Research Group on Human Capital
Working Paper Series

Trends in cognitive skill inequalities by socioeconomic status across Canada

previously circulated as
The Evolution of Cognitive Skills Inequalities by Socioeconomic Status across Canada

Working Paper No. 20-04

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November 2020

Groupe de recherche sur le
CAPITAL HUMAIN
ESG UQÀM

https://grch.esg.uqam.ca/en/working-papers-series/

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This analysis is based on Statistics Canada surveys which produced PISA data sets for the Departments of Education of the Canadian provinces and the OECD consortium. All computations on these micro-data were prepared by the authors who assume responsibility for the use and interpretation of this data. This research was funded by two research grants from the Fonds de recherche du Québec – Société et Culture (FRQSC), Subvention Soutien aux équipes de recherche et Subvention Action concertée, Programme de recherche sur la pauvreté et l'exclusion sociale, Phase 4.

Abstract

In this article, we document the trends in cognitive skill gaps across Canada. We use PISA test scores over 7 cycles, from 2000 to 2018, to provide an exhaustive portrait of the trends in the test score distribution over time and the score gaps by parental socioeconomic status. We find that the achievement gap between top performing students (90th percentile) and students facing challenges (10th percentile) is large. It represents more than 4 years of schooling. We also show that socioeconomic differences in PISA scores, for reading, mathematics and science, are large but generally stable over time. There are variations in the SES score gaps by province, a proxy for the extent of inequality of opportunities, but these variations are not large.

JEL: I20, I21, I28
Key words: socioeconomic inequalities, PISA, literacy and numeracy skills, proficiency scales, provincial education policy, education attainment gradients, Canadian provinces

1. Introduction

In Canada, information on the trends in achievement gaps in students' cognitive skills, measured in the Programme for International Student Assessment (PISA), has been fragmented and in some cases non-existent. While the average PISA scores across Canada are generally well known, the inequalities in PISA scores across the country are not as well understood. Yet PISA data are extremely well suited to provide a representative portrait of teenagers' skills inequalities across the country over time. Given ongoing debates about educational inequalities, especially in Québec where the debate has raised the attention of the UN[1], it appears that providing a portrait of skills inequalities in Canada would contribute to improving the quality of our collective understanding on the subject.

This article provides a complete review of PISA skills inequalities by province in reading, mathematics and science. While PISA and TIMSS[2] have been used extensively in international research on education inequalities (e.g. Chmielewski (2019); Chmielewski and Reardon (2016); Hanushek et al. (2020, 2019), Chiu and Khoo (2005)), to our knowledge, education inequalities over time have not been documented using several cycles of PISA data in Canada[3]. PISA data are particularly attractive because they have been collected every three years for almost 20 years, thus providing a reliable portrait over time. They are representative of each province and measure 15-year-olds skills in three complementary domains. Focusing on 15-year-olds is especially strategic because it captures youth skills at a time where most kids are still in school yet have completed about ten years of compulsory schooling. Finally, estimates measured using PISA data can be easily compared across countries.

Concretely, this paper documents trends over time and across provinces of PISA achievement gaps between (1) low and high performing students, which we label the *performance gap*, and (2) low and high socioeconomic status (SES) students, which we label the *SES gap*. We then show the relationship between the SES gap and the performance gap. A clear linear relationship emerges suggesting that the two are interconnected. Finally, we document which provinces appear more successful at raising the academic achievement of low performing students. This

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

[2] The Trends in International Mathematics and Science Study (TIMSS) is another international initiative that assesses skills in mathematics and science in several countries.

[3] Academics in Canada have offered some commentaries using PISA data (e.g. Mou and Atkinson (2020); Richards (2014a, 2014b); Stokke (2015); Haeck, Lefebvre and Merrigan (2014)).

unique portrait provides an opportunity to learn about our comparative evolution over time and identify where we can and must improve.

Our results suggest that test score differences between top performing students (90^{th} percentile) and students generally not meeting basic competencies (10^{th} percentile) are large in all three domains (mathematics, reading, and science). The score gap between these two groups is equivalent to more than 4 years of schooling. Our analysis also shows that there is a strong relationship between parental SES and PISA test scores across the country, and this relationship is generally stable over time. The SES gradient appears slightly more severe in Newfoundland and Labrador, and Nova Scotia in the first survey cycle, but the differences eventually become comparable to those of other provinces. The SES gradient in all provinces is well over one year of equivalent schooling, or more than 0.6 of a standard deviation, when comparing students from the bottom quintile of the SES distribution versus the top quintile. Clearly, more work needs to be done to equalize the playing field. Finally, we document test score differences for low SES students, and find that in mathematics, low SES students generally perform better in Quebec. In science and reading, they perform better in Alberta, British Columbia and Ontario (reading only).

It is important to understand the trends in 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) rising income inequality could be further aggravated by rising skills inequalities in adulthood, (3) at the macroeconomic level skills measured by PISA are linked with economic growth, and (4) inequalities in our system need to be understood and taken into account in our collective decision making processes.

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 (Ingram and Newmann (2006); Green and Riddell (2003); Murnane et al. (1995, 2000); Neal and Johnson (1996)), 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)). Several Canadian papers have also documented the link between high school performance and later educational outcomes (e.g. Finnie and Mueller (2009), Kottelenberg and Lehrer (2019), Foley, Gallipoli and Green (2014)). Furthermore, Duckworth et al. (2015), Duncan and Magnuson (2011) and Watts et al. (2014), among others, show that adolescent academic achievement, especially in math, 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), Foley, Gallipoli and Green (2014), Foley (2019)).

Second, academic gaps are highly associated with adulthood skills gaps (e.g. Carneiro and Heckman (2003), Hanushek and Ruhose (2015), Krueger (2012)). In Canada, like in many wealthy 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 the intergenerational relationship in SES is linked to independent and persistent components of parental class (employment and occupational unit-group), status (status scale derived from the occupational structure), and education (levels of educational qualifications) (Bukodi and Goldthorpe (2013)). Finally, Simard-Duplain and St-Denis (2020) show that the education level of children explains a large share of intergenerational income mobility in Canada. Understanding high school skills inequality over time is essential since it is tightly linked to educational attainment and labour market outcomes.

Third, not only does educational achievement exert a large impact on individual earnings, it also has long term consequences for economic growth. In a series of papers based on cross-country PISA test scores (cognitive skills in reading and math as well as proficiency levels) and simple models of growth, Hanushek and Woessmann (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 students' 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 where a small fraction of students continue to have low skill levels. 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.

The rest of the paper is organised as follows. The data used is presented in section 2, along with some descriptive statistics. Section 3 presents the performance gap across the country over time, while section 4 describes trends in SES gaps across the country. We conclude in section 5.

2. PISA data

2.1 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, math 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 and 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, MB, AB, and BC (see province acronyms in Table A1).[4] 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 criticism 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, math, 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 math and science. In each survey cycle, one domain is tested in more detail. The major domain was reading in 2000, 2009 and

[4] 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).

2018, mathematics 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 9 to 18 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, their school and teachers (perception, attitudes), and various features of their family. These characteristics include their gender and month of birth,[5] language at home (same as the test or other), their mother and father level of education and occupations, whether they themselves and/or 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 score, 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 across all students surveyed by the OCED. The OECD average score is presented in Table 1. According to a recent report published by the OECD, a 40 points difference in PISA test score is approximatively equivalent to one additional year of schooling (OECD 2019, p. 42). This is obviously an approximation, but it is useful to get a sense of the magnitude of the gaps we measure. Table 1 presents mean scores by domain and year for all Canadian students who took the tests:

[Insert Table 1 here]

Table 1 shows that the average scores in Canada are consistently higher than the OECD average. The score differential ranges from +23 to 34 in reading, +18 to 33 in mathematics 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

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

all 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 math. Figure 1 shows the provincial score in 2018, and in the first year (Year 1) the domain was tested in more details. Reading was the major domain for the first time in 2000, math in 2003, and science in 2006. To highlight the transition between first year and 2018, Figure 1 also shows the average score between the second year after being the core domain (Year 2) and 2015. Figure 1 shows that the decline in reading is also visible in each province, but slightly more acute in MB 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 math, 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 math, 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 math, only Québec's performance was consistently above the national average (Figure A2). In reading, Québec, Ontario, Alberta and British Columbia were generally above the national average during the entire period (Figure A1). Finally, in science, Alberta, British Columbia and Québec were consistently above or on the Canadian average (Figure A3).

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 math. Since education is managed at the provincial level, having detailed portraits of our strengths and weaknesses may help us learn from each other.

2.2 Provincial differences in educational systems

Our goal is to document the trends in educational inequalities and the relationship with parental SES, not to analyze which provincial differences are driving inequalities across the country. Nonetheless, since education at all levels is a provincial responsibility in Canada, this section documents some of the provincial similarities and differences to provide some contextual information. This is however not an exhaustive review.

Within the provinces under the Department of Education auspices, district school boards administer schools. PISA surveys 15-year-olds in the survey year. In Canada, this restriction implies that not all students are in the same grade since school entry age varies across provinces. PISA students entered school between 1990 and 2008, during that period the cut-off date was December 31st in most provinces, except QC where it was September 31st and NS where the cut-off date changed in 2008. In NS, prior to 2008, the cut-off date was October 1st. As of 2008, it became December 31st. Finally, in PE, parents have the choice to hold back their children if they believe they are not yet ready for school[6]. This implies that 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. However, in QC and NS, a large percentage of students are expected to be in grade 9.

In practice, while most students in the survey are in grade 10 or higher (around 85 percent), a large percentage of students in NS and QC are still in grade 9 (about 30 to 36 percent) (Table A2). These students, for the most part, were born between October and December and are therefore following a normal trajectory. PISA data also includes a small fraction of students in grades 7, 8 and 11. It is not clear if all provinces sample students 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. 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). Another reason may be that grade repetition is not allowed in some provinces. This would imply a very small number of students in a grade below their expected grade. While the OECD generally conducts its analysis using students in main grade (which here would be grade 10), we take a conservative approach and keep all students in grades 8 to 11 throughout our analysis. In doing so, we keep both students lagging behind and students who skipped a grade. When reading descriptive statistics, it is important to keep in mind that, while most grade 9 students in QC and NS are following their normal trajectories, they will nonetheless pull the provincial performance downward 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.

Many studies on test score 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, 2013a,b)). Across all countries (Table 2.8 of Hanushek and Woessman (2011a)), private/independent school

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

management tends to be positively associated with student achievement, with a difference relative 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 schools managed privately or independently, around 8% in 2012 and 6% in 2000. Five provinces provide partial subsidies to private/independent schools — BC, AB, MB, SK, and QC.[7]

Moreover, in some provinces, school boards provide additional local choices, such as alternative and specialized schools, schools emphasizing a particular language, music, dance, sport, or some other activity[8]. Open enrolment (as opposed to school assignment by postal code), and the presence of geographically overlapping separate Catholic and public school boards also create diversity and competition in a number of provinces (e.g. Allison (2015); Card, Dooley and Payne (2010); Azimil, Friesen and Woodcock (2015); Friesen, Cerf Harris and Woodcock (2015)). To our knowledge, open enrolment is mainly used in ON and BC, but also AB and QC (Bosetti, and Gereluk (2016)), and Catholic schools are mainly present in ON, SK, and AB[9]. Finally, the Constitution of Canada also provides constitutional protections for some types of publicly funded religious-based[10] (e.g. Catholics in ON, SK, AB) and language-based school systems (Anglophone and Francophone school systems in NS, NB, QC, ON, MB, AB, and BC) (MacLeod and Hasan (2017)).

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[7] Percentage of students aged 15 in independent schools: BC =12.9% (Catholic=0); AB=4.4% (Catholic=25.5%); SK=2.4% (Catholic=22.1%); MB=7.9%, (Catholic=0); QC= 24% (Catholic=0); ON=6.1% (Catholic=29.7%); Atlantic provinces=0 (Catholic and private=1.5%). In Canada, the provincial school systems are complex with many types of schools (public, Catholic, independent, and private) operating in parallel. International surveys (e.g. PISA) do not identify all types of schools available in Canada, which makes comparison rather difficult. In Canada, PISA does not identify Catholic schools but only the public and independent schools. Private but independent schools charging high fees and receiving no public funding are mainly in provinces that do not provide partial subsidies: ON (6.1%) and the four Atlantic provinces (approximately 1.5%). [Allison, Hasan and Van Pelt, D. (2016); MacLeod and Hasan (2017)] In PISA, privately managed schools are classified as independent when at least 50% of the funding comes from private sources; they are classified as government-dependent when at least 50% of the funding comes from the government (including departments, local, regional, state and national). In the Canadian PISA survey, there is no private independent school, but only private government-dependent schools.

8 In Québec, competition with private schools led many school boards to introduce augmented instruction at the high school. These programs offer several options such as international studies, music, and sports.

[9] In a 2020 unanimous decision, the Saskatchewan Court of Appeal has upheld the right of separate schools in the province to receive government funding for the education of non-Catholic students. The province's highest court overturned a 2017 court ruling by that would have prevented provincial funding of non-Catholic students attending Catholic schools. https://news.rcdos.ca/2020/03/26 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.

[10] 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.

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)).[11] In 2000, government spending per student in public schools was equal to or below $10,000 (2017 constant dollars) in most provinces except MB. By 2016, per-student spending in public schools had reach more than $14,000 in NB, MB, SK, AB, and around $12,000 in all other provinces. Government (public) expenditures[12] per student in public schools are the lowest in QC and BC.

[Insert Figure 2 here]

2.3 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 A3). Cornoy and Rothstein (2013) [13] document the arbitrary character of the index and its convoluted computational formula. As a result, we strongly suggest avoiding the use of the ESCS at the provincial level, but note that our main results are robust to using the ESCS.

To measure students' SES, 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 organizers from students' reports of their mother's and father's occupation (the higher of the two). It takes values between 11 and 90. Low-values (e.g. 11-20) regroup, for example, 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, engineers, lawyers, and medical doctors. This index, widely used in

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[11] According to Van Pelt and Emes (2015), if government spending had remained constant between 2004 and 2013, the aggregate amount of education spending in Canada would have decreased by 20.3% (or $12.7 billion). At the provincial level, they document a similar decline of -14.6% to -28.2%.

[12] Public and private expenditures in private or independent schools are not accounted for here.

13 "The ESCS index arbitrarily gives equal weight to parental educational attainment, parental occupational status, and a sub-index of the collection of possessions." see p. 41 of Cornoy and Rothstein (2013) for more details.

sociological research, was developed by Ganzeboom, De Graaf and Treimn (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 parental education or the number of books in the home[14]. From the HISEI, we create for each province (and for Canada) a set of dummy variables representing quintiles of the HISEI distribution within each survey year. Using a provincial SES index sticks more closely to the social environment of each province and their changes over the years, and may reflect local customs[15].

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 education is coded with five levels according to the International Standard Classification of Education (ISCED) and then transformed by PISA into number of years of schooling (6, 9, 12, 15 or 17 years) the information poses some problems, especially in 2000 where the measure does not match official education statistics in Canada (Bussière et al. (2001)). 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 mentioned above. Together, this scientific evidence suggests the HISEI better captures the parental SES over time within provinces.

3 The performance gaps

In this section, we first position Canadian performance among the top performing countries in the OECD. Then we present variation at the provincial level in light of our overall performance at the country level. Finally, we assess where in Canada students with more difficulties fare better.

3.1 Canadian performance relative to the performance of top performing European countries

We define the performance gap as the score gap between low and high performing students. Here we focus on students at the 10th and 90th percentile of the test score distribution. In 2018, the

[14] 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.

[15] Using national quintiles as opposed to provincial quintiles does not change the trends, but may change the gap.

performance gap in Canada was 255 score points in reading (p10 = 390), 244 points in science (p10 = 395), and 234 points in math (p10 = 395) (Table 2, column 1). A gap of more than 240 points represents more than 4 years of equivalent schooling. For the sake of completeness, the 25th versus 75th gap is around 130 points, or about 3 years of equivalent schooling. Clearly, these gaps are important and their long-term impact should not be underestimated.

These gaps are however not drastically different from that of Finland (Table 2, column 2), 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 math (p10 = 399). The Canadian performance gaps are extremely comparable except in mathematics where we observe a larger gap. The gap differential in mathematics 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 in some domain. In Estonia, p10 is generally higher, but in Denmark, p10 is often lower. Relative to Canada, only Estonia has a smaller gap but higher p10 scores.

[Insert Table 2 here]

3.2 The provincial performance gaps over time

Figures 3a to 3c present the trends in performance gap in each province in reading (Figure 3a), mathematics (Figure 3b) and science (Figure 3c). The gap is identified by the connected triangles (left y-axis), while the p90 and p10 score are respectively marked using diamonds and hollow diamonds (right y-axis). Overall, between 2000 and 2018, we observe that the gap between high performing students and low performing students has been relatively stable, but sometimes increasing, across the country[16]. Note that a similar portrait would emerge with the 25th and 75th percentile, but of course the gap would be narrower

In reading, Figure 3a shows the score gap in reading between students at the 90th percentile of the score distribution and students at the 10th. Most provinces show a fairly stable gap around 240 points, with some increases between 2000 and 2018. As mentioned above, PISA states that a 40 point difference in test score is approximatively equivalent to one additional year of schooling. A

[16] Tables provided online complement these figures and provide even more details.

240 point gap is therefore a huge difference in skills acquisition, one that we should take very seriously. As of 2018, the gap is especially high in PE and NB, followed by BC and AB. In QC, the score gap is generally lower than that of other provinces, but still imposing at around 230 points for most of the period. Looking at the performance of high performing students (p90) and low performing students (p10) (right y-axis), we observe that the performance of high performing students across the country has remained fairly stable over time and is generally comparable across provinces. Among low performing students we observe a slight decline in performance, but students in QC, ON and AB consistently score above 380 points. Finally, it is important to note that a reading score below 335 points marks a very low level of competency, while a score between 335 and 406 points is considered a low level of competency. By 2018, low performing students (p10) were below 400 points in all provinces except QC. This implies that across Canada, students at the very bottom of distribution do not possess the core skills required to pursue postsecondary education (score above 480 and 552).

[Insert Figure 3a to c here]

Figure 3b shows the performance gap in mathematics. The first year is 2003 because mathematics was the major domain for the first time in 2003. Between 2003 and 2018, we observe that the performance gap generally increased or remained stable, except in SK where the performance gap has decreased over the period, going from 220 to 204. Figure 3b shows that both low and high performing students (p10 and p90 respectively) performed less well in 2018 relative to 2003, except in PE and QC. In QC, the performance of top performing students remained stable at 659 in 2013 and 655 in 2018, well above the national average at 649 in 2013 and 629 in 2018. The sharpest decreases in top performance (p90) are observed in SK (-43), MB (-40) and AB (-38). The sharpest decline among low performing (p10) students is observed in BC (-47) and the smallest in QC (-19). In mathematics, QC seems to be performing particularly well, especially at the bottom of the test score distribution. In QC, both low and high performing students are 20 to 30 points ahead of the national average. This represents at least half a year of equivalent schooling. This is surprising given that 32 percent of its students are in grade 9 and 5 percent are in grade 8, while in other provinces (except PE and NS) the vast majority of students are in grade 10. As mentioned above, grade differences are largely driven by the cut-off date for school entry, but also in part because QC allows grade repetition while other provinces such as ON do not. By 2018, in all provinces except QC, students at the 10^{th} percentile of the score distribution had a low level of competency (score between 358 at 419), but none possessed the core skills required to pursue postsecondary education (score above 482).

Science was the major domain for the first time in 2006. The trends in science (Figure 3c) are similar to those observed in mathematics. The skills gap increased in a number of provinces, except in NL, QC, MB and SK. In these provinces, the gap has shrunk or remained stable. The sharpest decline is observed in QC, from 238 to 220, followed by NL, MB and SK. High performing students (p90) are strongest in AB and BC, but low performing students (p10) do better over the period in QC. The performance of low performing students has declined in many provinces, leading to a rise in the performance gap. Again, by 2018, in all provinces except QC, students at the 10th percentile of the score distribution had a low level of competency (score between 335 at 408).

In summary, in all three domains, there is a large and persistent gap between students at the top of the score distribution and students at the bottom. The gap generally increased in reading over time, mainly because the score of low performing students decreased over time. In mathematics, the performance gap also increased but not as much, and in that case both low and high performing students obtained a lower score over time. Finally, in science the performance gap did not generally increase, and both the performance of high and low performing students decreased.

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. In reading and science, QC resembles Estonia in terms of equality and p10 performance (Table 3). In SK, the score gap is generally below the national average, and even decreasing in mathematics over time. However, the performance at the 10th percentile is below the national p10 performance.

3.3 Performance at the bottom of the score distribution

Clearly the observed gaps between students are high, and raising the performance of the bottom of the distribution should be a priority. None of the provinces seem to be able to produce small gaps in performance. Attributing these gaps entirely to the educational system would be a mistake since gaps in skills are present even before kids enter school (e.g. Cunha and Heckman (2008, 2009), Bradbury et al. (2015)) and are tightly linked with parental characteristics including parents own ability (Crawford, Goodman and Joyce (2011)). Schools are working with students who have different skills to start with, and different abilities to learn new skills. At first glance, there does not seem to be a clear link between the provincial performance gaps and the type of schools in place (public, independent/private, religious, laic, open enrolment, etc.). In fact, systems with different characteristics and funding mechanisms coexist across the country and produce similar score gaps. Some provinces appear to be doing better where the performance of students at the 10th percentile is higher. However, what about the average performance of the least performing students? To formally validate the relative performance of different provinces with respect to low performing students, we estimate the following equation for the bottom 20 percent of students in each province:

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

where $S_{i,py}$ is the PISA test score in math, reading or science of student i in province p, in year y. The model includes year fixed effects γ_y and province fixed effects ρ_p. The vector X_i includes the student gender, age in months, expected grade for age at school entry, along with a dummy for immigration status[17]. The expected grade is based on the birth date of the student. It is different from the actual grade. Including the actual grade would in part control for score of grade repeaters who are performing less well and doing so would raise the provincial coefficient for QC and NS.

Table 3 presents the estimates from equation (1). The reference category for the province fixed effects is always the province with the highest performance among low performing students. Results in Table 3, columns 1 to 3, suggest that, over the period, low performing students perform better in AB in reading and science, while in mathematics, low performing students performed better in QC. In 2018, Table 3 columns 4 to 6, the advantage seems to be concentrated in QC and AB in reading and science and in QC in mathematics. Here we include students in grades 8 to 11. Of course, restricting our attention only to grade 9 and 10 students would raise the QC coefficients since it is one of the only provinces to have 15-year-olds in grade 8. This would however not be a fair comparison to the performance of provinces in which grade repetition is not allowed.

[Insert Table 3 here]

[17] PISA does not provide information on indigenous status in each cycle.

While the performance gaps reveal the extent to which students' performance varies across the test score distribution, they do not tell us whether students from different SES fare differently. The next section explores the link between parental SES and test scores.

4 The SES gaps

In this section, we first provide a portrait of the SES gaps across provinces and over time. We then document in which province low SES students perform better, and conclude the section by estimating the relationship between the performance gap and the SES gap.

4.1 Portrait of the provincial SES gap over time

We define the SES score gap as the difference in test scores between students whose parents are in the top quintile of the occupational index (the HISEI) and students whose parents are in the bottom quintile. To study the evolution of the SES gap over time, we mainly use a descriptive approach, but to estimate the standard error of the SES gap, we estimate the following model:

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

where $S_{i,py}$ is again the PISA test score in math, reading or science of student i in province p, in year y. Equation (2) is estimated for each domain, in each province and each year separately. The term $SES_{q,i}$ represents four dummy 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. As a result, the β_5 coefficient captures the SES gap. All estimations use the students sampling weights derived by Statistics Canada. All plausible values and student weights are used in the estimation procedure, and the Fay's adjustment is set at 0.5 (refer to PISA Technical Reports for more information). Standard errors are estimated using bootstrapped weights provided by PISA. Students with missing SES are dropped from the analysis.[18]

Figures 4a to 4c show the average test scores and confidence intervals for students whose parents are in the bottom quintile (Q1) of the HISEI distribution (full circle, right y-axis) and the average test score of students whose parents are in the top quintile (Q5) of the HISEI distribution (hollow circle, right y-axis). The estimated SES gaps (β_5) and confidence intervals are also reported on these figures (connected triangles, left y-axis).[19]

[18] The SES index is missing for 6% of our students across all surveys, but 12% in 2003.
[19] β_2 to β_4 can also be observed in our web appendix, where each regression is reported in full detail.

In reading (Figure 4a), we observe that top SES quintile (Q5) students score around 550 points, while low SES quintile (Q1) students score less than 500 points. In some provinces, the average Q1 students does not possess the core skills required to pursue postsecondary education (score above 480 marked by the horizontal red line). The gap appears somewhat comparable across provinces, but declining in NL, NS and ON. By 2018, the SES gap in reading was around 64 points in Canada, or about 0.6 standard deviation or more than a year of schooling (40 points).

In mathematics (Figure 4b), a similar portrait emerges, but students in some provinces appear to be doing consistently better, both at the bottom and top of the SES distribution. In QC, low SES students are always around or above 500 points, while high SES students are around 575 points. In AB and BC, the pattern was similar in 2003, but a decline in the performance of both low and high SES students took place over the years. The SES gap over time seems fairly stable in each province, except for a decline in NL and NS of 28 points and 19 points (respectively). Over the period, the SES gap in Canada was 65 points. By 2018, the SES gap in math was around 62 points in Canada, with a high of 73 points (AB) and a low of 53 points (MB). Again, in some provinces, low SES students did not possess the skills required to pursue postsecondary education (marked by the horizontal red line).

Finally, in science (Figure 4c), we observe that students in AB and BC are consistently better both at the bottom and the top of the SES distribution, except in 2018. Top SES students score around 575 points, while bottom SES students score generally above 500 points. Again, we find that the SES gap is also fairly stable over time in most provinces, but declining significantly in NL and NS by 48 points and 29 points (respectively). By 2018, the SES gap in science is around 61 points, comparable to that of reading and math. Finally, at the national level, Table 2 shows that the SES gaps we observe in Canada are similar to the gaps observed in Finland and Sweden, and a few points higher than the gaps in Denmark and Estonia.

[Insert Figures 4a to 4c here]

The above estimates do not control for any students or school characteristics. If we control for the expected grade of students based on his or her birth date, the results are almost identical. If instead we control for the actual grade of students, the SES gap slightly decreases in most provinces, but the largest decrease is observed in QC in all three domains. When student grade is controlled for, the SES gap in QC becomes the second smallest in the country. However, is this the appropriate gradient to measure? When controlling for actual grade, we measure the gradient within grade. Of course, students from lower SES backgrounds are more likely to be in lower grades in provinces where grade repetition is possible. It is not clear if grade repetition 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, the SES gap (accounting for confidence intervals) is always within a few PISA points across provinces.

Finally, one might wonder if SES explains more of the score variance in some provinces. In Table 4, we report the R-square of equation (2), but to summarize the information we pooled all survey years together and added year fixed effects in addition to SES fixed effects. The percentage of the variance explained by SES and year fixed effects is fairly small at around 7 percent. The R-square suggest that, in NL and MB, a larger fraction of the variance in test scores is explained by SES and year dummies. In contrast, in ON and SK, the variance in test scores is least explained by these fixed effects. When all years are pooled together, we find that the SES gaps (β_5) (not presented here) are significantly below the national average in SK by around 3 to 5 PISA points, and always above the national average in NL by 9 to 16 PISA points.

[Insert Table 4 here]

4.2 Trends in provincial SES gradient over time

To understand how the relationship between the socioeconomic status of students and their performance has evolved over time, and measure whether these changes are statistically significant or not, in a second step, we pool all years together to estimate the trends in socioeconomic gradient, not only for β_5 but also β_2 to β_4. More specifically, we estimate the following model for each province and each domain separately:

$$S_{iqy} = \alpha + \theta_q + \gamma_y + \sum_{k=2}^{5} \left[\sum_{j=2003}^{2018} \beta_{qy} I[q = k] * I[y = j] \right] + \delta X_i + \varepsilon_{iqy}. \qquad (3)$$

In this model, because we interact SES fixed effects θ_q with year fixed effects γ_y, the coefficients on the SES fixed effects θ_q measure the SES gradients in the first survey year, and the coefficients on the year fixed effects measure the trends for students in the first SES quintile. The β_{qy} capture the evolution over time of each SES quintile relative to the evolution of the first quintile. When describing the data, we mentioned that a sizeable fraction of students in QC and

NS had one less year of completed education. While the SES gap should not be impacted by this institutional difference, the average score certainly is. Also, over time, the composition of students may have changed and this may have interacted with both the average score by province and the gap. Again, the vector X_i includes the student gender, age in months, expected grade, along with a dummy for immigration status. To further control for changes in students' characteristics, here we also include the language spoken at home[20]. Students' weights and plausible values are accounted for using the estimation strategy described by PISA. The Fay's adjustment is set at 0.5. Standard errors are estimated using bootstrapped weights provided by PISA.

Tables 5a to 5c present estimates of equation (3). We report only the β_{qy} coefficients since our interest is to understand how the gradient has evolved over time. The complete tables are presented in our web appendix.

In reading (Table 5a) the SES-year interactions suggest the SES gradient has not increased over time, except in SK. There, relative to 2000, the SES gaps increases in the top three quintiles of the distribution. So, not only are top SES students getting ahead, but also those in the middle part of the distribution. In ON, NL and NS, the SES gradient decreased in some years not only for Q5 but also for Q4. NS has successfully compressed it SES gradient for most survey years, except 2018.

In mathematics (Table 5b), the portrait is different. First, the gradient did not increase relative to 2003 in any province, but it did decline in NL and SK. In SK, the gap between Q1 and middle SES students (Q3 and Q4) decreased in most years. In NL, the compression came mainly from the top quintiles (Q4 and Q5).

Finally, in science (Table 5c), we observe that the SES gradient did not increase relative to 2006 in any province, but it did decrease in NL and NS. In NS, the gradient decreased not only in Q5, but also in Q4.

[Insert Tables 5a to 5c here]

From these tables a clear portrait emerges. NL and NS were successful in reducing their SES gradients over the years. In SK, the portrait is mixed, while in other provinces, the gradient has largely been stable.

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[20] We do not control for language spoken at home when we are interested in provincial dummies in models for Canada (e.g. equation (1)) because the vast majority of French speakers are in Quebec.

4.3 Where are low SES students performing better?

Our results above suggest that low SES students are doing better in some provinces relative to others. To formally validate the relative performance of different provinces with respect to low SES students, we estimate the equation (1), but this time we only including students in the bottom quintile of the SES distribution.

In mathematics, we find that it is in QC that students from low SES fare better over the period (see Table 6). In science and reading, low SES students in AB are leading, but they are closely followed by BC (not statistically different) and ON (in reading only). So although inequality may be comparable across provinces, being a low SES student in Canada is better in AB, BC and QC.

[Insert Table 6 here]

When we focus on survey year 2018 only (Table 6, columns 4 to 6), we observe that QC students perform better in mathematics relative to low SES students in all other provinces. In reading and science, low SES students perform equally well in NL, QC, ON, AB, and BC. While there is a clear and stable pattern in mathematics, in science and reading, AB seems to be consistently in the top performers, but other provinces seemed to have caught up by 2018.

4.4 How strong is the link between the performance gap and SES gap?

The performance gap and SES gap are likely correlated. Figure 5a to 5c present a scatter plot of the average yearly performance gap and associated SES gap. There is one point per province per year (full circles), and one point for Canada for each year (hollow circles). The fitted line is estimated using the yearly provincial data. Figure 5a to 5c show that a clear linear relationship exists between the performance gap and the SES gap. More specifically, a 1-point increase in the SES gap in reading is associated with a 0.65 point increase in the performance gap, while in mathematics and science it is associated respectively with a 0.29 and 0.31 point increase. Given the standard errors of these point estimates, it appears that the relationship is stronger in reading.

[Insert Figures 5a to 5c here]

Finally, the SES gap explains around 23 percent of the variation in the reading performance gap, but only 9 percent of the mathematics or science performance gap. This is clearly not a causal relationship, it only suggests that these two measures are deeply interconnected and interventions reducing one or the other would likely be beneficial to both.

5. Conclusion

Canada's overall test scores have decreased over time, but in 2018 Canada still had the fourth strongest performance in the OECD, just behind Estonia, Japan and South Korea. However, these results mask important differences by SES. Our analysis clearly reveals the presence of a strong SES gradient across the country that is stable over time. This means that students coming from lower SES backgrounds 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 since these skills are linked with labour market outcomes. Inequality is strongest in NL and NS, and weakest in MB, BC and SK. However, being a low performing student or a low SES student is better in AB and QC, since this is where these students achieve the highest scores 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 students from the bottom quintile versus the top quintile, or more than 0.6 standard deviation. Furthermore, in some provinces, the average low SES student does not possess the core skills required to pursue postsecondary education. Actions need to be taken to remedy this situation, here and in other countries facing a similar situation.

Canada does not have a national education system, but thirteen autonomous systems (one for each province and territory). Public schools are widely present in all provinces, but Catholic schools and independent/private schools partially funded by the government are also present, especially in high schools. While learning from other provinces may provide some solutions, no single province entirely stands out. The SES gradient is slightly smaller in ON, but students from low SES fare better in QC, AB and BC. The 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 the most equal or least equal province relative to the SES gradient and its performance gap is one of the smallest. Low SES students in QC get higher test scores in mathematics relative to comparable students across the country. In reading and sciences, AB and

BC are ahead, closely followed by ON. In this sense, both QC and AB are not producing more equality or inequality than other systems across the country, but they seem to help low SES students achieve higher test scores.

To reduce performance inequalities, we will have to think outside of the box to find meaningful solutions since all provinces and also other countries have similar SES gradients. This challenge we are facing as a country is critical since cognitive skills acquired early in life are critical to fostering the accumulation of human capital, supporting economic growth favorable to knowledge-based economies and reducing economic and social inequalities (Hanushek et Woessmann 2015a, 2015b; Carneiro et Heckman, 2003; Kruger, 2003).

It is now clear that skills inequalities emerge early and that early investments in the child's life have been shown to be particularly efficient (Cunha and Heckman (2009). Innovative actions taken early in the child's life, such as high-quality childcare for disadvantaged children (e.g. Heckman et al. (2010)) and programs enriching the family environment (Reynolds and Temple (2006)) may help reduce inequalities. It is not clear if schools play a larger role in the determination of educational achievement than socioeconomic and biological factors (Foley, 2019, 2014). However, modifying parental behaviour and the child's home environment is arguably more difficult than changing the school environment. More research needs to be done to understand what works and what does not, but there is evidence that high quality teachers create substantial economic value (e.g. Chetty, Friedman and Rockoff (2014), Hanushek (2011); Hanushek and Rivkin (2006)), and that school principals can also contribute to reducing the achievement gap (Dhuey and Smith (2011)). School accountability and quality (e.g. Figlio and Loeb (2011), Woessmann (2016), Goussé and Le Donné (2015)) and teacher wages (Loeb and Page (2000); Dolton and Marcenaro-Gutierrez (2011)) may improve student performance and reduce skills inequalities. We also know that mathematics skills correlate more strongly with earnings, and that math courses can help reduce SES inequalities (Rose and Betts (2004); Ingram and Neuman (2006)). Finally, some promising targeted interventions have been documented, see for example Pathways to Education (Oreopoulos, Brown and Lavecchia (2017)).

Finally, 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.

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TABLES

Table 1: PISA estimated average score by domain and year of survey, Canada 2000-2018

	Canada			OECD		
Year	Reading Mean/SD	Math Mean/SD	Science Mean/SD	Reading Mean/SD	Math Mean/SD	Science Mean/SD
2000	*534/94	#527/84	#521/90	500/100	500/100	500/100
2003	529/88	*533/86	520/98	494/100	500/100	500/104
2006	527/96	527/86	*535/94	492/99	498/92	500/94
2009	*524/90	527/88	529/90	493/93	496/92	501/94
2012	523/92	*518/89	526/91	496/94	494/92	501/93
2015	527/92	516/88	*528/92	487/100	490/89	493/94
2018	*521/100	513/92	519/96	487/99	489/91	489/94

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. SD: Standard deviation.
Source: Authors computation from weighted PISA data sets, grades 8-11.

Table 2: 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
N		22,653	5,262	5,019	7,009	4,855
Participation rate (%)		85	96	86	88	93

Note: In European countries we observe students in grade 8 (14%) and grade 9 (86%). In Canada, students are in grade 8 (1%), grade 9 (10%), grade 10 (88%), and grade 11 (1%). Details by province are provided in our web appendix.
Source: Authors' computation from PISA weighted data sets (2018).

Table 3: Test scores among low performing students across the country in PISA 2000 to 2018

	All survey years			Survey year 2018 only		
	Reading (1)	Math (2)	Science (3)	Reading (4)	Math (5)	Science (6)
NL	-29.9***	-28.4***	-26.5***	-17.8***	-42.1***	-26.1***
	(2.5)	(2.7)	(2.7)	(6.8)	(7.7)	(8.2)
PE	-39.4***	-36.8***	-40.3***	-36.7***	-58.6***	-37.4***
	(2.8)	(3.8)	(3.0)	(13.4)	(20.1)	(10.5)
NS	-23.0***	-22.5***	-21.0***	-19.3***	-39.2***	-26.0***
	(2.9)	(2.5)	(3.0)	(5.4)	(7.5)	(7.5)
NB	-38.0***	-27.1***	-37.0***	-47.6***	-50.3***	-40.8***
	(2.8)	(2.8)	(3.1)	(6.7)	(10.0)	(8.0)
QC	-6.0**	Reference	-10.6***	5.1	Reference	6.9
	(2.7)	Group	(2.5)	(5.2)	Group	(5.8)
ON	-17.0***	-12.4***	-22.6***	-21.7***	-21.4***	-12.9**
	(2.6)	(2.7)	(2.3)	(5.4)	(7.2)	(6.4)
MB	-26.4***	-24.1***	-34.8***	-27.7***	-44.7***	-32.9***
	(2.1)	(2.8)	(3.0)	(5.5)	(9.0)	(6.8)
SK	-25.1***	-26.2***	-28.2***	-18.4***	-34.9***	-17.9**
	(2.3)	(2.8)	(2.4)	(4.6)	(7.3)	(7.5)
AB	Reference	-6.9***	Reference	Reference	-21.4**	Reference
	Group	(2.3)	Group	Group	(9.7)	Group
BC	-4.7**	-5.5*	-5.0**	-16.7***	-31.3***	-18.8**
	(2.3)	(3.1)	(2.5)	(6.1)	(11.5)	(7.4)
Constant	453.4***	426.3***	434.0***	419.4***	351.6***	396.7***
	(34.9)	(39.8)	(39.3)	(70.8)	(86.3)	(90.2)
Controls	yes	yes	yes	yes	yes	yes
N	30,125	24,782	19,926	3,923	3,986	3,996
R2	0.063	0.039	0.046	0.076	0.050	0.052

Note: Includes students in grades 8 to 11 in the first quintile of the score distribution (low performance). All survey years are pooled together. We exclude survey year 2000 for mathematics, and survey years 2000 and 2003 for science. Controls not reported above include year dummies, immigrant status, expected grade based on birth month, gender, and age in years. Bootstrapped standard errors are reported in parentheses. Significance is denoted using asterisks: ***is p < 0:01, ** is p < 0:05, and * is p < 0:1.
Source: Authors computation.

Table 4 : Percentage of the variance in test score explained by the SES quintiles

	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
Reading	0.093	0.070	0.072	0.069	0.066	0.057	0.071	0.056	0.069	0.056
Math	0.109	0.069	0.081	0.084	0.079	0.068	0.092	0.071	0.087	0.078
Science	0.089	0.059	0.056	0.069	0.077	0.058	0.074	0.057	0.065	0.060

Note: Present the R-square of pooled regression of test score on SES quintile dummies and year fixed effects. Full results are reported in Web Appendix.
Source: Authors computation.

Table 5a: Reading score SES gradient over time by province (reference year 2000)

	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
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***
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
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 year dummies, immigrant status, expected grade, gender, language spoken at home, and age in years. Significance is denoted using asterisks: ***is p < 0:01, ** is p < 0:05, and * is p < 0:1.
Source: Authors computation.

Table 5: Math score SES gradient over time by province (reference year 2003)

	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
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***
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
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 year dummies, immigrant status, expected grade based on birth month, gender, language spoken at home, and age in years. Significance is denoted using asterisks: ***is p < 0:01, ** is p < 0:05, and * is p < 0:1.
Source: Authors computation.

Table 5c: Science score SES gradient over time by province (reference year 2006)

	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
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***
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
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 year dummies, immigrant status, expected grade based on birth month, gender, language spoken at home, and age in years. Significance is denoted using asterisks: ***is p < 0:01, ** is p < 0:05, and * is p < 0:1.

Source: Authors computation.

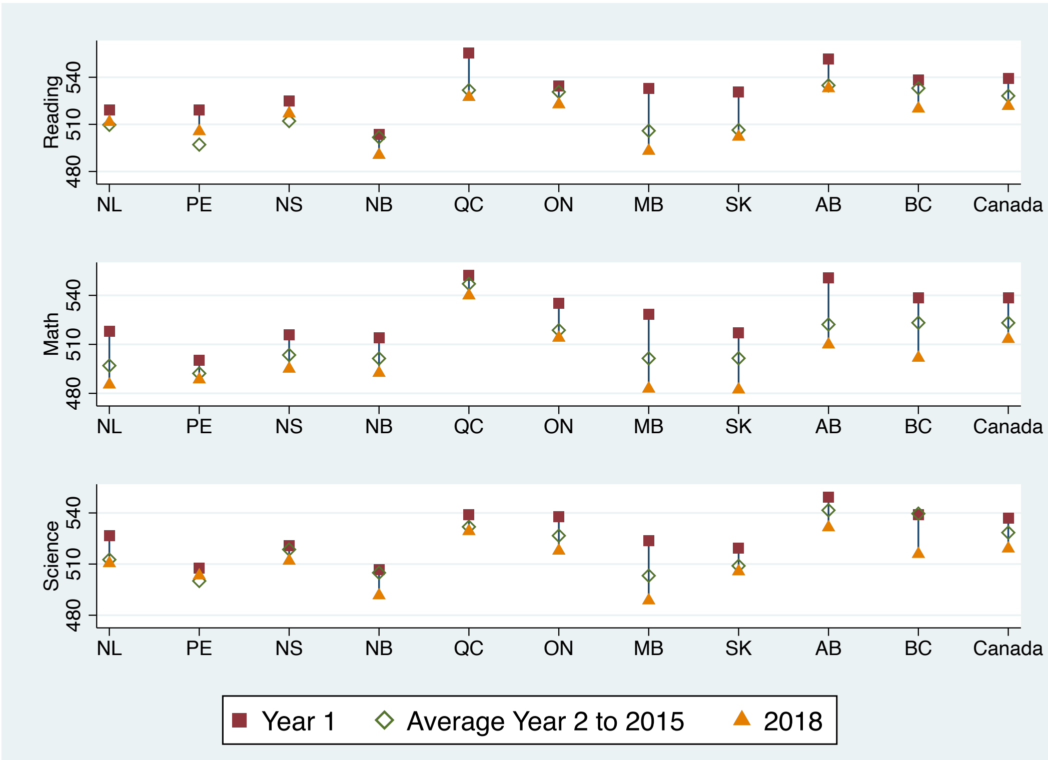
Table 6: Test scores among low SES students across the country in PISA 2000 to 2018

	All survey years			Survey year 2018 only		
	Reading	Math	Science	Reading	Math	Science
	(1)	(2)	(3)	(4)	(5)	(6)
NL	-27.3***	-39.0***	-30.2***	1.7	-39.3***	-10.8
	(3.0)	(3.9)	(4.4)	(11.6)	(9.2)	(14.0)
PE	-36.4***	-43.9***	-42.7***	-28.8*	-55.5***	-37.6**
	(3.5)	(4.2)	(4.5)	(17.3)	(17.4)	(16.6)
NS	-21.4***	-30.9***	-20.9***	-2.3	-46.4***	-18.7*
	(3.5)	(3.2)	(4.4)	(9.7)	(7.7)	(10.4)
NB	-34.3***	-35.0***	-41.2***	-22.8**	-47.6***	-31.0***
	(3.5)	(4.2)	(4.3)	(10.8)	(9.8)	(11.8)
QC	-8.6***	Reference Group	-18.0***	3.1	Reference Group	-2.2
	(3.2)		(4.0)	(8.8)		(9.4)
ON	-4.3	-15.5***	-13.0***	7.9	-18.4**	-2.2
	(3.5)	(3.4)	(3.9)	(9.6)	(8.7)	(9.3)
MB	-26.2***	-33.0***	-37.2***	-17.4*	-49.1***	-30.8***
	(3.1)	(3.3)	(4.6)	(9.9)	(8.7)	(11.1)
SK	-24.9***	-34.4***	-32.1***	-20.4**	-51.0***	-26.9**
	(3.7)	(3.6)	(3.9)	(10.1)	(7.8)	(11.0)
AB	Reference Group	-12.2***	Reference Group	Reference Group	-32.3***	Reference Group
		(3.8)			(12.2)	
BC	-2.6	-14.9***	-4.4	4.0	-33.2***	-6.1
	(3.5)	(3.3)	(4.3)	(10.1)	(12.8)	(11.1)
Constant	392.3***	353.5***	417.5***	365.0***	374.9***	411.9***
	(52.5)	(51.7)	(66.5)	(130.6)	(114.4)	(118.2)
Controls	yes	yes	yes	yes	yes	yes
N	30,316	24,440	19,258	3,782	3,782	3,782
R2	0.040	0.026	0.016	0.026	0.032	0.011

Note: Includes students in grades 8 to 11 whose parents are in the first quintile of the SES distribution (low SES). All survey years are pooled together. Again, we exclude survey year 2000 for mathematics, and survey years 2000 and 2003 for science. Controls not reported above include year dummies, immigrant status, expected grade based on birth month, gender, and age in years. Bootstrapped standard errors are reported in parentheses. Significance is denoted using asterisks: ***is p < 0:01, ** is p < 0:05, and * is p < 0:1.
Source: Authors computation.

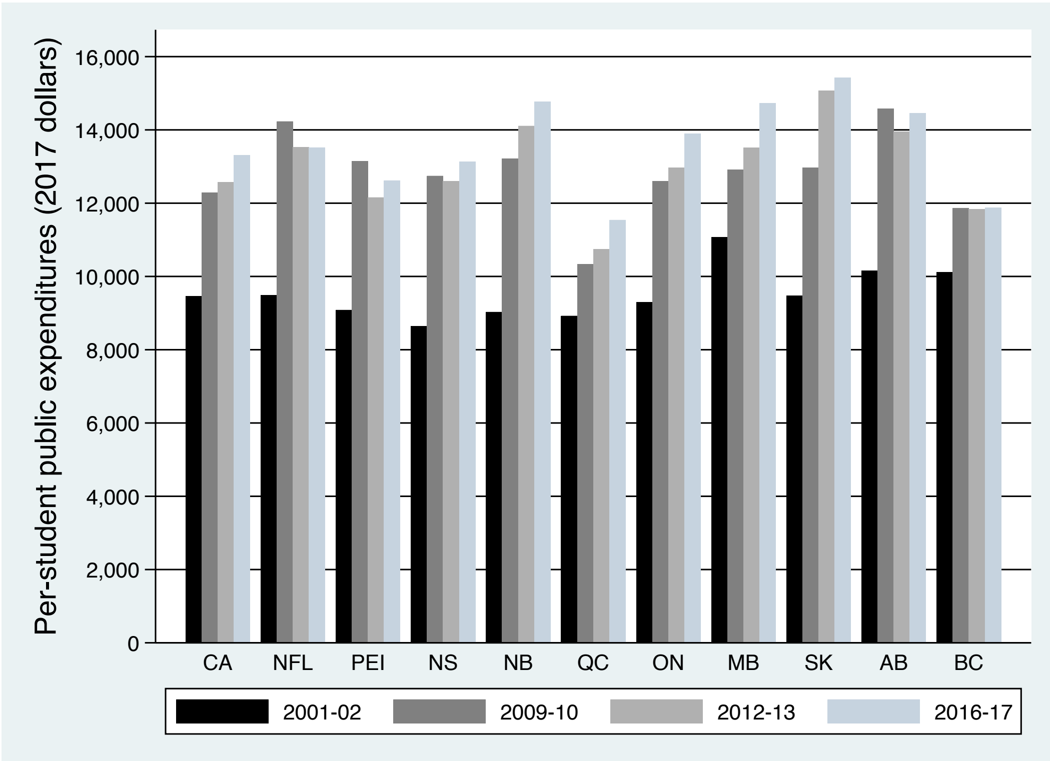
FIGURES

Figure 1: Mean test score by provinces over time



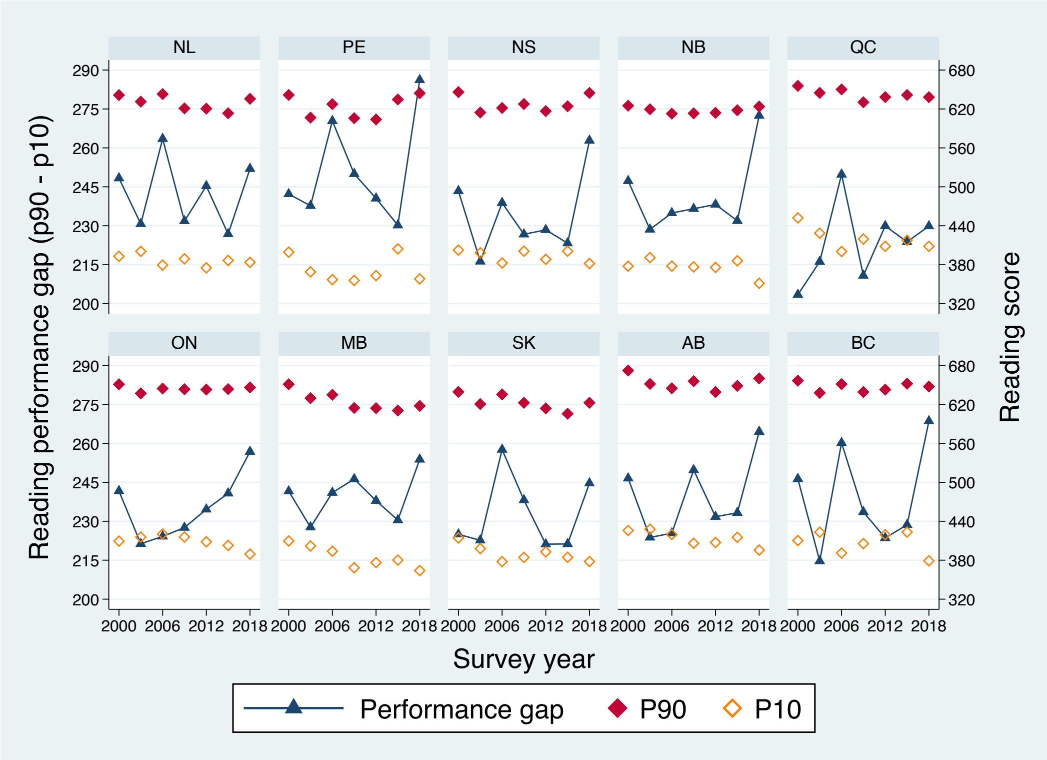
Note: Includes grades 8 to 11 students. Year 1 represents the first year of the major domain (red square): 2000 in reading, 2003 in math, and 2006 in science. The average is computed on all years between Year 2 to 2015 (hollow diamond).
Source: Authors computation.

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



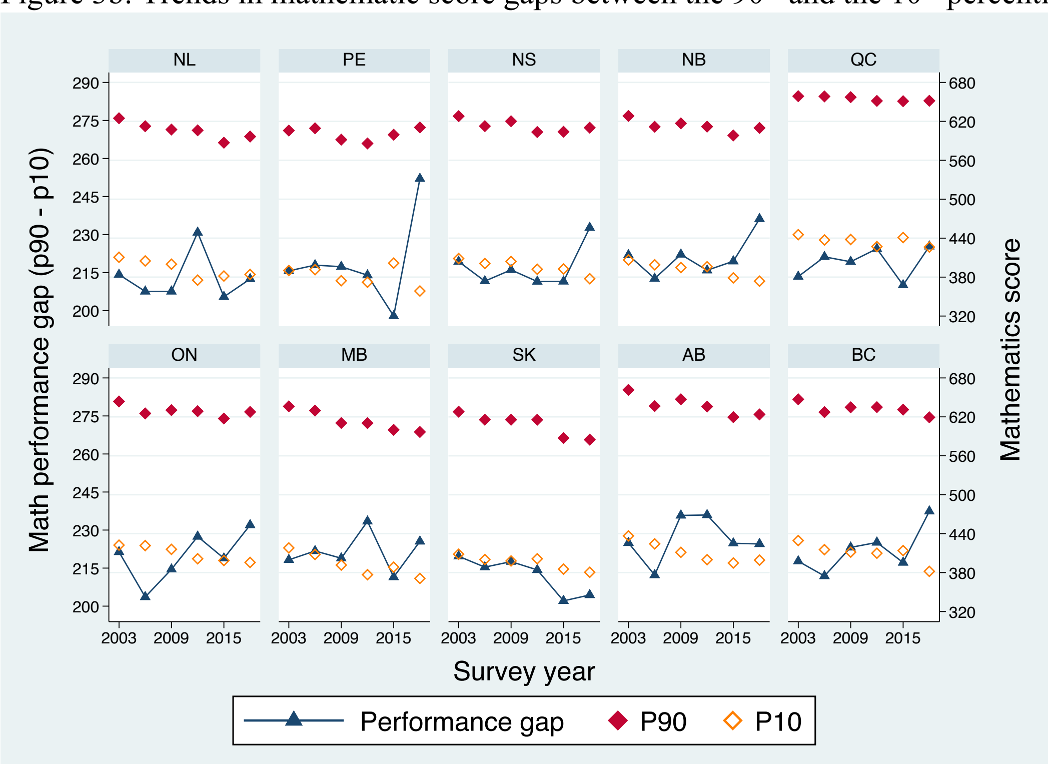
Note: Per-student spending in public schools deflated by the CPI (2017 dollars). Public spending in private school is not included.
Source: Authors computation using data from Table 478-0014, Public and Private Elementary and Secondary Education Expenditures, Statistics Canada, Table 477-0025; Enrolments 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, A. and J. Emes (2017). 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, A. and J. Emes (2019). *Education Spending in Public Schools in Canada.* Fraser Institute. http://www.fraserinstitute.org. ; and (3) Van Pelt, D. N. and J. 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: Trends in reading score gaps between the 90th and the 10th percentile



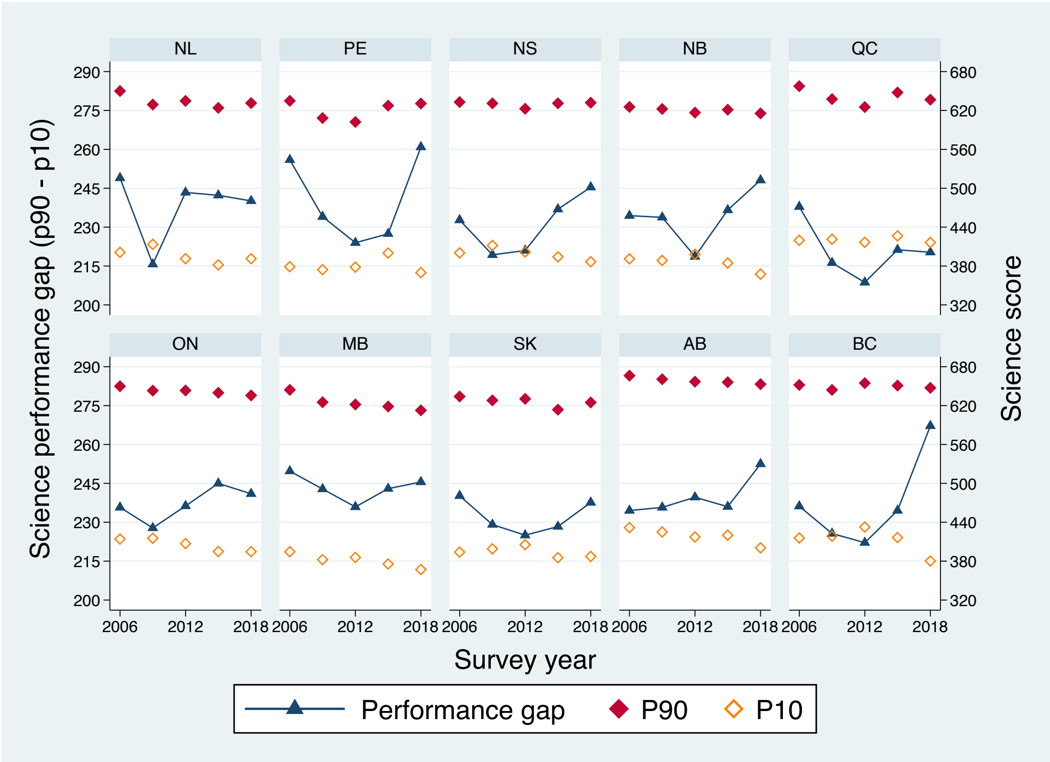
Note: Includes grades 8 to 11 students. The performance gap is on the left y-axis. The score at p10 and p90 is on the right y-axis. The score at p10 and p90 is calculated using the raw data and does not accounted for school grade differences in QC and NS.
Source: Authors computation.

Figure 3b: Trends in mathematic score gaps between the 90th and the 10th percentile



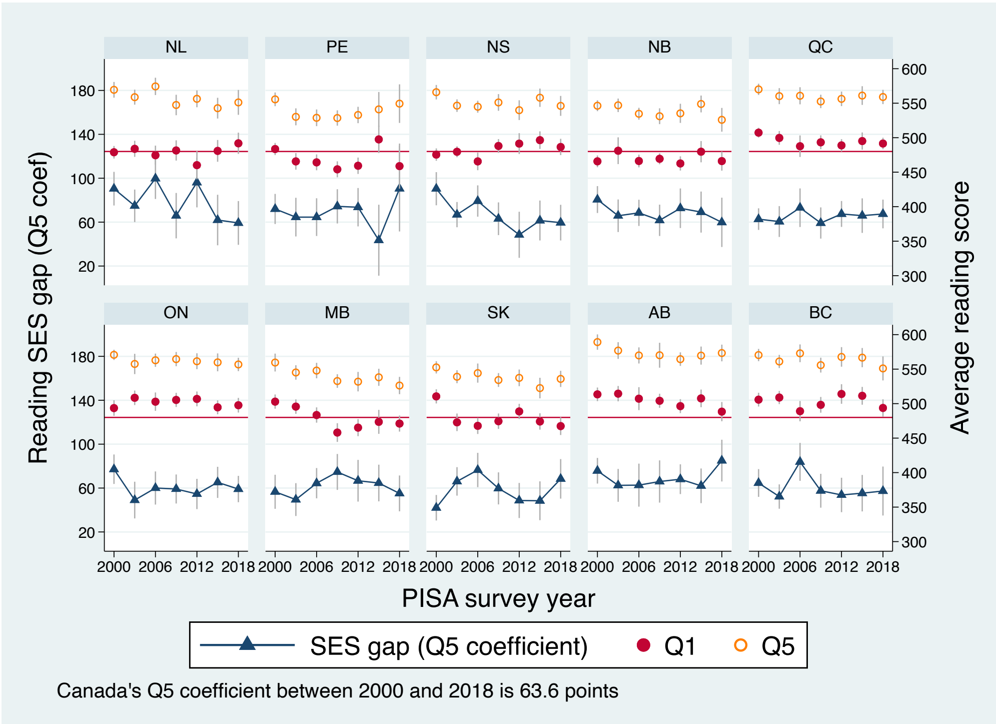
Note: See Note Figure 3a. Gap (left y-axis), p10 and p90 score (right y-axis). Source: Authors computation.

Figure 3c: Trends in science score gaps between the 90th and the 10th percentile



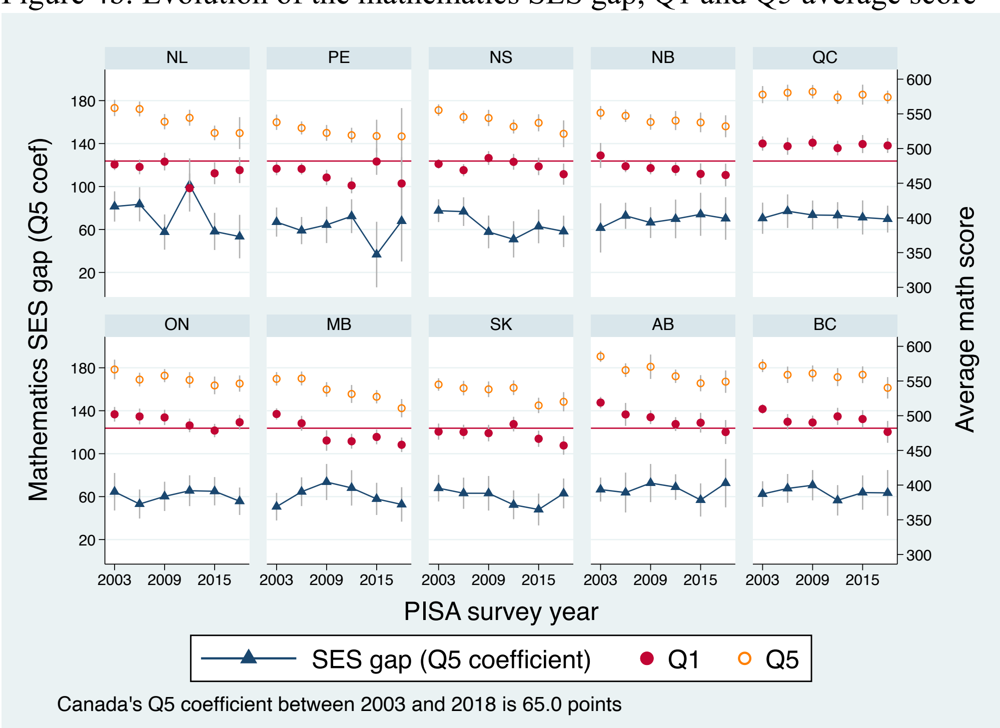
Note: See Note Figure 3a. Gap (left y-axis), p10 and p90 score (right y-axis). Source: Authors computation.

Figure 4a: Evolution of the reading SES gap, Q1 and Q5 average score



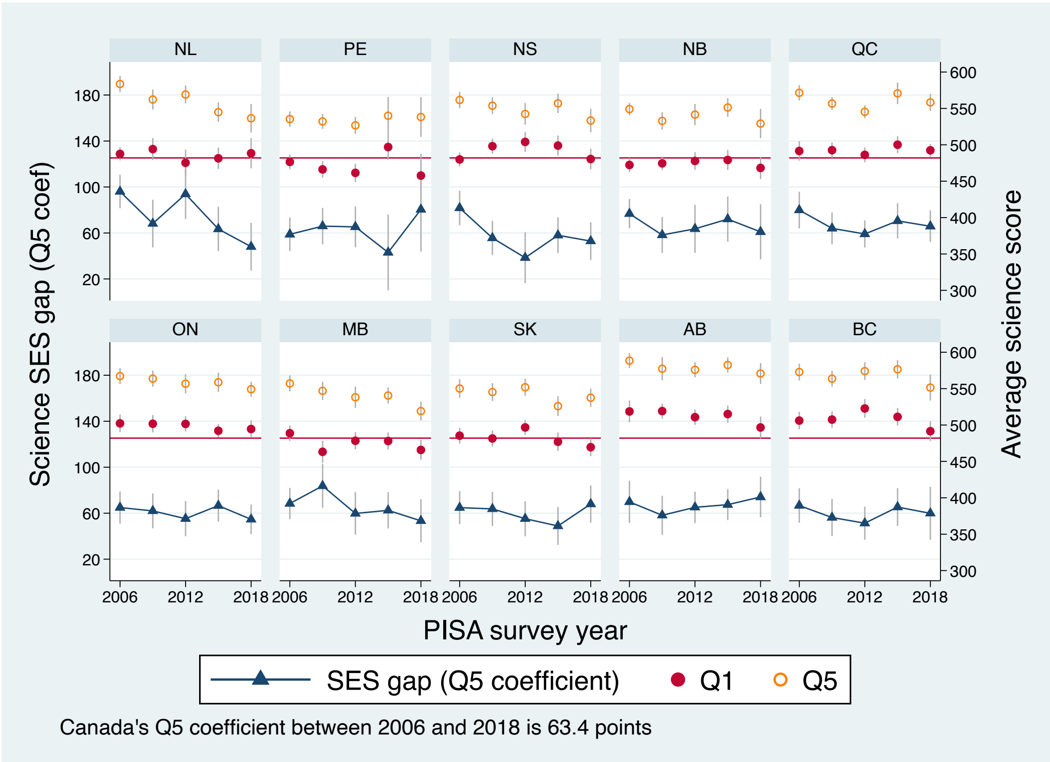
Note: Includes grade 8 to 11 students. The SES gap is on the left axis. The average score for Q1 and Q5 students is on the right axis. The SES gap is the Q5 coefficient of a regression of test score on SES quintile dummies. No control variables are included. The average score by quintile (Q1 and Q5) is calculated using the raw data and does not accounted for school grade differences in QC and NS. The horizontal red line marks the threshold for core skills required to pursue postsecondary education. Confidence intervals are calculated at 95%.
Source: Authors computation.

Figure 4b: Evolution of the mathematics SES gap, Q1 and Q5 average score



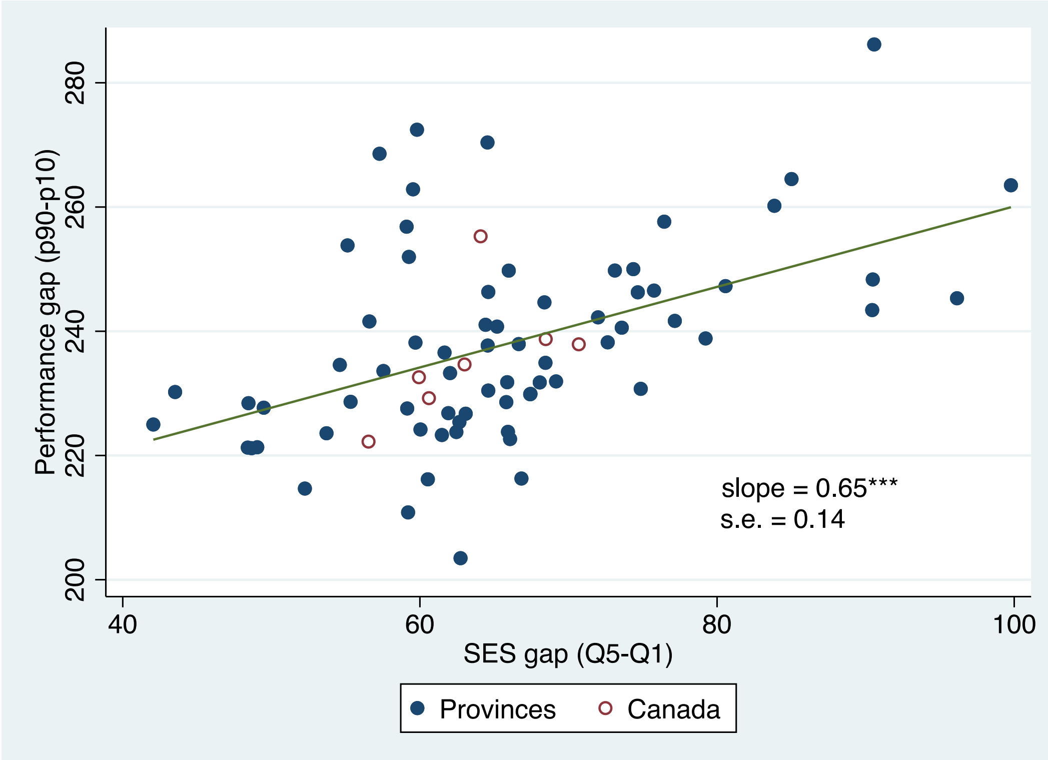
Note: See Note Figure 4a. Gap (left y-axis), Q1 and Q5 score (right y-axis). Source: Authors computation.

Figure 4c: Evolution of the sciences SES gap, Q1 and Q5 average score



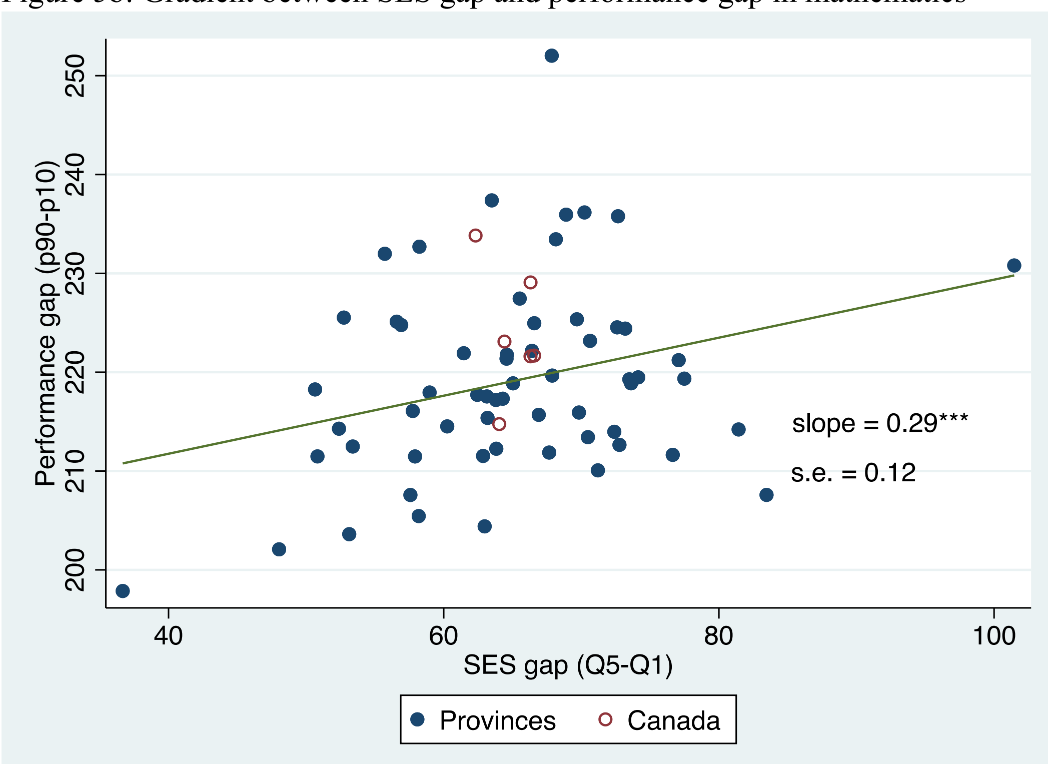
Note: See Note Figure 4a. Gap (left y-axis), Q1 and Q5 score (right y-axis). Source: Authors computation.

Figure 5a: Gradient between SES gap and performance gap in reading



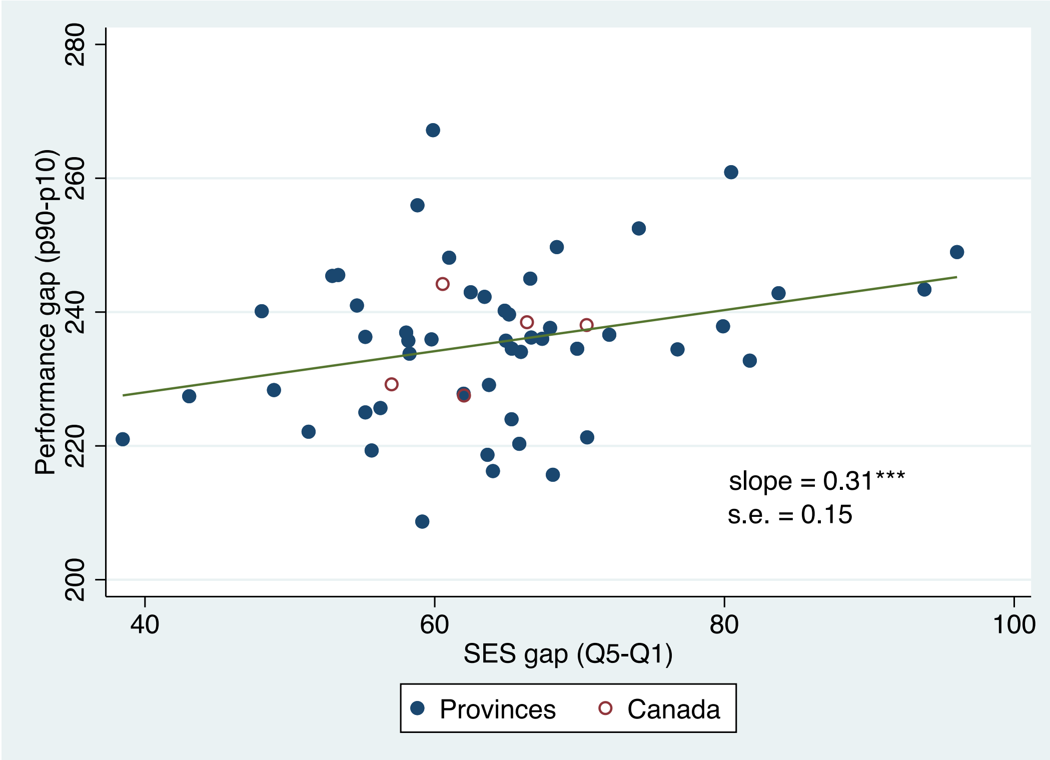
Note: Includes grade 8 to 11 students, year 2000 to 2018.

Figure 5b: Gradient between SES gap and performance gap in mathematics



Note: Includes grade 8 to 11 students, year 2003 to 2018.

Figure 5c: Gradient between SES gap and performance gap in sciences



Note: Includes grade 8 to 11 students, year 2006 to 2018.

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
MB	Manitoba
SK	Saskatchewan
AB	Alberta
BC	British Columbia
CA	Canada

Table A2: Percentage of students by grade by PISA cohorts

Grade	CANADA	NL	PE	NS	NB	QC	ON	MB	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	2,993
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 A3: 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
MB	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

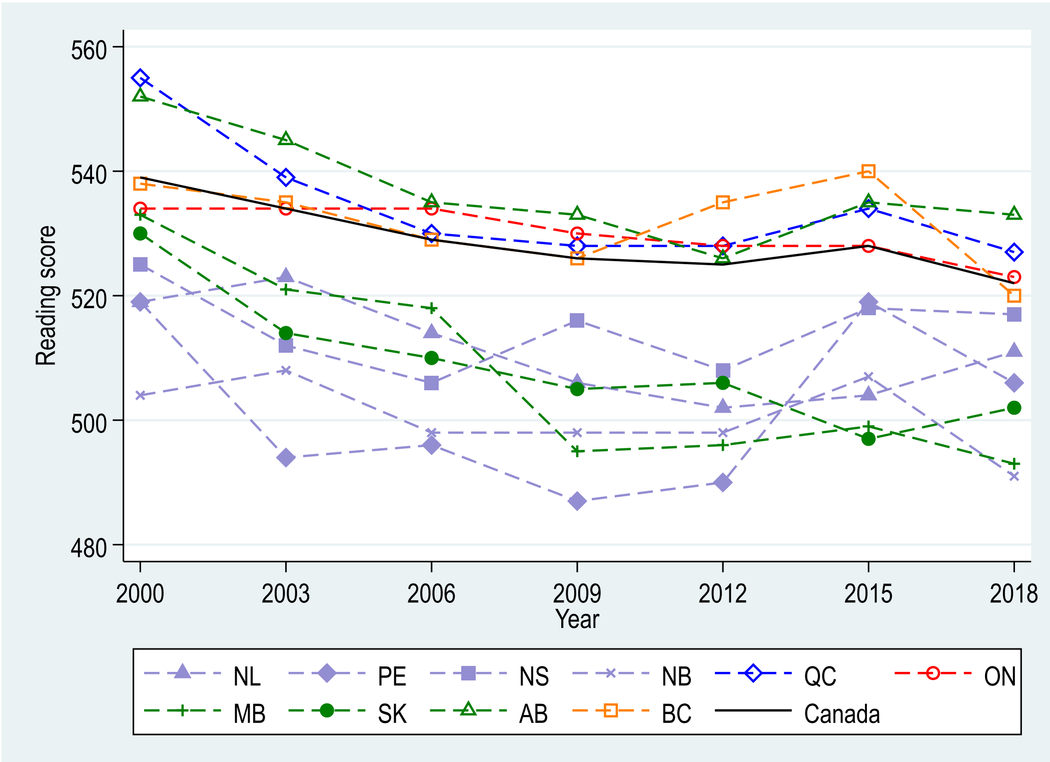
Note: All students, weighted. The ESCS is the index of economic, social and cultural status.
Source: Authors' computation from PISA weighted data sets 2000-2018.

Table A4: 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
MB	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
MB	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

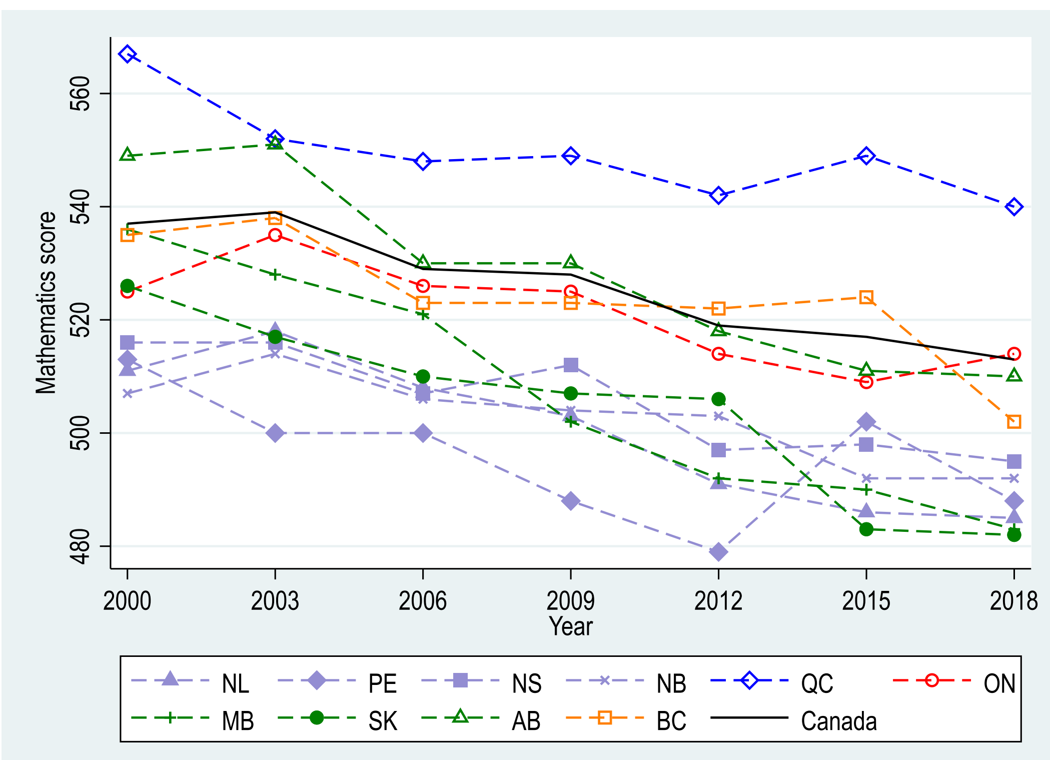
Notes: The HISEI index is the highest score, between 16 and 90, assigned to each occupation (father or mother) by the PISA survey. The index was calculated for each province and year. Includes students in grades 8 to 11; SD: standard deviation; P10 indicates the 10th percentile of the distribution, P25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

Figure A1: Reading mean test score by provinces over time



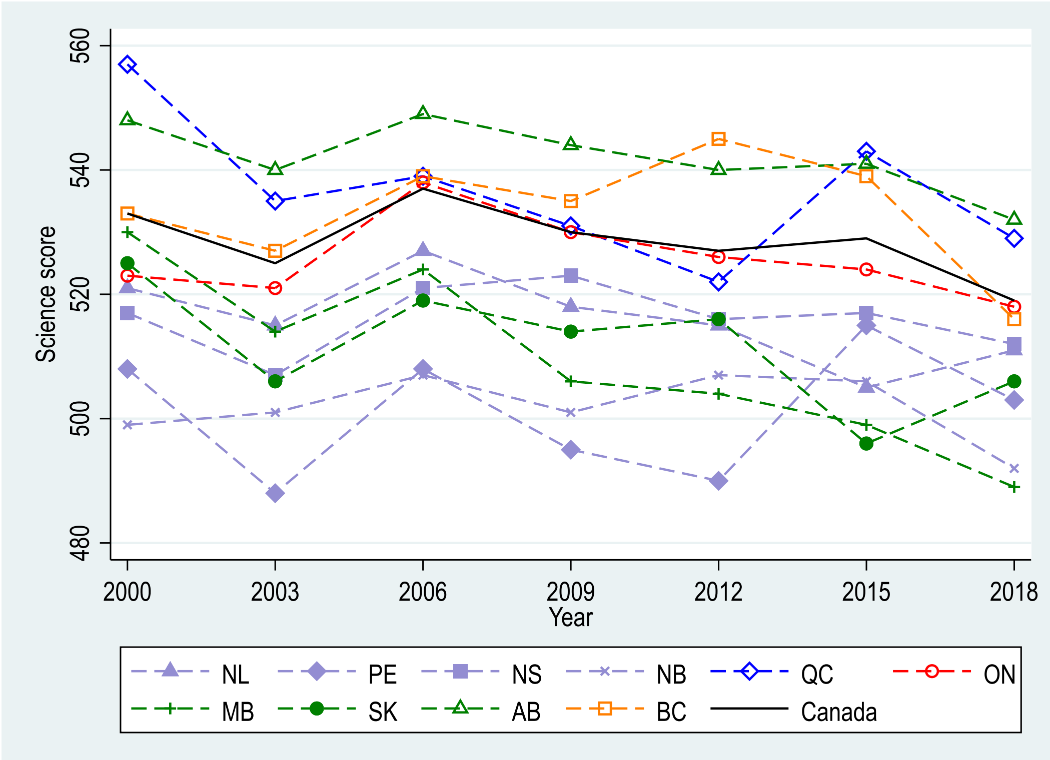
Note: Reading was the major domain in 2000, 2009 and 2018. Includes grades 8 to 10 students.

Figure A2: Mathematics mean test score by provinces over time



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

Figure A3: Science mean test score by provinces over time



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