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We use a national Brazilian test (SAEB) and an international test (PISA) to measure whether Brazilian students 13-15 years old improved their mathematics and language learning in1995-2012. We control for part of out-of-school influences by comparing test scores for students with similar family academic resources. Our empirical strategy is descriptive and comparative. We find that Brazilian students have made test score gains during this period on the PISA, but much less so on the SAEB. Gains on the PISA test for advantaged Brazilian students are smaller than among disadvantaged students. This is also the case for the SAEB.

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As developing countries have expanded their educational systems to provide an increasing proportion of youth with secondary education, there has been a shift in focus from policies concerned with access to schooling to policies that improve the quality of schooling (UNESCO, 2005). Two other factors have contributed to this shift. The first is research claiming that quality of education, as measured by international test scores, is a better predictor of economic growth than the number of years of schooling in the labor force (Hanushek and Kimko, 2000; Hanushek et al, 2013). The second is the increase in testing itself, both at the national and international levels. Student test results are being used increasingly to pressure national and local educational systems, schools, and individual teachers to have their students do better on the tests (OECD, 2013). League tables comparing schools, local school districts, regions, and nations against others are now a regular feature of educational politics in many countries of the world. To some extent, test scores are becoming important enough to affect government legitimacy.

It is therefore not unusual that a country such as Brazil, which considers itself an up-and-comer in the world economy, should be concerned with how well its students are doing compared to students in other countries, and particularly whether Brazilian student performance on tests is improving over time. Brazil has had its own national evaluation system for a number of years—the SAEB (1995-2011), and since 2005, the *Prova Brasil*, are national tests given to 4th (this changed to 5th graders in the new Brazilian system[8] after 2007) and 8th graders (this changed to 9th graders after 2007) every two years. The SAEB is based on a large sample of Brazilian students in both public and private schools, and the *Prova Brasil* is a test applied to all students in all public schools with 20 students or more in the tested grade—4th/5th or 8th/9th (INEP, 2014).

In addition, Brazil has participated in the Program of International Student Assessment (PISA), administered by the OECD, in all five rounds—2000, 2003, 2006, 2009, and 2012 (see OECD, 2013, Volume 1, Chapter 2). Unlike the SAEB, the PISA is a test administered to a sample of 15 year-olds based on the distribution of that age student in various grades. The SAEB is a classroom sample, which tests all students in selected classrooms,[9] and the PISA is a school sample, testing a sample of about twenty-five 15 year-olds in each selected school.

These two assessments can be used to draw some inferences as to whether Brazilian students are improving the amount of mathematics and language skills they have learned by the end of basic

[8] Beginning in 2007, students were admitted into schools at 6 years-old rather then at 7 years-old. This has added a year of schooling for these new earlier entrants, so that the first cycle of basic education is 5 years rather than 4 years, and the last year of middle school is the 9th grade rather than the 8th grade. Many schools (about one-third) elected to wait a year (2008) to implement the new law, and a small percentage waited until 2009 or 2010.

[9] Up to 2005, half the students tested did the reading test, and half the math; since 2005, all students in the class did both the reading and the math tests.

education (SAEB $8^{th}/9^{th}$ grade) and by 15 years-old (PISA 7^{th}-11^{th} grades, then 8^{th}-12^{th} grades). Our methodological approach is to approximate improvements in school system quality is to "net out" one major part of out-of-school influences by comparing students with similar family academic resources across countries. We argue that changes in test scores over time of students controlling for student characteristics (gender, ethnicity) and family academic resources provide a better assessment of whether a country's educational system is improving than simply tracking average national scores. There are additional complexities concerning the PISA test because students sampled are in a given age group, not in a single grade, and, in the Brazilian case, the test was applied at different dates in 2000, 2003/2006, 2009, and 2012, further biasing estimates of gains over time (Klein (2011). We attempt to control for grade and date of test in estimating the test score changes in the PISA for advantaged and disadvantaged students.

Our empirical strategy is descriptive and comparative. We first estimate the level of and changes in Brazilian disadvantaged and advantaged students' PISA scores in mathematics and reading and compare them with their counterparts in other countries, focusing on Portugal, Argentina, Chile, and Mexico in 2000-2012. Secondly, we describe the test scores gains for Brazilian students in reading/Portuguese and mathematics by family resource groups using PISA and SAEB data in the period 1995-2011 (SAEB) and 2000-2012 (PISA) to draw some tentative conclusions from these estimates concerning the changing effectiveness of Brazil's basic schooling (grades 1-8/9). We use the SAEB test rather than *Prova Brasil* in 2005-2011 because *Prova Brasil* only includes public school students; as a result, the scores of students from higher academic resource families are severely downward biased.

We find that Brazilian students have made test score gains in the first decade of the 2000s on the PISA, but much less so, if at all, on the SAEB. Brazilian gains on the PISA mathematics test are much larger than on the PISA reading test, and part of the gain on the PISA mathematics test and most of the gain on the reading test result from 15 year-old students' gradually increasing the number of years they stay in school. The gains (or lack of gains) in 1999-2011 on the SAEB are about the same in mathematics and Portuguese. Gains on the PISA test for advantaged Brazilian students are smaller than among students with low levels of family academic resources. This is also the case for the SAEB. Advantaged students' gains on the PISA mathematics test are also smaller than those for advantaged students in Chile, but larger than advantaged students' gains in Argentina and Mexico. By the PISA 2012 test, Brazilian students at all levels of family academic resources performed as well or better than students in Argentina, Colombia, and Peru, but not as well as students in Chile, Mexico, Uruguay, Portugal, or Spain.

The Argument for Comparing Test Scores by Students' Family Academic Resources

Studies have shown that various proxy measures of students' family academic resources, such as mother's education, parents' education, articles in the home, or books in the home, are correlated with students' academic achievement (for example, for the United States, Coleman et al, 1966; Jencks and Phillips, 1998; for the United Kingdom, Peaker, 1971; for PISA, see Schulz, 2005; Buchmann, 2002; Adamson, 2010; for TIMSS, see Raudenbush et al, 1996. Woessmann, 2004; Chudgar et al, 2012; for a meta-analysis across different types of tests, see Sirin, 2005).

There many reasons why a student's family academic environment could be important factor in his or her cognitive (and non-cognitive) achievement. Students raised in a family in which reading materials are readily available and where a parent or parents have attained higher levels of schooling are more likely to be exposed to more complex verbal interaction (Bryce Heath, 1983), to have been read to as a young child, to have had access to better health care and a more nutritious diet (regardless of income), to be subject to higher academic expectations once in school, and to interact with peers from similarly reading-oriented, verbal, higher academic expectation families. Whether one calls such family "investments" during early childhood and after the child enters school cultural capital (Bourdieu and Passeron, 1979), human capital (Schultz, 1961), or social capital (Coleman, 1988), the concept is the same: outside of school factors associated with family environment are influential in how well a student achieves in school. Beyond this direct influence, families with more academic resources at home are generally more motivated to gain access for their children to schools with more academically motivated students and to pay for tutoring outside school (Bray, 2006).

If students tested in various countries live, on average, in family environments (in terms of human, cultural, and social capital) that differ considerably, and family environments have an important influence on school achievement, comparisons of *average* student performance could incorrectly attribute higher or lower outcomes to educational policies when they may be the result of differing outside of school influences. Furthermore, educational policies may affect students from different environments differently. By comparing the academic performance of students in particular family and social environments over time, we can better understand the nuances of educational policies in various countries. Such comparisons are the core of our analysis in this study.

Which proxies should be used for measuring family academic resources? There is no precise way to make such comparisons between countries. PISA collects data on many characteristics that are arguably related to family resources. PISA also assembles them into an overall index called the "index of economic, social, and cultural status" (ESCS), which has the important disadvantages of combining various factors that may not be international comparable and not revealing which factors are contributing to explaining test score differences (Hauser, 2013). Although none of the possible indicators of family resource differences is entirely satisfactory, we use two in this paper: the number of books in the home (BH) and mother's education (ME) for our analysis, since they can be divided into specific categories that can be compared between Latin American countries, Spain, and Portugal. A very high fraction of students in the PISA survey answers the BH question, something less true for other important family academic resource indicator questions asked on the student questionnaires, including mother's education. The advantage of using ME and BH definitions of family academic resources is that the SAEB also asks the mother's education question from 1999-2011 and the books in the home question from 1999-2005. We note that PISA samples of students in Latin American countries are more equally distributed across categories of mother's education than BH categories. Most students in the Latin American PISA samples, including Brazil's, fall into the bottom two BH categories, 0-10 and 11-25 BH. Yet, even with the more equitable distribution across mother's education categories, a high percentage of students fall into the bottom three categories, mothers with no education, primary, and lower secondary. It is likely that the proportion of students in these three lower ME categories is biased downward.

Comparing PISA 2012 Performance

As noted, we disaggregate mathematics and reading scores in Brazil and in eight comparison countries by two different measures of family academic resources: (a) books in the home (BH), and (b) mother's education (ME). In (a), we divide students into the six BH categories from the PISA student questionnaire representing six family academic resource groups, from the least to the most advantaged. We refer to the group of students reporting 0-10 books in the home as very disadvantaged students, those with 11-25 books in the home as disadvantaged, those with 26-100 books in the home as middle advantaged students, and to those with more than 100 books in the home as advantaged students. Table 1a shows that in 2012, only 7.4 percent of Brazilian students fell into the advantaged group as defined by BH. In (b), we can also create six family resource levels from the seven categories of ME in the PISA student questionnaire. These six categories are mothers reported by students to have had "no education," "primary education" (ISCED 1), "lower secondary education" (ISCED 2), "upper secondary education" (ISCED 3A, 3B, 4), "non-university tertiary education" (ISCED 5B), and "university or graduate education" (ISCED 5A, 6).

Table 1a. PISA 2012: Proportion of Sample by Family Academic Resource Group (Books in the Home and Mother's Education), Brazil and Comparison Countries

Books in the Home	*Argentina*	*Brazil*	*Chile*	*Colombia*	*Mexico*	*Peru*	*Uruguay*	*Spain*	*Portugal*
0-10 books	33.7	44.8	25.3	37.3	44.6	34.1	37.8	9.5	21.2
11-25 books	26.6	29.3	29.8	32.0	27.7	33.3	24.5	15.0	20.9
26-100 books	25.1	18.6	29.1	22.9	18.7	23.1	23.3	31.8	30.3
101-200 books	8.4	4.3	9.5	5.6	5.2	6.3	8.1	20.8	13.8
201-500 books	3.7	1.9	4.3	1.7	2.5	2.1	4.0	14.1	9.3
More than 500 books	2.5	1.1	2.1	0.5	1.3	1.1	2.3	8.9	4.6
Mother's Education	*Argentina*	*Brazil*	*Chile*	*Colombia*	*Mexico*	*Peru*	*Uruguay*	*Spain*	*Portugal*
None	6.9	9.5	5.7	14.4	13.3	18.9	3.8	2.7	7.9
Primary	17.8	22.1	5.1	17.6	21.1	14.5	25.0	10.3	24.1
Lower Secondary	15.6	17.5	20.6	17.1	27.8	9.1	26.4	22.0	23.5
Upper Secondary	20.0	32.7	43.2	15.3	12.0	39.4	19.6	28.6	22.2
Tertiary Non-University	15.6	2.4	10.0	20.5	10.9	5.8	11.1	11.0	3.6
University	24.1	15.8	15.5	15.1	15.0	12.2	14.2	25.3	18.7

Source, OECD PISA, 2012 microdata.

We have to make some adjustments to compare scores by family resource group in 2000-2012 because the BH and ME categories used in the 2000 survey differ from the categories in subsequent surveys (2003, 2006, 2009, and 2012). In the 2000 survey, the BH categories on the student questionnaire were 0, 1-10, 11-50, 51-100, 101-251, 251-500 and more than 500 books in the home. In subsequent years the student questionnaire changed the categories to 0-10, 11-25, 26-100, 101-200, 201-500, and more than 500 books in the home. Because of these changes in categories we need to interpolate scores for Groups 2-5.[10]

For mother's education, PISA 2000 only provides the option of reporting mothers as having non-university tertiary and university as one category (ISCED 5B, 5A, and 6), but in later years, they are disaggregated into ISCED 5B and a second category, ISCED 5A, 6. We have to

[10] We estimate the interpolated scores by assuming that students' average scores increase linearly from category to category. We assume that that average score corresponded to students with the average number of books in the category—30 books. The similar social class in the 2003, 2006, and 2009 PISA samples was 11-25 books in the home—an average of 17.5 books. The next lowest social class category in 2000 was 1-10 books in the home, an average of 5 books. We assume that students with 17.5 books would score lower than those with 30 books by the proportion (17.5-5)/(30-5) of the difference in test score between categories. This is the average score we assign to the interpolated category of 11-25 books in the home (Group 2) in 2000. We make similar estimates for the interpolated categories, 26-100 books (Group 3), 101-200 books (Group 4), and 201-500 books (Group 5) for the 2000 PISA math test in each comparison country. These are the estimates we use in calculating test score differences by books in the home groups in 2000-2009.

approximate test scores for students in the non-university tertiary and the university groups in 2000 by interpolating the scores for students with ME university education in 2000 based on 2006 (Argentina and Chile did not take the test in 2003) proportions of reported ME and test score ratios for the two subgroups—those with mothers who had non-university tertiary education and those with mothers who had university education.

We want to create categories that are more comparable (in sample proportions) between our two definitions of students' family academic resources (BH and ME). Thus, we refer to students who reported that their mothers have no education or only primary education as very disadvantaged students, those who reported mothers with lower secondary education (ISCED 2) as disadvantaged, those who reported mothers with upper secondary education and non-university tertiary education (ISCED 3A, 3B, 4, and 5B) as middle advantaged, and those who reported mothers with university education (ISCED 5A, and 6) as advantaged.

Even so, the two definitions of family academic resources show somewhat different proportions of the PISA sample in the very disadvantaged, the disadvantaged, the middle advantaged and the advantaged groups, especially in the Latin American countries. For example, based on BH, the very disadvantaged Brazilian PISA 2012 group was 45 percent of the sample and the advantaged group, only 7.5 percent of the sample. Based on mother's education, the very disadvantaged group was 32 percent of the sample, and the advantaged group was 16 percent of the sample. The comparison Latin American countries have similar differences in the way the two variables we use to measure family academic resources categorize students in very disadvantaged, disadvantaged, and advantaged groups. However, one reason that this may occur is that students overestimate their mothers' education levels. It is unlikely that such high percentages of mothers educated in the late 1980s and early 1990s in Latin American countries completed university when the proportion of the population attending university was considerably lower. In Brazil, only about 10-12 percent of the age group reached higher education before 1995.[11] The percentages of students reporting mothers with higher education in the other countries in our comparison group are also suspiciously high. Thus, our estimated test scores, for the advantaged group as defined by mother's education, may underestimate the "true" average scores of advantaged students. Yet, since we are focused on changes over time, the level of scores is of less interest than the trend, and these may be similar in both definitions of advantaged and disadvantaged groups.

[11] In 2003, 30 percent of Brazilian students taking the PISA reported that their mothers had university education. As we shall show, the average PISA math and reading scores for "advantaged" Brazilian students are significantly lower in 2003 compared to 2000 and subsequent years. It is probable that this is the result of an large group of students "overestimating" their ME and therefore downwardly biasing the average score of the advantaged group.

Brazil has one of the highest proportions of students with low family academic resources among our comparison countries, whether we measure family resources by books in the home or mother's education. Seventy-two percent of the Brazilian sample reported less than or equal to 25 BH, more than the other three countries with high proportions of low family academic resources—Colombia, Mexico, and Peru. In the Brazilian sample, 34 percent of students reported mother's education of primary school completed or less, comparable with other low family academic resource student samples in Colombia, Mexico, and Peru.

At the other end of the spectrum, the proportion of the Brazilian sample of students with more than 100 BH (8 percent) was the lowest in our comparison groups, although similar to the proportion in the three other low family resource country samples. In the case of mother's education, however, the proportion of Brazilian students reporting that their mothers had some higher education (22 percent) was about the same or higher than all our comparison countries except Argentina, Colombia, or Spain.

Table 1b shows that Brazilian students with similar family academic resources to students in Argentina, Colombia, and Peru generally scored about the same or higher in both reading and mathematics on the PISA 2012. However, Brazilian students of similar family academic resources scored significantly lower than students in Chile, Mexico, Uruguay,[12] Portugal, and Spain.[13] Advantaged students in Brazil tended to have a much larger gap with their family resource counterparts in the higher scoring countries. In some cases (for example, advantaged students' mathematics scores in Brazil and Portugal) the gap is more than a standard deviation. Using mother's education as the measure of family academic resources produces the same comparative conclusions.

Table 1b. PISA 2012: Mean Student Mathematics and Reading Scale Scores by Family Academic Resource Group (Books in the Home and Mother's Education), Brazil and Comparison Countries

	Mean Mathematics Scale Scores by Books in the Home								
Books in the Home	*Argentina*	*Brazil*	*Chile*	*Colombia*	*Mexico*	*Peru*	*Uruguay*	*Spain*	*Portugal*
0-10 books	362	376	389	355	402	340	382	409	434
	(3.26)	(1.92)	(3.3)	(3.04)	(1.27)	(2.81)	(3.01)	(3.18)	(4.37)
11-25 books	384	386	407	376	413	362	405	438	462
	(3.39)	(2.47)	(3.41)	(2.88)	(1.78)	(3.11)	(3.49)	(3.45)	(4.11)
26-100 books	411	412	445	402	434	399	436	481	501
	(4.37)	(3.43)	(3.89)	(3.81)	(1.97)	(4.48)	(3.87)	(1.8)	(3.66)
101-200 books	428	426	457	415	441	429	465	508	528
	(4.96)	(6.09)	(5.18)	(6.12)	(3.08)	(7.88)	(4.95)	(2.25)	(5.08)
201-500 books	453	447	499	449	454	438	481	533	552

[12] An interesting exception is that Brazilian students with lower family academic resources, defined either by BH or ME, scored higher than low FAR Uruguayan students; the opposite was true for middle advantaged and advantaged students in Brazil and Uruguay.

[13] The standard errors of the mean scores vary according to family resource group and country because sample sizes differ for each group/country. We employ a conventional "rule of thumb" to define a statistically significant different between mean scores; namely, two standard errors.

	(6.21)	(8.87)	(6.36)	(12.43)	(5.25)	(14.39)	(7.96)	(2.62)	(4.98)
More than 500 books	413	405	480	408	449	376	479	533	551
	(10.32)	(13.2)	(8.75)	(19.01)	(6.99)	(19.76)	(13.94)	(2.43)	(7.88)
Average	388	389	423	376	413	368	409	484	487

Books in the Home	**Mean Reading Scale Scores by Books in the Home**								
0-10 books	360	394	409	378	411	353	386	406	433
	(4.06)	(2.22)	(3.88)	(3.94)	(1.50)	(3.66)	(3.22)	(3.64)	(5.61)
11-25 books	397	407	431	407	426	382	408	448	471
	(3.55)	(2.74)	(3.26)	(3.22)	(1.88)	(3.97)	(3.86)	(3.24)	(4.24)
26-100 books	425	432	460	432	445	416	439	487	503
	(4.51)	(3.11)	(3.02)	(3.72)	(2.26)	(5.35)	(4.15)	(1.81)	(3.44)
101-200 books	448	440	476	448	454	443	462	516	528
	(5.77)	(5.26)	(4.67)	(7.66)	(3.48)	(8.6)	(5.32)	(2.17)	(4.44)
201-500 books	457	464	510	471	463	456	482	534	542
	(8.86)	(7.83)	(4.79)	(10.69)	(5.45)	(15.03)	(9.13)	(2.94)	(4.71)
More than 500 books	418	417	481	425	458	389	482	528	535
	(12.03)	(13.78)	(8.17)	(21.47)	(7.82)	(21.97)	(15.63)	(3.4)	(8.38)
Average	398	412	449	413	425	370	426	481	489

Mean Mathematics Scale Scores by Mother's Education

Mother's Education	*Argentina*	*Brazil*	*Chile*	*Colombia*	*Mexico*	*Peru*	*Uruguay*	*Spain*	*Portugal*
None	345	350	373	340	382	322	337	405	452
	(5.70)	(2.55)	(5.51)	(3.99)	(2.34)	(3.39)	(5.78)	(5.71)	(7.73)
Primary	368	366	389	358	395	342	377	459	460
	(4.61)	(2.09)	(5.04)	(3.7)	(1.94)	(3.61)	(3.21)	(4.16)	(4.31)
Lower Secondary	379	379	387	368	416	350	396	468	476
	(4.09)	(2.46)	(3.51)	(3.25)	(1.58)	(3.62)	(3.32)	(2.86)	(3.88)
Upper Secondary	400	402	429	391	431	385	433	488	509
	(4.30)	(2.15)	(3.0)	(4.56)	(1.98)	(3.49)	(3.19)	(2.16)	(5.5)
Tertiary Non-University	405	403	444	389	427	424	441	486	468
	(4.06)	(6.33)	(5.06)	(3.24)	(1.89)	(6.88)	(4.2)	(2.95)	(9.79)
University	418	432	479	414	442	409	468	522	548
	(4.26)	(5.45)	(4.49)	(5.37)	(2.63)	(8.5)	(6.59)	(2.41)	(3.7)
Higher Education [a]	413	428	465	399	436	414	456	511	535

Mother's Education	**Mean Reading Scale Scores by Mother's Education**								
None	345	368	394	368	390	335	352	400	451
	(7.19)	(2.75)	(6.95)	(5.45)	(2.74)	(3.93)	(6.75)	(7.44)	(7.43)
Primary	374	385	411	380	406	353	378	470	459
	(4.79)	(2.47)	(6.07)	(4.46)	(2.01)	(4.3)	(3.5)	(3.9)	(4.63)
Lower Secondary	383	397	410	393	425	365	400	473	484
	(4.73)	(2.92)	(3.53)	(4.01)	(1.68)	(4.62)	(3.87)	(2.83)	(4.11)
Upper Secondary	405	423	450	415	443	403	434	493	513
	(4.87)	(2.5)	(2.84)	(4.69)	(2.24)	(4.19)	(4.08)	(2.41)	(3.98)
Tertiary Non-University	423	423	463	423	444	445	446	485	471
	(4.76)	(7.93)	(4.46)	(3.88)	(2.23)	(7.91)	(4.99)	(3.15)	(10.91)
University	429	444	488	442	451	430	464	526	540
	(5.08)	(4.33)	(3.73)	(5.95)	(2.88)	(9.6)	(7.0)	(2.46)	(3.72)
Higher Education [a]	427	442	478	431	448	435	456	513	529

Source, OECD PISA, 2012 microdata. Note: a. The higher education category combines "tertiary non-university" and "university". Since the 2000 PISA defines the highest level of mother's education as this combined category, when we compare 2003, 2006, 2009, and 2012 scores with 2000 scores, we use this combined definition of higher education.

To compare average scores across countries corrected for the differences in the family academic resource composition of the samples, we weighted each of the family resource groups' scores in the comparison countries by the Brazilian sample proportions. Table 2 shows the average reported and Brazilian sample weighted scores for PISA mathematics and reading using the BH category and the ME category proportions. The results are similar: when we adjust the scores for family academic resource differences in the samples, Brazil's students score higher in mathematics than students in Argentina, Colombia, and Peru, and substantially lower than students in the other comparison countries. In reading, when we use BH weights, Brazilian students score substantially higher than students in Argentina and Peru, about the same as students in Colombia and Uruguay, and lower than students in the other comparison countries. When we use the ME weights, the results are the same except that students in Brazil score higher than students in Colombia and lower than students in Uruguay.

Table 2. PISA 2012: Mean Student Mathematics and Reading Scores Adjusted for Sample Family Academic Resource Differences, Brazil and Comparison Countries

Test Score Category	*Argentina*	*Brazil*	*Chile*	*Colombia*	*Mexico*	*Peru*	*Uruguay*	*Spain*	*Portugal*
2012 Reported Math Score	388	389	423	376	413	368	409	484	487
2012 Math Score, Brazil BH Weights	383	389	410	375	414	363	405	439	462
2012 Reported Reading Score	396	407	441	403	424	384	411	488	488
2012 Reading Score, Brazil BH Weights	389	407	430	402	425	379	408	442	465
2012 Reported Math Score	388	389	423	376	413	368	409	484	487
2012 Math Score, Brazil ME Weights	387	389	416	379	418	368	411	476	492
2012 Reported Reading Score	396	407	441	403	424	384	411	488	488
2012 Reading Score, Brazil ME Weights	393	407	435	404	428	384	413	481	493

Test Score Category	*Argentina*	*Brazil*	*Chile*	*Colombia*	*Mexico*	*Peru*	*Uruguay*	*Spain*	*Portugal*
2012 Reported Math Score	388	389	423	376	413	368	409	484	487
2012 Math Score, Brazil BH Weights	383	389	410	375	414	363	405	439	462
2012 Math Score, Brazil ME Weights	387	389	416	379	418	368	411	476	492

2012 Reported Reading Score	396	407	441	403	424	384	411	488	488
2012 Reading Score, Brazil BH Weights	389	407	430	402	425	379	408	442	465
2012 Reading Score, Brazil ME Weights	393	407	435	404	428	384	413	481	493

Source, OECD PISA, 2012 microdata.

Trends in PISA Scores, 2000-2012

PISA has been administered every three years since 2000. This gives us the opportunity to estimate changes in PISA mathematics scores over time. By observing such changes, we can assess how Brazil's academically disadvantaged and advantaged students increased their performance on the PISA test.14 We can also compare Brazilian students' performance over time to students' performance in several other Latin American countries and in Portugal and Spain. We make our estimates by family academic resource group, because changes over time in the composition of a country's test takers by books in the home or mother's education can affect a country's average score while masking real changes (or lack of change) in the performance of that country's students.

Tables 3a and 3b shows that Brazilian students made large gains in the PISA mathematics test across family academic resource groups in the period 2000-2012, and much smaller gains in the PISA reading test. The gains in Brazil were larger in both math and reading for lower and middle family academic resource students than for higher resource students, although when FAR is measured by mother's education, the differences are less apparent, in part because the BH definition of FAR is a much more "exclusive" definition of "advantaged" (only 10 percent of students in 2000 and 8 percent in 2012). Table 3a and 3b also compare gains by Brazilian students in this period with gains by students in other Latin American countries and Spain and Portugal. Colombia and Uruguay are not shown because they did not take the PISA test in 2000. Lower (<26 BH; mother has zero or primary education) and higher (> 100 books in the home; mother has university education) family academic resource Brazilian students' gains in mathematics are as high or higher than any comparison country students' gains except Peru's. Yet in reading, lower and higher family academic resource students in Brazil only made larger gains than students in Argentina, Mexico (particularly among higher resourced students) and in the ME definition of FAR, Spain.

[14] According to the OECD, the 2000 PISA mathematics test score may not be completely comparable to later year scores. However, the trends in 2000-2003 math scores by family academic resource group are not substantially different from trends in reading scores across the eight countries we study so feel confident in the comparability of our estimated trends.

Table 3a. PISA Gains in Mathematics and Reading, 2000-2012, by Books in the Home Categories and Country

			Mathematics				
Books in the Home Category	*Argentina*	*Brazil*	*Chile*	*Mexico*	*Peru*	*Spain*	*Portugal*
0-10 books	25.7	63.1	54.4	41.3	75.4	8.4	35.5
11-25 books	19.5	54.6	44.8	38.9	74.1	21.3	39.6
26-100 books	-8.2	56.7	34.4	31.7	75.4	24.0	47.3
101-200 books	-17.0	48.7	29.2	17.1	77.0	18.6	48.4
201-500 books	-23.4	43.7	63.7	-0.9	85.6	21.1	53.5
> 500 books	-42.3	36.8	56.8	23.8	34.7	6.1	35.7
Average	0.9	54.6	39.1	26.0	76.0	8.0	33.3
>100	-28.0	42.5	40.5	7.0	70.5	11.2	43.3
			Reading				
Books in the Home Category	*Argentina*	*Brazil*	*Chile*	*Mexico*	*Peru*	*Spain*	*Portugal*
0-10 books	-7.0	18.6	45.4	23.6	61.3	-8.7	20.2
11-25 books	-1.9	13.8	40.6	19.6	61.0	9.9	34.4
26-100 books	-23.2	14.3	27.8	5.8	49.8	8.6	32.6
101-200 books	-24.7	1.6	21.8	-8.2	54.0	12.4	27.1
201-500 books	-39.6	9.5	44.6	-30.6	63.7	10.1	18.3
> 500 books	-71.1	-5.8	34.2	-10.5	13.7	-5.3	2.4
Average	-22.3	10.5	31.8	1.6	57.1	-4.6	17.6
>100	-41.0	-0.3	27.0	-20.3	49.3	3.4	14.8

Source: OECD, PISA microdata, 2000, 2003, 2006, 2009, 2012.

Table 3b. PISA Gains in Mathematics and Reading, 2000-2012, by Mother's Education Categories and Country

				Mathematics			
Mother's Education Category	*Argentina*	*Brazil*	*Chile*	*Mexico*	*Peru*	*Spain*	*Portugal*
None	0.8	62.9	78.8	36.4	50.5	-5.1	86.5
Primary education	23.0	57.2	45.5	27.3	79.4	4.2	20.2
Lower secondary education	-1.9	46.3	31.0	20.7	63.9	-20.3	17.4
Upper secondary education	-28.7	30.4	29.9	-4.6	64.2	-12.9	49.2
Tertiary Non-University	-18	38	18	0	68	0	3
University	-33	53	27	1	61	-8	28
Average	0.9	54.6	39.1	26.0	76.0	8.0	33.3
				Reading			
Mother's Education Category	*Argentina*	*Brazil*	*Chile*	*Mexico*	*Peru*	*Spain*	*Portugal*
None	-2.7	16.4	70.2	14.7	66.8	-16.2	76.0
Primary Education	-11.0	11.1	44.9	1.8	58.8	-4.0	3.2
Lower Secondary Education	-26.4	3.5	29.4	-1.8	36.5	-28.8	14.0
Upper Secondary Education	-48.9	-8.2	21.4	-35.7	47.7	-23.4	25.9
Tertiary Non-University	-26	2	11	-30	56	-27	-14
University	-47	3	16	-23	41	-11	2
Average	-22.3	10.5	31.8	1.6	57.1	-4.6	17.6

Source: OECD, PISA microdata, 2000, 2003, 2006, 2009, 2012.

When we chart the progression of gains by Brazilian students across the five applications of PISA tests (2000, 2003, 2006, 2009, and 2012) they vary for mathematics and reading and somewhat by whether we measure family academic resources by books in the home or mother's education. In Table 4, Brazilian students' performance is divided into "very disadvantaged," "disadvantaged," and "advantaged," as defined earlier, and compared with Argentine, Chilean, Mexican, and Portuguese (one of the European countries) students' test scores. These (plus Spain) are the countries for which we have results for at least four of the five PISA rounds.

The Table 4 results confirm those in Tables 3a and 3b. Brazilian "very disadvantaged" and "disadvantaged" students made large and steady gains in the PISA mathematics test in 2000-2012. Brazilian advantaged students also made substantial gains in mathematics in this period, mainly in 2000-2003 when we define advantaged by BH and mostly after 2003 when measure advantaged by the broader definition of mother's higher education. The Brazilian gains in reading were smaller, as noted, and the pattern of gains from test to test varies considerably across family resource group and the measure of family resource group. In some cases, the reading scores declined in 2000-2003 and rose thereafter, and for advantaged students particularly, they fell in 2000-2003 and increased moderately (BH) to slightly (ME) after 2003.

When comparing Brazilian students' gains with this other group of countries, it is notable that advantaged Chilean students make substantial gains in reading as well as mathematics no matter how we define family academic resources. Advantaged Portuguese students also made gains after 2003 in reading. Only advantaged Argentine students did not make gains in mathematics, and also disadvantaged students in Argentina defined by ME among comparison countries did not make substantial gains in mathematics.

Table 4. Trends in PISA 2000-2012 Mathematics and Reading Performance by Family Academic Resources (books in the home and mother's education) and Country

	Books in the Home Definition of Advantage									
	Mathematics					*Reading*				
Country/Family Resources	*2000*	*2003**	*2006*	*2009*	*2012*	*2000*	*2003**	*2006*	*2009*	*2012*
Brazil Very Disadvantaged [a]	313	334	349	366	376	375	384	372	392	394
Argentina Very Disadvantaged	336	335	334	349	362	367	348	328	352	360
Chile Very Disadvantaged	334	350	365	385	389	364	380	396	410	409
Mexico Very Disadvantaged	360	369	383	399	402	387	384	388	404	411
Portugal Very Disadvantaged	398	416	418	434	434	413	428	412	439	433
Brazil Disadvantaged [b]	332	353	369	383	386	393	405	393	409	407
Argentina Disadvantaged	365	369	373	379	384	399	381	363	390	397
Chile Disadvantaged	362	378	394	405	407	390	407	424	435	431
Mexico Disadvantaged	374	380	400	414	413	406	395	407	423	426
Portugal Disadvantaged	422	431	431	453	462	436	449	445	462	471

Brazil Advantaged [c]	386	419	425	428	428	443	441	444	453	443
Argentina Advantaged	460	467	446	450	432	486	464	442	462	445
Chile Advantaged	431	450	469	466	471	459	478	496	494	486
Mexico Advantaged	439	433	452	463	446	478	450	455	470	457
Portugal Advantaged	497	510	509	533	540	519	516	516	527	534

	Mother's Education Definition of Advantage									
	Mathematics					*Reading*				
Country/Family Resources	*2000*	*2003**	*2006*	*2009*	*2012*	*2000*	*2003**	*2006*	*2009*	*2012*
Brazil Very Disadvantaged [d]	306	330	335	360	361	372	330	361	384	380
Argentina Very Disadvantaged	344	344	343	353	361	383	359	336	359	366
Chile Very Disadvantaged	339	352	364	382	380	362	380	397	408	402
Mexico Very Disadvantaged	362	361	377	391	390	396	361	379	396	400
Portugal Very Disadvantaged	435	445	443	457	458	452	445	447	463	457
Brazil Disadvantaged [e]	333	355	367	383	379	374	401	390	410	397
Argentina Disadvantaged	381	378	375	385	379	385	379	372	395	383
Chile Disadvantaged	356	367	378	393	387	366	389	413	421	410
Mexico Disadvantaged	395	392	414	421	416	404	407	421	427	425
Portugal Disadvantaged	459	476	471	473	476	456	494	481	481	484
Brazil Advantaged [f]	379	366	403	420	432	441	407	422	441	444
Argentina Advantaged	451	436	421	430	418	477	445	413	444	429
Chile Advantaged	450	463	475	474	479	472	490	508	494	488
Mexico Advantaged	436	388	442	450	442	474	404	443	457	451
Portugal Advantaged	525	518	521	545	548	540	519	531	536	540

Source: OECD, PISA microdata, 2000, 2003, 2006, 2009, 2012. Notes: * Since Argentina and Chile did not take the PISA test in 2003, their scores are interpolated (numbers in red). a. 0-10 BIH; b. 10-25 BIH; c. >100 BIH; d. ME = primary education or less; e. ME = secondary education; f. ME = university education.

Correcting Brazilian PISA Gains for Changes in the Test Date

PISA differs from other tests such as the Trends in International Mathematics and Science Survey (TIMSS) and national surveys such the SAEB because the target student population is defined by age (15 year-olds) rather than grade. Thus, students surveyed in the PISA in countries such as Brazil and other Latin American countries are distributed over a number of grades. Even in most developed countries, 15 year-olds in the PISA survey are concentrated in two grades, and not always the same ones (OECD 2010a; 2013). Ruben Klein (2011) has argued that the date of the PISA test in Brazil changed twice in the 2000-2009 period, but apparently stayed the same in 2012 as in 2009. According to Klein, the changes in 2000-2009 resulted in increases in the grade level of the students surveyed and therefore biased upward changes in the results over time. In 2003 and 2006, the average student surveyed was two months older than in the 2000 survey, and in 2009, the average student was six months older than in the 2000 survey. In 2012, according to the OECD, the test date was moved forward again and the average student surveyed was again only two months older than in 2000, reducing the bias in comparing with that base year.

In this section, we will apply a modified version of Klein's methods to estimate how much the PISA mathematics and reading scores of Brazilian students in disadvantaged and advantaged family academic resource groups (books in the home) changed in 2000-2012. We then assess how the Brazilian test-date adjusted gains compare with gains for students in other countries.

Klein corrects the reported PISA test scores for Brazil in reading, mathematics, and science for these test date changes in two ways: first, he weights the reported scores for each test year by grade with the sample proportions by grade for a constant test year—for example, the mean test scores of students in each grade in 2000, 2003, 2006, and 2009 are weighted by the proportions in each grade for the test year 2000 to get an average test score in each subject as if the sample proportions were always as in the year 2000. Second, he estimates an average test score in each test year only for students born in the months common to three of the four test dates and all four test dates; i.e., from May 1 to December 31 or from July 1 to December 31.

Klein concludes that Brazilian students had lower actual increases in test scores than reported by the OECD (OECD, 2010b). Using the first method (weighting by proportions in a constant year), he estimated that scores in 2000-2009 declined in reading (rather than the 16 point increase reported), increased by 22-27 points in math, depending on the year used to weight the gains, compared to the 52 point gain reported, and increased 4-7 points in science rather than the 30 point increase reported. Using the second method (constant age group), Klein estimated that the corrected gains were 11 points in reading, 42 points in math, and 29 points in science. Thus, it appears that the lower bound (first method) may not take into effect the increase in average grade attended by 15 year-olds in Brazil, whereas the upper bound (second method) may.

Klein also makes correction for changes in the test date in other countries of interest to use—namely Argentina, Chile, and Mexico. Mexico has the largest changes in test dates, but in different directions: between the 2000 and 2003 surveys, the sample shifted dates so that the those sampled were younger in 2003; between 2003 and 2006/2009, the sample date shifted so that those sampled were older than in 2003 but still one month younger than in 2000. In each case, Klein uses only the first method to adjust the scores, thus assuming that the average grade attended by 15 year-olds remained the same (proportion in each grade constant) in the years affected by the change in test date.

Applying Klein's Corrections to Family Academic Resource Groupings

We estimated the proportion of students sampled in each year by grade for two family academic resource groups, 0-10 books in the home and more than 100 books in the home. We call the first "very disadvantaged" and the second, "advantaged." Both groups' definitions are the same as we used earlier in our analysis. Table 5 shows that Brazilian very disadvantaged students were much more likely to be in 7th and 8th grade than in 9th, or, in later years, in 10th grade, than advantaged students, who are mostly in 9th and 10th grade.

Klein's argues that there was a particularly large shift of students sampled from lower to higher grades from 2006 to 2009, when the test was applied later in the year and the birthdate used to define who would be sampled rose by several months (Klein, 2011). We can observe this for both FAR groups in Table 5.

In 2012, PISA shifted its sample up one grade and did not sample any 15 year olds in 7th grade, limiting the sample to the 8th-12th grades. A law passed in 2006 dropped the age of initial enrollment, and in 2007, Brazilian children in 60 percent of schools began entering the first grade of "ensino fundamental" (EF) a year younger. In turn, EF schools have extended the first cycle (first to fourth grades) from four to five years. The second cycle is still four years long and now ends in 9th grade. Secondary school (EM) remained a three-year program, but moved from 9th-11th grade to 10th-12th grade.

At the same time, the Brazilian school system renumbered all its grades to account for the one-year increase in EF. A 15 year-old 8th grader in 2009 is a 9th grader in 2012, a 9th grader in 2009 is a 10th grader in 2012, and so forth. However, the 15 year-olds sampled in 2012 have not attended schools a year longer—the first 15 year-olds who entered Brazilian schools a year earlier will begin showing up in the 2015 PISA, and the full impact on PISA results will be felt in 2018. In 2012, we can consider that the grade number change is simply a renaming of the grade without implications for curriculum exposure or opportunity to learn.

Table 5. Brazil PISA: Proportion of Students in Sample, Very Disadvantaged and Advantaged Students, by Grade Enrolled, 2000-2012

0-10 Books in the Home (Very Disadvantaged)						
			Grade			
Year	*7*	*8*	*9*	*10*	*11*	*12*
2000 Math	20.69	28.13	43.93	7.25		
2000 Reading	20.07	28.28	44.59	7.06		
2003	16.52	26.53	41.34	15.03	0.58	
2006	13.89	25.01	45.96	14.51	0.63	
2009	8.90	21.95	37.77	29.60	1.78	
2012	----	9.67	17.15	34.66	36.53	1.99

More than 100 Books in the Home (Advantaged)						
			Grade			
Year	*7*	*8*	*9*	*10*	*11*	*12*
2000 Math	11.48	19.21	61.00	8.31		
2000 Reading	10.27	17.68	59.32	12.73		
2003	9.23	19.66	46.47	24.33	0.31	
2006	5.98	13.93	55.86	24.00	0.24	
2009	4.48	11.72	37.01	44.56	2.23	
2012	----	4.39	9.51	32.30	49.88	4.69

Source: OECD, PISA microdata, 2000, 2003, 2006, 2009, 2012.

Table 6a shows that in 2000-2009 the estimated PISA mathematics scores increased for Brazilian students within each grade for both very disadvantaged and advantaged students in 2000-2009 (only exception, 9th grade for advantaged students), suggesting that mathematics performance on the PISA really did increase in Brazil during this period. Many of the increases within grade are considerably smaller than that reported by the OECD for the Brazilian sample as a whole. The gains for advantaged students also tend to be somewhat smaller than very disadvantaged students.

The opposite is true for reading scores—in almost every grade for Brazilian disadvantaged and advantaged students scored lower in 2009 than in 2000 on the PISA reading test (Table 6b). If we shift the 2012 scores over by a grade, the same lack of increase in reading scores holds for 2000-2012 in every grade. The declines for advantaged students tend to be larger than for disadvantaged students. The only exception is for the small percentage of advantaged students in the 11th/12th grade in 2000-2012. They had a large increase in reading scores.

In both mathematics and reading, the scores for the very disadvantaged students are lower than for advantaged students, as we would expect. The differences get larger in the 9th/10th and 10th/11th grades, where most of the advantaged 15 year-old students are found. We cannot say whether the lower test scores of disadvantaged students are partly "caused" by less exposure to subject matter (being in a lower grade because of a late school start) or whether lower test scores reflect lower academic ability or spending their school years in worse schools, both of which could cause disadvantaged students to repeat and be in a lower grade.

Table 6a. Brazil PISA: Mean Mathematics Scores of Students in Sample, Very Disadvantaged and Advantaged Students, by Grade Enrolled, 2000-2012

			0-10 Books in the Home (Very Disadvantaged)			
			Grade			
Year	*7*	*8*	*9*	*10*	*11*	*12*
2000	251	296	340	395		
2003	268	295	362	397	412	
2006	293	312	368	403	346	
2009	318	334	365	402	425	
2012	---	319	332	374	411	433
			More than 100 Books in the Home (Advantaged)			
			Grade			
Year	*7*	*8*	*9*	*10*	*11*	*12*
2000	241	318	424	460		
2003	290	345	452	465	351	
2006	292	351	442	464	336	
2009	302	340	411	474	481	
2012	---	313	346	412	463	455

Source: OECD, PISA microdata, 2000, 2003, 2006, 2009, 2012.

Table 6b. Brazil PISA: Mean Reading Scores of Students in Sample, Very Disadvantaged and Advantaged Students, by Grade Enrolled, 2000-2012

			0-10 Books in the Home (Very Disadvantaged)			
			Grade			
Year	*7*	*8*	*9*	*10*	*11*	*12*
2000	320	357	401	436		
2003	312	347	409	453	457	
2006	306	325	398	432	406	
2009	315	346	396	439	455	
2012	---	319	339	393	436	456
			More than 100 Books in the Home (Advantaged)			
			Grade			
Year	*7*	*8*	*9*	*10*	*11*	*12*
2000	320	372	470	517		
2003	347	368	481	460	338	
2006	306	350	462	493	393	
2009	299	349	437	504	534	
2012	---	302	360	425	480	482

Source: OECD, PISA microdata, 2000, 2003, 2006, 2009, 2012.

Using Klein's first method of weighting these scores by grade for each of the two family academic resource groups (0-10 BH and >100 BH), we show in Table 7 how average scores behaved from 2000 to 2012 for very disadvantaged and advantaged students when we apply the PISA 2000 grade distribution to subsequent test years and when we apply the PISA 2012 grade distribution to previous test years.[15] We find that very disadvantaged students have substantially large mathematics gains in 2000-2012 of 31-41 points depending on the set of weights used, and that the gains are fairly steady over the nine years of testing. Advantaged students show much smaller gains in mathematics, but notably, they made large gains in 2000-2003, and declined subsequently.

[15] When we use the 2012 weights, we assume that the 8th grade proportion is equivalent to the 7th grade proportion, the 9th grade to the 8th grade proportion, and so forth.

We also find that reading test scores declined or remained not significantly lower for disadvantaged students (depending on the grade weights used) and declined more for advantaged students. The decline is particularly notable using the 2000 weights, which suggests that the decline in reading scores was much greater among higher FAR students in lower grades.

Table 7. Brazil PISA: Mean Mathematics and Reading Scores Adjusted for Changed Sample Proportions in Various Grades, Very Disadvantaged and Advantaged Students, 2000-2012.

	Adjusted Mathematics Scores			
Year of Test	*0-10 Books in the Home, 2000 Weights*	*0-10 Books in the Home, 2012 Weights*	*> 100 Books in the Home, 2000 Weights*	*> 100 Books in the Home, 2012 Weights*
2000	313	345	386	425
2003	326	347	414	436
2006	339	364	409	433
2009	349	370	390	433
2012	354	376	397	428
	Adjusted Reading Scores			
Year of Test	*0-10 Books in the Home, 2000 Weights*	*0-10 Books in the Home, 2012 Weights*	*> 100 Books in the Home, 2000 Weights*	*> 100 Books in the Home, 2012 Weights*
2000	375	399	443	455
2003	375	406	445	447
2006	361	389	430	457
2009	369	396	416	460
2012	366	394	408	443

Source: OECD, PISA microdata, 2000, 2003, 2006, 2009, 2012.

Correcting for Higher Grade Attainment, 2000-2012

Klein's method assumes that all of the increase in grade level occurred because of the changes in the date of the test, which, relative to the 2000 test year, increased the average age of students, hence the likelihood that they would be in a higher grade on the test date. However, the average grade of attendance did increase among Brazilian students in 2000-2012 independent of the test date, and even without accounting for the year earlier entry that began in 2008. We should therefore consider the estimates of PISA gain controlling for grade drift a "lower bound" estimate, and, as Klein interpreted it, an estimate of the increase in the "pure quality" of Brazilian education. This interpretation of increases in educational quality is also implicit in OECD publications, as well as the studies pushing "quality of education" as a main driver of economic growth (Hanushek et al, 2013). If we were to take that interpretation seriously, the quality of mathematics education in Brazil in 2000-2012 increased considerably for low FAR students but hardly at all for higher FAR students, and reading instruction became slightly worse for low FAR students but considerably worse for high FAR students.

However, assuming that students learn more by staying longer in school, attaining higher grades should, in and of itself, raise a student's PISA score. In the Brazilian case, there is strong evidence that with the reform of 2006, those pupils who entered school a year earlier in 2007 did score about 0.25 standard deviations higher because of that extra year on the 2011 *Prova Brazil* fifth grade test than students who did not enter early (Martins, 2014). Therefore, when Brazilian students spend more years in school, it is likely that they learn more.

We can approximate the increase in average grade attended by students in PISA test years using Klein's data on the grade distribution of 15 year-old students at the June 30th cutoff in the 2000 PISA test application and the December 31st cutoff in the 2009 PISA application, which was also the cutoff data in the 2012 PISA application.[16] Our estimates of the average grade are shown in Figure 1. From the curve in Figure 1, the change in grade attained in 2000-2012 assuming the PISA 2000 definition of 15 year-olds is 8.80 minus 8.45 years, or 0.35 years. Assuming the 2009/2012 definition, the gain in grade is 0.47 years.

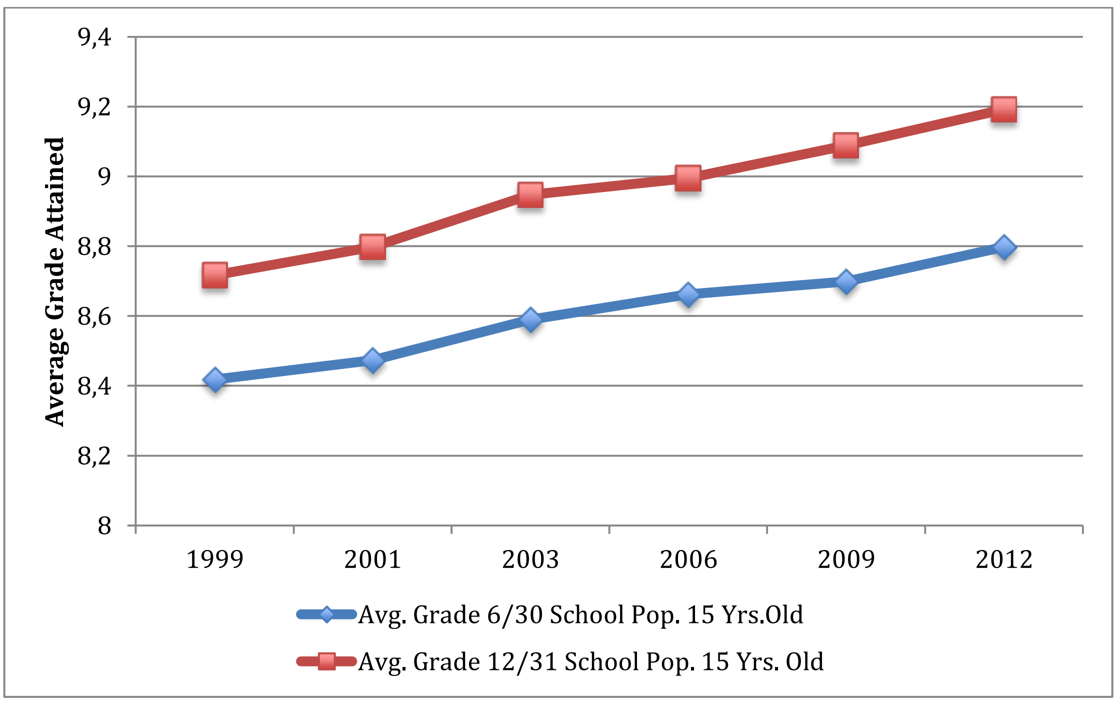

Figure 1. Brazil PISA: Increase in Average Grade Attended by Sampled Students, 2000-2009, Assuming 2000 and 2009 Age Definitions of Students. Source: Estimated from Klein, 2011 and OECD, PISA microdata –test scores by grade, 2000, 2003, 2006, 2009, 2012.

When we apply the estimated change in grade level to the estimates of test score by grade in the various test years for the very disadvantaged and advantaged groups we employ in our estimates, we find that very disadvantaged Brazilian students added about 15-17 points in PISA math score and 15-21 points in PISA reading score because in 2012 they were likely to be in a higher grade than in

[16] Correspondence with Ruben Klein.

2000 regardless of the date of the test. As estimates we made for Table 7, we assume that in 2012, grade 8 is equivalent to grade 7 in earlier years, grade 9 to grade 8, and so forth. Advantaged students added even more points from the likelihood of being in a higher grade because the average test scores of advantaged students tended to have a higher grade-achievement gradient in both the test years 2000 and 2012. Advantaged Brazilian students added 25-37 points in math and 26-34 points in reading scores from the likelihood of being in a higher grade when they took the 2009 PISA test than when they took the 2000 test, regardless of the date of the test.[17]

The summaries of these calculations in Table 8 show that Brazilian student gains in PISA mathematics tend to be substantial, particularly for very disadvantaged students, and may also be large for advantaged students, depending on the assumptions of increased grade attainment in 2000-2012. The results also show that gains in PISA reading have been much smaller, and may have been negative, depending on the assumptions made about gains from increased grade attainment, especially for advantaged students. The lower bound estimates conform to Klein's estimates using constant grade distributions across PISA test years, and the upper bound estimates represents the assumption that students learn more as they stay in school longer (the average grade level attained by the 15 year-old population increases over time), regardless of how 15 year-olds are defined by the data of the test.

The upper bound estimates in Table 8 are generally the same or smaller than the gains in 2000-2012 reported directly from the PISA scores disaggregated by family academic resources in Table 3a. Very disadvantaged and advantaged Brazilian students' gains in math of 63 points and 43 points are as large or larger than the 48/56 (<10 BH) and 28/48 points (>100 BH) upper bound gains in Table 8. In reading, the gain of 19 points in 2000-2012 reported for very disadvantaged students in Table 3a is as large or larger than the 6-16 point upper bound gain shown in Table 8, but the gain for advantaged students estimated directly from "uncorrected" PISA scores is the same or *smaller* than the upper bound "corrected" -1/14 point gain for advantaged students shown in Table 8.

As mentioned, Klein also attempts to estimate the effects of changing dates of PISA tests in Argentina, Chile, and Mexico—countries of interest to us for comparison purposes. In Argentina, he adjusts the reported PISA test score gains upward because of test date changes, but in Chile and Mexico, the gains are adjusted downward—only slightly in Mexico but substantially in Chile.

[17] This assumes that disadvantaged and advantaged Brazilians in the PISA samples had the same increases in grade level attained in the 2000-2012 period of the PISA tests. We have no evidence that confirms this assumption, although it seems likely that with the large expansion of lower and upper secondary schooling in this period, very disadvantaged students would be more likely to increase attainment more rapidly than advantaged children. If this were true, we are underestimating the gains for very disadvantaged pupils and overestimating the gains for advantaged pupils.

Nevertheless, these conform to his lower bound estimates for Brazil (first method). Chilean secondary school enrollment and completion expanded quite rapidly in the first decade of this century, suggesting that using constant grade weights to estimate test score gains probably underestimates the "true" increase in Chilean PISA test scores.

If we compare Argentine, Chilean, and Mexican student PISA performance in math and reading with Klein's adjustments, we would still conclude (as above) that Brazilian students made as large or larger gains than students in those three countries in mathematics in 2000-2012, made about the same low gains in reading as Mexico but did relatively better than Argentina, and made considerably lower gains in reading than Chile (see Table 8).

Table 8. Brazil PISA: Student Test Score Gains in Mathematics and Reading Under Different Adjustment Assumptions, 2000-2012

	Adjusted Mathematics Scores			
	0-10 Books in the Home, 2000 Weights	*0-10 Books in the Home, 2012 Weights*	*>100 Books in the Home, 2000 Weights*	*>100 Books in the Home, 2012 Weights*
Gain Constant Grade (Lower Bound)	41	31	11	3
Gain from Attaining Higher Grade	15	17	37	25
Total Gain (Upper Bound)	56	48	48	28
	Adjusted Reading Scores			
	0-10 Books in the Home, 2000 Weights	*0-10 Books in the Home, 2012 Weights*	*>100 Books in the Home, 2000 Weights*	*>100 Books in the Home, 2012 Weights*
Gain Constant Grade (Lower Bound)	-9	-5	-35	-12
Gain from Attaining Higher Grade	15	21	34	26
Total Gain (Upper Bound)	6	16	-1	14

Source: OECD, PISA microdata, 2000, 2003, 2006, 2009, 2012.

Brazilian Student Gains on the SAEB Test

Brazil has tested its students nationally in the 4th/5th and 8th/9th grades for almost 20 years. This is called the SAEB test (based on a large sample of schools nationwide). After 2005, the *Prova Brasil* was also given to all students in public schools with 20 or more students in the same two tested grades. Although SAEB was applied to students in both private and public schools, the *Prova Brasil* was only given to public school students. The results of the SAEB test were not published in 2007 and 2009, but are available for 2011. We can therefore chart scores for 8th/9th graders over the same period as the PISA test for students, estimating scores for groups of students with different levels of family academic resources (books in the home and mother's education). Since many advantaged students attend private schools and only the SAEB test applies the test in private schools, we will focus on the SAEB test in the period 1995-2011.

Several limitations exist in charting mean mathematics and Portuguese test results over the seven test applications in 1995-2011 because books in the home are not included in the student questionnaire in 1995, 1997, and 2011, and the categories for mother's (and father's) education change from the earlier years in 2003 and 2005, and then again in 2011. We present results with the data we have on books in the home (Table 9a), and show two different estimates for mean scores for students grouped by mother's education (Tables 9b and 9c). The first (Table 9a and Figure 2b) defines mother's education groups in one way in 1995-2001, conforming to the group definitions in those years, and a second way in 2003-2011, conforming to the group definition in 2011. The second (Table 9c and Figure 2c) is able to unify definitions for 1995-2005, but in that table, the group definitions are different in 2011. As a result of that different definition in 2011, mean scores are biased downward in 2011 relative to earlier years' scores.

The results suggest that there may have been significant increases in mean mathematics and Portuguese SAEB scores for $8^{th}/9^{th}$ graders in 2005-2011, but these gains did not increase scores to earlier levels. We do not observe the differences in gains between mathematics and reading (Portuguese) reported in the PISA results. Mathematics and Portuguese scores declined similarly in 1995-1999, leveled off (except for students with university educated mothers) in 1999-2005, and apparently rose for all groups but the most advantaged in both subjects in 2005-2011. In the second version of our mother's education estimates (Table 9c, Figure 2c), note that the definition of mother's education in 2011 is such that the mean score is biased downward except for the university complete category (shown separately in Figure 2c). The first version of the estimates (Table 9b, Figure 2b) more accurately reflects the "true" gains in 2005-2011.

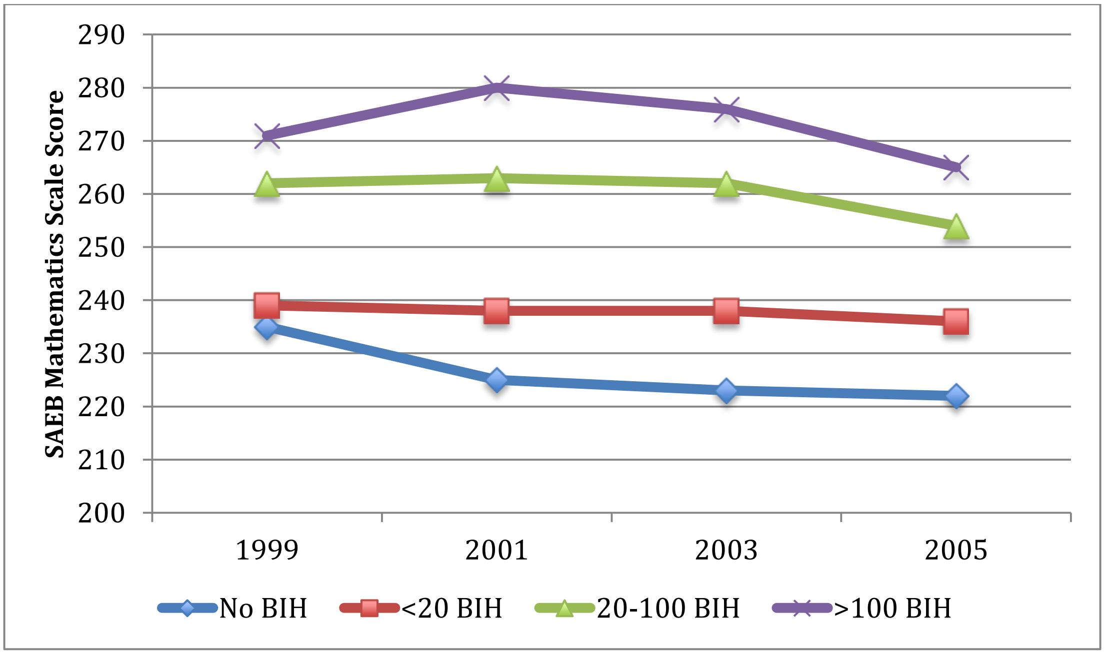

Figure 2a. Brazil: SAEB Mean Mathematics Scores by Students' Reported Books in the Home, 1999-2005 (not available 2011).
Source: INEP, SAEB microdata, 1999, 2001, 2003, 2005.

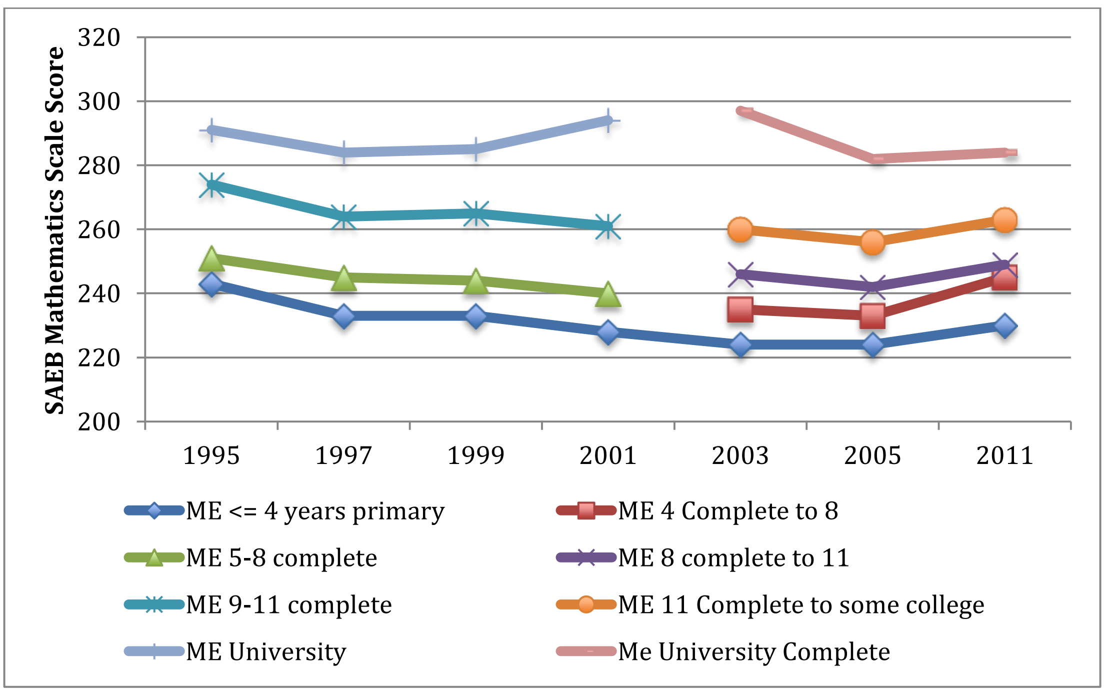

Figure 2b. Brazil: SAEB Mean Mathematics Scores by Students' Reported Mother's Education, 1995-2011, Definitions of Mother's Education, Version I.
Source: INEP, SAEB microdata, 1999, 2001, 2003, 2005, 2011.

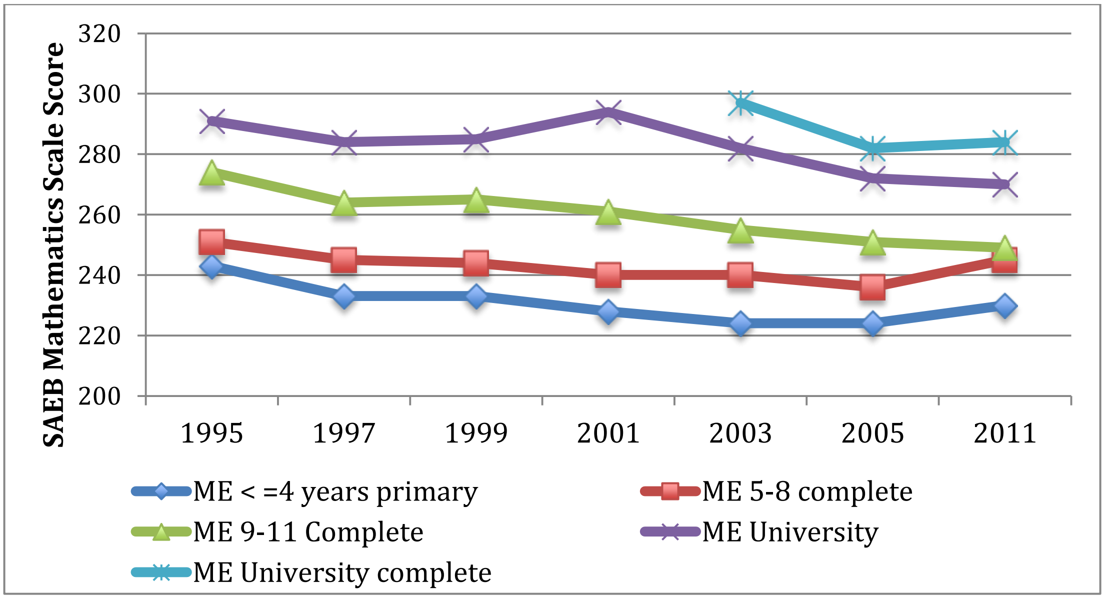

Figure 2c. Brazil: SAEB Mean Mathematics Scores by Students' Reported Mother's Education, 1995-2011, Definitions of Mother's Education, Version II.
Source: INEP, SAEB microdata, 1999, 2001, 2003, 2005, 2011.

The results of the SAEB test therefore conflict with the results of the PISA mathematics test, which has Brazilian students making substantial gains in 2000-2012 in PISA but not SAEB. There is agreement, however, that SAEB Portuguese gains are small and so are PISA reading gains. There is also some agreement in that the gains may be somewhat larger in 2005-2011 for very disadvantaged and disadvantaged students on both PISA and SAEB. There are many possible explanations for the difference in the gains on the two tests. For example, the SAEB tests to an assumed version of a Brazilian curriculum (states and municipalities very in their curricula and use a wide variety of textbooks) rather than an assumed version of what 15 year-olds worldwide should know in the tested subjects, so may better reflect the gains that students are making on what they are being taught. Students may not be making much progress in how much mathematics they are learning in terms of what they are seeing in their classrooms. The SAEB is also a much larger sample than the PISA. Could there be some problems with the PISA sample as it expanded in 2000-2012?

Table 9a. Brazil: 8th/9th Grade SAEB, Mean Student Scale Scores by Books in the Home, 1999-2005

	Family Academic Resources Measured by Books in the Home							
	Portuguese				**Mathematics**			
Year	*None*	*< 20*	*20 - 100*	*> 100*	*None*	*< 20*	*20 - 100*	*> 100*
1999	226	225	246	253	235	239	262	271
	(0.58)	(0.59)	(0.69)	0.98)	(0.57)	(0.63)	(0.73)	(0.95)
2001	216	232	253	263	225	238	263	280
	(0.61)	(0.30)	(0.43)	(0.80)	(0.54)	(0.28)	(0.46)	(0.82)
2003	213	227	247	255	223	238	262	276
	(0.79)	(0.34)	(0.49)	(0.88)	(0.72)	(0.34)	(0.51)	(0.98)
2005	217	229	247	254	222	236	254	265
	(0.80)	0.37)	(0.52)	(0.94)	(0.79)	(0.37)	(0.56)	(1.03)

Source: INEP, SAEB microdata, 1999, 2001, 2003, 2005.

Table 9b. Brazil: 8th/9th Grade SAEB, Mean Student Scale Scores by Mother's Education, 1995-2011

	Family Academic Resources Measured by Mother's Education									
	Portuguese					Mathematics				
Test Year	*Less than or Equal to Grade 4*	*Complete Grade 5*	*Complete Grade 8*	*Complete Secondary*	*University Degree*	*Less than Grade 5*	*Complete Grade 5*	*Complete Grade 9*	*Complete Secondary*	*University Degree*
1995	244[1]	-	255[2]	273[3]	287[4]	243	-	251	274	291
	(0.42)	-	(0.84)	(0.95)	(1.14)	(0.41)	-	(0.76)	(0.91)	(1.20)
1997	233	-	247	262	281	233	-	245	264	284
	(0.42)	-	(0.75)	(0.82)	(0.71)	(0.42)	-	(0.71)	(0.82)	(0.72)
1999	223	-	230	248	263	233	-	244	265	285
	(0.57)	-	(0.75)	(0.77)	(0.90)	(0.54)	-	(0.74)	(0.80)	(0.95)
2001	227	-	231	252	275	228	-	240	261	294
	(0.27)	-	(0.47)	(0.46)	(0.54)	(0.27)	-	(0.45)	(0.47)	(0.59)
2003	219[5]	230[6]	240[7]	253[8]	271[9]	220	235	246	260	297
	(0.43)	(0.43)	(0.61)	(0.50)	(0.68)	(0.43)	(0.41)	(0.59)	(0.50)	(0.74)
2005	217	230	240	249	267	218	233	242	256	282
	(0.48)	(0.47)	(0.62)	(0.50)	(0.75)	(0.47)	(0.46)	(0.62)	(0.51)	(0.79)
2011	224	239	242	256	270	230	245	249	263	284
	(0.08)	(0.08)	(0.08)	(0.07)	(0.13)	(0.08)	(0.07)	(0.08)	(0.07)	(0.14)

Source: INEP, SAEB microdata, 1999, 2001, 2003, 2005.
Note: Standard errors in parentheses. 1. In 1995, 1997, 1999, and 2001, the category is an aggregation of "never went to school" and "completed first to fourth grade". 2. In 1995, 1997, 1999 and 2001, the category is "completed fifth to eight grade". 3. In 1995, 1997, 1999 and 2001, the category is "completed ninth to eleventh grade". 4. In 1997, the category is "university" or "graduate school", without specifying whether the person completed or not. In 1995, 1999 and 2001, the category is just "university", without specifying whether it the person has some college or whether the person completed a higher education course, obtaining a degree. 5. In 2003, 2005, and 2011, this category is no schooling to incomplete 4 years. 6. In 2003, 2005 and 2011, this category is grade 5 to "incomplete grade 8/9". 7. In 2003, 2005, and 2011, this category is an aggregation of "completed grade 8/9" and "incomplete secondary school". 8. In 2003, 2005 and 2011, this category is an aggregation of "completed secondary" and "some college". 9. In 2003, 2005, and 2011, this category in "completed university."

Table 9c. Brazil: 8th/9th Grade SAEB, Mean Student Scale Scores by Mother's Education, 1995-2011

	Family Academic Resources Measured by Mother's Education							
	Portuguese				*Mathematics*			
Test Year	*Less than or Equal to Grade 4*	*Grade 5-Grade 8 Complete*	*Some or Complete Secondary*	*Some or Complete University*	*Less than or Equal to Grade 4*	*Grade 5-Grade 8 Complete.*	*Some or Complete Secondary*	*Some or Complete University*
1995	244[1]	255[2]	273[3]	287[4]	243	251	274	291
	(0.42)	(0.84)	(0.95)	(1.14)	(0.41)	(0.76)	(0.91)	(1.20)
1997	233	247	262	281	233	245	264	284
	(0.42)	(0.75)	(0.82)	(0.71)	(0.42)	(0.71)	(0.82)	(0.72)
1999	223	230	248	263	233	244	265	285
	(0.57)	(0.75)	(0.77)	(0.90)	(0.54)	(0.74)	(0.80)	(0.95)
2001	227	231	252	275	228	240	261	294
	(0.27)	(0.47)	(0.46)	(0.54)	(0.27)	(0.45)	(0.47)	(0.59)
2003	224	235	252	279	224	240	255	282
	(0.35)	(0.49)	(0.42)	(0.48)	(0.30)	(0.48)	(0.41)	(0.47)
2005	224	233	250	272	224	236	251	272
	(0.35)	(0.52)	(0.41)	(0.51)	(0.34)	(0.53)	(0.41)	(051)
2011	224[5]	239[6]	242[7]	261[8]	230	245	249	270
	(0.08)	(0.07)	(0.08)	(0.06)	(0.08)	(0.07)	(0.08)	(0.07)

Note: Standard errors in parentheses.
1. In 1995, 1997, 1999, 2001, 2003, and 2005 the category is an aggregation of "never went to school" and "completed first to fourth grade". 2. In 1995, 1997, 1999 2001, 2003, and 2005 the category is "completed fifth to eight grade". 3. In 1995, 1997, 1999, 2001, 2003, and 2005, the category is "completed ninth to eleventh grade". 4. In 1997, the category is "university" or "graduate school", without specifying whether the person completed or not. In 1995, 1999 2001, 2003,

and 2005, the category is just “university,” without specifying whether it the person has some college or whether the person completed a higher education course, obtaining a degree, or in 2003 and 2005, combines some college with university completion. 5. In 2011, this category is no schooling plus “incomplete grade 4/5”. 6. In 2011, this category is completed grade 5 up to grade 8 incomplete. 7. In 2011, this category is “completed grade 8/9” and “incomplete secondary school”. 8. In 2011, this category is “completed secondary” and “some college” plus “completed university.”

Conclusions

Brazilian 15 year-old students have definitely made substantial gains on the PISA mathematics test in 2000-2012, and may have made more modest gains on the PISA reading test. This has taken place while Brazil, like other Latin American countries, has greatly increased the enrollment rate in 9th and 10th grades and reduced age-grade distortion. Brazilian students’ gains in mathematics are as high or higher than achieved by students in most other Latin American countries, and those in Spain and Portugal. This is not the case for the PISA reading test, where gains in Brazil have been lower than in most other countries. On the other hand, Brazilian 8th/9th grade students have shown very modest gains on the SAEB mathematics test (as well as the Portuguese test), and those only since 2005. In both PISA and SAEB, gains have been generally somewhat larger for students from families with fewer academic resources than for students from families that could be called “advantaged” in term of family academic resources.

The results on the two tests give conflicting signals. The SAEB suggests that Brazilian students are making small gains in reading (Portuguese) and mathematics; the PISA results agree on the reading but suggest that Brazilian middle and secondary school students are making major gains in mathematics. This is an unusual combination of results. There are a number of countries, such as the United States, Russia, and England/United Kingdom, that do relatively well and have made gains in mathematics on the 8th grade Trends in International Mathematics and Science Survey (TIMSS) but not on the PISA test (Carnoy and Rothstein, 2013; Carnoy et al, 2013). Yet, the examples are rare of countries that make large gains on an international test such as the PISA, which is not linked to the national curriculum, but not on their national test, linked to the curriculum.

Like the SAEB, the TIMSS is designed to measure the math taught in school whereas the PISA measures more general math problem solving skills (Scott, 2004; Gromno and Olsen, 2006). Further, in PISA 2000 and 2003—the first two PISA tests—Brazilian students scored among the lowest in Latin America (along with Peru) in mathematics; they did relatively much better in reading. Therefore, the large gains in math may have been mainly a “catching up” to where they should have been in terms of their math knowledge, particularly because the PISA was a new type of test, very unlike the SAEB or the tests they take in school.

However, the results of both tests suggest that students with fewer resources at home are definitely not falling farther behind their more advantaged counterparts; to the contrary, they may be gaining on advantaged students. The gains in PISA math and reading by Brazilian students have been greater in the past decade among lower family academic resource students. Despite these gains, by PISA 2012, disadvantaged Brazilian students were still not scoring as high in math and reading as their counterparts in the higher scoring Latin American countries. Advantaged Brazilian students were in a somewhat worse position compared to their counterparts. From the standpoint of greater educational equity, this is a positive result for the educational system; however, in terms of producing excellence at the higher end of the distribution, the results suggest important difficulties.

The small gains in the SAEB math and Portuguese, to the extent that there have been gains at all, were among students with low and middle levels of family academic resources, as measured by mother's education (data are not available on BIH for 2011, when the gains were made).

What should policy makers take away from these results? Are Brazilian students learning more in school today than 10 years ago? The answer is probably yes, but also probably not as much as the reported PISA test results would have us believe. Klein's work has already made the point that the published PISA results are overestimated. We suggest that it is more likely that disadvantaged students made larger gains on the PISA than advantaged students. We also suggest that the mathematics gains that Brazilian students made on the PISA conflict with the SAEB results that show much smaller gains in math even for disadvantaged students, further clouding the picture. On the other hand, the SAEB and PISA results for reading/language arts agree that gains there have been small even for disadvantaged groups.

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