 to 0.45σ. The link between special needs and income is highlighted in Figure 4, which presents the proportion of special needs students by income quintile for each student group. We see that for Indigenous students, there is a pronounced trend between special needs diagnosis and income. Almost forty percent of Indigenous students in the bottom income quintile have special needs in comparison to twenty percent in the top income quintile. This explains why controlling for special needs status reduces the P90-P10 income achievement gap for Indigenous students but not for other groups of students. The higher prevalence of special needs among Indigenous students is related to work on the health disparities between Indigenous and non-Indigenous children.[13] Work by

[12] Due to data disclosure reasons we use income quintiles here instead of deciles.

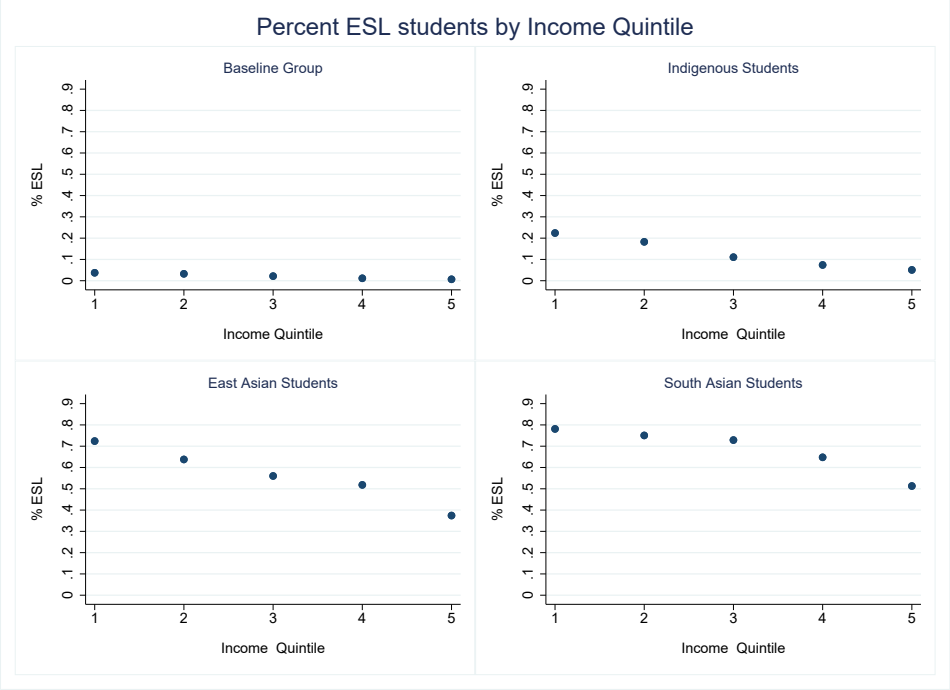
[13] Relatedly, Elder et al. (2021) study the identification of special needs students among Black and Hipsanic

Table 2: Income Achievement Gaps: English-Language, Indigenous, East Asian, and South Asian Students

	Grade 4				
	(1)	(2)	(3)	(4)	(5)
Panel A: Baseline					
P90-P10	0.508***	0.337***	0.338***	0.328***	0.295***
	(0.0180)	(0.0137)	(0.0137)	(0.0136)	(0.0133)
Number of Students	109440	109440	109440	109440	109440
R^2	0.034	0.175	0.175	0.178	0.209
Panel B: Indigenous					
P90-P10	0.714***	0.509***	0.509***	0.446***	0.454***
	(0.0428)	(0.0356)	(0.0356)	(0.0342)	(0.0351)
Number of Students	19300	19300	19300	19300	19300
R^2	0.056	0.242	0.242	0.279	0.273
Panel C: East Asian					
P90-P10	0.456***	0.351***	0.351***	0.200***	0.358***
	(0.0396)	(0.0367)	(0.0366)	(0.0334)	(0.0361)
Number of Students	8930	8930	8930	8930	8930
R^2	0.024	0.165	0.166	0.222	0.181
Panel D: South Asian					
P90-P10	0.550***	0.386***	0.384***	0.278***	0.367***
	(0.0778)	(0.0660)	(0.0663)	(0.0656)	(0.0649)
Number of Students	11270	11270	11270	11270	11270
R^2	0.011	0.296	0.296	0.335	0.316
School Fixed Effects	No	Yes	Yes	Yes	Yes
Peer Effects	No	No	Yes	Yes	Yes
English as a Second Language	No	No	No	Yes	No
Special Needs Status	No	No	No	No	Yes

Notes: This table presents the average test score gap in standard deviation units between the top and bottom income decile for the Grade 4 FSA. FSA scores are averaged across subjects. Column (1) presents results with No Controls, Column (2) adds school fixed effects, with peer effects also included in Column (3). Column (4) includes school fixed effects and an indicator for whether the student is English as a Second Language. Column (5) includes school fixed effects and an indicator for whether the student has special needs. Panel A presents the P90-P10 gap for our "baseline" group: students who speak English at home. Results for Indigenous students are in Panel B. Panel C presents results for East Asian students and Panel D for South Asian students. In the case of multiple FSA attempts, the first attempt is used.

Figure 3



Notes: Each figure plots the share of ESL students each income quintile. Top left figure is for the baseline group of students, who speak English at home. Top right figure is for Indigenous students. Bottom left figure is for students speaking Chinese or Korean at home. Bottom right figure is for students speaking a South Asian language at home. Income quintiles are calculated from before-tax household income and the quintiles are calculated across the entire cohort of students.
Source: Author's own calculations using data from B.C. Minister of Education, Statistics Canada.

Smylie, 2012 highlights that the rate of pre-term births and low-weight births among Indigenous mothers is higher compared to the rate for all Canadians, and both these conditions may lead to developmental disabilities. We also find that there is a pronounced decrease in the rate of special needs diagnosis for Indigenous students as income increases. In line with our findings, Hajizadeh et al., 2018 report strong links between income and health outcomes for Indigenous individuals.

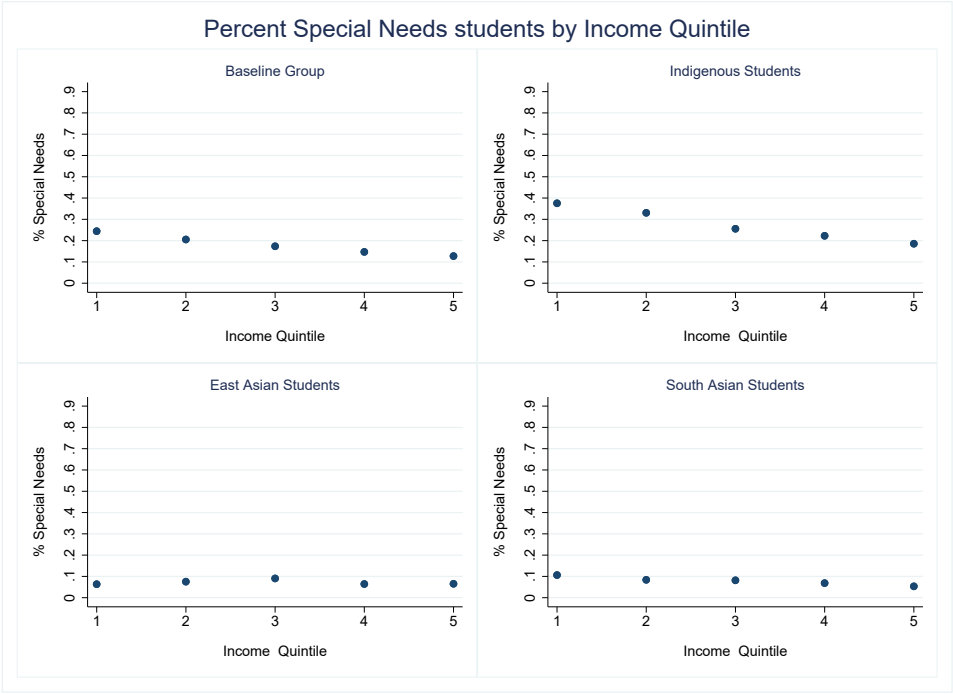
6.4. Achievement Gaps across time and subject

We now study how income-achievement gaps vary by subject and across time. Panel A (B) in Table 3 presents the raw P90-P10 gaps in numeracy (reading) results for Grade 4, and Panel C (D) presents the raw P90-P10 gaps in numeracy (reading) results for Grade 7.

We start by discussing subject differences. First, for English Language speakers, there is more inequality in test scores by income for numeracy with a gap of 0.55σ in Grade 4 (Column (1) Panel A) compared to 0.46σ in reading (Column (1) Panel B). On the contrary, the P90-P10 gap for Indigenous students is large for both numeracy (Column (2) Panel A) and reading

children in the United States.

Figure 4



Notes: Each figure plots the share of special needs students each income quintile. Top left figure is for the baseline group of students, who speak English at home. Top right figure is for Indigenous students. Bottom left figure is for students speaking Chinese or Korean at home. Bottom right figure is for students speaking a South Asian language at home. Income quintiles are calculated from before-tax household income and the quintiles are calculated across the entire cohort of students.
Source: Author's own calculations using data from B.C. Minister of Education, Statistics Canada.

(Column (2) Panel A) at around 0.7σ.

Differences across subjects are most pronounced for East Asian students. In Grade 4, the East Asian P90-P10 gap in math is 0.36σ (Column (3) Panel A) compared to 0.54σ (Column (3) Panel A). Relatedly, previous work has documented that East Asian students outperform other racial groups in mathemathics (Kao, 1995). Part of this difference may stem from the fact that lower-income East Asian students are more likely to be ESL and thus may struggle more in reading comprehension. For South Asian students, we also see slightly higher gaps in reading though there is less of a difference (Column (4) of Panel A and B).

How do the income-achievement gaps change as students progress through school? Jerrim et al., 2012 study the difference in achievement gaps by socioeconomic status for Canada and find no significant increase from ages ten to fifteen.[14] However, we find that the gaps from Grade 4 to Grade 7 change differently by subject and student group. For English Language students, the Numeracy gap widens by 0.1σ, to 0.65σ (Panel C Column (1)) while the Reading gap only grows slightly, to 0.50σ (Panel D Column (1)). We saw in Grade 4 that Indigenous students have the largest P90-P10 gap among the groups of students we study and this holds true in Grade 7 as well. The P90-P10 gap in Reading for Indigenous students grows to 0.77σ in Grade 7 (Panel D Column (2)).

We previously saw that there was significantly less inequality in outcomes in Numeracy for East Asian students in Grade 4 than in Reading. In Grade 7, the gap in Numeracy is similar at 0.34σ (Panel C Column (3)) while the reading gap narrows to 0.47σ (Panel D Column (3)). We know from the discussion above that ESL status is an important factor in explaining the P90-P10 gap. As East Asian students progress through school and become more comfortable with English, the discrepancy in their scores across income for reading falls. For South Asian students, the gap in numeracy narrows to 0.46σ (Panel C Column (4)) while the gap in reading is pretty constant at 0.54σ (Panel D Column (4)). Overall, our findings show that the P90-P10 gaps are for East Asian and South Asian students narrow as these students get older. The gaps for English Language students grow, especially in math. Indigenous students have the largest income-achievement gaps across both subjects, and this is consistent in both Grades 4 and 7.

For our Baseline, Indigenous, and South Asian group, the participation in the FSA decreases from grade 4 to grade 7. In contrast, the number of East Asian students writing the FSA increases from grade 4 to grade 7. One likely reason for this is that students learning English as a Second Language may be exempt from the FSA if their language skills are not sufficient. From Table 2 we saw that ESL explains a significant proportion of the P90-P10 gap among East

[14]While they use parental education and number of books at home as a measure of socioeconomic status, we use before-tax household income. We also use panel data and our time frame is from ages nine to twelve.

Asian students. Therefore, East Asian students who were ESl in grade 4 and did not write can now write in grade 7.

In summary, our findings point to important differences in the relationship between income and achievement across different minority groups. For Indigenous students, there is the biggest disparity in test scores across income, while the gap for East Asian students is almost twice as small. Students who speak English at home and South Asian students have similar income-achievement gaps. These gaps arise by the fourth grade, when children are aged nine, and they persist into the seventh grade, three years later.

Table 3: Income-Achievement Gaps by Subject Across Grades 4 and 7

Panel A: Grade 4 Numeracy				
	English Language	Indigenous	East Asian	South Asian
	(1)	(2)	(3)	(4)
P90-P10	0.551***	0.691***	0.358***	0.539***
	(0.0203)	(0.0496)	(0.0453)	(0.102)
Number of Students	108350	18990	8900	11210
R^2	0.031	0.045	0.016	0.009
Panel B: Grade 4 Reading				
	English Language	Indigenous	East Asian	South Asian
	(1)	(2)	(3)	(4)
P90-P10	0.457***	0.719***	0.536***	0.565***
	(0.0180)	(0.0452)	(0.0451)	(0.0760)
Number of Students	108780	19060	8830	11210
R^2	0.023	0.045	0.024	0.010
Panel C: Grade 7 Numeracy				
	English Language	Indigenous	East Asian	South Asian
	(1)	(2)	(3)	(4)
P90-P10	0.649***	0.721***	0.335***	0.464***
	(0.0238)	(0.0480)	(0.0465)	(0.0869)
Number of Students	99720	17030	9190	11130
R^2	0.043	0.056	0.013	0.011
Panel D: Grade 7 Reading				
	English Language	Indigenous	East Asian	South Asian
	(1)	(2)	(3)	(4)
P90-P10	0.498***	0.767***	0.474***	0.543***
	(0.0200)	(0.0527)	(0.0415)	(0.0776)
Number of Students	100540	17270	9180	11180
R^2	0.027	0.052	0.020	0.012

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: P90-P10 achievement gaps by for numeracy (reading) for Grade 4 in Panel A (B). P90-P10 achievement gaps by for numeracy (reading) for Grade 7 in Panel C(D). Columns (1)-(4) present the raw P90-P10 gaps for English Language, Indigenous, East Asian and South Asian students.

6.5. Results using the Census

The previous results characterized East Asian and South Asian students using language spoken at home. While it seems likely that students who speak an Asian language at home are likely to be of an East Asian or South Asian race, students who speak English at home may also be East or South Asian. Here, we use racial groups as defined in the census, which is linked to twenty percent of our sample. The census asks respondents to identify which visible minority group they belong in and we focus again on East Asian (Chinese/Korean)[15], South Asian and Indigenous students. As our baseline group, we use students who identify as White.

Intuitively, when using the census definitions of visible minorities, the previous income-achievement gaps reported for East Asian and South Asian students may narrow, due to the role of ESL status. By only looking at whether a student speaks an Asian language at home, we may be missing out on Asian students who have been in Canada for longer and are more comfortable with English. These students are likely to have higher test scores than newcomers to Canada, and thus the estimated gap could narrow.

Figure 5 below presents the average test score across both subjects in Grade 4 for White, Indigenous, East Asian, and South Asian students as defined by the Census. Due to the smaller sample size and data reporting guidelines, we bin income by before-tax household quintile (instead of decile). We see very similar patterns for income-achievement gradients in the census as previously reported using the administrative data. Namely, the slope of the gradient for East Asian students is the lowest among the four groups of students. White and South Asian students have similar gradients, while Indigenous students have the lowest test scores in terms of level and also the steepest income gradients.

Table 4 presents the average score in the top quintile relative to the bottom quintile (P80-P20 gap). The first column uses the administrative data and the definition of the student groups from that dataset. The second column presents P80-P20 estimates using the definitions of students from the census. We start with Panel A, which compares English-Language speaking students in Column (1) from the administrative data to students identifying as White in the Census in Column (2). We find similar estimates among these two groups. Over eighty percent of students who speak English at home identify as White in the Census and the remainder are mostly East Asian or South Asian. The P80-P20 gap for White students is slightly higher than that for English-speaking students (0.46σ versus 0.44σ). That the P80-P20 gap increases when using White as opposed to English language could be due to the exclusion of East Asian students who speak English at home and have high test scores.

[15] We select these two groups so that it matches with the language groups in the BC administrative data

Panel B of Table 4 calculates the P80-P20 gap for Indigenous students in the administrative data (Column (1)) and the Census (Column (2)). As expected, since both data sets ask students to self-identify as Indigenous, the estimates are identical. In Panel C, for East Asian students, we find that using the Census definition reduces the P80-P20 gap but only by 0.04σ. On the other hand, the gap for South Asian students (Panel D) falls by around 0.1σ. One reason for this is that South Asian low-income students who speak English at home may be more assimilated and have higher test scores.

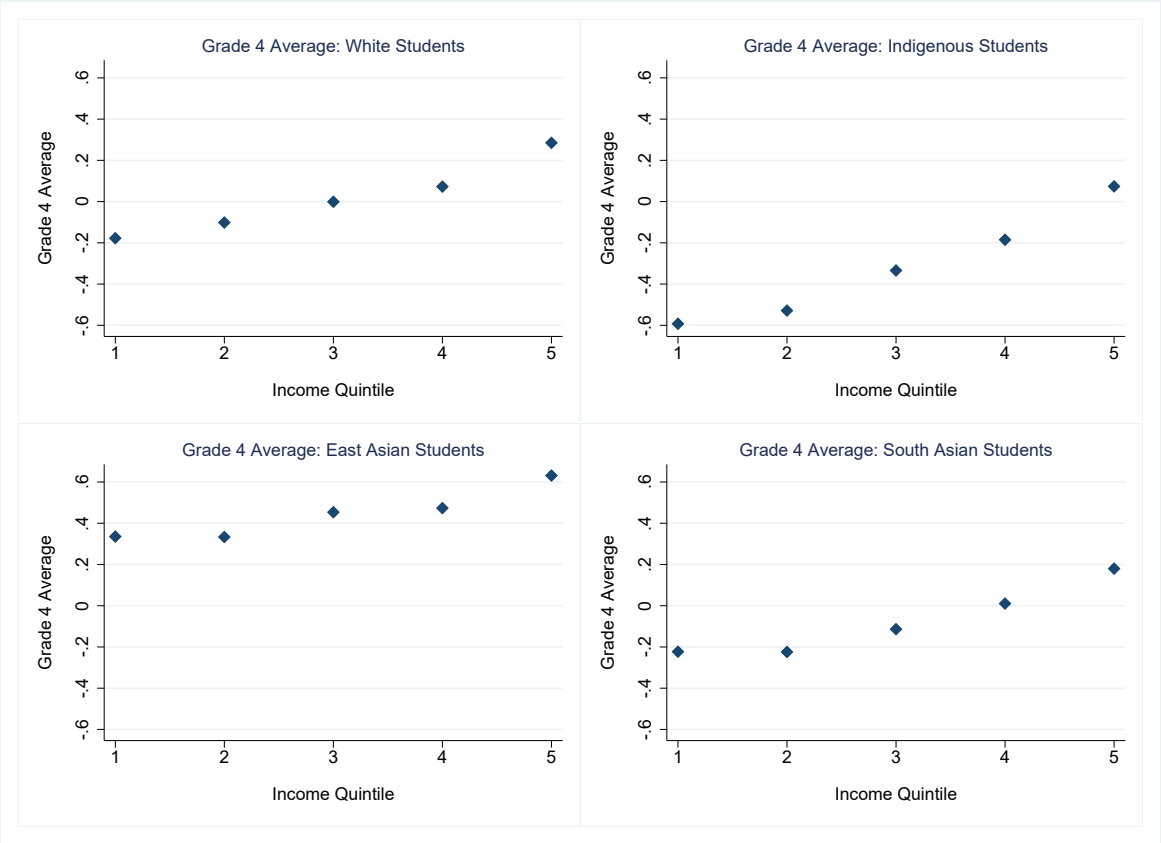
Thus, whether using language at home as a proxy for race from the administrative education data, or visible minority definitions from the census we find that the following facts are consistent: East Asian students have the smallest income-achievement gradients. The relationship between income and test scores is similar between White students and South Asian students. Indigenous students have significantly larger income-achievement gaps.

Table 4: Grade 4 Income Achievement Gaps: Group classification from Administrative Data and Census

	(1) Admin	(2) Census
Panel A: English Language and White		
P80-P20	0.436^{***}	0.457^{***}
	(0.0128)	(0.0235)
N	109440	20630
R^2	0.031	0.034
Panel B: Indigenous		
P80-P20	0.664^{***}	0.665^{***}
	(0.0343)	(0.0802)
Number of Students	19300	3260
R^2	0.054	0.053
Panel C: East Asian		
P80-P20	0.402^{***}	0.357^{***}
	(0.0190)	(0.0564)
Number of Students	8930	2320
R^2	0.022	0.027
Panel D: South Asian		
P80-P20	0.463^{***}	0.358^{***}
	(0.0451)	(0.0750)
Number of Students	11270	2860
R^2	0.010	0.014

Notes: Column (1) presents the raw P80-P20 estimates using student classification groups from the Administrative data. Column (2) presents the raw P80-P20 estimates using student classification groups from the 2016 Census.

Figure 5: Income-Achievement Gaps: Census



Notes: Each figure plots the average Grade 4 FSA score across both reading and numeracy by each income quintile. Top left figure is for the group of students who identify as White. Top right figure is for Indigenous students. Bottom left figure is for students who are East Asian. Bottom right figure is for students who are South Asian. Visible minority classifications are based on the census. Income quintiles are calculated from before-tax household income and the quintiles are calculated across the entire cohort of students.
Source: Author's own calculations using data from B.C. Minister of Education, Statistics Canada.

6.6. The Income-Achievement gap among Indigenous students

A key result of our findings is the large gap in achievement outcomes by income for Indigenous students. Previous work studying inequality between Indigenous and non-Indigenous people in Canada have also studied the test score gap[16] and the labor earnings gap.[17]

To the best of our knowledge, we are the first to show different income-achievement gaps for Indigenous versus non-Indigenous students. In Section 6.3 we showed that a contributing factor to the large Indigenous income-achievement gap was the high rates of special needs diagnosis among these students. Here, we use linked Census data to provide further suggestive evidence into why the income-achievement gaps for Indigenous students are larger than for other groups of students. Our census linkage is based on the identifiers of the children, implying we can only look at information common to the census family. For instance, we cannot see information on parental education or occupation. We can however use variables at the family level, such as family structure and dwelling information. Note that since only twenty percent of our full sample is linked to the census, we are more limited in the analyses that we can do. Nevertheless, we provide two graphs below in Figure 6 that shed light on the Indigenous income-achievement gap.

First, we study the housing conditions of Indigenous versus non-Indigenous students. Previous research has emphasized that Indigenous people are more likely to live in unsuitable housing (Shapiro et al., 2021). The 2016 Census asks respondents to identify whether their dwelling needs major repairs, which the census defines as a home where plumbing or electrical wiring is not functioning properly, or where structural repairs are required.[18]

In the left graph of Figure 6 we plot the percentage of children living in homes that need major repairs across income quintiles and by Indigenous status. Conditional on being in the same quintile of the income distribution, Indigenous children have worse housing conditions than non-Indigenous children. For those from families in the bottom income quintile, around 25% of Indigenous children live in a dwelling needing major repairs while only around 10% of Non-Indigenous children do. The difference in the share of Indigenous versus non-Indigenous children living in unsuitable housing falls drastically as the income quintiles increase. The right graph of Figure 6 shows the percentage of Indigenous and non-Indigenous children with single-parent families across income quintiles. Over 50% of Indigenous students in the bottom quintile live in a single-parent family compared with close to 40% for non-Indigenous children. Again,

[16] See Friesen et al. (2010), Richards et al. (2010) and Barber et al. (2021).

[17] For examples, see Hu et al. (2019), Lamb (2013), and Pendakur et al. (2011).

[18] See https://www12.statcan.gc.ca/census-recensement/2016/ref/dict/dwelling-logements003-eng.cfm

the gap between Indigenous and non-Indigenous children narrows across the income quintiles.

Thus, we show that housing quality and family structure may be factors that create the large income-achievement gap among Indigenous students. Ferrer et al., 2018 show that children who change from intact to non-intact families have worse performance on reading test scores. Single parents may have less resources, or there may be family conflicts that create a stressful childhood environment(Amato, 2000). Furthermore, safe housing conditions are crucial for child development. Shapiro et al. (2021) show that living in a house needing major repairs is linked to higher risk of pre-term birth and infant mortality for Indigenous mothers. In the United States, Howell et al. (2005) found that children living in low-quality housing were more likely to develop asthma, which is associated with absenteeism from school and can be disruptive to skill development (Kinney et al., 2002). Therefore, improving housing conditions for Indigenous families may help to close their income-achievement gap.

Figure 6

Notes: The left figure plots the share of students from each income quintile who live in a house that needs major repairs by Indigenous status. Major repairs are defined as defective electrical wiring, plumbing, or structure. The right figure plots the share of students from each income quintile who live with a single parent. Indigenous classification is based on the 2016 Census. Income quintiles are calculated from before-tax household income and the quintiles are calculated across the entire cohort of students.
Source: Author's own calculations using data from B.C. Minister of Education, Statistics Canada.

7. Robustness

Table 5: Income Achievement Gaps: English-Language, Indigenous, East Asian, and South Asian Students: Different Measures of Income

	Grade 4			
	Baseline	Indigenous	East Asian	South Asian
	(1)	(2)	(3)	(4)
Panel A: Before- Tax				
P90-P10	0.508^{***}	0.714^{***}	0.456^{***}	0.55^{***}
	(0.018)	(0.056)	(0.024)	(0.011)
N	19300	19300	8930	11270
R^2	0.034	0.056	0.024	0.011
Panel B: After Tax				
P90-P10	0.527^{***}	0.713^{***}	0.450^{***}	0.539^{***}
	(0.0183)	(0.0423)	(0.0423)	(0.0715)
N	109390	19290	8910	11250
R^2	0.036	0.053	0.025	0.011
Panel C: After Tax Scaled by Family Size				
P90-P10	0.523^{***}	0.730^{***}	0.478^{***}	0.530^{***}
	(0.0190)	(0.0407)	(0.0410)	(0.0743)
N	109390	19290	8910	11250
R^2	0.034	0.058	0.029	0.011

Notes: This table presents the average test score gap in standard deviation units between the top and bottom income decile for the Grade 4 FSA. FSA scores are averaged across subjects. Column (1) presents estimates for the Basline group (those who speak English at home), Column (2) for Indigenous students, Column (3) for East Asian Students and Column (4) for South Asian Students. No controls are included. Panel A presents estimates where income deciles are computed across all students using before-tax household income. Panel B presents estimates where income deciles are computed across all students using after-tax household income. Panel C presents estimates where income deciles are computed across all students using after-tax household income scaled by family size. The scaling is done by dividing after-tax household income by the square root of family size.

Here we show that our results are robust to two different definitions of income. In our main results, the measure of income we used was before-tax household income. However, low-income families receive tax credits and therefore, before-tax income will not necessarily be representative of their financial resources. We check the sensitivity of our results using after-tax household income. We group our students into deciles based on the after-tax household income across the entire distribution. Then,we separately calculate the P90-P10 gaps using our new definition of income for each student group. In Panel A of Table 5 we have our original P90-P10 estimates using before-tax household income for comparison, and Panel B presents the new P90-P10 gap estimates using after-tax household income results.

Comparing our estimates between Panel A and Panel B, we see that using after-tax household income hardly changes our results. The P90-P10 gaps for each group of students is essentially the same as our original estimates.

Another check we do is to scale our measure of income by household size. Children in our dataset come from families varying in size and a household income of $40,000 for a family of three is not equivalent to the same income for a family of six. Controlling for household size may also be important since one of our subgroups of interest is Indigenous students. The Indigenous population in Canada has lower-income and higher birth rates than non-Indigenous people (Smylie et al., 2014). Therefore, using income that is not scaled by household size may overstate the resources that can be allocated to each child in the family. We follow the Statistics Canada guidelines for scaling and divide after-tax household income by the square root of family size, which takes into consideration that resources can be shared among household members[19]. We then calculate each student's decile of scaled after-tax family income across all students.

Panel C of Table 5 presents our results using the scaled measure of income. Again, using this definition of income does not changes our measures of the P90-P10 gap substantially. The Indigenous P90-P10 gap rises slightly to 0.73, possibly because of the higher birth rates among the population. However the difference in estimate compared to the baseline of 0.71 is not significant. Thus, our estimates of the income-achievement gap across racial groups are robust to different definitions of income.

8. Conclusion

In this paper we studied the income-achievement gaps among race using administrative education data from British Columbia. We find income-achievement gaps between the bottom and top income decile ranging from 0.45 to 0.71σ at age nine. The range in gaps widens slightly when children are aged 12. While these magnitudes are lower than the average of around one standard deviation documented for the United States, there is important heterogeneity.

East Asian students have the lowest income-achievement gaps, while Indigenous students have the highest. These trends in education performance and income by race are in line with the work done on economic opportunity by race from (Chetty et al., 2020). Thus, the unequal opportunity by race found is already apparent at an early childhood age. We note that school sorting explains a significant part of the income-achievement gap across all student groups, while ESL status is important for students of East Asian and South Asian descent.

We are able to link the high income-achievement gap among Indigenous students to health inequities. Conditional on being low-income, Indigenous students are much more likely to be diagnosed with special needs or to live in unsuitable housing conditions than non-Indigenous students. Our work points to the need for closing the health gap as a way of equalizing oppor-

[19]See https://www23.statcan.gc.ca/imdb/p3Var.pl?Function=DEC&Id=103386

tunity.

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A. Appendix

Table A.1: Demographics in British Columbia and Canada, 2006 Census

	British Columbia	Canada
% Indigenous	4.8	3.7
% Chinese	10	3.9
% Southeast Asian	1.0	0.8
% South Asian	6.4	3.9
% Black	0.7	2.5
% No High School	12	15
% University Degree	23	24

Notes: Demographic shares from British Columbia in Column (1) and Canada overall in Column (2). *Source: 2006 Census, Statistics Canada*