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The evolution of cognitive skills inequalities by socioeconomic status across Canada

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The Evolution of Cognitive Skills Inequalities by Socioeconomic Status
across Canada

Working Paper No. 20-04

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Abstract

In this article, we document the evolution of the cognitive skills gap across Canada. We use PISA tests scores over 7 cycles, from 2000 to 2018, to provide an exhaustive portrait of the evolution of the tests scores distribution over time and by parental socioeconomic status. We find that the achievement gap between top performing students (p90) and students facing challenges (p10) is large. It represents about 4 years of schooling. We also show that socioeconomic differences in PISA scores, in reading, maths and science, are large but unwavering. In other words inequality by SES is stable, and decreasing in some years. There are wide-ranging variations in the size of the SES score gaps by provinces, a proxy for the extent of inequality of opportunities.

JEL: I20, I21, I28

Key words: socioeconomic inequalities, PISA, literacy and numeracy skills, proficiency scales, provincial education policy, education attainment gradient, Canadian provinces

1. Introduction

In Canada, information on the evolution of students' performance in the Programme for International Student Assessment (PISA) by socioeconomic status has been fragmented. Debates about the inequality of our system have been ongoing, in some provinces more than others. In Québec, the debate has been so fierce that it raised the attention of the UN¹. In the midst of the COVID-19 pandemic, primary and secondary schools across the country have been closed, yet school interruptions have short and long term negative effects on students (e.g. Meyers and Thomasson (2017); Belot et al. (2010)) and have the potential to exacerbate inequalities among students. Understanding where Canada stands in terms of student achievement inequalities has never been more important as we face the decision to reopen schools or not.

Microdata from the Programme for International Student Assessment (PISA) are extremely well suited to provide such a portrait. PISA data are of high quality, are representative of each province, have been in place for almost 20 years, and are comparable across countries. While the average PISA scores across Canada are generally somewhat well known, the inequalities in PISA scores across the country are not as well understood. Using PISA microdata between 2000 and 2018, this article provides a complete review of inequalities by provinces using PISA data from 2000 to 2018 in reading, maths and science. To our knowledge, such a portrait does not exist², yet would offer a unique opportunity to learn about our comparative evolution over time and identify where we can and must improve. Our analysis reveals important gaps between students by socioeconomic status (SES) in all provinces, and these gaps are generally unwavering. In the aftermath of the crisis, this stability will provide a strong basis to capture how the pandemic has impacted the scholastic achievement gap in Canada using PISA 2021 data.

Concretely, this paper documents for all three domains (reading, maths and science) the evolution of the achievement gap over time between (1) low and high performing students and (2) low and high SES students. More specifically, we document three neglected issues in relations to students' school achievement over time in Canada. First, we present the evolution of the dispersion of academic performance, measured using the standardised PISA test scores, across the country. Second, we show the link between PISA tests scores and family SES measured using the occupation of the parents. Third, we document the evolution of the

¹ <https://ici.radio-canada.ca/nouvelle/1686980/mouvement-ecole-ensemble-systeme-public-selectif-prive-nations-unis>

² Academics in Canada have offered some commentaries about the decrease in PISA test scores and teaching methods (e.g. Mou and Atkinson (2020); Richards (2014a, 2014b); Stokke (2015); Haeck, Lefebvre and Merrigan (2014)).

proficiency levels by SES. This third measure is rarely used, yet proficiency is a leading predictor of economic and social success for young adults.

Our study of the achievement gaps among 15-year-olds across the country between 2000 and 2018 reveals that while the overall test scores have decreased over time, the SES gradient has remained fairly stable in most provinces. The relative stability of the SES gradient is however nothing to be cheerful about. Across the country, there is a strong relationship between parental SES and PISA test scores. This is true in each province, but appears slightly more severe in Newfoundland and Labrador, and Nova Scotia. Depending on the domain evaluated, the SES gradient is smallest in Manitoba, British Columbia or Saskatchewan. The SES gradient in all provinces is well over one year of equivalent schooling when comparing students from the bottom quintile of the SES distribution versus the top quintile.

Inequality in scholastic performance is also visible when top performing students (90th percentile) are compared to students with more challenges (10th percentile). The school gap between these two groups is equivalent to more than 4 years of equivalent schooling. Clearly, more work needs to be done to equalize the playing field. Being a low SES student is better in Québec, since this is where low SES students achieve the highest score on average in all three domains over the 2000 to 2018 period.

It is important to understand the evolution of PISA achievement gaps because (1) skills measured in high school are related to adulthood labour market outcomes, such that equality of opportunity depends on skills formed earlier in life, (2) skills measured by PISA are linked with economic growth and gaps in these skills also, (3) rising income inequality could be further aggravated by rising skills inequalities in adulthood, (4) inequalities in our system need to be understood and taken into account when deciding how to provide education across the country during the pandemic, and (5) in the aftermath of the pandemic, having a clear understanding of how our systems fared for several years prior to the crisis, will help us use the PISA 2021 results to assess the impact of the pandemic and our collective decisions on inequality among students.

To come back to our first point, there is ample empirical evidence that skills – cognitive and non-cognitive – along with educational attainment are powerful predictors of socioeconomic outcomes (Heckman, Urzua, and Stixrud (2006)). Since skills are strongly correlated with labour market outcomes, such as earnings (Neal and Johnson (1996); Murnane et al. (2000)), students leaving secondary education without a strong scholastic foundation may experience difficulty in accessing the postsecondary education system and the labour market. Several studies show that scholastic attainment is an important factor to later education achievement, or in other words gaps

in postsecondary education attainment can be related to differences in prior high school academic achievement (Jerrim and Vignoles (2015); Ermish and Bono (2012); Lefebvre and Merrigan (2010)). Duckworth et al. (2015), Duncan and Magnuson (2011) and Watts et al. (2014), among others, further show that adolescent academic achievement, especially in maths, is a stronger predictor of completed schooling than measures of non-cognitive skills. However, the consensus on the relative importance of high school grades and skills versus parental education and household income has yet to emerge (Belley and Lochner (2007); Carneiro, Crawford, and Goodman (2007)).

Second, not only does educational achievement exerts a large impact on individual earnings, it also has long term consequences for economic growth. In a series of paper based on cross-country PISA test scores (cognitive skills in reading and maths as well as proficiency levels) and simple models of growth, Hanushek et al. (2015a, 2015b, 2012, 2011b, 2008) show that long-term growth is closely related to the skills measured by assessments such as PISA. These authors argue that if low-performing countries could raise student's test scores, these students would gain higher skills and likely experience different schooling trajectories, which would in turn contribute to economic growth. The gains are not limited to countries with poor performance, but also to high performing countries such as Canada with a small fraction of students experiencing low skill level. Hanushek and Woessman (2015a) also stress the importance of measuring skills as opposed to educational attainment, since the traditional approach of measuring human capital by educational attainment alone can be of limited power to explain economic growth and promote policies for our 'knowledge-based' economies.

Third, academic gaps are highly associated with adulthood skills gaps (e.g. Carneiro and Heckman (2003), Hanushek and Ruhose (2015), Krueger (2012)). Also, in Canada, like in many rich countries, market income inequality has increased over the past several decades, even though incomes have risen across all income groups (Green, Riddell, and St-Hilaire (2015)). Greater levels of income inequality have led to the delicate issues of equality of opportunity and intergenerational mobility. Recent work by Connolly, Haeck and Lapierre (2019) shows that intergenerational mobility had slightly decreased in Canada for individuals born between 1963 and 1985. In other words, the link between parental income and child income once the child has become an adult increased. Most social mobility researchers focus on income, as it can be converted to many other goods, and because it provides a robust basis for measurement, comparison and trends. However, other researchers have focused on the transmission of parental education and occupation to characterize social inequalities and stratification (Blanden (2013)).

Eminent sociologists show that social origins are linked to independent and persistent components on the basis of parents' class (employment and occupational unit-group), status (status scale derived from the occupational structure), and parental education (levels of educational qualifications) (Bukodi and Goldthorpe (2013)). Understanding high school skills inequality over time is essential since it is tightly linked to educational and labour market outcomes. The rest of the paper is organised as follows. Sections 3 and 4 describe the data and the methodology. The evolution of the performance gap by province over time is presented in Section 5, while the evolution of the SES gradient is presented in Sections 6 and 7. We conclude in section 8.

3. PISA data

3.1 Survey overview

In 2000, the OECD began the Programme for International Student Assessment (PISA), a triennial survey of the knowledge and skills of 15-year-olds in three domains: reading, maths and science. As of 2020, seven survey cycles were completed: 2000, 2003, 2006, 2009, 2012, 2015 and 2018. The PISA tests were administered in English or French according to the respective school system, during regular school hours generally in April and May. The Canadian samples were selected to produce reliable estimates representative of each province, and of both Francophone and Anglophone school systems in NS, NB, QC, ON, MN, AB, and BC (see province acronyms' Table A.1).³ As a result, the number of students surveyed across Canada is much larger than what is typically observed in other countries. This large sample size ensures that our results are representative not only nationally, but also provincially. Since education is a provincial competence, having reliable results at the provincial level is essential in order to get a sense of the performance of each system in a comparable way. Few measures of performance are comparable across the country, even the high school dropout rate is subject to criticisms because it is not measured in the same way across provinces. One of the main contributions of the PISA survey is to use the same instrument to measure performance across the country providing directly comparable results.

Each PISA survey assesses one of three core domains in depth (considered the major domain) among reading, maths, and science. Students were tested in all three domains in each survey cycle, except in 2000 when only half of the students were tested in maths and science. In each

³ For the sampling procedures and responses rates in Canada across surveys, see Bussière et al. (2001, 2004, 2007), Brochu et al. (2013), and Knighton et al. (2010), O'Grady et al. (2016, 2019).

survey cycle, one domain is tested in more details. The core domain was reading in 2000, 2009 and 2018, maths in 2003 and 2012, and science in 2006 and 2015. As a result, more than one cohort was tested using the longer test. Since the skills measured are directly comparable across time and provinces, even if the tests were adjusted slightly over time, we are able to measure the link between SES and the distribution of scores over a period of at least 9 years (Brochu et al. (2013); OECD (2010a)). Students are tested in a two-hour paper-and-pencil test, and also completed a thirty minute background questionnaire providing information about themselves, their home environment, and various features of their family. These characteristics include their gender and month of birth,⁴ language at home (same as test or other), their mother and father level of education and occupations, whether they themselves and their parents were born in Canada. The home environment questions refer to material possessions of the family or the students (number of cars, bathrooms, televisions, cell-phones, books, art and poetry books, and own room, study desk, computer). We always use the overall score of a domain, not the scores in subdomains.

The survey test scores for cognitive ability in all three domains are summarized using an “item-response model” which produces five “plausible values” to estimate the student’s true ability from the answers to the test. As of 2015, ten plausible values were produced. Even if the OECD (2010a) asserts that the first plausible value represents a valid summary of each participant country/entity test scores, in this article, all our results are based on all available plausible values, the main approach recommended by the OECD. Each score in all three domains is standardized to a mean of 500 and a standard deviation of 100 across all student surveyed by the OCED. The OECD average score is thus 500 in all domains in each survey cycle. The PISA Technical report (OECD 2010b) states that a 40 points difference in test score is approximatively equivalent to one additional year of schooling. The following table presents mean scores by domain and year for all Canadian student who took the tests :

[Insert Table 1 here]

Table 1 shows that the average scores in Canada are consistently higher than the OECD average of 500. The score differential ranges from 23 to 34 in reading, 18 to 33 in maths and 19 to 29 in science. Canada is ahead by slightly more than half a year of schooling compared to the OECD average. Considering the average scores for Canada, the country performed well for all

⁴ All the 15-year-olds are born on the same year, for example 1984 in the 2000 survey, 1987 in the 2003 survey and 1996 in the 2012 survey.

domains and remained in the top places among PISA participants over the years. Between 2000 and 2018, student performance in science has remained fairly stable, while it has decreased in reading and maths. Figure 1 shows the provincial score in the first year of the main domain (2000 in reading, 2003 in math, and 2006 in science), the average in year 2 to 2015, and the 2018 score. Figure 1 shows that the decline in reading is also visible in each province, but slightly more acute in MN and SK, where the decline in both the 2018 score and the average score between 2003 and 2015 is more pronounced. The decline is also present in each of the provinces in maths, but more acute in the west. In reading and science, AB and QC have maintained a performance above the average Canadian performance in all three domains over the entire period. In maths, only QC has remained consistently above the average. Variations across provinces are also fairly stable—with provinces above the country average maintaining their lead over time. In maths, only Québec's performance was consistently above the national average (Figure A.2). In reading, Québec, Ontario, Alberta and British Columbia were generally above the national average during the entire period (Figure A.1). Finally, in science, Alberta, British Columbia and Québec were consistently above or on the Canadian average (Figure A.3).

While Canada has generally been performing well in PISA over the years, it has also experienced a slight decline in performance, especially in reading and maths. Since education is managed at the provincial level, having detailed portraits of our strength and weaknesses may help us learn from each other.

3.2 Provincial differences

To better understand our approach and results, here we highlight some of the key provincial differences in education systems, keeping in mind that our goal is to document the evolution of educational inequalities and the relationship with parental SES, not to analyze which provincial differences are driving inequalities across the country.

In Canada, elementary, secondary, and post-secondary education is a provincial responsibility, with many variations between provinces. The Constitution of Canada provides constitutional protections for some types of publicly funded religious-based⁵ (e.g. Catholics in ON) and language-based school systems (Anglophone and Francophone school systems in NS, NB, QC, ON, MN, AB, and BC). Within the provinces under the Department of Education auspices,

⁵ This constitutional provision was repealed in Québec by a constitutional amendment in 1997, and for Newfoundland and Labrador in 1998. The constitutional provision continues to apply in Ontario, Saskatchewan and Alberta.

district school boards administer the schools. School entry age varies by province; the cut-off is December 31st in most provinces today, except QC where it is still September 31st. However, PISA students entered school between 1990 and 2008. Cut-off dates changed during this period in NS. In NS, prior to 2008, the cut-off date was October 1st. In PE, parents also have the choice to retain their children if they believe they are not yet ready for school⁶. So although all students surveyed are 15 years old, they may be in different school grades. In provinces with a December 31st cut-off, all students should be in grade 10. In QC and NS, a large percentage of students will also be expected to be in grade 9.

Table 2 indeed shows that while most students in the survey are in grade 10 or more (around 85 percent), a large percentage of students in NS and QC are also in grade 9 (about 30 percent). These students, for the most part, were born between October and December and are therefore following a normal trajectory. Table 2 also shows that a small fraction of student are in grades 7, 8 and 11. It is not clear if all provinces sample student in grades 7 and 8. Since students with disabilities or students who recently immigrated are present in all provinces, we would have expected a small fraction in each province. This may be an artifact of the sampling design. It may be because in some provinces high school starts in grade 7 (the case of QC), while in others high school starts in grade 9 (the case of ON and BC for example). If only high schools are included in the sampling design, by definition, student in grades 7 and 8 would not be included. Official transition statistics show that the transition between grades is not 100 percent in BC, students with special needs and student from indigenous communities have a lower transition rate⁷. Nonetheless, we take a conservative approach and keep students in grades 8 to 11. In doing so, we keep all reported students lagging behind. When reading descriptive statistics, it is important to keep in mind that most grade 9 students in QC and NS, follow their normal trajectories, but will nonetheless pull the provincial performance downwards since these students have one less year of schooling. In the empirical work, to account for this structural difference between provinces, we control for the expected grade of the students based on his or her birth date.

[Insert Table 2 here]

⁶<https://www.princeedwardisland.ca/en/information/education-early-learning-and-culture/register-your-child-for-school> (April 3, 2020).

⁷ Visited <https://studentsuccess.gov.bc.ca/school-district/039/report/grade-to-grade-transitions> on February 18.

Many studies on test scores performance in PISA surveys have shown that non-resource institutional features of school systems affect student outcomes, such as accountability measures, school autonomy, competition and private involvement, school tracking, teacher quality and experience, and the pre-primary education system (for a survey Hanushek and Woessman ((2011a)); Hanushek, Link, and Woessmann ((2013)); OECD ((2010c, 2012, 2013))). Across all countries (Table 2.8 of Hanushek and Woessman (2011a)), private school management tends to be positively associated with student achievement, with a difference to publicly operated schools of 16–20 percent of an international standard deviation in the three subjects in PISA 2000 (Fuchs and Woessmann (2007)). Similar results are found in PISA 2003 (Woessmann (2007)). A minority of students in Canada attends privately managed schools, around 8% in 2012 and 6% in 2000. Only, five provinces provide partial subsidies to private schools—BC, AB, MN, SK, and QC.⁸ Moreover, in some provinces, school boards can provide locally additional choices, such as alternative and specialized schools, schools emphasizing a particular language, music, dance, sport, or some other activity⁹. Open enrolment (replacing school assignment by postal code), a strategy used in ON and BC, and Catholic and independent schools, a strategy mainly used in ON, SK, AB, and BC also introduce diversity and competition (e.g. Allison (2015); Card, D., M. Dooley, and A. Payne (2010); Azimil, Friesen, and Woodcock (2015); Friesen, Cerf Harris, and Woodcock (2015)).

Finally, it is often believed that per-student public educational expenditures have decreased over time (see Van Pelt and Emes (2015)). However, Figure 2 shows that not only has educational spending not fallen when taking enrolment into account, but it has risen in constant dollars in all provinces over our observation period. This implies that in real terms, public educational expenditures have risen more than necessary to account for enrolment and price changes (Clemens, Van Pelt, and Emes (2016)).¹⁰ In 2000, public spending per students in public schools was equal to or below \$10,000 (2017 constant dollars) in most provinces except MN. By 2016, per-student spending in public schools had reach more than \$14,000 in NB, MN, SK, AB,

⁸ Québec sets a relatively low ceiling for the fees that depend on level of studies in exchange for a subsidy: the fee cannot be higher than the yearly subsidy which is equal to 60 percent of the subsidy to public schools (that have access to property taxation).

⁹ In Québec, to compete from private schools, many school boards have introduced augmented instruction at the secondary level through one or more non-public options such as international studies, music, sports.

¹⁰ According to their calculations, between school year 2004-05 and 2013-14 if for public schools had remained constant, the aggregate amount of education spending in Canada would have been 20.3% lower (by 12.7 billion); and respectively for each province from NL to BC, by -15.5%, -24.7%, -19.2%, -22.8%, -21.7%, -20.1%, -17.8%, -28.2%, -20.6%, -14.6%.

and around 12,000\$ in all other provinces. Government (public) expenditures¹¹ per student in public schools are the lowest in QC and BC.

[Insert Figure 2 here]

3.3 Measuring the socioeconomic status

The index developed by PISA to measure SES is the index of economic, social and cultural status (ESCS). While this index may be reliable at the country level, at the provincial level, this index varies a lot between survey cycles which is incompatible with the smooth progression of SES over a short period (Table A.2). As a result, we strongly suggest avoiding the use of the ESCS at the provincial level. Furthermore, Cornoy and Rothstein (2013) document the arbitrary character of the index and its convoluted computation formula:

“The ESCS index arbitrarily gives equal weight to parental educational attainment, parental occupational status, and a sub-index of the collection of possessions. Once OECD statisticians calculated the index for each student and weighted the ESCS index by the student weights within each country, they set the mean of the distribution in each country at zero, with a standard deviation of one, and estimated each student’s ESCS as the student’s standard deviation from the mean of that country’s ESCS. The statisticians used the index of student “possessions in the home” to calculate each country’s average position relative to the OECD mean and adjusted each student’s ESCS index in that country by that constant term. Finally, they combined all the OECD country distributions of ESCS with their adjusted means into a single OECD distribution. To preserve the integrity of country distributions, the statisticians “compressed” the data into an artificial “sample” of one thousand students from each country to construct the distribution of ESCS for the OECD, with a mean of zero and standard deviation of one. The ESCS ranks the index number of each test taker, in all countries, on that single continuous standardized scale. Since each country is given equal weight in constructing the distribution, relative to the number of 15-year-olds in each country, the ESCS of students in smaller countries is weighted.” (p. 41).

To measure socioeconomic status (SES) of student, within each province and over years, we instead use the highest international social and economic index (HISEI) of parental occupational status. This index is a predetermined variable created by the survey organisers from student’s reports of their mother’s and father’s occupation (the higher of the two). It takes values between 11 and 90. The low-values (e.g. 11-20) regroup, for example is individuals serving in restaurants and manual workers with no or minimal qualifications, while high values (e.g. 80-90) refer to professionals with high qualifications such as judges, CEO, engineers, lawyers, and medical doctors. This index, widely used in sociological research, was developed by Ganzeboom et al.

¹¹ Public and private expenditures in private or independent schools are not accounted for here.

(1992). It assigns to each particular occupational category a score based upon the weighted average of education level required for the occupation, as well as the associated earnings. Jerrim and Micklewright (2014) present evidence that students' report of parental occupation in PISA provides a very reliable basis on which to base comparisons of socioeconomic gradients in test scores. This is less true of another proxy, also frequently used in sociological research, such as the number of books in the home. This measure can be interpreted as a family indicator of the value parents place on education and academic success, and also on their willingness to promote their child's academic effort. From this SES indicator, for estimation purposes, we create specifically for each province (and overall for Canada and survey's year) dummy variables representing quintiles of the HISEI distribution (reference is the bottom quintile). Using a 'local', that is a provincial SES index, sticks more closely to the social environment of each province and their changes over the years, and may reflect local customs¹².

An alternative measure of SES could be parental education, a background standard proxy widely used by economists to distinguish between more- and less-advantaged students as it is an exogenous background variable that has been identified as a powerful, independent determinant of student test performance. However, since we use the international data sets for Canada and that education is coded with five levels according to the International Standard Classification of Education (ISCED), and transformed by PISA in number of years, the information poses some problems, especially in 2000 where the measure does not match official education statistics in Canada (Bussière et al. (2001) using the Youth in Transition Survey matched with PISA). Parental education levels are over-stated or over-coded for university degrees in 2000. Finally, Jerrim and Micklewright (2014) conclude that SES gradient measure is less robust when a child instead of a parent reports parental education, a conclusion that also directly affects the reliability of ESCS index. Together, these scientific evidences suggest that we focus on the HISEI to capture the parental SES.

Table 3 presents for years 2000 and 2018 the HISEI distribution by province and for Canada (other years are available online). We can observe that all provincial SES's (measured by the HISEI index and here after designated by the term SES) are higher in 2018 than in 2000, in particular from the 50th to the 90th percentile. Overall, these two distributions show rather large gaps in SES: for example, in 2018 for Canada, the difference between the 25th percentile

¹² When the calculated Canadian SESs (and quintiles) were used for all provinces, the estimated gap sizes changed but not their trends.

indicators and the 50th, 75th, and 90th are respectively 23, 37, and 42 points. The SES profile across the country is fairly comparable.

[Insert Table 3 here]

4. Methodology

To study the evolution of the achievement gap over time between low and high performing students, we use a descriptive approach. To study the evolution of the achievement gap over time between low and high SES students, we also use a descriptive approach, but we also estimate the relationship between the SES while controlling for other factors.

Two types of model estimate the SES economic gradient on students test scores. The first one is an OLS which measures the link between reading, math or science scores, and the SES index is measured by HISEI and transposed in quintiles. For each province and for the country, we estimate the following model:

$$S_{i,py} = \alpha + \sum_{q=2}^5 \beta_q SES_{q,i} + \delta X_i + \varepsilon_i \quad (1)$$

where $S_{i,py}$ is the PISA test score of student i in province p , it can be in maths, reading or science in year y . The equation is estimated for each province and each year separately at first. The term $SES_{q,i}$ represents four dummies variables, one for each of the top four quintiles of the HISEI index, such that the most disadvantaged group becomes the reference group. The quintiles are measured at the provincial level, but measuring them at the national level does not change our main conclusions. The vector X_i includes the student characteristics and the family characteristics. More specifically, it includes the student gender, age in months, grade, along with a dummy for immigration status, and two dummies indicating the language used at home (French, English, and others as the reference). All estimations use the students sampling weights derived by Statistics Canada. All plausible values and bootstrapped weights derived by the OECD are used in the estimation procedure (refer to PISA Technical reports for more information. Missing information for the control variables imply that the student are dropped off the analysis.¹³ Results from this model provide the average SES gradient over the period and are presented in our companion paper (Haeck and Lefebvre, 2020).

¹³ The SES index is the variable with more missing value (approximately 6% for all years, but 12% for year 2003).

In a second step, we pool all years together to estimate the trend in the socioeconomic gradient. To do so, for reading, maths and science, we estimate the following regression for each province separately using

$$S_{iqy} = \alpha + \theta_q + \gamma_y + \sum_{k=2}^5 \left[\sum_{j=2003}^{2018} \beta_{qy} I[q = k] * I[y = j] \right] + \delta X_i + \varepsilon_{iqy} \quad (2a),$$

and for Canada as a whole using

$$S_{ipqy} = \alpha + \theta_q + \gamma_y + \sum_{k=2}^5 \left[\sum_{j=2003}^{2018} \beta_{qy} I[q = k] * I[y = j] \right] + \rho_p + \delta X_i + \varepsilon_{ipqy} \quad (2b).$$

We capture the evolution of the score over time through year fixed effects γ_y and the average score by SES through SES fixed effects θ_q . As a result, the coefficient β_{qy} on the interaction of time and SES captures the incremental evolution over time by socioeconomic gradient within the province relative to the evolution in the first quintile. The evolution in the first quintile over time equals that of the year dummies. This approach is helpful to understand how the relationship between the socioeconomic status of student and their performance as evolved over time. When we estimate this equation for Canada, we add province fixed effects (ρ_p) to capture permanent differences across provinces. Students weights, plausible values and bootstrapped weights are also used to estimate the above models. The estimations of standard errors account for clustering at the school level. Finally, to identify where in Canada low SES students perform better, we estimate the following equation while only including students in the bottom quintile of the SES distribution :

$$S_{ipy,q=1} = \alpha + \gamma_y + \rho_p + \delta X_i + \varepsilon_{ipy} \quad (3).$$

In the next two sections, we first focus on the evolution of the achievement gap over time between low and high performing students (section 5) and then on low and high SES students (sections 6 and 7).

5 Achievement gap over time between low and high performing students

Concerning the evolution of the achievement gaps between students, we observe that the gap between high performing students and low performing students has generally increased between 2000 and 2018 across the country, in reading (Figure 3a), maths (Figure 4a) and science (Figure 5a). Tables provided online complement these figures and show even more details.

In reading, Figure 3a shows that the score gap between students at the 90th percentile of the score distribution and students at the 10th percentile increased from below 238 points to 255 points nationally. As mentioned above, PISA Technical report (OECD 2010b) states that a 40

points difference in test score is approximatively equivalent to one additional year of schooling. A 255 points gap is therefore a huge difference in skills acquisition, one that we should take very seriously. Most provinces show similar pattern of increase, but they do not all start from the same level. QC score gap is markedly lower than that of other provinces, but still imposing at around 230 points for most of the period. Figure 1b shows the average score of high performing students (bottom panel) and low performing students (top panel). We observe that the performance of high performing students across the country has fallen and is generally comparable across provinces. Among low performing students we observe a similar pattern, but students in QC generally performed better, which explains the lower score gap in this province.

[Insert Figure 3a and b here]

Maths was the main domain for the first time in 2003. Figure 4a shows that the score gap has also increased from 222 points to 234 points. Two exceptions are NL and SK, where the score gap has decreased over the period, going in the complete opposite direction: from 222 to 212 in NL and 214 to 204 in SK. Figure 4b shows that both low and high performing students (top and bottom panel respectively) performed less well in 2018 relative to other years, except in QC. In QC the performance between 2003 and 2018 was maintained and well above the national average. Low performing students had a score of 426 points in 2018, relative to a national average of 395 points. High performing students had a score of 652 points relative to a national average of 629 points in 2018. Both low and high performing students in QC were almost one full year of schooling ahead of the national average, even if in practise, a large fraction of students in QC were in fact in grade 9 and not grade 10 like in most other provinces. Clearly, the teaching of maths in QC raises achievements for both low and high performing students.

[Insert Figures 4a and b here]

Science was the main domain for the first time in 2006. The trends in science are not different from those observed in maths (Figure 5a): the skills gap has also been increasing, from 238 points in 2006 to 244 points in 2018. The exceptions are QC, MN and SK. In these provinces, the gap has shrunk or remained stable (238 to 220 in QC, 250 to 246 in MN, and 240 to 238 in SK). High performing students AB and BC get higher test scores, but low performing students do better in QC. The increase in the score gap is attributable to a larger decrease in the score of low performing students relative to the decrease of high performing students.

[Insert Figures 5a and b here]

In summary, in all three domains there is a large gap between students at the top of the score distribution and students at the bottom. This gap has increased in all three domains over the years. Two provinces stand out: QC and SK. Low performing students generally fare better in QC than in other provinces, especially as of 2018, and the score gap is also lower there in reading and science. QC's performance is especially high since this province has a much larger share of students in grades 8 and 9 relative to other provinces. In SK, the score gap is generally below the national average, and sometimes even decreasing (maths). Clearly the gap between students is high, and raising the performance of the bottom of the distribution should be a priority. None of the provinces seems to be able to produce small gaps in performance. Attributing these gaps to a faulty school system would be a poor mental shortcut (heuristics). Gaps in skills are present even before kids enter schools and increase over the school lifecycle (Bradbury et al. (2015)). Schools are working with students who have different skills to start with, and different capacities to learn new skills. There does not seem to be a link with the type of system (entirely public vs a combination of public and private schools) and the magnitude of the score gaps. Systems with different characteristics and funding mechanisms coexist across the country and produce similar score gaps. The system that appears to be performing better for both low and high performing students is the QC system.

The performance gaps observed in 2018 in Canada are not drastically different from those of Finland (Table 4), a country that is often considered the gold standard of academic achievement and equality of opportunities. In Finland, the performance gap (P90-P10) was 260 points in reading (P10=383), 251 points in science (P10=389), and 214 points in maths (P10=399). In Canada, the gap was 255 points in reading (P10=390), 244 points in science (P10=395), and 234 points in maths (P10=395). The Canadian performance gaps are extremely comparable except in maths where we observe a larger gap. The gap differential comes from a higher performance among top performing students in Canada, not a lower performance of students with more challenges (P10 is almost identical in both countries). Canada's performance gap is also comparable to that of Sweden, but higher to that of Estonia and Denmark.

[Insert Table 4 here]

These gaps while informative of the overall performance of the school systems across the country in developing skills measured by PISA, do not tell us much about where these differences are coming from. The next section explores the extent to which students lagging behind are also students from low SES background.

6 Proficiency levels by SES over time

In this section, we present the distribution of student performance by SES using the proficiency scales in each test. Proficiency scales is another way to capture the skills distribution of students, and it reveals the ability of students in an arguably more meaningful light than a standardized score. To establish the proficiency levels, PISA organisers estimate the ability of all students taking the PISA assessment, and the difficulty of each PISA items, locating these estimates of student ability and item difficulty on a single continuum (see OECD technical reports, and Annex A1 for presentation of Literacy in each PISA domain). Some tasks are deemed easier and therefore meet the lower end of the proficiency scale (level 1 or 2) while more complex tasks will allow a student to reach the higher levels of proficiency (levels 6 or 7). This multi-level scale ranges from “low” to “outstanding”. Levels 1 and 2 capture the low and basic proficiency levels: these levels are considered insufficient to perform as an adult in our society. Students at levels 3 to 5 completed test items of moderate to relatively higher difficulty. At levels 6 and 7, in reading, students demonstrate complex understanding of text structure and its implications. At levels 6 and 7, in maths, students can apply insight and understanding, along with a mastery of symbolic and formal mathematical operations and relationships, to develop new approaches and strategies for attacking novel situations.

Table 5 provides an overview of the proficiency levels in the main domains across the country. Reading was the main domain in 2000, 2009 and 2018, math in 2003 and 2012, and science in 2006 and 2015. We focus on the main domains to maximize the number of questions used to determine the proficiency level. We observe that, in reading (top three panels), the percentage of students with low proficiency level has increased across the country between 2000 and 2018, from 9 to 13 percent. This increase is visible in all provinces. We should take this result seriously. Over the period, it is in QC and AB that students have been less likely to fall behind. The percentage of students reaching level 4 and above is the highest in these provinces, at 76 and 78 percent in 2000, down to 68 and 71 percent in 2018. In NB, only 54 percent of students were not lagging behind (level 4 or more) in 2018.

In maths, a similar portrait emerges, with QC, BC and AB leading in 2003, and QC and BC leading in 2012. A few provinces in 2012 had 55 percent or less of their students in level 4 and more, namely NL, PE, MN. The national average was 71. The lag in maths is more pronounced than in reading. A number of studies have documented the specific importance of mathematical abilities for young workers on earnings (e.g. Murnane et al. (1995); Rose and Betts (2004); Ingram and Neuman (2006)). Consistent evidence of maths skills measured by test scores suggests that one standard deviation in maths performance at the end of high school is likely to translate into 10 to 15 percent higher annual earnings (Murnane et al. (2000)). Strengthening the curriculum and providing more assistance to students and teachers would be a valuable investment.

Finally, in science (bottom two panels), in 2006, ON, AB and BC were ahead of other provinces with at least 73 percent of their students in level 4 or more. AB and BC maintained their position in 2015, but QC surpassed ON at 73 relative to 67. The performance of QC is notable given that the province has a large share of younger students in grade 9 as opposed to grade 10, and also the largest share of students lagging behind in grade 8.

[Insert Table 5 here]

Now we cross tabulate proficiency levels with SES quintiles. Table 6 presents the percentage of students in five proficiency levels in reading for by SES quintile: the lowest (Q1) and the highest (Q5). Statistics in the Table 6 clearly show the performance inequalities by SES (Q1 vs Q5). In 2018 (last year of main domain in reading, first panel), in Canada, 19 percent of Q1 students (low SES) were in the lowest two levels of proficiency relative to 6 percent for Q5 student: a difference of 13 percentage points. At the upper end of the performance spectrum (column 6+), 8 percent of Q1 students were observed compared to 25 percent of Q5 student: a difference of 17 percentage points. Clearly, there is a strong SES performance gradient. Similar findings are found across the country. The smallest SES gap in proficiency in levels 1 and 2 are observed in NL, QC and BC, while the highest are observed in PE and AB. The smallest gap in proficiency in levels 6 and 7 are observed in NB and SK, while the highest are observed in NL and AB. It appears that SES plays a larger role in the determination of skills in AB, relative to any other provinces. Looking purely at the percentage of students in low SES (Q1) by proficiency level, we observe that only 16 percent of students in QC and 18 percent in ON and NL have a low proficiency level, relative to a national average of 19. Low SES students in these provinces fare

better. Across the country, the percentage of students from low SES in the low proficiency level has increased from 16 in 2000 to 19 percent in 2018, and the increase is observable in each province, except NL and ON. Globally, the situation of low SES students has worsened, but some provinces are better than others at protecting them from falling behind in reading.

[Insert Table 6 here]

Table 7 presents a similar portrait but this time in maths. In maths for 2012 (left panel), in Canada, 20 percent of students with low SES (Q1) had also a low proficiency level, compared to only 5 percent for high SES (Q5) students. Low SES students were also less likely to reach an excellent proficiency level, only 8 percent compared to 25 percent for high SES students. Across the province we find similar patterns. In maths, only 17 and 16 percent of students in QC and BC have a low proficiency, while this percentage rises to 39 and 37 percent in NL and PE. The SES gradient seems to be stronger in some provinces and sharper differences emerge in maths.

[Insert Table 7 here]

In 2015, the last year in which science was the main domain, there was also an important difference in science proficiency by SES. In Table 8, we observe 12 percentage points more students in Q1 relative to Q5 in the lowest level of proficiencies (2-); and 16 percentage points more students in Q5 relative to Q1 in the highest level of proficiencies (6+). This portrait is very similar to that of 2006. The SES gradient has therefore not evolved much over the period in Canada. Across provinces, we observe that the SES gap in the lowest level of proficiency is lowest in PE and AB, and highest in NL and NB. In the highest level of proficiency (5+), the SES gap is smallest in NL, PE, and SK, and largest in AB, QC, and BC. Children in Q1 and Q5 do better in science in AB relative to other provinces.

[Insert Table 8 here]

These estimates sustain the affirmation that a significant and increasing proportion of 15 year old Canadian students over the years are not doing very well and students from lower SES background are struggling more. Also, while the SES gap and percentage of students have generally increased at the bottom of the proficiency scale, the SES gap and percentage of students

have decreased at the top of the proficiency scale. To measure the extent to which the SES gap in score is increasing over time, we will need to rely on the model discussed above (equation (2)).

7 Evolution of the achievement gap by SES

7.1 Canada

To get a clearer picture of the evolution of the SES gradient over time for Canada, we present the estimates from equation (2b) in Table 9. The coefficients on the SES quintile dummies show the average SES gradient over the entire period. The estimates suggest a positive relationship between the reading score and the SES of the parents: a higher parental SES is associated with a higher reading score on average. More specifically, students with parents in the second quintile (Q2) obtain an average score that is 25.0 points higher relative to students of Q1 parents. At the top end of the distribution, students of parents in the highest quintile (Q5) generally obtain 70.5 points more on average. On average, over our observed period, there is a clear gradient between PISA score and parental SES, but has the gradient increased or decreased over time? Our results do not suggest that this gradient has increased or decreased over time in Canada.

The average score over time has decreased for all students in Canada. By 2018, the overall score was 7.7 points lower relative to 2000. However, this decrease is similar in all quintiles, since most of the coefficients of the SES quintile-year interaction are generally not significant. In fact, if significant, these coefficients are generally negative in higher quintiles which would suggest that the decrease in average test scores over time was steeper in quintiles 2 to 5 relative to Q1. This would suggest a slight *reduction* of the SES gradient in Canada in some years.

In practise, we observe that relative to the decrease in Q1 (the one observed through the year fixed effects) the decrease in Q2 was slightly larger in 2009 and 2012, but similar in 2015 and 2018. No differences can be noted for Q3 relative to Q1 over time. In Q4 and Q5 (the highest, most privileged quintiles) we observed some negative coefficients suggesting a larger decrease in test scores in some years relative to Q1. By 2018, none of the coefficients are significant, which suggest that the SES gradient did not widen or narrowed significantly over time in Canada. Finally, the province fixed effects show again that there are important permanent differences across provinces, with AB, ON, and BC leading by 25.0, 20.7, and 20.4 points respectively relative to NL

In maths, our reference point here is 2003 instead of 2000, because the main domain in PISA 2003 was maths (Table 9, column 2). The SES gradient for Canada is not as steep in maths, from 22.3 points for Q2 relative to Q1, to 64.4 points for Q5 relative to Q1. The overall test score in

maths in Canada has however decreased over time more than the reading score. By 2018, Canada had lost 20.2 points in maths. None of the SES-year interaction coefficients are significant, which tells us that the decrease was comparable in all SES quintiles. As a result, the SES gradient did not become better or worse over the period. Looking at the provincial fixed effects, which AB is again ahead of the other provinces, but QC is the leader in maths.

Finally, in science our reference point is 2006 (Table 9, column 3). We find a SES gradient starting at 27.8 in Q2 to 68.2 in Q5. A gradient that is comparable to the one observed in reading and maths. The average score has been maintained over time, except in 2018, where we lost 10.5 points on average. The SES gradient has not really changed over time, except for Q2 relative to Q1. These students are now more comparable in science. At the provincial level, we observe that AB and BC are clearly leading the way. The overall results for Canada suggest that we have an important SES gradient, but this gradient has clearly not increased over time. While school closures are implemented across the country to fight the coronavirus, one cannot help think that academic inequalities will be on the rise post-crisis. The stability of the SES gradient documented in this paper constitutes a strong argument to use PISA 2021 results to assess the impact of the crisis on academic inequalities in Canada.

[Insert Table 9 here]

Table 4 however reveals that Canada's SES gradient is not different from that of Finland or Sweden (overlapping confidence intervals are available from the authors). In reading and maths, but not in science, Canada's gradient is slightly above the gradient observed in Estonia and Denmark.

7.2 Provinces

The global results for Canada may hide differences by provinces. Tables 10 to 12 show the estimated coefficients of equation 2a for each province. First, in reading (Table 10) we observe a large gradient between parental SES and test score in each province. It is widest in NL and NS, and smallest in SK and MN, followed by QC and BC. Relative to Q1 student, Q5 student obtain a score that is 90.6 and 89.3 points higher in NL and NS respectively. At the other end of the spectrum, in SK and MN we observe a gain for Q5 student relative to Q1 of 41.5 and 54.4 points. Over the years, some provinces have seen their overall score decrease more than others. The year fixed effects are particularly large and negative in PE and SK, but also in other provinces. Only

BC, ON and NL do not appear to have suffered from major decreases over time. The SES-year interactions suggest that the decrease observed overall was not steeper in Q2 relative to Q1 in most provinces, except NS. The evolution over time for Q3 student is very similar to that of Q1 student, except in NS and SK. In SK, Q3 student seem to have increased their score relative to Q1 student, thereby contributing to an increase in the SES gradient. In Q4 and Q5 (highest, most privilege quintiles) we observe that student in NL, NS and ON performed less well over time relative to Q1 student. These suggest a decline in the SES gradient between 2000 and 2018. It is however important to keep in mind that these two provinces have among the steepest SES gradient in Canada over the entire period. In SK, the opposite pattern is observed. Children from the most privileged families (Q5) have increased their performance relative to student in the lowest quintile over time. This implies an increase of the SES gradient, but SK has one of the smallest SES gradient in the country. In the other provinces, the SES gradient has remained fairly stable over time. The contraction of the SES gradient in ON and NL, and the expansion in SK has moved these provinces closer to the Canadian average. While some improvements are noted in NL, NS, and ON, overall, SK, MN, BC and QC are the provinces in which SES plays a less important role, they thus provide more equal opportunities to student in reading.

[Insert Table 10 here]

The results by provinces for maths are presented in Table 11 are in line with those observed for reading. The SES gradient is highest in NL and NS with a Q5 coefficient of 79.5 and 75.1 respectively. The SES gradient is the lowest in MN at 49.3. All other provinces have a Q5 coefficient somewhere between 60 and 68, none of which are statistically different from one another. Over time, the average score in maths has decreased in many provinces (NB, MN, AB, BC). The decrease over time was however not more or less pronounced in Q2 to Q5 relative to Q1 since the coefficient of the SES-year interaction are generally not significant. In other words, we do not observe any particular trend in the SES gradient, except in NL and SK where it appears to have become steeper over time.

[Insert Table 11 here]

Finally, the portrait in science presented in Table 12 generally in line with previous results. All provinces have a strong SES gradient. It is again strongest in NL and NS. However, if we look at

the Q5 year interaction, we see that the coefficient is negative and large in both NL and NS. This implies that these provinces have improved a lot over the period and that their SES gradient as of 2018 was not as steep and in fact very comparable to those other provinces.

[Insert Table 12 here]

It is not clear if and how we should control for student grade. In a sense, we have to control for the expected grade, because students with one less year of education because of their birth date also have one less year of schooling. They have a lower score on average. Only students in QC and NS are in this situation. However, not controlling for grade has virtually no effect on the Q5 coefficient (Table 13, No grade controls panel). This means that the SES gradient does not really depend on the expected grade of the child. This is not entirely surprising, since the expected grade depends on the birth date which should not be related to the occupation of the parent (at least not in a meaningful way).

[Insert Table 13 here]

Controlling for the actual grade of the student, however, slightly reduces the SES gradient in most provinces. The largest decreases are observed in QC in all three domains. When student grade is controlled for, the SES gradient in QC becomes the second smallest SES gradient in the country. But is this the appropriate gradient to measure? When controlling for the actual grade of the student, we measure the gradient within grade. So this tells us that for students in the same grade, the SES gradient is lowest in QC, MN and SK. Of course, students from lower SES backgrounds are more likely to be in lower grades, and this appears to be especially true in QC (assuming other provinces sample students below grade 9). Other provinces also retain students : for example, in SK 11 percent of students were behind by one year. It is not clear if grade retention is a sound strategy (e.g. Jacob and Lefgren (2009) among others) but that is beyond the scope of this paper. Here our goal is to measure inequalities in the system. No matter how we control for grade, there are two main take aways, the least equal provinces over the period are always NL and NS, and the most equal ones are MN, SK, and BC. Canada's two largest provinces, QC and ON are somewhere in the middle.

Where do students from low SES fare better in the country ? To answer this question, we estimate equation (3). In reading and maths, we find that it is in QC that students from low SES

fare better in all three domains over the period (see Table 14), but the estimated coefficients for QC are not statistically different from those of AB, BC and ON. In sciences, it is students in AB that are leading, but again, these results are not statistically different from those of BC. So although inequality may be comparable across provinces, being a low SES student in Canada is better in AB, QC, BC and ON.

[Insert Table 14 here]

8. Conclusion

Canada's overall test scores have decreased over time, but in 2018 Canada still had the second strongest performance in the OECD, just behind Estonia. However, these results mask important differences by SES. Our analysis clearly reveals the presence of a strong SES gradient across the country that is unwavering. This means that student coming from lower SES background gained lower skills which inevitably hurts them over the long run. Our future ability to improve intergenerational mobility is tightly linked to our ability to promote equality of opportunities in the development of cognitive skills so long as these skills are linked with labour market outcomes. The inequality is strongest in NL and NS, and weakest in MN, BC and SK. However, being a low SES student is better in AB and QC, since this is where low SES students achieve the highest score on average over the period. As of 2018, Canada's performance gap and SES gradient were comparable to that of Finland and Sweden, two of the leading countries in PISA. This is however nothing to be cheerful about. The SES gradient remains well over one year of equivalent schooling for student from the bottom quintile versus the top quintile. Actions need to be taken to remedy this situation, here and in other countries facing a similar situation.

The challenge we are facing as a country turns out to be imperative since the cognitive skills acquired early in life are critical to foster the accumulation of human capital, support economic growth favorable to knowledge-based economies and reduce economic and social inequalities (Hanushek et Woessmann 2015a, 2015b; Carneiro et Heckman, 2003; Kruger, 2003). Innovative actions, taken early in the child's life, need to be taken. Early investments in the child's life will make a difference. More specifically, investing in the prenatal and postnatal periods and in high quality preschools for students facing challenges will be beneficial. Prevention is our key parameter of success. Promoting quality and accountability of our

education system, and providing schools with more autonomy could be helpful. Finally, valuing education and the teaching profession would also be beneficial for both teachers and student.

While learning from other provinces may provide some solutions, no single province is doing exceedingly well in terms of equality of opportunities. Some provinces only finance public schools, while others finance independent catholic schools (ON, SK, AB)¹⁴ or a combination of public and privately managed schools, yet both have similar SES gradient (see QC and ON for example). QC private school network is often at the center stage of an ongoing debate about the equity and efficiency of the education system, yet ongoing debates rarely rely on rigorous scientific evidence over multiple years using a stable SES measure. In fact, QC is neither more nor less equal relative to other provinces, it is generally somewhere in the middle. However, low SES students in QC (closely followed by AB) get higher test scores relative to comparable students across the country. In this sense, both QC and AB are not producing more equality or inequality than other systems across the country, but they clearly help low SES students achieve higher test scores in all domains.

To reduce performance inequalities, clearly, we will have to think outside of the box to find meaningful solutions since all provinces and also other countries have significant SES gradients. It is important to keep in mind that no system will ever achieve perfect equality in one dimension given that human beings are multidimensional and have different preferences and innate abilities. While we want to promote scholastic achievements, we also want to develop our students' well-being, a dimension that PISA should consider measuring in more depth, especially in the aftermath of the pandemic.

¹⁴ Saskatchewan decided in March 2019 to contest in the appeal court judgment estimating that public financing of catholic schools is discriminatory according to religion (no respect relative to Canadian Charter of Rights and Freedoms and the religious neutrality of the State). The attorney of the government defended in court the existing equity of financing to both type of schools by not testing the religion of students and affirming that demanding a baptismal certificate would be discriminatory to the children. According to independent observers, many subsidized catholic schools in Canada accept students according to a declaration of faith by parents, and function as a "private school".

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TABLES

Table 1: PISA estimated average score by domain and year, Canada 2000-2012

Year of survey	Reading	Math	Science
2000	534*	533#	529#
2003	528	532*	519
2006	527	527	534*
2009	524*	527	529
2012	523	518*	525
2015	527	516	528*
2018	520*	512	518

Note: * indicates year of major domain; # indicates that not all students participated in the math and science tests, randomly 50 percent were assigned to one of the two tests.

Sources: Bussière et al. (2001, 2004, 2007); Brochu et al. (2013); Knighton et al. (2009); O’Grady et al. (2016); O’Grady et al. (2019).

Table 2: Percentage of students by grade by PISA cohorts

Grade	CANADA	NL	PE	NS	NB	QC	ON	MN	SK	AB	BC
Percentage 2000											
7	0	0	0	0	0	1	0	0	0	0	0
8	2	0	0	2	1	8	0	1	1	0	0
9	13	9	16	33	13	30	4	11	15	13	7
10	83	90	80	65	87	59	94	87	83	83	92
11	2	0	4	0	0	1	2	1	1	3	1
N	29,026	2,252	1,601	2,895	2,922	4,130	4,247	2,567	2,701	2,715	,,993
W.N	323,772	5,709	1,601	9,557	7,607	70,502	126,928	11,441	12,136	34,733	43,416
Percentage 2012											
7	0	0	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	5	0	0	0	0	0
9	13	5	6	33	11	36	4	11	12	11	3
10	85	95	89	66	89	59	95	88	87	85	96
11	1	0	4	1	0	0	1	1	1	3	1
N	21,544	1,312	1,292	1,374	1,784	4,166	3,699	2,079	1,934	1,088	1,816
W.N	338,052	4,094	1,292	10,144	6,233	75,902	136,455	13,047	10,267	37,064	43,554
Percentage 2018											
7	0	0	0	0	0	2	0	0	0	0	0
8	1	0	0	0	0	5	0	0	0	0	0
9	10	1	25	23	7	32	1	5	11	7	3
10	88	99	75	77	92	61	98	94	88	88	96
11	1	0	0	0	1	0	1	1	1	5	1
N	22,653	1,124	327	1,511	1,555	4,616	4,491	2,353	2,209	2,199	2,268
W.N	323,592	3,859	1,212	7,446	5,852	66,788	133,881	12,106	10,018	39,985	42,445

Source: Authors’ computation from PISA weighted data sets, 2000, 2012, 2018. N reports the number of unweighted observations, while W.N reports the number of weighted observations.

Table 3: Highest international social and economic index of occupational status (HISEI) at different percentiles of the distribution across province and for Canada

Province	N	Mean	SD	P10	P25	P50	P75	P90
Year	2018							
NL	950	56	21	25	32	61	72	80
PE	297	55	22	24	31	60	76	79
NS	1,388	56	21	25	39	60	74	80
NB	1,373	54	22	25	31	58	74	80
QC	3,948	59	21	26	44	65	77	82
ON	3,855	59	21	26	41	65	76	81
MN	2,087	52	22	24	28	55	72	79
SK	1,954	53	22	25	31	57	71	79
AB	1,962	56	22	25	36	60	76	81
BC	2,041	57	21	25	38	62	76	81
CANADA	19,855	58	21	26	39	62	76	81
Year	2000							
NL	2,181	48	16	28	32	49	59	69
PE	1,576	49	17	28	34	51	64	69
NS	2,825	52	16	30	40	53	66	69
NB	2,848	50	17	29	34	51	65	69
QC	4,320	52	16	30	39	53	67	70
ON	4,145	54	16	30	43	54	69	71
MN	2,531	50	16	30	36	51	66	69
SK	2,664	51	16	29	38	52	66	69
AB	2,675	54	16	30	43	53	69	71
BC	2,924	53	16	30	43	53	67	70
CANADA	28,689	53	16	30	41	53	67	70

Notes: The HISEI index is the highest score, between 16 and 90, assigned to each occupation (father or mother) by the PISA survey. The index was calculated for each province and year. Includes students in grades 8 to 11; SD: standard deviation; P10 indicates the 10th percentile of the distribution, P25 the 25th percentile, etc.
Source: Authors' computation from PISA weighted data sets (2000 and 2018).

Table 4: Score distribution in Canada and top performing European countries in 2018

Score		Canada	Finland	Sweden	Denmark	Estonia
Mean	Math	513	508	503	510	523
	Reading	522	520	506	502	523
	Science	519	519	499	493	530
P10	Math	395	399	381	401	419
	Reading	390	383	363	380	403
	Science	395	389	366	371	415
P90	Math	629	613	618	614	627
	Reading	645	643	638	620	644
	Science	639	640	623	607	646
Performance gap		Canada	Finland	Sweden	Denmark	Estonia
P90-P10	Math	234	214	237	214	208
	Reading	255	260	275	240	241
	Science	244	251	257	236	231
P75-P25	Math	127	115	128	113	112
	Reading	139	136	150	128	128
	Science	130	132	137	126	122
SES gradient		Canada	Finland	Sweden	Denmark	Estonia
Q5 vs Q1	Math	68	63	60	53	55
	Reading	70	66	59	58	56
	Science	64	69	61	61	57
	Average	67	66	60	57	56

Note: In European countries above students grades are: grade 8 (14%) and grade 9 (86%). In Ontario, the students are in grade 9 (2%) and the rest in grade 10, while in Québec students are respectively in grade 8 (4%), grade 9 (29%), and grade 10 (65%). Details by province are provided in our web appendix.

Source: Authors' computation from PISA weighted data sets (2018).

Table 5: Percentage of students by proficiency levels across provinces (main domain only)

Scale	NL	PE	NS	NB	QC	ON	MN	SK	AB	BC	CANADA
Reading 2000											
1+2. Low + Basic	13	12	11	16	7	9	10	9	8	9	9
3. Some limits	21	23	21	23	17	18	18	20	14	17	18
4. Very good	29	28	30	31	30	27	31	30	27	27	28
5. Excellent	24	25	24	21	31	29	26	29	29	30	29
6+7. Outstanding	13	13	13	9	15	16	15	13	22	18	16
4+5+6+7	66	66	67	61	76	72	72	72	78	74	73
Reading 2009											
1+2. Low + Basic	13	21	10	15	10	8	16	15	9	10	10
3. Some limits	25	25	22	26	19	19	27	23	20	20	20
4. Very good	31	29	33	31	32	30	27	32	27	30	30
5. Excellent	23	20	26	21	29	29	22	23	28	28	28
6+7. Outstanding	8	6	9	7	10	1	7	8	15	12	12
4+5+6+7	62	55	68	58	71	60	56	63	70	70	70
Reading 2018											
1+2. Low + Basic	14	16	15	19	11	13	19	16	11	14	13
3. Some limits	23	21	20	27	22	20	25	25	17	20	21
4. Very good	28	30	30	25	29	26	27	29	27	26	27
5. Excellent	23	20	20	20	26	25	20	21	26	24	24
6+7. Outstanding	13	13	15	10	13	16	9	9	19	16	15
4+5+6+7	63	63	66	54	68	67	56	59	72	66	66
Math 2003											
1+2. Low + Basic	11	17	13	12	9	9	10	12	7	8	9
3. Some limits	22	24	22	23	17	20	19	22	15	17	18
4. Very good	29	28	30	30	24	29	28	28	26	26	27
5. Excellent	25	22	23	23	28	25	24	24	27	28	26
6+7. Outstanding	13	9	13	12	23	16	18	14	26	21	20
4+5+6+7	67	59	66	65	75	70	71	66	78	75	73
Math 2012											
1+2. Low + Basic	21	24	17	16	10	13	20	15	15	11	13
3. Some limits	24	27	26	24	17	23	26	25	20	22	22
4. Very good	28	28	29	29	24	28	26	28	27	28	27
5. Excellent	18	16	20	21	26	21	18	21	22	23	23
6+7. Outstanding	9	6	8	10	23	15	10	12	17	17	16
4+5+6+7	55	50	57	60	73	65	53	60	66	67	66
Sciences 2006											
1. Low	12	16	11	15	11	9	12	13	6	9	10
2. Basic	22	23	23	27	20	18	19	21	18	19	19
3. Good	29	29	31	30	29	29	32	30	30	28	29
4. Very good	23	21	25	21	25	30	24	26	28	30	28
5+6. Excellent	15	11	11	9	16	14	13	10	19	15	14
3+4+5+6	67	61	67	60	70	73	69	66	77	73	71
Sciences 2015											
1. Low	16	12	14	16	9	14	18	17	8	9	11
2. Basic	23	24	22	24	18	20	24	28	18	19	20
3. Good	32	32	30	32	30	30	32	31	29	30	30
4. Very good	21	23	26	22	30	26	19	18	29	28	27
5+6. Excellent	7	9	9	8	13	11	7	6	15	15	12
3+4+5+6	61	65	65	61	73	67	58	56	73	73	69

Notes: Includes students in grades 8 to 11. Band definitions of scales from level 7 to level 1 are respectively: for reading >698; 698-626; 626-553; 553-480; 480-407; 407-335; 335-262; for math >669; 669-607; <607-544; 544-482; <484-420; <420-358; <358; for science >708; 708-633; 633-559; 559-484; 484-410; 410-335. Source: Authors' computation.

Table 6: Percentage of students by proficiency levels for the lowest and highest quintiles of socioeconomic status (HISEI) – Main domain reading 2000 and 2018

Province	Quintile	Proficiency level – reading 2018						Proficiency level – reading 2000					
		2-	3	4	5	6+	Total	2-	3	4	5	6+	Total
NL	Q1	18	25	33	19	6	100	20	29	33	17	2	100
	Q5	7	16	29	25	24	100	4	13	21	34	28	100
	Q1-Q5	11	9	4	-6	-18		16	16	12	-17	-26	
PE	Q1	25	30	32	8	5	100	20	28	29	18	5	100
	Q5	5	11	32	31	20	100	7	11	27	33	23	100
	Q1-Q5	20	19	0	-24	-16		14	17	1	-15	-18	
NS	Q1	22	27	25	18	8	100	21	31	31	13	4	100
	Q5	10	17	28	22	23	100	4	10	29	32	25	100
	Q1-Q5	12	10	-3	-3	-16		17	21	2	-19	-20	
NB	Q1	29	24	20	11	14	100	26	30	28	13	3	100
	Q5	10	22	24	27	18	100	6	14	31	32	17	100
	Q1-Q5	19	2	-4	-16	-4		20	16	-3	-19	-13	
QC	Q1	16	29	30	18	6	100	12	26	33	24	6	100
	Q5	5	13	25	33	23	100	4	11	23	35	27	100
	Q1-Q5	11	16	5	-15	-17		8	15	10	-11	-21	
ON	Q1	18	25	28	20	9	100	19	26	27	21	7	100
	Q5	7	14	26	28	26	100	3	11	25	35	26	100
	Q1-Q5	12	11	3	-8	-16		16	15	2	-14	-19	
MN	Q1	27	28	25	16	5	100	16	26	27	22	10	100
	Q5	11	23	27	23	17	100	5	12	30	30	23	100
	Q1-Q5	16	5	-3	-7	-13		11	14	-3	-8	-13	
SK	Q1	25	29	27	14	5	100	13	22	31	26	8	100
	Q5	8	17	28	30	17	100	5	14	27	36	19	100
	Q1-Q5	17	12	-1	-16	-12		8	8	4	-10	-11	
AB	Q1	23	23	26	18	10	100	13	21	32	21	12	100
	Q5	4	12	19	34	30	100	3	9	21	28	39	100
	Q1-Q5	19	11	7	-16	-20		10	12	11	-7	-27	
BC	Q1	19	24	29	19	9	100	15	25	27	22	11	100
	Q5	10	13	25	28	24	100	5	10	24	33	28	100
	Q1-Q5	9	10	4	-9	-14		11	15	3	-11	-17	
Canada	Q1	19	26	28	19	8	100	16	26	29	22	7	100
	Q5	6	14	25	30	25	100	4	11	24	34	28	100
	Q1-Q5	13	12	3	-11	-17		12	15	5	-12	-20	

Notes: Quintile of HISEI index, where index is the highest score, between 16 and 90, assigned to each occupation (father or mother) by the PISA survey. Band definitions of scales from level 7 to level 1 are respectively: for reading >698, 698-626, 626-553, 553-480, 480-407, 407-335, 335-262. Percentages are calculated for students in grades 8-11.

Source: Authors' computation from PISA weighted data sets (2000 to 2018), and PISA for band definitions of scales.

Table 7: Percentage of students by proficiency levels for the lowest and highest quintiles of socioeconomic status (HISEI) – Main domain mathematics 2003 and 2012

Province	Quintile	Proficiency level – maths 2012						Proficiency level – maths 2003					
		2-	3	4	5	6+	Total	2-	3	4	5	6+	Total
NL	Q1	39	31	22	7	2	100	24	28	30	15	3	100
	Q5	5	15	30	29	22	100	3	15	22	32	28	100
	Q1-Q5	34	16	-8	-22	-20		20	13	8	-17	-25	
PE	Q1	37	29	23	8	3	100	24	32	26	15	3	100
	Q5	10	23	30	25	12	100	8	17	25	32	19	100
	Q1-Q5	27	6	-7	-17	-9		16	15	1	-17	-16	
NS	Q1	18	32	33	12	5	100	24	31	26	14	5	100
	Q5	7	17	30	28	17	100	5	13	26	32	24	100
	Q1-Q5	11	15	3	-16	-12		19	18	0	-18	-19	
NB	Q1	25	29	28	16	2	100	19	27	29	18	7	100
	Q5	7	15	31	25	22	100	4	13	29	33	22	100
	Q1-Q5	18	15	-3	-10	-20		15	14	0	-15	-15	
QC	Q1	17	24	28	19	12	100	15	23	27	25	11	100
	Q5	4	11	19	31	35	100	3	11	20	30	37	100
	Q1-Q5	13	13	9	-12	-23		12	12	7	-5	-26	
ON	Q1	19	28	30	17	6	100	13	26	32	21	9	100
	Q5	5	16	25	28	27	100	6	11	24	25	34	100
	Q1-Q5	14	12	5	-11	-21		7	15	8	-4	-25	
MN	Q1	29	32	22	13	3	100	14	26	29	21	10	100
	Q5	13	15	28	22	22	100	6	14	26	28	26	100
	Q1-Q5	17	17	-6	-9	-18		8	12	3	-7	-15	
SK	Q1	21	27	30	14	9	100	25	30	23	17	5	100
	Q5	6	19	27	25	24	100	7	15	26	29	23	100
	Q1-Q5	15	8	2	-11	-15		18	15	-3	-12	-18	
AB	Q1	23	28	24	17	9	100	15	20	25	26	14	100
	Q5	5	15	25	28	27	100	3	6	20	27	44	100
	Q1-Q5	18	13	-1	-11	-18		12	14	5	-1	-30	
BC	Q1	16	28	29	17	10	100	14	24	29	20	13	100
	Q5	5	13	29	26	28	100	4	10	18	37	31	100
	Q1-Q5	11	15	0	-9	-18		10	14	11	-16	-18	
Canada	Q1	20	27	29	17	8	100	15	25	29	21	10	100
	Q5	5	14	25	28	28	100	4	10	22	29	35	100
	Q1-Q5	15	13	4	-11	-20		11	15	7	-8	-25	

Notes: Quintile of HISEI index, where index is the highest score, between 16 and 90, assigned to each occupation (father or mother) by the PISA survey. Band definitions of scales from level 7 to level 1 are respectively: for math >669, 669-607, <607-544, 544-482, <484-420, <420-358, <358. Percentages are calculated for students in grades 8-11.

Source: Authors' computation from PISA weighted data sets (2003 to 2012), and PISA for band definitions of scales.

Table 8: Percentage of students by proficiency levels for the lowest and highest quintiles of socioeconomic status (HISEI) – Main domain science 2006 and 2015

Province	Quintile	Proficiency level – science 2015						Proficiency level – science 2006					
		1	2	3	4	5+	Total	1	2	3	4	5+	Total
NL	Q1	22	24	38	10	7	100	21	29	28	18	4	100
	Q5	5	21	27	35	12	100	3	8	25	31	34	100
	Q1-Q5	17	3	11	-25	-5		18	21	3	-13	-30	
PE	Q1	14	26	40	11	8	100	26	26	27	15	5	100
	Q5	7	14	38	27	15	100	11	20	30	23	16	100
	Q1-Q5	8	12	2	-16	-7		15	6	-3	-8	-11	
NS	Q1	18	27	23	27	5	100	23	29	29	16	4	100
	Q5	4	15	27	34	19	100	4	15	27	34	19	100
	Q1-Q5	14	12	-4	-8	-14		19	13	2	-18	-15	
NB	Q1	21	32	31	14	3	100	26	30	28	13	3	100
	Q5	5	16	33	32	15	100	7	15	31	28	19	100
	Q1-Q5	17	16	-2	-18	-12		19	15	-3	-15	-16	
QC	Q1	18	24	29	24	6	100	15	24	36	19	6	100
	Q5	5	8	27	36	24	100	4	14	25	31	27	100
	Q1-Q5	13	17	2	-12	-18		12	10	11	-12	-21	
ON	Q1	19	26	32	17	6	100	16	25	31	22	7	100
	Q5	7	13	29	31	20	100	4	11	25	40	20	100
	Q1-Q5	12	13	3	-14	-14		12	14	6	-18	-14	
MN	Q1	22	28	34	14	2	100	20	25	34	17	5	100
	Q5	8	18	31	28	14	100	7	13	33	28	20	100
	Q1-Q5	14	10	3	-14	-12		13	12	1	-11	-15	
SK	Q1	21	33	30	13	4	100	22	27	31	13	8	100
	Q5	9	22	34	24	10	100	7	15	29	31	18	100
	Q1-Q5	12	11	-4	-11	-7		15	12	2	-18	-10	
AB	Q1	11	28	28	22	11	100	14	22	31	21	12	100
	Q5	3	10	23	35	28	100	1	10	23	36	30	100
	Q1-Q5	8	18	5	-13	-17		13	12	8	-15	-18	
BC	Q1	12	28	30	25	5	100	17	24	30	22	8	100
	Q5	3	12	24	37	24	100	4	15	21	33	27	100
	Q1-Q5	9	16	6	-12	-19		13	9	9	-12	-19	
Canada	Q1	17	27	31	19	6	100	17	24	33	20	7	100
	Q5	5	12	27	34	21	100	4	12	24	35	24	100
	Q1-Q5	12	15	3	-14	-16		13	12	8	-15	-17	

Notes: Quintile of HISEI index, where index is the highest score, between 16 and 90, assigned to each occupation (father or mother) by the PISA survey. Band definitions of scales from level 7 to level 1 are: for science >708; 708-633; 633-559; 559-484; 484-410; 410-335. Percentages are calculated for students in grades 8-11.

Source: Authors' computation from PISA weighted data sets (2006 to 2015), and PISA for band definitions of scales.

Table 9: SES gradient over time for Canada

		Reading		Maths		Sciences	
		ref. year 2000		ref. year 2003		ref. year 2006	
		coef.	s.e.	coef.	s.e.	coef.	s.e.
SES quintile (reference Q1)	Q2	25.0***	(3.0)	22.3***	(2.8)	27.8***	(3.3)
	Q3	36.0***	(2.7)	32.6***	(2.7)	39.1***	(4.0)
	Q4	54.9***	(3.0)	46.8***	(2.8)	47.9***	(3.4)
	Q5	70.5***	(3.0)	64.4***	(3.3)	68.2***	(3.9)
Year fixed effects	2003	3.5	(3.5)				
	2006	-5.9	(4.4)	-7.4**	(3.5)		
	2009	-3.5	(3.5)	-8.4**	(3.5)	-1.0	(4.1)
	2012	-0.0	(3.9)	-13.7***	(3.3)	2.0	(4.3)
	2015	-3.5	(4.0)	-18.8***	(3.7)	-3.8	(3.9)
	2018	-7.7**	(3.9)	-20.2***	(3.4)	-10.5**	(4.4)
Q2 SES by survey year	2003	-4.9	(4.7)				
	2006	0.7	(4.5)	1.3	(4.3)		
	2009	-8.3**	(4.0)	-2.7	(3.8)	-8.7**	(4.4)
	2012	-8.8**	(4.3)	-4.9	(4.1)	-11.6***	(4.5)
	2015	-0.4	(4.1)	0.2	(3.7)	-4.2	(4.1)
	2018	-4.4	(4.3)	-3.0	(3.9)	-9.2*	(4.9)
Q3 SES by survey year	2003	-6.4	(4.1)				
	2006	2.7	(4.7)	0.8	(4.3)		
	2009	-3.2	(4.3)	2.5	(4.3)	-4.7	(4.9)
	2012	-5.5	(3.8)	2.4	(3.9)	-8.4*	(4.7)
	2015	0.6	(4.4)	0.7	(4.4)	-4.0	(5.0)
	2018	2.2	(4.7)	3.2	(4.2)	-3.2	(5.0)
Q4 SES by survey year	2003	-11.7***	(4.4)				
	2006	-6.9	(4.6)	-3.6	(4.6)		
	2009	-9.5**	(4.0)	2.0	(4.3)	-2.1	(4.7)
	2012	-14.2***	(4.0)	-1.1	(3.7)	-7.1	(4.5)
	2015	0.4	(4.5)	5.1	(3.9)	7.0*	(4.2)
	2018	-4.3	(4.8)	1.5	(4.0)	-0.2	(4.6)
Q5 SES by survey year	2003	-14.8***	(4.7)				
	2006	-3.8	(5.3)	-2.2	(4.5)		
	2009	-10.5**	(4.4)	1.0	(4.6)	-7.6	(5.6)
	2012	-12.4***	(4.3)	0.6	(4.5)	-13.0**	(5.4)
	2015	-7.9*	(4.7)	0.4	(4.9)	-1.7	(4.9)
	2018	-7.7	(4.7)	-2.1	(4.8)	-8.0	(5.3)
Province (reference NL)	PEI	-11.2***	(2.0)	-8.3***	(2.5)	-13.4***	(2.3)
	NS	4.2***	(1.5)	5.9***	(1.6)	3.9*	(2.4)
	NB	-11.4***	(1.6)	-0.8	(1.9)	-12.8***	(2.5)
	QC	18.1***	(1.8)	35.4***	(2.1)	14.0***	(2.6)
	ON	20.7***	(1.8)	21.1***	(2.0)	16.7***	(2.4)
	MB	-1.8	(1.8)	3.4*	(1.9)	-7.2***	(2.2)
	SK	-2.9*	(1.6)	1.3	(1.8)	-5.3***	(2.0)
	AB	25.0***	(1.7)	24.5***	(2.0)	28.8***	(2.4)
	BC	20.4***	(1.9)	20.9***	(2.3)	22.2***	(2.4)
Constant		260.0***	(23.9)	215.5***	(26.2)	225.4***	(29.4)
N		152,010		123,713		98,935	
R2		0.108		0.105		0.084	

Note: Controls include immigrant status, expected grade based on birth date, gender, language spoken at home, and age in years. Includes grade 8 to 11 students.

Table 10: Reading score SES gradient over time by province (reference year 2000)

	NL	PE	NS	NB	QC	ON	MN	SK	AB	BC
SES quintile (reference Q1)										
Q2	15.7**	30.0***	35.7***	24.6***	20.5***	28.1***	12.5*	10.7*	30.5***	28.6***
Q3	41.0***	32.9***	56.3***	38.4***	33.5***	38.9***	30.7***	23.0***	35.2***	34.8***
Q4	60.5***	47.4***	59.8***	45.6***	49.2***	68.1***	40.5***	23.0***	52.5***	45.7***
Q5	90.6***	71.3***	89.3***	77.0***	64.7***	77.5***	54.4***	41.5***	75.3***	63.9***
Year fixed effects (reference 2000)										
2003	0.0	-36.2***	-17.1**	-0.7	-3.4	4.4	-0.5	-43.6***	-11.6	12.6
2006	-8.9	-37.4***	-31.1***	-17.4***	-16.2*	1.4	-12.9	-48.1***	-19.2	-9.9
2009	0.5	-42.8***	-9.5	-14.4**	-11.6**	1.5	-36.7***	-43.5***	-21.0*	0.1
2012	-19.7	-41.2***	-5.9	-19.4***	-13.6**	5.1	-25.7***	-30.0**	-27.1**	19.3*
2015	1.4	2.5	-1.9	-7.8	-9.6	-7.2	-15.9	-37.8***	-17.1	13.9
2018	7.0	-40.7*	-13.4	-22.1**	-13.9***	-3.4	-19.4**	-44.6***	-35.0***	-2.6
Q2 SES interacted with survey year										
2003	10.2	-12.7	-18.1**	-22.3**	-7.5	-1.3	6.6	25.4***	-12.6	-10.5
2006	-6.2	-9.0	-8.1	-3.4	4.3	1.4	16.1	16.3	-14.2	-2.8
2009	-4.3	-6.0	-16.6*	-9.0	-0.8	-15.8*	19.5*	23.1**	-18.5*	-8.5
2012	9.8	-5.7	-29.1**	-0.4	0.7	-13.7	5.9	2.4	-11.8	-18.6*
2015	-1.7	-25.0	-22.4**	-10.6	8.9	3.0	-6.2	9.2	-17.1**	-13.4
2018	2.0	21.5	-12.8	-15.4	0.3	-11.0	1.7	14.5	10.0	-14.2
Q3 SES interacted with survey year										
2003	3.5	3.2	-16.1*	-13.6	-8.2	-8.0	-9.9	21.9**	-6.0	-7.9
2006	1.6	4.2	-18.9*	-7.8	5.3	2.3	5.7	25.9**	-6.8	4.2
2009	-6.7	-4.7	-27.2***	-3.5	3.5	-5.3	4.9	-1.8	-9.9	-3.6
2012	6.8	10.6	-32.8**	-5.3	4.5	-9.2	9.8	-4.0	-8.0	-13.7
2015	-7.0	-21.6	-21.5*	1.7	10.0	3.1	-5.3	-5.3	-12.8	-6.9
2018	-11.8	41.9	-7.6	0.8	3.8	-2.3	-0.5	18.0*	13.9	-0.3
Q4 SES interacted with survey year										
2003	-1.2	-3.4	-10.2	-14.9	-2.5	-27.4***	-3.6	33.3***	-10.8	-7.0
2006	1.2	2.3	2.7	-8.3	-3.3	-20.3**	11.2	32.0***	-11.1	7.0
2009	-36.8**	-2.9	-15.9	-6.0	-6.6	-21.1**	21.4**	27.4***	-2.9	-6.3
2012	8.9	-12.7	-23.2*	-4.9	0.9	-30.4***	5.0	6.7	-4.7	-17.6*
2015	-27.8*	-13.0	-20.4*	6.6	17.0*	-7.5	-3.9	4.1	-9.0	3.3
2018	-6.1	-8.3	-11.6	-6.9	2.1	-18.3*	-4.2	21.0*	6.3	7.3
Q5 SES interacted with survey year										
2003	-13.2	-7.1	-24.6***	-16.4*	-5.5	-27.7**	-7.4	20.4***	-14.9	-13.8*
2006	10.5	-2.2	-9.8	-13.2*	7.0	-20.0**	9.3	32.9***	-13.1	17.7*
2009	-27.8*	-0.4	-27.0**	-16.7*	-7.0	-17.8*	18.4	20.2**	-12.7	-7.8
2012	5.1	1.9	-40.6***	-15.1	1.5	-23.7***	11.2	6.6	-9.4	-15.3
2015	-29.7**	-31.0*	-28.4**	-6.4	-1.3	-11.5	4.8	-0.4	-15.3	-8.7
2018	-27.7**	18.9	-28.6***	-17.1	3.2	-20.0**	-4.3	25.1**	6.5	-6.4
Constant	327.8***	106.6	189.4***	269.5***	354.0***	276.5***	226.6***	254.3***	325.3***	312.1***
N	10,353	7,671	12,835	14,707	24,773	23,347	14,604	13,722	14,936	15,062
R2	0.145	0.138	0.128	0.134	0.120	0.097	0.119	0.115	0.105	0.098

Note: Restricted to grade 8 to 11 students. SES quintiles are measured at the provincial levels. Controls not reported above include immigrant status, expected grade, gender, language spoken at home, and age in years.

Table 11: Maths score SES gradient over time by province (reference year 2003)

	NL	PE	NS	NB	QC	ON	MN	SK	AB	BC
SES quintile (reference Q1)										
Q2	23.9***	18.0**	20.6***	0.9	12.0**	34.5***	17.8***	33.3***	18.8***	20.1***
Q3	43.6***	31.6***	39.2***	25.2***	30.8***	36.6***	24.1***	44.1***	27.4***	29.3***
Q4	59.5***	40.9***	54.0***	32.5***	50.1***	45.7***	37.8***	57.2***	47.2***	42.6***
Q5	79.7***	65.5***	75.1***	61.2***	67.9***	62.5***	49.3***	66.4***	65.1***	59.8***
Year fixed effects (reference 2003)										
2006	-4.2	0.7	-9.0	-16.1**	-4.6	-2.4	-11.5*	0.8	-15.8*	-18.4***
2009	3.1	-13.9*	9.3*	-19.3**	-0.3	-4.9	-35.6***	-1.7	-19.2***	-19.2***
2012	-33.6***	-23.4***	4.9	-20.8**	-6.3	-15.1**	-36.0***	9.6	-28.6***	-8.7
2015	-13.3	13.0	-5.6	-28.3***	-3.0	-23.9***	-32.9***	-10.0	-28.6***	-16.0**
2018	-9.1	-19.2	-18.1**	-30.9***	-6.6	-13.2*	-40.9***	-18.2**	-42.5***	-35.3***
Q2 SES interacted with survey year										
2006	-12.4	1.2	0.2	20.6*	13.3	-8.3	4.5	-15.1	0.3	1.8
2009	-15.7	11.7	-1.2	17.8	11.7*	-18.8**	14.8	-1.9	-4.3	3.1
2012	5.6	5.8	-19.9	26.6**	13.7**	-19.3**	-1.8	-20.0*	-1.5	-9.5
2015	-7.8	-7.3	-4.5	13.1	15.6*	-8.4	-10.5	-18.2*	-2.6	-3.7
2018	-10.4	8.7	-0.0	10.6	10.2	-18.6*	-4.4	-6.2	13.0	-4.8
Q3 SES interacted with survey year										
2006	-14.3*	-1.9	-4.6	10.1	10.1	-5.7	9.4	-10.7	-0.7	5.0
2009	-11.4	-0.7	-14.1*	12.7	9.2	0.0	12.5	-23.6**	-3.6	5.1
2012	8.8	9.3	-24.5	9.4	11.2	1.2	15.9	-21.8**	0.7	-6.3
2015	-12.6	-17.5	-3.4	11.2	9.8	-0.2	-1.3	-26.3***	-10.3	2.3
2018	-24.2**	16.0	10.0	15.7	7.5	-4.8	5.7	-3.3	16.3	5.9
Q4 SES interacted with survey year										
2006	-8.6	-0.6	7.4	5.4	-3.0	-3.1	9.5	-15.2*	-8.8	-4.2
2009	-35.9***	3.6	-17.1*	14.2	-0.6	2.3	17.9	-8.8	7.7	6.5
2012	17.0	-3.5	-22.8**	7.2	5.3	-0.3	7.0	-28.6***	0.4	-8.3
2015	-29.1**	-7.3	-11.8	15.8	11.6	11.2	0.0	-30.7***	-11.4	6.4
2018	-19.7	-8.5	-12.9	8.5	1.1	0.8	-1.7	-18.2**	5.1	13.2
Q5 SES interacted with survey year										
2006	4.0	-6.8	-1.4	10.0	5.3	-9.9	12.3	-6.8	-4.0	6.9
2009	-22.9**	-0.9	-20.5**	3.9	3.6	-2.1	20.3*	-4.0	4.7	8.4
2012	20.2	5.1	-28.2**	6.7	4.6	2.4	18.5*	-14.6	3.6	-7.5
2015	-21.0*	-32.3*	-10.9	10.6	2.9	3.2	8.5	-20.1**	-9.5	4.7
2018	-26.6**	-3.4	-15.7	7.8	1.3	-5.8	-0.4	-5.3	7.2	5.1
Constant	311.4***	94.2	125.2	312.9***	351.7***	255.5***	152.2***	151.3***	215.3***	251.8***
N	8,205	6,120	10,055	11,901	20,494	19,246	12,115	11,102	12,300	12,175
R2	0.122	0.087	0.106	0.101	0.115	0.084	0.112	0.089	0.102	0.099

Note: Restricted to grade 8 to 11 students, year 2003 to 2018. SES quintiles are measured at the provincial levels.

Controls not reported above include immigrant status, expected grade based on birth month, gender, language spoken at home, and age in years.

Table 12: Science score SES gradient over time by province (reference year 2006)

	NL	PE	NS	NB	QC	ON	MN	SK	AB	BC
SES quintile (reference Q1)										
Q2	12.6**	24.7***	26.4***	18.8***	29.0***	32.4***	27.7***	20.0***	20.9**	24.7***
Q3	35.5***	33.9***	35.6***	35.0***	44.5***	41.7***	36.7***	36.6***	32.2***	32.8***
Q4	56.0***	44.6***	65.5***	40.8***	49.3***	50.7***	51.1***	40.9***	43.9***	40.0***
Q5	96.4***	60.4***	80.7***	72.2***	76.3***	63.3***	65.3***	61.0***	68.2***	65.1***
Year fixed effects (reference 2003)										
2009	6.2	-10.6	18.5**	1.6	0.6	-2.7	-23.7**	-5.0	1.9	2.1
2012	-11.2	-14.6*	23.6***	4.8	-3.4	-0.1	-7.9	9.0	-5.2	20.1**
2015	-5.2	23.9**	17.0*	2.8	7.7	-12.4*	-9.1	-7.3	-2.7	4.9
2018	-0.1	-15.3	-1.9	-8.7	-1.6	-9.9	-20.8**	-12.3	-21.4**	-15.2
Q2 SES interacted with survey year										
2009	-1.6	3.2	-7.4	-5.9	-7.7	-15.1*	7.8	13.1	-9.9	-3.0
2012	10.1	-4.1	-25.8**	4.4	-9.2	-15.7*	-17.8	-4.9	-3.9	-14.3
2015	5.8	-18.2	-10.6	-2.8	-0.7	-3.3	-24.7**	-0.2	-4.1	-11.1
2018	1.5	15.8	-0.3	-6.7	-9.1	-16.2	-17.7	8.2	13.7	-15.7
Q3 SES interacted with survey year										
2009	-2.2	-5.4	-11.0	-5.6	-5.4	-5.0	5.6	-14.6	-10.0	-0.7
2012	7.5	3.4	-20.4	-7.7	-9.7	-8.7	-2.0	-14.9	-3.9	-11.0
2015	3.3	-18.0	-7.2	5.2	-3.2	-1.6	-14.6	-19.3*	-12.3	-3.3
2018	-13.8	33.4	8.5	2.6	-8.5	-7.6	-6.9	3.6	11.2	2.4
Q4 SES interacted with survey year										
2009	-33.5**	-1.1	-26.2**	-6.4	-4.0	-0.3	12.9	6.8	-0.7	-3.7
2012	12.2	-6.5	-33.5***	-5.3	-3.2	-10.2	-14.7	-9.0	5.0	-9.3
2015	-21.1	-12.9	-28.1**	11.6	13.0	9.9	-12.5	-15.1	-0.4	12.0
2018	-8.7	-0.5	-22.6*	-4.1	2.9	-5.1	-15.9	2.7	8.4	11.1
Q5 SES interacted with survey year										
2009	-28.9**	5.1	-26.8**	-16.1*	-14.6	-1.3	13.6	2.8	-13.6	-11.3
2012	-3.1	3.9	-43.3***	-14.2	-19.2**	-9.1	-5.8	-6.8	-4.0	-18.1
2015	-32.0***	-20.2	-21.6*	0.7	-7.0	4.5	-5.6	-16.2	-3.1	0.3
2018	-45.6***	15.5	-25.8**	-11.6	-10.5	-8.4	-15.9	3.6	5.0	-3.8
Constant	318.4***	14.0	131.5	308.0***	332.1***	253.1***	153.4**	198.0***	292.4***	212.7***
N	6,113	4,584	7,364	8,422	17,400	17,023	9,578	8,962	10,024	9,465
R2	0.102	0.081	0.077	0.093	0.111	0.071	0.097	0.077	0.075	0.076

Note: Restricted to grade 8 to 11 students, year 2006 to 2018. SES quintiles are measured at the provincial levels.

Controls not reported above include immigrant status, expected grade based on birth month, gender, language spoken at home, and age in years.

Table 13: Robustness checks : school grade controls

READING		CANADA	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
Control expected grade	Q5 coef	70.5*** (3.0)	90.6*** (7.6)	71.3*** (7.3)	89.3*** (7.3)	77.0*** (6.1)	64.7*** (4.7)	77.5*** (6.8)	54.4*** (7.7)	41.5*** (5.7)	75.3*** (5.8)	63.9*** (6.5)
	N	152,010	10,353	7,671	12,835	14,707	24,773	23,347	14,604	13,722	14,936	15,062
	R2	0.108	0.145	0.138	0.128	0.134	0.120	0.097	0.119	0.115	0.105	0.098
No grade controls	Q5 coef	70.5*** (3.0)	90.6*** (7.6)	71.3*** (7.3)	89.2*** (7.3)	77.0*** (6.1)	64.7*** (4.6)	77.5*** (6.8)	54.4*** (7.7)	41.5*** (5.7)	75.3*** (5.8)	63.9*** (6.5)
	N	152,010	10,353	7,671	12,835	14,707	24,773	23,347	14,604	13,722	14,936	15,062
	R2	0.108	0.145	0.138	0.128	0.134	0.119	0.097	0.119	0.115	0.105	0.098
Control actual grade	Q5 coef	63.8*** (3.1)	88.3*** (7.3)	63.6*** (6.9)	78.3*** (6.9)	66.2*** (5.8)	43.4*** (4.1)	74.8*** (6.8)	47.2*** (7.5)	35.2*** (5.5)	69.9*** (5.6)	59.6*** (5.9)
	N	151,688	10,351	7,671	12,835	14,707	24,476	23,331	14,597	13,722	14,936	15,062
	R2	0.151	0.163	0.171	0.160	0.195	0.254	0.114	0.143	0.156	0.138	0.117
MATHS		CANADA	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
Control expected grade	Q5 coef	64.4*** (3.3)	79.7*** (7.3)	65.5*** (7.0)	75.1*** (5.6)	61.2*** (8.8)	67.9*** (7.3)	62.5*** (8.9)	49.3*** (6.9)	66.4*** (6.1)	65.1*** (5.7)	59.8*** (6.1)
	N	123,713	8,205	6,120	10,055	11,901	20,494	19,246	12,115	11,102	12,300	12,175
	R2	0.105	0.122	0.087	0.106	0.101	0.115	0.084	0.112	0.089	0.102	0.099
No grade controls	Q5 coef	64.4*** (3.3)	79.7*** (7.3)	65.5*** (7.0)	75.1*** (5.6)	61.2*** (8.8)	67.6*** (7.3)	62.5*** (8.9)	49.3*** (6.9)	66.4*** (6.1)	65.1*** (5.7)	59.8*** (6.1)
	N	123,713	8,205	6,120	10,055	11,901	20,494	19,246	12,115	11,102	12,300	12,175
	R2	0.105	0.122	0.087	0.106	0.101	0.113	0.084	0.112	0.089	0.102	0.099
Control actual grade	Q5 coef	55.4*** (3.2)	77.5*** (7.2)	59.6*** (6.7)	70.2*** (5.6)	52.5*** (8.1)	40.9*** (6.6)	60.0*** (9.0)	43.9*** (6.7)	61.3*** (5.9)	58.6*** (6.0)	57.9*** (5.9)
	N	123,711	8,204	6,120	10,055	11,901	20,494	19,245	12,115	11,102	12,300	12,175
	R2	0.157	0.131	0.126	0.132	0.181	0.276	0.099	0.136	0.135	0.137	0.115
SCIENCES		CANADA	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
Control expected grade	Q5 coef	68.2*** (3.9)	96.4*** (7.5)	60.4*** (7.5)	80.7*** (7.4)	72.2*** (6.6)	76.3*** (8.1)	63.3*** (7.2)	65.3*** (6.9)	61.0*** (7.6)	68.2*** (9.1)	65.1*** (7.8)
	N	98,935	6,113	4,584	7,364	8,422	17,400	17,023	9,578	8,962	10,024	9,465
	R2	0.084	0.102	0.081	0.077	0.093	0.111	0.071	0.097	0.077	0.075	0.076
No grade controls	Q5 coef	68.3*** (3.9)	96.4*** (7.5)	60.4*** (7.5)	80.7*** (7.4)	72.2*** (6.6)	76.7*** (8.2)	63.3*** (7.2)	65.3*** (6.9)	61.0*** (7.6)	68.2*** (9.1)	65.1*** (7.8)
	N	98,935	6,113	4,584	7,364	8,422	17,400	17,023	9,578	8,962	10,024	9,465
	R2	0.083	0.102	0.081	0.077	0.093	0.110	0.071	0.097	0.077	0.075	0.076
Control actual grade	Q5 coef	62.2*** (3.8)	91.7*** (7.8)	57.3*** (7.4)	76.0*** (7.2)	65.6*** (6.3)	57.0*** (6.8)	60.4*** (7.2)	62.4*** (6.9)	55.0*** (8.3)	66.3*** (8.5)	64.8*** (7.8)
	N	98,935	6,113	4,584	7,364	8,422	17,400	17,023	9,578	8,962	10,024	9,465
	R2	0.121	0.108	0.109	0.093	0.145	0.240	0.087	0.118	0.108	0.099	0.088

Note: Include grade 8 to 11 students. Estimates from equation 2a with time trends. Only the Q5 coefficient for each specification is presented for conciseness. Controls not reported above include SES quintiles (Q2 to Q4), SES quintiles interacted with year dummies, year dummies, immigrant status, expected grade based on birth month, gender, language spoken at home, and age in years.

Table 14: Test scores among low SES students across the country in PISA 2000 to 2018

	Grades 8 to 11			Grades 9 and 10		
	Reading	Maths	Sciences	Reading	Maths	Sciences
Province of reference NL						
PEI	-9.0** (3.6)	-5.9 (3.8)	-12.3*** (3.9)	-9.9*** (3.7)	-6.7* (3.8)	-13.5*** (4.0)
NS	5.9* (3.2)	5.7 (3.6)	8.0** (3.8)	5.6* (3.2)	4.8 (3.6)	7.1* (3.9)
NB	-3.5 (3.6)	0.3 (4.0)	-6.3 (4.2)	-2.4 (3.6)	0.2 (4.0)	-6.6 (4.1)
QC	28.8*** (3.4)	30.7*** (4.1)	14.4*** (3.9)	39.6*** (3.4)	37.7*** (4.1)	21.3*** (3.8)
ON	23.8*** (3.2)	19.7*** (4.0)	16.1*** (3.3)	23.6*** (3.2)	19.3*** (4.0)	15.6*** (3.4)
MB	2.6 (3.3)	4.3 (3.5)	-1.6 (3.5)	2.7 (3.3)	4.0 (3.5)	-1.8 (3.5)
SK	3.1 (3.4)	4.1 (4.1)	-1.4 (3.6)	4.0 (3.4)	4.7 (4.1)	-0.9 (3.7)
AB	28.3*** (3.0)	23.2*** (3.7)	30.0*** (3.5)	27.3*** (3.1)	22.1*** (3.8)	29.2*** (3.5)
BC	25.7*** (3.5)	19.9*** (4.0)	25.2*** (3.4)	25.2*** (3.5)	19.2*** (3.9)	24.7*** (3.4)
Constant	352.7*** (53.0)	341.8*** (47.2)	346.2*** (53.6)	394.1*** (51.8)	377.3*** (47.2)	378.9*** (52.8)
N	30,316	27,665	27,793	29,429	26,904	27,038
R2	0.043	0.037	0.026	0.044	0.045	0.023

Note: Includes students whose parents are in the first quintile of the SES distribution (low SES). All survey years are pooled together. Controls not reported above include year dummies, immigrant status, expected grade based on birth month, gender, language spoken at home, and age in years.

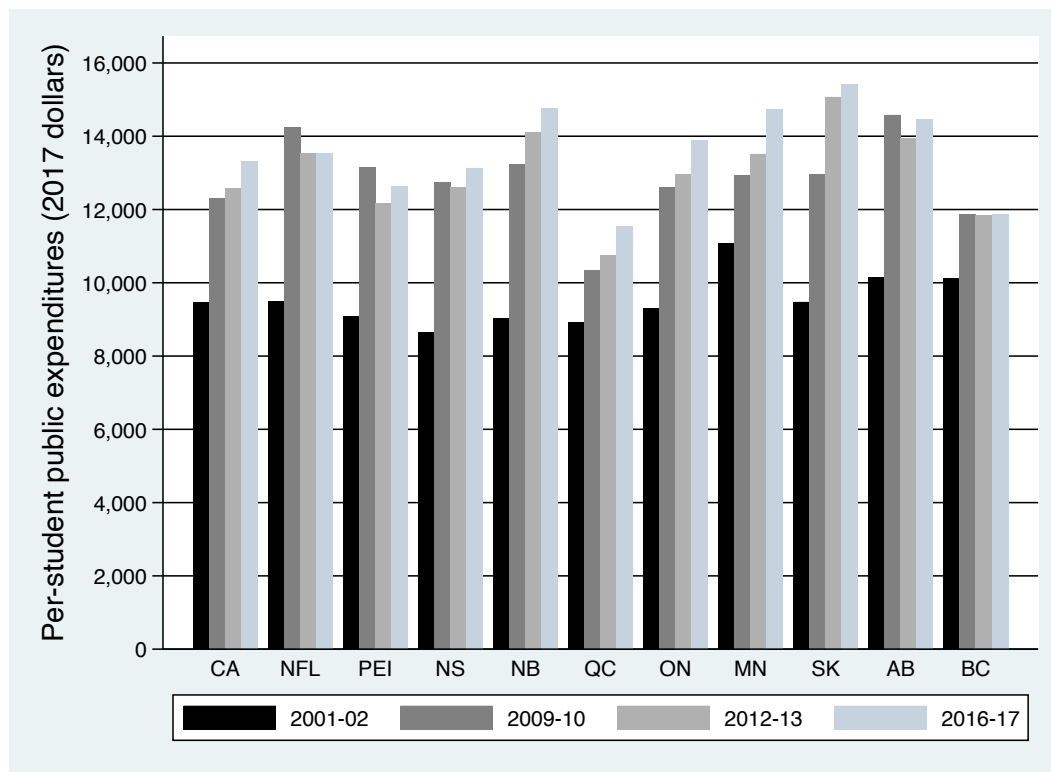
FIGURES

Figure 1: Mean test score by provinces over time



Note: Includes grade 8 to 10 students. Year 1 represents the first year of the main domain: 2000 in reading, 2003 in math, and 2006 in science. The average is computed on all years between Year 2 to 2015.

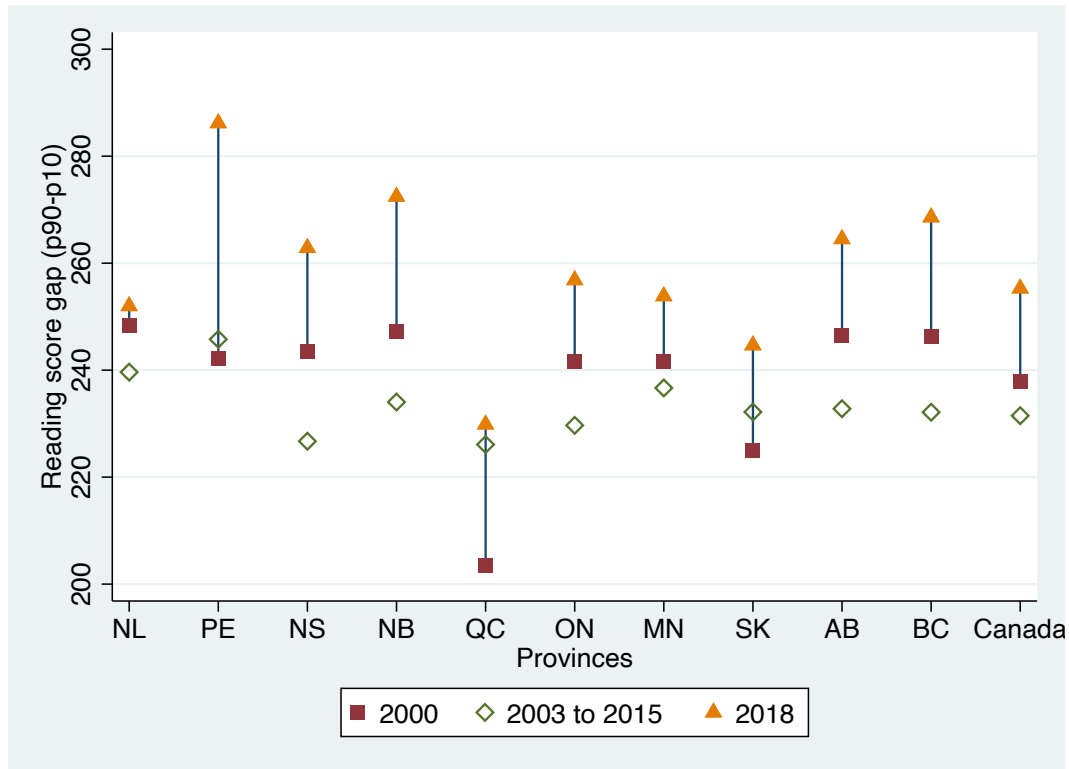
Figure 2: Per-student public expenditures for students in public elementary and secondary schools by school year in Canada



Note: Per-student spending in public schools deflated by the CPI (2017 dollars). Public spending in private school is not included.

Sources: Table 478-0014, Public and Private Elementary and Secondary Education Expenditures, Statistics Canada, Table 477-0025; Enrolments in Regular Programs for Youth in Public Elementary and Secondary Schools by Grade and Sex, Canada, Provinces and Territories, Statistics Canada; Table 326-0021, Consumer Price Index (CPI), 2011 Basket, Annual (2002=100), Statistics Canada. Adapted from (1) MacLeod, Angela, and Joel Emes (2017a). Enrolments and Education Spending in Public Schools in Canada, 2017 Edition. Fraser Institute. <https://www.fraserinstitute.org/sites/default/files/education-spending-and-public-student-enrolment-in-canada-2017.pdf> ; (2) MacLeod, Angela, and Joel Emes (2019). *Education Spending in Public Schools in Canada*. Fraser Institute. <http://www.fraserinstitute.org> ; and (3) Van Pelt, Deani Neven, and Joel Emes (2015). *Education Spending In Canada: What's Actually Happening?* Fraser Institute. <https://www.fraserinstitute.org/sites/default/files/education-spending-in-canada-whatsactually-happening.pdf>

Figure 3a: Reading score gap between the 90th and the 10th percentile of the score distribution between 2000 and 2018



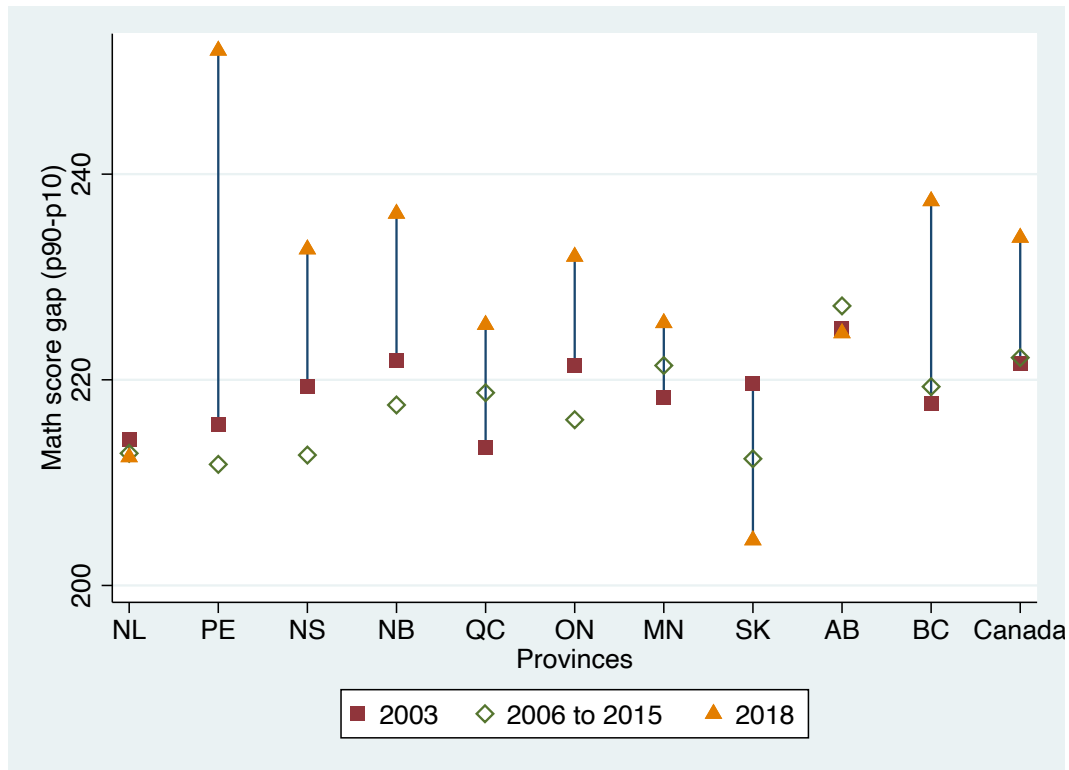
Note: Includes grade 8 to 10 students.

Figure 3b: Reading score at the 10th and 90th percentile of the score distribution between 2000 and 2018



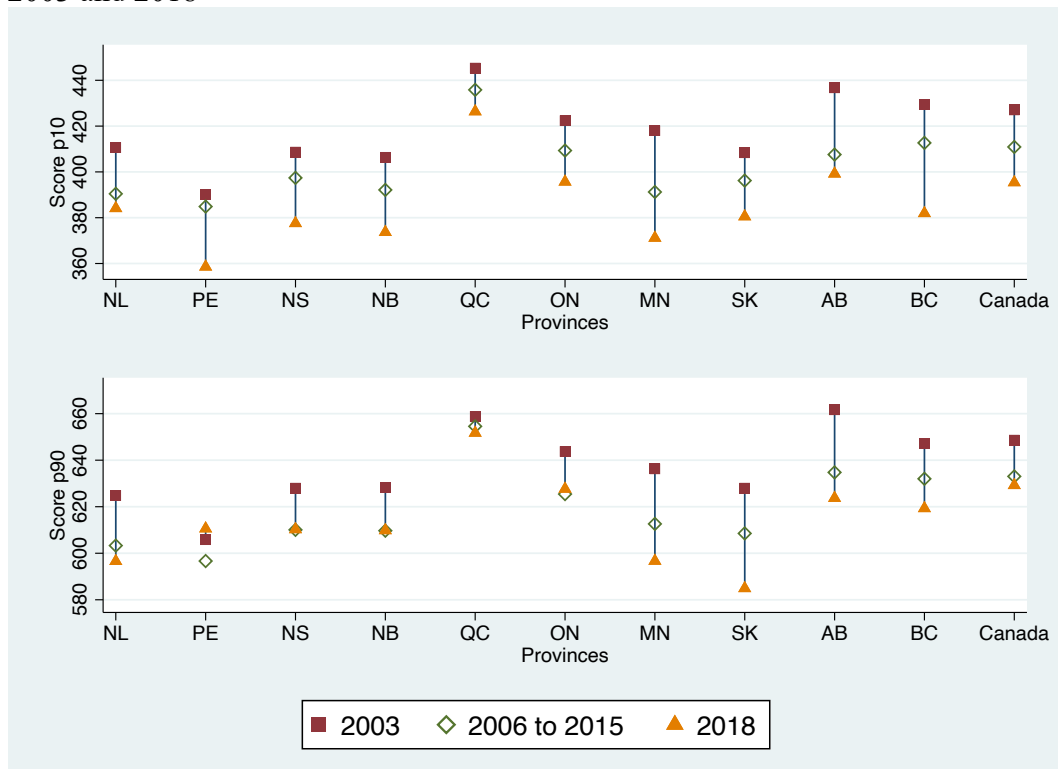
Note: Includes grade 8 to 10 students.

Figure 4a: Mathematic score gap between the 90th and the 10th percentile of the score distribution between 2003 and 2018



Note: Includes grade 8 to 10 students.

Figure 4b : Mathematic score at the 10th and 90th percentile of the score distribution between 2003 and 2018



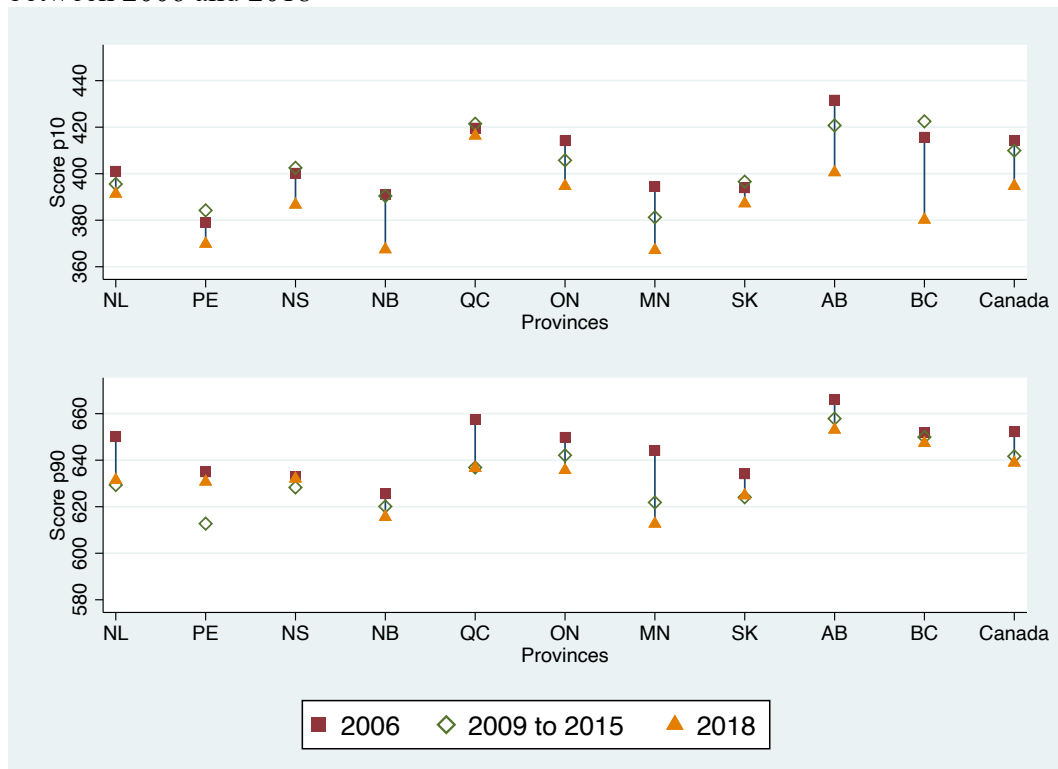
Note: Includes grade 8 to 10 students.

Figure 5a: Science score gap between the 90th and the 10th percentile of the score distribution between 2006 and 2018



Note: Includes grade 8 to 10 students.

Figure 5b: Science score gap between the 90th and the 10th percentile of the score distribution between 2006 and 2018



Note: Includes grade 8 to 10 students.

Appendix

Literacy in PISA

“In the PISA context, the term “reading” is used for “reading literacy” which is meant to focus on the active, purposeful and functional application of reading in range of situations and for various purposes: Reading literacy is understanding, using, reflecting on and engaging with written texts, in order to achieve one’s goals, to develop one’s knowledge and potential, and to participate in society.”

“In the PISA context, “mathematics” denotes “mathematical literacy,” which implies a focus on students’ active engagement in mathematics and their preparedness for life in a modern society. As such, it is expected that students can demonstrate their capacity to use mathematical content and language in contexts that are appropriate for 15-year-olds, when they are close to the end of their formal mathematics training. Mathematical literacy is defined as: As an individual’s capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens.”

“Scientific literacy (hereafter referred to as science): An individual’s scientific knowledge, and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena, and draw evidence-based conclusions about science-related issues; an understanding of the characteristic features of science as a form of human knowledge and enquiry; an awareness of how science and technology shape our material, intellectual, and cultural environments; and a willingness to engage in science uses, and with the ideas of science, as a reflective citizen.”

Source: OECD (2013) “PISA 2012 Assessment and analytical framework: Mathematics, reading, science, problem solving and financial literacy.” Paris.

Table A1: Acronym used for each province and Canada

Acronym	English name
NL	Newfoundland and Labrador
PE	Prince Edward Island
NS	Nova Scotia
NB	New Brunswick
QC	Québec
ON	Ontario
MN	Manitoba
SK	Saskatchewan
AB	Alberta
BC	British Columbia
CA	Canada

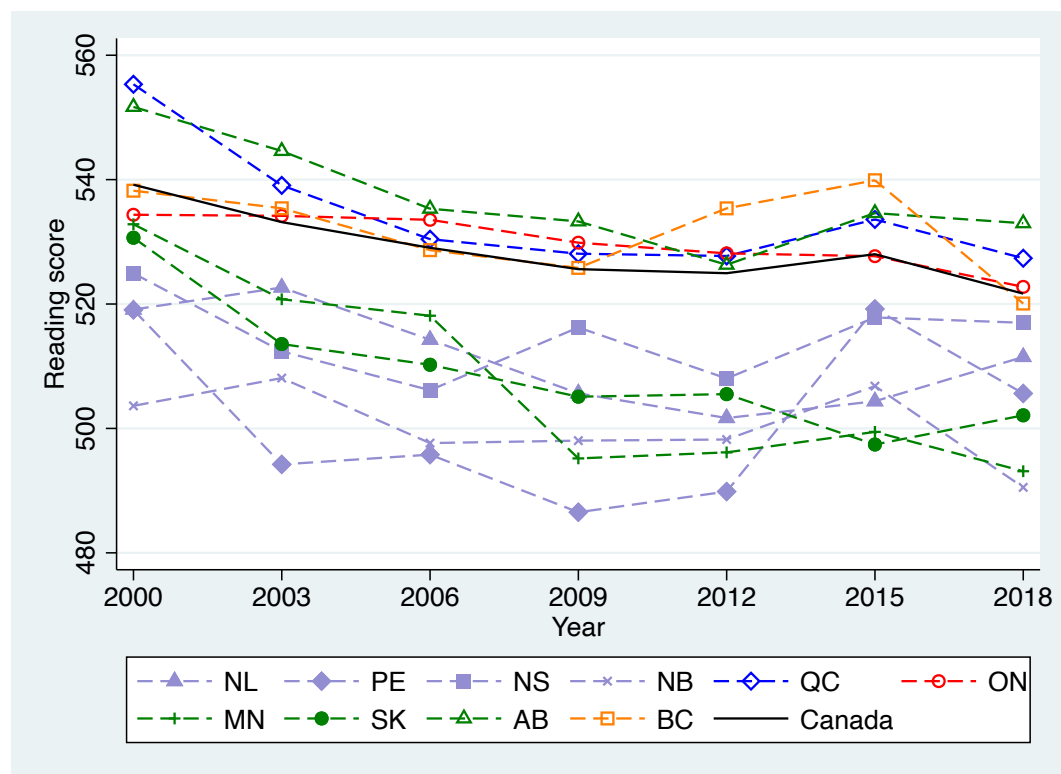
Table A2: ESCS by province over time

Province	ESCS 2000	ESCS 2003	ESCS 2006	ESCS 2009	ESCS 2012	ESCS 2015	ESCS 2018
NL	0.53	0.26	0.11	0.28	0.28	0.34	0.38
PE	0.54	0.31	0.21	0.36	0.33	0.53	0.32
NS	0.56	0.34	0.24	0.42	0.31	0.44	0.33
NB	0.50	0.30	0.20	0.31	0.37	0.34	0.24
QC	0.55	0.30	0.21	0.39	0.34	0.49	0.37
ON	0.52	0.56	0.48	0.56	0.44	0.57	0.48
MN	0.57	0.36	0.34	0.33	0.26	0.35	0.17
SK	0.49	0.34	0.28	0.43	0.4	0.32	0.29
AB	0.51	0.58	0.43	0.61	0.51	0.60	0.46
CB	0.58	0.53	0.40	0.59	0.46	0.61	0.43
Canada	0.53	0.45	0.37	0.50	0.41	0.53	0.42

Note: All students, weighted.

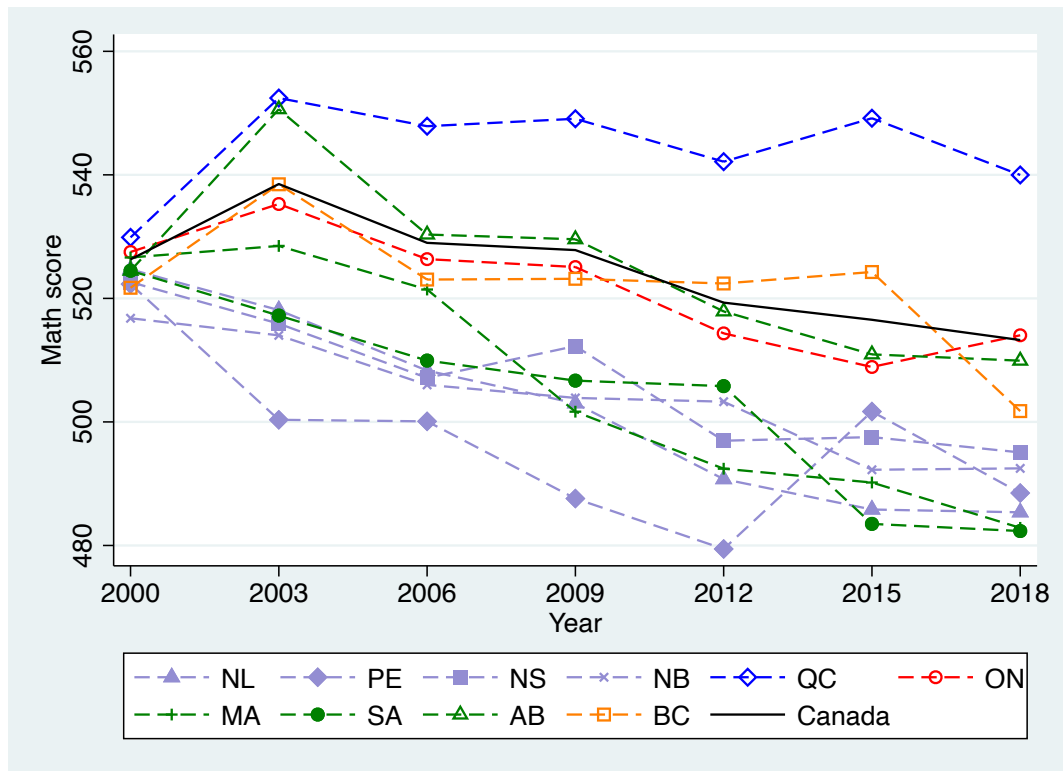
Tables A3 to A5 provide the backup of Figures 3 to 5. We also provide Tables A6 to A8 on the web, these shows the estimated coefficient on the SES quintiles for each province, each test and each year.

Figure A1: Reading mean test score by provinces over time



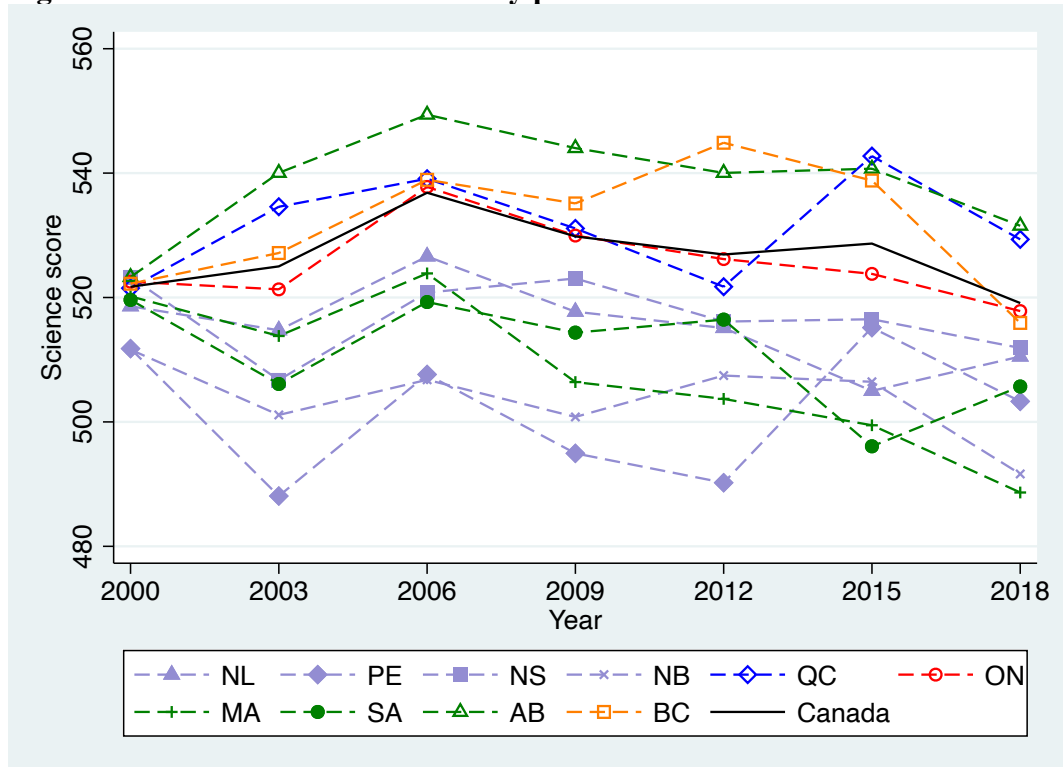
Note: Reading was the main domain in 2000, 2009 and 2018. Includes grade 8 to 10 students.

Figure A2: Maths mean test score by provinces over time



Note: Math was the main domain in 2003 and 2012. Includes grade 8 to 10 students.

Figure A3: Science mean test score by provinces over time



Note: Science was the main domain in 2006 and 2018. Includes grade 8 to 10 students.