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E-BRIEF

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SOCIAL POLICY

Warning Signs for Canadian Educators: The Bad News in Canada's PISA Results

PART 1 OF A TWO-PART REPORT

by
John Richards

- The Program for International Student Assessment (PISA) conducts core competency tests that are solid predictors of future economic growth – more so than "input measures," such as average years of schooling. PISA assesses the academic ability of 15-year-olds across three subject areas – reading, mathematics and science. While Canada's outcomes remain well above the OECD average, they have been slipping.
- Every three years since 2000, PISA has administered tests in these three subject areas, with a rotating focus. The focus for the latest round, in 2012, was on mathematics, with fewer questions posed on the other two subjects. From the respective "base years" to 2012, Canada experienced statistically significant declines in two of the three subject areas, science and mathematics.
- There are wide provincial variations in outcomes. For example, Quebec has avoided a decline in its mathematics score over the last decade while all other provinces have seen declines. Prince Edward Island and Manitoba have experienced statistically significant declines in all three subjects.
- The 2012 results rarely mentioned the relative ability of Canadian schools to overcome the education disadvantage of students from families with low socio-economic status. Canada ranked fifth among OECD countries in terms of minimizing the negative impact of low socio-economic status on mathematics scores.

Education is much more than training the next generation's labour force, but the contribution to economic prosperity from a well-run primary and secondary school system is undeniable. There is solid evidence that economic growth in any country is a function of the academic abilities of

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the country's workers. Furthermore, national performance on student "outcome measures" such as PISA's core competency tests are solid predictors of future economic growth – more so than "input measures," such as average years of schooling.[1,2]

This E-Brief discusses some concerning trends in Canadian results at a provincial level, with an emphasis on mathematics results. I also examine the success of the Canadian education system, relative to most OECD countries, in offsetting the education disadvantage incurred by students from families with low socio-economic status.

In Part II, to be published subsequently, I analyze six education policies discussed in the PISA background research – three that seem to "work," one that may be working in the case of Quebec, and two that seem "not to work."

An implicit assumption underlying PISA is that student mastery of reading, mathematics and science should be a common element of all modern school systems. The study of national and regional history as well as literature is a necessary complement to, not a substitute for, mastering basic mathematical reasoning or learning to communicate an idea via a coherent, grammatically correct paragraph.

Starting with the first "round" in 2000, the OECD has organized five rounds of PISA evaluations of 15-year-old upper secondary students in participating countries (See Brochu 2013, 15-17 for how PISA defines "mathematical literacy" in assessing students).[3] Subsequent rounds have taken place every three years, the latest in 2012. In the 2012 round, mathematics was the focus, as in 2003.

The most commonly cited PISA statistics are national scores on each of the three subject areas. The scores are normalized such that, in the base year for a subject area, the average score for OECD member countries is 500 (with a standard deviation of 100).[4] The average OECD member country score for mathematics in 2012 was 494, implying an overall decline relative to the mathematics base year of 2003.

In the 2012 results, the average Canadian mathematics score was 518, the reading score was 523, and science 525. In terms of all participating countries (and cities), Canada ranked 13th in mathematics, 9th in reading and 10th in science. In terms of the OECD-member countries participating, Canada ranked respectively 7th, 5th and 6th.[5] In summary, Canada is doing reasonably well. But when drilling down into the results, there are signs for concern:

1 Hanushek and Woessmann (2008) provide a comprehensive review of evidence on the role of "outcome measures" – as opposed to "input measures" – in explaining economic growth across countries.

2 The PISA, organized by the Organisation for Economic Cooperation and Development (OECD), is undoubtedly the most ambitious comparative evaluation of national school systems currently being undertaken by an international agency. Canada is one of 65 "countries" to have participated in the latest PISA round, conducted in 2012. Some participants have been subunits within countries. Canada participated as a single country. However, PISA also reported Canadian provincial results.

3 The first round covered 32 OECD-member countries. Since then, the number of participants has grown to 65, half of them outside the OECD. In 2012, the total sample of students assessed was nearly 500,000. The Canadian sample in this latest round was 21,000 students in 900 schools, spread across all provinces. In addition to assessing student performance, PISA asked of participating students information about their families, and the principal of each participating school reported relevant characteristics of the school. In each round, one of three subjects is the primary focus, with fewer questions related to the other two. In the 2012 round, mathematics was the focus, as in 2003. "Link items" common to successive rounds enable PISA to maintain consistent inter-round grading.

4 The base year for mathematics is the 2003 round, for reading 2000, for science 2006.

5 While these are the rankings based on the scores, the differences between Canada and some of the jurisdictions immediately above it are not statistically significant.

Table 1: Average 2012 PISA Scores and Change from Subject Base Year to 2012, Canada and Provinces

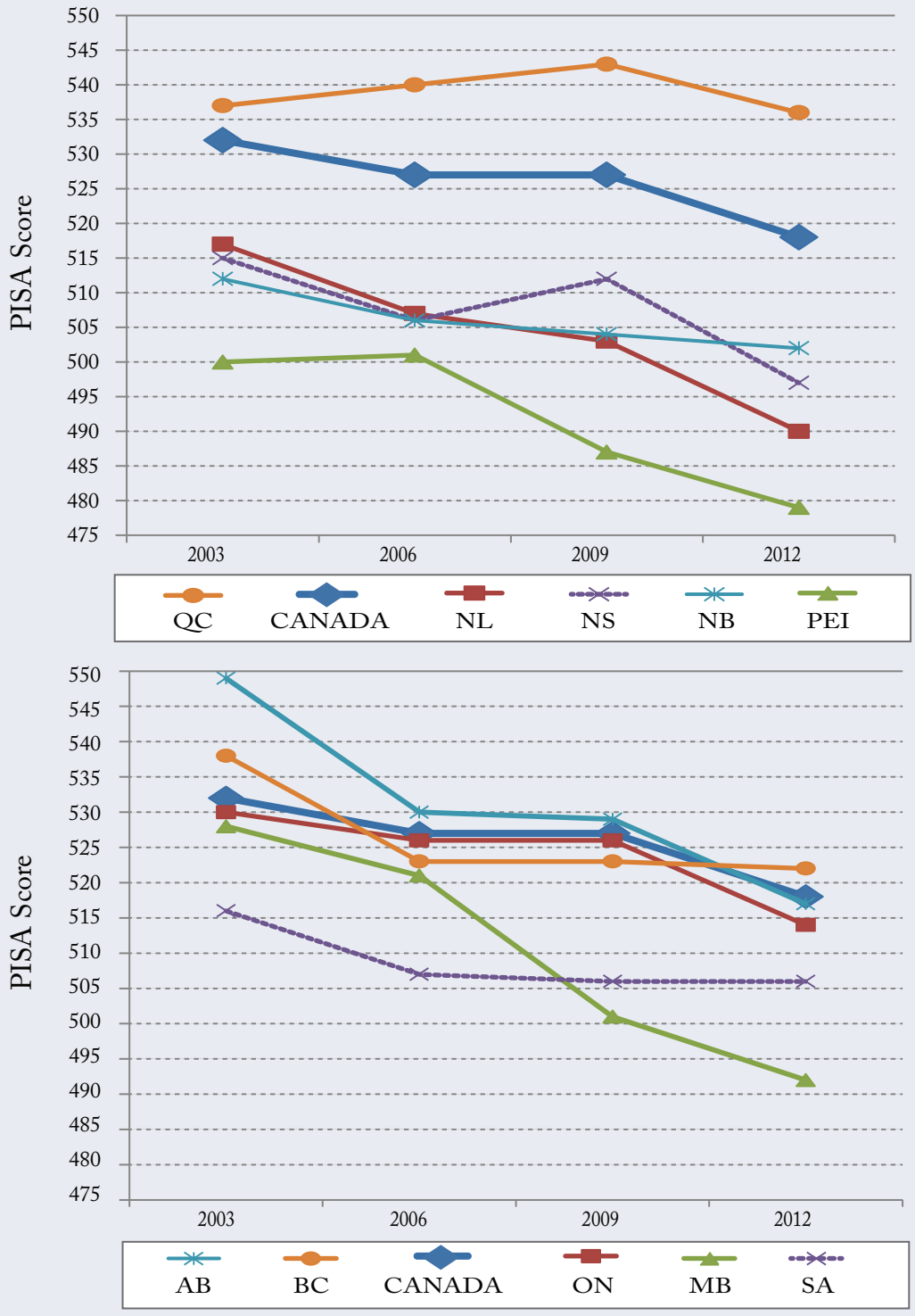
	Science		Reading		Mathematics	
	Score	Change 2006-12	Score	Change 2000-12	Score	Change 2003-12
OECD average	*501*		*496*		*494*	
Canada	525	**-9**	523	-11	518	**-14**
Newfoundland	514	**-11**	503	-14	490	**-27**
Prince Edward Island	490	**-18**	490	**-28**	479	**-21**
Nova Scotia	516	-4	508	-13	497	**-18**
New Brunswick	507	1	497	-5	502	**-10**
Quebec	516	**-15**	520	**-16**	536	-1
Ontario	527	-10	528	-5	514	**-16**
Manitoba	503	**-21**	495	**-34**	492	**-36**
Saskatchewan	516	0	505	**-25**	506	-10
Alberta	539	-11	528	**-22**	517	**-32**
British Columbia	544	6	535	-3	522	**-16**

Note: The bolded changes are statistically significant from 0, at a 5 percent level, based on reported standard errors of the 2012 estimates, the relevant base year for each of science, reading, and mathematics, and the "link error."

Sources: Bussière et al. (2001; 2004; 2007), Brochu et al. (2013) and calculations by author.

- From the respective base years to 2012, Canada experienced statistically significant declines in two of the three subject areas (Table 1).
- Figure 1 illustrates the trend in national and provincial average mathematics scores between 2003 (base year for mathematics) and 2012. Eight provinces experienced statistically significant declines. Quebec's score remained essentially constant; Saskatchewan's decline was not significant, but close to being so.
- Provincial average 2012 scores display a wide range: in mathematics, from 536 (Quebec) to 479 (PEI), in reading from 535 (BC) to 490 (PEI), in science from 544 (BC) to 490 (PEI). All provinces were consistently above the relevant OECD average, except for PEI (below in all three subjects) and Manitoba (below in two subjects).
- Every province experienced a statistically significant decline in at least one subject between the base year and 2012.
- Two provinces (PEI and Manitoba) experienced statistically significant declines in all three subjects.
- Three provinces (Newfoundland, Quebec and Alberta) experienced statistically significant declines in two subjects.
- Five provinces (Nova Scotia, New Brunswick, Ontario, Saskatchewan and BC) experienced statistically significant declines in one subject.
- Three provincial declines were in excess of 30 points (mathematics in Manitoba and Alberta, reading in Manitoba).

Figure 1: PISA Mathematics Scores, Canada and Provinces, 2003-2012



Sources: Bussière et al. (2004; 2007), Knighton et al. (2010), Brochu et al. (2013).

Questions arise from these outcomes. For example, why has Quebec avoided a decline in its composite mathematics score over the last decade while other provinces have seen declines? Why have Alberta and Manitoba experienced exceptionally large declines? Perhaps the explanation lies in variation over the decade in socio-economic conditions in one province relative to another. But perhaps major policy shifts took place in particular provinces, and they are the proximate explanation. High-quality comparative statistics provide the first stage in any search for an explanation.

Separating School from Family Effects

Educational outcomes vary according to the supply of education services to students – by schools and by their families – and the demand for formal education – by parents and, as they become older, by students themselves. On the supply side, the distinction between the services provided by schools and by a student's family is fundamental. In any population, students from families with higher socio-economic status usually realize better education outcomes than those with lower status. High-status families are better placed to supplement school-based teaching by personal tutoring or by hiring private tutors, and in general such families demand more from the school system.[6]

Separating the contribution of schools from that of families is not easy. PISA attempts to do so by the construction of an index of social, economic and cultural status of students' families and regressing student performance on the index plus available observations on the student's school. The smaller the variation among students in a country or province explained by the index, the less important are socio-economic differences among students' families. An appreciation of the PISA strategy is afforded by the social gradients illustrated in Figures 2 and 3.[7] The smaller the slope of its social gradient, the more effective is the jurisdiction's school system in offsetting social differences of students' families. Among OECD countries, Canada has the fifth-lowest social gradient slope.

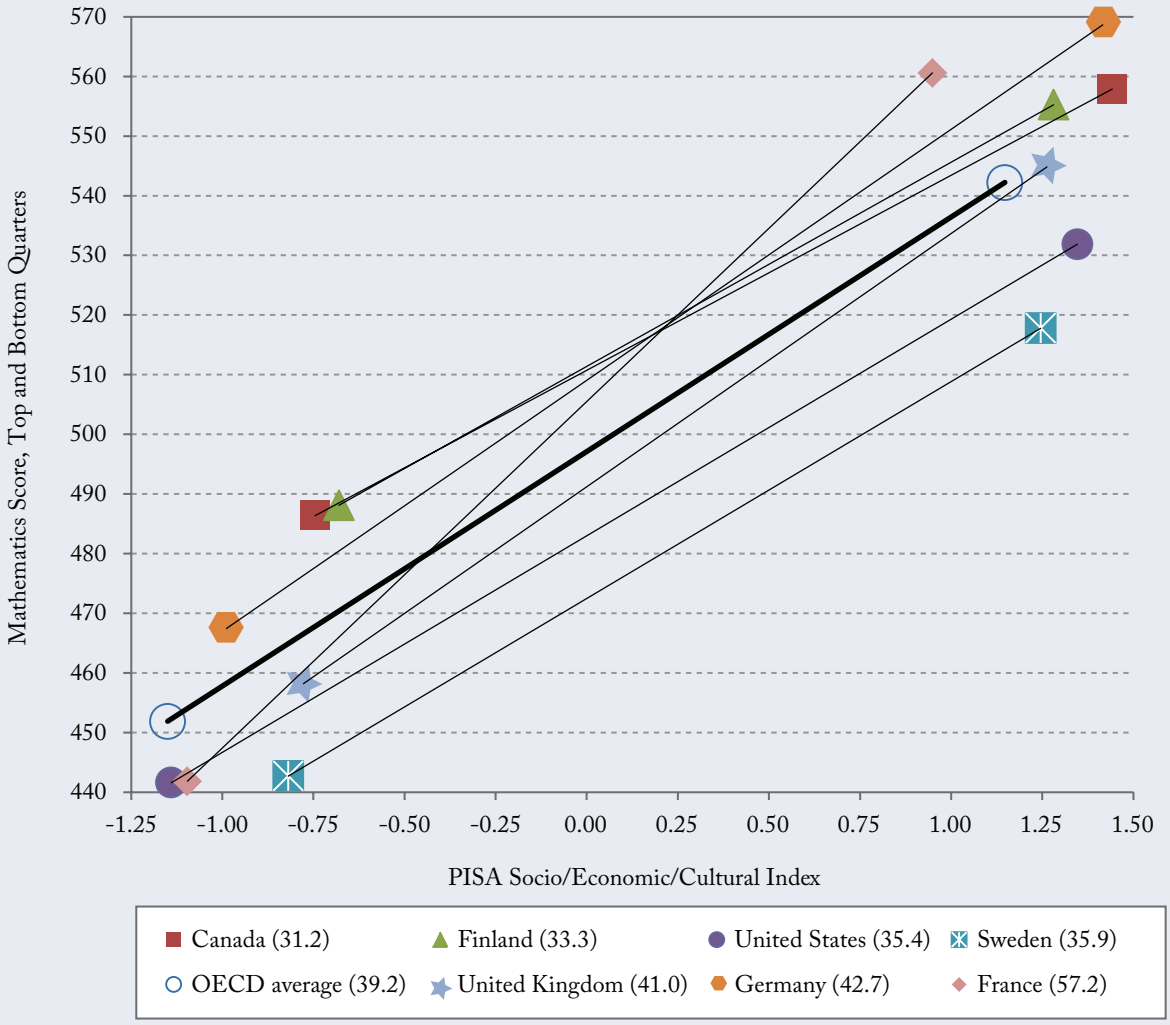
Figure 2 illustrates social gradients in eight populations. In the overall sample in OECD countries, in Canada, United States and five selected European countries, the assessed students are ranked in terms of the socio/economic/cultural index. The two data points associated with a population are the respective average social index values among the bottom and top quarters of students (ranked by this index), with the corresponding mathematics scores. The line connecting them is roughly the social gradient as defined by PISA. The gradient slope is a measure of the increase (decline) in expected mathematics score for a unit increase (decrease) in students' family socio-economic status. The "flatter" the gradient (the smaller the slope) the more successful is the national school system in offsetting social disadvantage.

Canada and Finland are two countries with nearly identical average mathematics scores in 2012 (Finland 519, Canada 518). Their top and bottom quarter scores are also close. And consequently so are their respective gradients. The slope of the Canadian gradient (31.2) is the "flattest" among the jurisdictions illustrated; Finland's is second lowest (33.3). Both are well below the OECD average (39.2), which means Canada and Finland are offsetting social disadvantage more effectively than is the typical OECD country.

6 For example, by moving into neighbourhoods with high-performing schools.

7 The index was derived from the following three sub-indices: highest occupational status of parents, highest educational level of parents in years of education, and home possessions indicative of cultural level (for example, number of books in the family home).

Figure 2: Social Gradients, OECD Average, Canada, and Selected OECD Countries, 2012

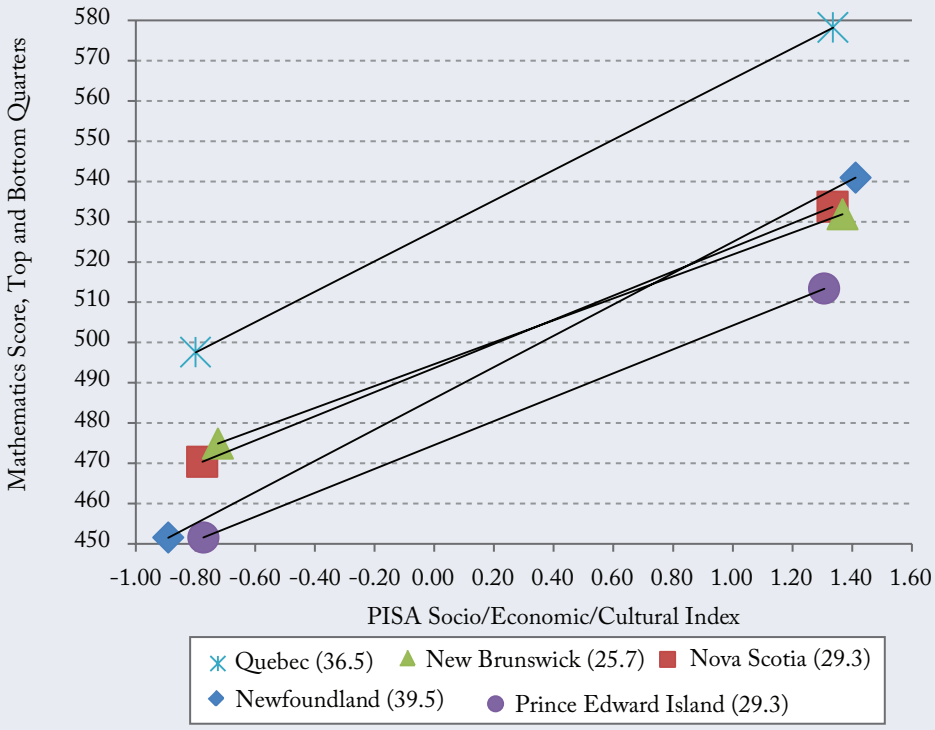


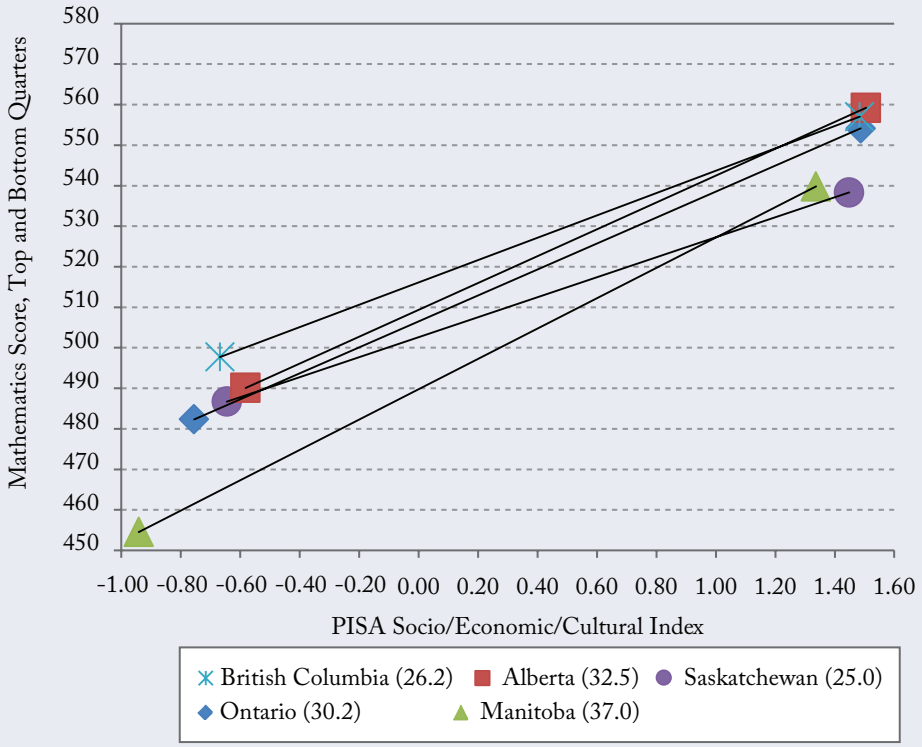
Note: In Figures 2 and 3 the bracketed numbers in the legend are the respective gradients, as defined by PISA. In jurisdictions of interest PISA regressed student mathematics scores on respective student socio/economic/cultural index values. The social gradient is the index coefficient. These coefficients differ slightly from the slopes of the linear social gradients illustrated.

Source: OECD (2013,43,174).

Figure 3 illustrates the social gradient among Canadian provinces. Quebec (578) displays by a wide margin the best top-quarter mathematics score. Three provinces – Alberta, British Columbia, Ontario – follow with top-quarter results approximately 20 points lower. The weakest result is for PEI (513): its top-quarter score is below the overall Canadian average. In terms of bottom quarter scores, Quebec and British Columbia perform best (498). The three weakest provinces by this measure (Manitoba, Newfoundland and PEI) have bottom-quarter scores more than 40 points below Quebec and British Columbia.

Figure 3: Social Gradients, Provinces, 2012





Source: OECD (2013,281,285).

Box 1: Aboriginal Education Performance and PISA

The weak performance of Aboriginal students arises, in part, from demand side factors. Many Aboriginal parents harbour a mistrust of formal education as an instrument of assimilation. It also arises from the supply side. Disproportionately, Indian/FN students come from low-income families and reside in isolated communities. Despite higher per student funding, the education outcomes in mathematics, science and reading in small schools in isolated communities are, for all students, generally inferior to outcomes in urban communities. Negative peer effects may play a role. In schools with large Aboriginal student cohorts, Aboriginal students tend to perform less well. Finally, discrimination may exist in the school system. For example, teachers and administrators may form low expectations of Aboriginal student potential.

To illustrate what PISA might have assessed – but didn't – consider the bottom-quarter performance of students in the four western provinces. In these provinces, Aboriginals constitute, on average, 15 percent of school-age cohorts, and for the reasons cited above are over-represented in the four bottom-quarter student samples. The BC bottom-quarter mathematics score (498) is tied for highest among the provinces; the Manitoba score (455) is among the weakest. Via the census, we know that young Indian/FN adults in BC have much higher high-school completion rates than those in Manitoba, but the census offers very little in explaining why this is so. To the extent provincial education policies are relevant, PISA could have provided tentative answers.

The explanations for low Aboriginal education invite controversy. In this vein, Demmert et al. (2006) survey the range of research on American Indians. Colleagues and I have analyzed Aboriginal student performance in BC provincial schools, using data disaggregated to the school level (Richards et al. 2008).

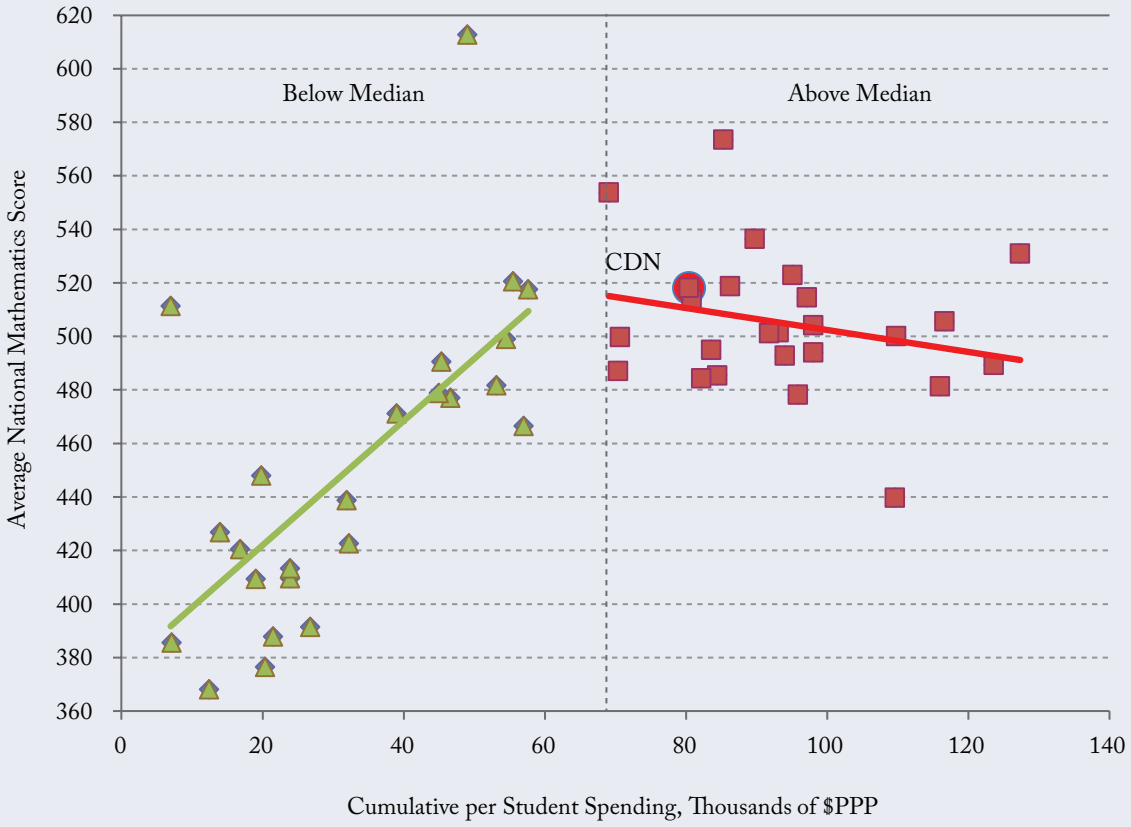
The provinces with the flattest gradients are Saskatchewan, followed closely by New Brunswick and BC. Saskatchewan realizes its flat gradient due to a below-average top-quarter score and near-average bottom-quarter score; New Brunswick has below-average top and bottom quarter scores; BC realizes its relatively flat gradient with a near-average top score and above-average bottom quarter score. The steepest gradients are in Newfoundland, followed by Manitoba and Quebec. Quebec's result arises from its superior top-quarter performance. Newfoundland and Manitoba realize exceptionally weak bottom-quarter scores.

If we accord equal importance to average mathematics score and to gradient slope, the two provinces whose parents should be most concerned are those in Newfoundland and Manitoba.[8] Both experienced average mathematics scores well below the Canadian average, and gradient slopes well above average.

The PISA exercise in separating the impact of social, economic and cultural features of students' families from that of schools has limitations. The most important is its failure to capture the impact on education outcomes of religious and ethnic identities. Identity matters in explaining outcomes, even after allowing for socio-economic and school quality differences. In Canada the most important instance where identity "matters" is among Aboriginal students, particularly those identifying as North American Indian or First Nation – as opposed to Métis. See Box 1 for a discussion on PISA and Aboriginal student performance.

8 Alberta technically qualifies for this list, but the difference of its average mathematics score from the national average is not statistically significant. The slope of its gradient is only slightly above the national average.

Figure 4: Average Mathematics Score, by Cumulative per Student Spending, PISA, 2012



Notes: Median cumulative spending per student is $69,000. PPP = Purchasing power parity.

Source: OECD (2014a,35).

Is Spending More the Answer?

Among countries ranked by cumulative spending per student (from age 6 to 15), spending more is clearly associated with better outcomes – but only among countries with cumulative per student spending below the $69,000 median (Figure 4). Among countries spending above the median, spending more has no consistent effect. This does not mean it is pointless to spend more per student than the median country. Spending more on particular programs may well generate better outcomes – the range in mathematics outcomes among countries spending above the median is obviously wide (from 440 to 573) – but at the same time spending less on other education programs may have no detrimental effect on outcomes. Beyond a certain point, better education outcomes are not primarily a matter of aggregate per student spending.

Conclusion

This E-Brief has highlighted concerning trends behind Canada's seemingly satisfactory scores on the PISA tests. Wide variation in provincial performance, both in terms of average scores and the ability to offset social

disadvantages, suggests there are lessons for weaker provinces to learn from what the stronger provinces are doing. Spending more, as we have seen, is no panacea. But how can Canada address these challenges? In Part II, I will examine what the PISA results reveal about six oft-discussed education policies: three that seem to work, one that may be working in Quebec, and two that do not work.

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John Richards is Professor, School of Public Policy, Simon Fraser University and Fellow-in-Residence, C.D. Howe Institute.

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