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Mapping inequalities of education quality in Brazil in the period 1995-2003

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Mapping inequalities of education quality in Brazil in the period 1995-2003 [**]

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Abstract: The average performance of Brazilian pupils is still very low by international standards, as reveal cross-country exams such as OECD's PISA. Moreover, Brazil is also one of the most unequal countries in terms of education quality. In this article, we highlight the importance of investigating education quality and its distributional characteristics; we provide a methodological discussion on the applicability of the inequality toolbox on test scores; and, finally, we present a mapping of education inequalities in Brazil in the period 1995-2003, both at the national and at relevant sub-national levels. Results show that less advanced grades are more unequal than more advanced grades, especially in more recent years. The South-East and the North-East are the most unequal regions, while São Paulo and Rio Grande do Norte are the most unequal states.

Resumo: Em média, a qualidade da educação é ainda muito baixa no Brasil segundo parâmetros internacionais, como mostram os maus resultados dos alunos brasileiros nas provas do PISA/OCDE. Além disso, o Brasil é um dos países mais desiguais em termos de qualidade de educação. Neste artigo, ressaltamos a importância de se investigar a qualidade da educação e as características de sua distribuição; discutimos a possibilidade de se aplicar ferramentas de análises de desigualdade a distribuições de desempenho de alunos; e, por fim, apresentamos um diagnóstico das desigualdades educacionais no Brasil (com dados do SAEB) no período 1995-2003, tanto no nível nacional como em níveis sub-nacionais. De modo geral, séries mais baixas são mais desiguais do que séries mais avançadas, especialmente nos anos mais recentes. O Sudeste e o Nordeste são as regiões mais desiguais, enquanto São Paulo e Rio Grande do Norte são os estados mais desiguais.

Palavras-chave: desigualdade educacional, qualidade educacional, desigualdade regional, capital humano

Key words: education inequality, education quality, regional inequality, human capital

JEL classification: I21, R11, D63

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1. Introduction

In the last two decades Brazil has seen a sharp improvement in its quantitative educational indicators. However, average *education quality* is still very low by international standards, as reveal cross-country exams such as OECD's PISA. Moreover, Brazil is also one of the *most unequal countries* in terms of education quality. In spite of that, we still lack a more thorough understanding of the patterns of the distribution of education quality.

In this study, we highlight the importance of education quality and of analysing its distributional characteristics and we also provide a methodological discussion on the applicability of the inequality toolbox on test scores. In addition to that, we also present a mapping of education inequalities in Brazil in the period 1995-2003, both at the national and at relevant sub-national levels. In our view, such diagnosis is useful, not only for immediately informing policy-making, but also for nourishing future research.

The article is organized as follows. In section 2, we argue that, while Brazil's education system has recently seen a sharp improvement in quantitative indicators, quality-related issues are still in need of investigation. In section 3, we explain in detail why it is important to care about education quality and to study its distribution. We present the SAEB data in section 4, followed by a discussion of some methodological issues concerning the applicability of inequality and welfare analysis tools to distributions of test scores in section 5. Our main results and our final remarks are presented in sections 6 and 7, respectively.

2. From a quantitative revolution to a qualitative challenge

In a sense, a "quantitative revolution" has been taking place in Brazil's education over the past two decades, as Table 1 indicates. The improvements have been pervasive, both in terms of flow variables (decreased average delay, decreased fraction of delayed children, increased enrolment rates…) and in terms of stock variables (increased average years of schooling, reduced illiteracy rates…).

The drop out rate for lower-primary education has gone down considerably lately but it remains high. Table 1 confirms indeed that less than half of 15-17 year-old pupils are actually enrolled in secondary education, where they ideally should be. So there is still considerable room for improvements in order to provide universal access to education and minimal or at least reasonable drop out rates.

Another insufficiency of such "quantitative revolution" is that it has not led to a homogeneous situation across the country. There are extreme variations across states and across metropolitan areas, as the last column of Table 1 indicates.

Table 1. Brazilian educational system: quantitative indicators, 1992-2005

Indicator	**1992**	**2005**	**Change**	**Some remarkable contrasts in 2005**
Average years of schooling of people aged at least 25	4.9	6.6	34.69%	
Illiteracy rate among people aged 15 or more, in %	17.2	10.9	-36.63%	
Fraction of children (7-14) at school, in %	81.8	95.4	16.63%	UF Santa Catarina: 98.4 UF Maranhão: 89.1
Illiteracy rate among children (10-14), in %	12.4	3.2	-74.19%	MA Curitiba: 0.4 MA Fortaleza: 3.8
Average delay (actual age minus ideal age for grade)	2.1	0.9	-57.14%	UF São Paulo: 0.4 UF Maranhão: 1.7
Fraction of children (7-14) delayed more than 2 years, in %	37.4	12.2	-67.38%	
Gross enrolment rate, in%, at:				
school	67.2	85.8	27.68%	
primary school	103.6	121	16.80%	
secondary school	41.9	89.9	114.56%	
higher education	10.6	28.3	166.98%	
Net enrolment rate, in%, at :				
school	62.4	73.5	17.79%	
primary school	81.4	94.7	16.34%	MA São Paulo: 97.5 MA Salvador: 92.9
secondary school	18.3	46.4	153.55%	UF São Paulo: 66.6 UF Alagoas: 22.1
higher education	4.6	11.7	154.35%	UF Distrito Federal: 21.4 MA Salvador: 9.9

Source: PNAD; "MA" = Metropolitan Area; "UF" = Unit of Federation.

What the previous figures essentially suggest is that a quantitative change has taken place, but: (i) there are still many quantitative challenges to be faced in the coming years, both at the national front and at sub-national fronts; (ii) they do not indicate whether it has been accompanied by a substantial qualitative improvement.

It is not enough simply to make sure Brazilian pupils go to school – they should be learning something there. Unfortunately, there are reasons to believe this is not happening overall in Brazil. First, as compared to other countries, the quality of education in Brazil is very bad as expressed by average achievements in international exams such as OECD's PISA. And that is true, even when the samples are restricted to the best students in each country (e.g., Franco, 2002). Second, if instead of international comparisons, the attention is restricted to Brazilian data, the diagnosis is once again not favourable: most Brazilian pupils do not reach minimal achievement standards (defined by pedagogues), as reveal reports analyzing the results of Brazilian pupils in PISA and SAEB exams, which have been produced by INEP/MEC technical staff in the past ten years.

In an overview of the recent evolution and the current situation of education in Brazil, Schwartzman (2006) claims that, while issues of access, flow, and literacy (i.e., the quantitative ones shown in Table 1), should receive relatively less attention nowadays, they still are the most frequently evoked topics in the public debate. In his view, issues related to contents and quality - which, he stresses, are incidentally more difficult to address through policy - have not yet been granted the top priority they deserve. He relates education quality to the drop out phenomenon, questioning the common view according to which Brazilian children and teenagers quit public schools only because of liquidity constraints. He suggests they drop out also because they feel they waste their time at (bad) schools.

3. Why should we care about the distribution of education quality?

Inequalities are so widespread a phenomenon in Brazil that an informed Brazilian reader would probably dispense of a section which tried to provide a motivation for its study. Yet, it is worth it to highlight a couple of points related to this article's core object, namely, the distribution of education quality.

Brazil's income inequality is one of the largest among countries for which reliable income data is available. According to Ferreira (2000), in the 1980s and the 1990s, the average Gini coefficient has oscillated around: 0.25 and 0.29 in Eastern European countries; 0.33-0.34 in OECD countries and Cuba; 0.32-0.35 in Southern Asia; 0.38-0.41 in the Middle-East; 0.43-0.47 in Sub-Saharan Africa; and 0.49-0.50 in Latin America. In Brazil, it consistently remained around 0.59-0.60, that is, well above even its highly unequal Latin American neighbours. Brazil's income inequality has decreased steadily in the current decade, but despite that, it is still very high, placing it among the top 5% in any international ranking.

Although educational inequality is not of course the only source of income inequality, it does play an important role, both for current and for subsequent generations. For example, static decompositions of usual inequality indices show that individuals' education accounted for 1/4 to 1/3 of wage inequality in Brazil along the 1980s and 1990s (Ramos and Vieira, 2000). Studying the years 1981, 1990 and 1995, Ferreira and Litchfield (2001) find that educational attainment of the household head was the most important determinant of overall inequality, accounting for a share of 37 to 42%, at least three times as substantial as any other factor taken into account in their study.

The structure of private monetary returns to education plays an important role in shaping income inequality. Indeed, Ferreira and Litchfield (2001) conclude their paper as follows: "The overall lesson, to the extent that there is one, is that the main cause of Brazil's unenviable record inequality levels remains its combination of *inequality in educational achievements* and *high returns to education in the labour market*." (Our italics.) Average monetary returns to education in developing countries are typically higher than those in developed countries (Psacharopoulos and Patrinos, 2004), and Brazil is no exception to the rule: returns are high, as reveals a series of papers published between 1983 and 2006, surveyed by Resende and Wyllie (2006). Using 1996/97 data, and taking into account selection bias and a rough measure of education quality (self-reported education quality), those authors themselves found returns of 0.126 for women and 0.159 for men, results which do not differ much from those obtained in the studies they reviewed.

A drop in average returns could attenuate the role of years of schooling as a source of income inequality. If we examine the available findings on a long run perspective, there is evidence that the returns to schooling have been decreasing, from an average of 0.17 for male workers in 1976-77 to 0.14 in 1996-97, according to Menezes-Filho et al. (2006). Simulations reported by them predict a similar development over the following decades. The decrease in average returns to schooling has not yet led to a substantial drop in income inequality in Brazil, among other reasons, because returns have been reported to be convex in the period covered by such studies (mid-1970s to mid-1990s), according to Ferreira and Litchfield (2001) and Menezes-Filho et al. (2006), ensuring large returns to the highly skilled individuals and precluding income inequality from falling as fast as it would have otherwise.

A drawback of those studies is that they all employ as a measure of education simply the years of schooling of the individuals, without a proper adjustment for the *quality of education*.[1] Plausibly, returns to quality of education are not unimportant as a source of income inequality, since they could have an impact particularly on the inequality within educational groups. Actually, the need for taking quality into account is often raised in the debate on returns to schooling in Brazil, and also in studies on related topics, such as Bourguignon et al. (2006). Of course, it is not by lack of interest that such topic has not been more extensively explored, but to empirical obstacles – to lack of data in particular.

One thing we are able do with the data available right now in Brazil is to analyse the *distribution of quality of education by using test scores databases*. Provided that such scores appropriately reflect quality of education, expressing individuals' skills and possibly anticipating future productivity and wages, they have a potential link with income distribution in subsequent years. There is indeed evidence suggesting the link between test scores and future productivity holds, such as Currie and Thomas (2001) and the references therein.

[1] As mentioned before, Resende and Wyllie (2006) try to take education quality into account. However, the variable they use (self-reported quality) is not very reliable, as the authors themselves acknowledge. In a previous study, Behrman and Birdsall (1983) had controlled for quality using average years of schooling of teachers living in the same area where individuals of a specific age range had studied.

The more specific evidence on the relationship between *distributions of scores* and *distributions of income* is scarcer. Bedard and Ferrall (2003) report that distributions of test scores measured at age thirteen in 1964 and 1982 for eleven countries are significantly related to future wage dispersions.[2] Even if more data were available, another problem related to the patterns of the two sets of data would show up, as Card and Krueger (1996) have warned: "compared to test scores outcomes, the variance in earnings is large, making it more difficult to detect modest effects of school quality".

So while it is plausible to expect a relationship between distributions of test scores and future income distributions to hold, we cannot (yet) be sure it does. Such statement does not imply there is no interest whatsoever in studying test scores, for at least two reasons. Firstly, because, as already commented above, even if the distribution of education quality did not matter for shaping income distribution, a person's test scores at some point in time could still be positively correlated with the quantity of education, that is, with the probability of her staying longer in the schooling system, as postulated by Schwartzman (2006). And the distribution of quantity of education (schooling years) has been shown – as mentioned above – to have impacts on income inequality. Secondly, education and education quality in particular – possibly expressed by test scores – are valuable assets, not only because of the benefits in terms of future income stream it entails, but also because it paves the way for other life opportunities (Mincer, 1994), and because it may be viewed as having an intrinsic importance (Sen, 1985). It seems to us that investigating different aspects of educational inequality is thus a relevant research topic, certainly related to the study of income inequality, but which is important for its own sake.

While it is now widely known that Brazilian pupils obtain very bad average results in international examinations such as OECD's PISA, it is not so notorious how Brazil compares with other countries *in terms of test scores distribution*. Based on the 2000 edition of PISA, we have calculated that in that respect, Brazil ranked last (the more unequal country) in both exams. In math, for example, the score-Gini coefficient was 0.18. Finland was the less unequal one, with 0.08; Mexico, similar to Brazil in many respects, presented a math score-Gini of 0.12; Greece, which comes right above Brazil in the ranking, obtained 0.14.

So education quality is clearly very low and very unequal in Brazil, as compared to other countries, but we still lack a better understanding of the patterns of the distribution of

[2] They employ data from the First and Second International Mathematics Examinations (IME), conducted in the years mentioned above by the International Association for the Evaluation of Educational Achievement (IEEA).

education quality in the country, something which might be useful in our view, not only for immediately informing policy-making, but also for nourishing future research.

4. Data

Although imperfect, performance of students in standardized tests ("test scores") is the best available proxy for education quality: they express relevant skills and competences of pupils; they are a good proxy for the accumulated human capital embodied in each individual; having more skills opens the way for people to acquire certificates, enter college, find jobs, and so on. As a metric, test scores present some good characteristics: they are measurable at different points of the schooling process; quite often they are comparable across grades, across ages, or even across countries.

The data we use come from 5 waves of a survey on Brazilian pupils' achievement, the SAEB[3], an exam which is organized by INEP, a research institute which reports to Brazil's Ministry of Education, and it has taken place every two years since 1995. While SAEB datasets are not suitable for direct international comparisons, the objectives and statistical design, as well the procedures employed in the application of the tests, have been inspired by, and do not differ very much from, well-known cross-country assessments of pupils' performance, such as PISA, TIMSS/PIRLS, and LLECE.

SAEB consists of country-wide tests in reading and mathematics, coupled with a collection of data on relevant characteristics of students, teachers, principals, and schools. It focuses on the evaluation of pupils at three key stages of the schooling system: 4th grade of primary school, 8th grade of primary school, and 3rd grade of secondary school (labelled hereafter 11th grade). Each of these grades corresponds to the last year of a stage in the Brazilian schooling system (end of lower-primary, end of upper-primary, end of secondary). The recommended ages of pupils attending these grades are, respectively, 10, 14 and 17 years old. It should be noticed that during the period covered by our data schooling was mandatory in Brazil for children up to 14 years (regardless of the grade they were attending).

The database consists of repeated cross-sections (not panels) of samples of schools and students. The samples for each grade and subject are representative of the whole country, as well as specific sub-national units (e.g., regions, states). In a first step, schools that took part in SAEB have been randomly chosen. In a second step, inside each of these schools, one class has been randomly chosen. Each pupil has passed an exam of only one of the subjects.

[3] *Sistema de Avaliação do Ensino Básico*, or Basic Education Assessment System.

Pupils' test scores correspond to subject-specific scales elaborated by INEP staff together with teachers, researchers, and national and international survey experts. Possible scores range from 0 to 500, and are supposed to evaluate skills and abilities of students. Because of the invariance of the scale, pupils' scores are comparable across years and across grades. Scores are not comparable across subjects.

Table 2. Descriptive statistics of score

Grade	Subject	Year	# Obs	Mean	Std. Dev.	Min	Max	Weight	Coverage(*)
4th	Math	1995	11,886	190.62	40.57	95.27	383.98	2,955,941	76.82
		1997	23,535	190.80	43.61	80.37	377.95	3,556,306	86.45
		1999	21,572	181.00	40.84	81.53	355.93	3,755,076	87.08
		2001	57,258	176.26	45.85	59.84	367.25	3,689,237	84.97
		2003	46,131	177.13	44.82	66.42	369.98	3,764,153	89.62
	Reading	1995	12,033	188.28	46.68	62.62	348.29	2,976,778	77.37
		1997	23,404	186.46	45.81	60.66	362.88	3,556,306	86.45
		1999	21,542	170.73	44.69	59.12	353.04	3,755,076	87.08
		2001	57,254	165.12	48.70	45.76	343.62	3,689,237	84.97
		2003	46,067	169.42	46.85	51.43	340.57	3,764,153	89.62
8th	Math	1995	14,609	253.24	47.86	114.03	415.92	1,551,771	71.54
		1997	18,806	250.00	50.00	125.68	432.55	2,512,018	99.41
		1999	17,890	246.36	47.33	108.87	431.89	2,785,020	95.21
		2001	50,300	243.38	49.62	124.48	422.84	3,002,272	93.20
		2003	36,908	244.97	51.04	116.32	428.24	3,191,223	97.46
	Reading	1995	14,705	256.05	51.75	76.04	407.41	1,555,726	71.72
		1997	18,862	250.00	50.00	89.67	407.43	2,512,018	99.41
		1999	17,920	232.90	45.73	90.19	407.04	2,785,020	95.21
		2001	50,492	235.17	50.28	78.21	399.03	3,002,272	93.20
		2003	37,009	231.96	49.68	91.88	399.08	3,191,223	97.46
11th	Math	1995	9,049	281.94	53.69	144.44	460.69	805,427	68.12
		1997	8,136	288.70	59.36	178.71	463.22	726,982	50.31
		1999	11,788	280.29	56.21	159.63	471.39	1,842,251	97.74
		2001	36,152	276.71	55.96	177.73	456.31	2,067,147	96.64
		2003	26,187	278.68	57.48	148.32	459.33	2,113,641	95.99
	Reading	1995	9,171	290.01	54.18	90.58	427.13	815,234	68.95
		1997	8,147	283.86	55.55	115.95	435.53	726,982	50.31
		1999	11,890	266.57	53.23	140.49	438.95	1,842,251	97.74
		2001	36,263	262.34	53.29	117.98	426.52	2,067,147	96.64
		2003	26,219	266.67	52.43	114.24	428.81	2,113,641	95.99

(*) Proportion of the pupils' population represented by each sample.

Table 2 contains descriptive statistics for the scores obtained by Brazilian students in all the years, grades and subjects in the SAEB exams. Scores have been standardized by INEP such that the average for the 8th grade in 1997 is 250.00 and the standard deviation is 50.00, in both subjects. Table 2 also shows that:

- The observations expand via sample weights, to the population of pupils assessed by the SAEB exams. Due to drop out, grade retention, and demographic trends, for all years and for both subjects, the number of pupils decreases with the grade.[4]
- For a given year and subject, average scores increase as we move from the 4th to the 8th grade, and the same is true for the 11th grade as compared to the two less advanced ones, which is hardly surprising, given that all pupils are evaluated on the same set of skills, such that older, more instructed, pupils tend to perform better on average. Moreover, as we will comment below, some sort of selection mechanism may already have operated at more advanced stages, but not as much in less advanced ones (the 4th grade in particular).
- For a given grade and subject, average scores usually decrease (slightly) across cohorts from 1995 until 2001, and then increase a bit from 2001 to 2003. Average scores do not vary extraordinarily across cohorts.[5] So the bad performance of Brazilian pupils – attested by low average scores in PISA, already mentioned – seems to be persistent over time.

In order to keep manageable the number of tables and figures, in most cases we report national and regional results regarding exclusively the year 2001, the mathematics exam, and the 8th grade, choices we justify as follows:

Why the 8th grade: (i) it corresponds with the end of primary school and of mandatory schooling in Brazil (although the latter is only a rough correspondence, because the obligation is defined in terms of age and not of grade); (ii) the average age of 8th-grade Brazilian pupils is close to that of international pupils who passed the PISA 2000 exam; it is thus interesting to provide results that have a similar international benchmark.

Why mathematics: (i) it seems to be the case that schools can make more of a difference in the teaching of mathematics than in that of reading, given that the latter is typically determined, to a larger extent, by family background. If this is true, from a policy perspective, it is interesting to focus on a subject in which schools could make more of a difference; (ii) there is (sparse) evidence showing that math scores are the best academic predictor of future wages, at least in the US context (Bedard and Ferrall, 2003).

Why 2001: (i) the share of the pupils' population represented by the samples has increased from 1995 to 1997, and then from 1997 to 1999, and it has been stable since then. So, each of the three most recent waves were good candidates; (ii) an important reform (FUNDEF)

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[4] In 1995 there were 3.8 million pupils enrolled in the 4th grade, but four years later, in 1999, there were only 2.9 million enrolled in the 8th grade, figures which illustrate the spread of the drop out and retention phenomena (INEP/MEC website).

[5] The results of such across-years comparisons should be taken cautiously, given that the samples of the first wave (1995) were less extensive than those of subsequent waves for all grades; and those of the second wave (1997) were less extensive than those of subsequent waves for the 11th grade (cf. far-right column of Table 1).

modifying the mechanism of allocation of federal funds to primary schools started being implemented in 1998; it seemed to us that it made more sense to emphasize data collected after the reform had been fully implemented, so that 1999 was discarded, leaving us with the choice of 2001 or 2003, (iii) when using our data to order Brazil's regions, we realized that the 2001-math-8th-grade ranking was representative of different combinations of year, subject and grade, so that 2001 was finally chosen.

5. Methodological issues

Measuring and comparing *income* inequality consists of the following task, according to Cowell (2005): "how to *aggregate* (evaluate) the (change in the) distribution of an *attribute* over individual *units* of the population" (our italics). Defining the income recipient unit (e.g., household or individual?), the relevant attribute or income concept (e.g., income in a given month or lifetime's income?), and the aggregation method (e.g., *ad hoc* statistical indices or normatively-based social-welfare-based indices?) are the main sets of decisions that have to be taken into account in order to measure inequality of a particular distribution of income and to compare it with other distributions, be it over time or across space.

Inequality and welfare indices have been typically developed in a framework in which income is the attribute. As we were interested in using test scores as attributes, it was extremely important to understand if and how dominance tools (both of inequality and welfare), as well as inequality indices, could be employed to analyse test scores distributions. We believe the income toolbox is suitable to be used in the analysis of inequality and welfare in terms of test scores, as we now explain, commenting on each step of such kind of analysis.

If we are interested in evaluating inequality and welfare of test scores, choosing the *recipient unit* is straightforward. There is no need to calculate a "per capita measure of education outcome" weighted by some sort of equivalence scale, since test scores are, by definition, expressed in an individual basis and cannot be shared by individuals – human capital is embodied in the individuals. There are no household economies of scale involved, for example. So we can take pupils as the recipient units without further concerns.

As for the *attribute*, in the income case we have to: (i) define the time unit (e.g., month, year, or lifetime?); (ii) make spatial corrections (e.g., accounting for regional prices); (iii) make time corrections (deflating the nominal values). The choice of the *time unit* is not as important here as it is in the case of a flow variable, such as income. Educational achievement is essentially a snapshot stock variable, so that measuring it in a week's or in a year's length of time is a senseless distinction.

Should we make some kind of *spatial adjustment* of the kind which is typically made in income distribution studies, such as corrections for regional prices differentials? On the one hand, a similar set of skills is possibly valued differently according to the average level of skills at each community and, particularly, at each local labour market. A minimal set of reading skills might be very advantageous for a person who lives in a very backward community where she could provide services, for example, to all those that are not able to read. In a more developed community where most people have reached secondary school, only being capable of reading is by no means enough to find a good job and to enjoy a "good life". We can clearly relate this issue to more general debates, namely, on education as a positional good – especially in the philosophical literature (Brighouse and Swift, 2004) – and on the hypothesis of education as a signalling device – in the economics literature – which have challenged some of standard human capital theory's assumptions (Arrow, 1973).

On the other hand, pupils' and workers' mobility might well limit the relevance of different valuations of the skills in each community. Although Brazil is a large country, the language spoken throughout it is the same and the intra-country cultural differences are not as substantial as in other countries. This substantial homogeneity paves the way for a large potential mobility. So if a pupil achieves very high scores in tests (especially in advanced stages of schooling), but lives in a poor municipality, which does not offer her very good opportunities (e.g., further studies or well-paid jobs), in principle she could migrate to another municipality in which the set of such opportunities would be broader. The opposite case might also happen. A person having a relatively low level of skills in the local labour market where she was born could very well migrate to another, less-developed, place where her skills would pay off. Hence, although it is true that the human capital level expressed by scores is meaningful at the local level (in relative terms), it is also relevant at more aggregate levels (state-wide, nationally, or even internationally). Very recent data confirm that internal migration is still today a very important phenomenon in the country (IBGE, 2008).

Beyond the difficulties involved in adequately accounting for the two effects mentioned above, if we wanted to acknowledge the importance of regional differences on the value of skills, in order to do some kind of spatial adjustment, such corrections would probably be very demanding in terms of data, since we would have to determine quite precisely the equivalent of the "purchasing power of income" in the education field, that is, the *actual, multidimensional, value of education* in each community or labour market. As far as we know, there exists no incontestable procedure allowing one to take into account spatial heterogeneity in order to capture the actual value of scores. Because of that, we have worked with raw scores, ignoring positional good or signalling aspect of scores.

Still related to the definition of the attribute, *time correction* is frequently put forward when one is interested in measuring income inequality over the years. In the case of distributions of educational achievements, some kind of deflation procedure would need to be used to correct for variations over time of the "real value of the score". For example, a score of 300 points of score obtained ten years ago in a given place might correspond – in terms of actual value – to, say, a score of 320 points today, if for example the average score has increased since then and/or the demand for skills in the community at stake has augmented. The same difficulties related to correcting scores mentioned above (spatial adjustments) apply in the case of corrections for inflation. How should the deflation index be defined? The position we adopt is the same one we explained in the previous paragraph.

As for the *aggregation method*, studies relying on social-welfare-based indices and on the axiomatic approach allow one to understand more precisely the effects of a change in the relevant parameters, since such changes are normatively interpretable. A parameter shift in Atkinson indices represents an increase (decrease) in inequality aversion, whereas a shift in the parameters of the generalized-entropy class (for short: GE-class) indices represents a change in the relative weight attributed to inequality in specific ranges of income distributions, with indirect normative interpretations. As we know from the inequality measurement literature, Atkinson-class indices can be related to the CES family – Atkinson-class indices represent SWFs which range from maximin a utilitarian SWF. A subset of the GE-class, GE(α), indices is ordinally (but not cardinally) equivalent to the Atkinson-class, A(ε), with α=1- ε, so that a ranking established using a GE-class index has a unique correspondence with a ranking established using an Atkinson-class index:

- GE(-1) is ordinally equivalent to A(2), an index which expresses a normative view closer to maximin, given that it is quite sensitive to inequality in the bottom of the distribution;
- GE(1) is ordinally equivalent to A(0), an index which is closer to a utilitarian-like viewpoint (homogeneously sensitive to income differences along the distribution).;
- GE(0) corresponding to A(1), it occupies an intermediary position, balancing distributive and aggregative concerns;
- GE(2) is out of the range of Atkinson-class indices ($\varepsilon \geq 0$); it is also known as the "Herfindahl index"', which is more sensitive to inequality in the top of the distribution.

Most often we make use of GE-class indices (GE(0) in particular), a class of indices which is well-known for their good mathematical properties. Whenever relevant, we try to establish dominance relations, by means of standard tools in inequality and welfare analysis, such as Lorenz and generalized Lorenz (GL) curves.

6. Results

We now present our results in two sections, the first of which contains those at the national level (pooled sample), and the second of which is devoted to those at the sub-national level.

6.1. Intensity of educational performance inequality in Brazil

6.1.1. Inequalities across grades

Welfare assessments do not make much sense for across-grades analysis, since it is obvious that the distribution corresponding with a more advanced grade – driven by much higher means – will dominate that of a less-advanced grade distribution in the generalized Lorenz sense. Older pupils are expected to perform better than younger, less instructed, ones, and they do that on average. So we proceed to compare Lorenz curves.

Visual inspections of the plotted curves do not help us distinguishing each grade's Lorenz curve. By checking Lorenz curves deciles instead, we find that both 8^{th} and 11^{th} grades Lorenz-dominate 4^{th} grade. However, nothing can be concluded in terms of dominance when we compare grades 8 and 11. So the 4th grade is surely the most unequal one, but the two others could be ranked differently by different SEFs. The pattern found for 2001-math is repeated for all other years in math and reading, that is, for every year, $L_{11th} \approx L_{8th} \succ L_{4th}$.

We report in Table 3 the values obtained with a specific inequality index, GE(0), as well as the ranking of grades for each year and subject, and finally the ratio between the index for the 4^{th} grade and the index for both other grades. We observe that the 4^{th} grade invariably occupies the third position (i.e., the most unequal grade). Moreover, we observe that the magnitudes of the values for the 4^{th}-grades' index are substantially larger than those for the other two grades, with the ratios ranging from 1.20 to 2.16.

So the main finding is that the 4^{th} grade presents higher inequality than the two more advanced grades. And such pattern holds *for all the years*, and *in both subjects*. On the one hand, an optimistic reading of such result would consider it was somewhat expected, since in the first grades students are typically more heterogeneous, given that schools have not yet been able to reduce the spread of pupils' performance, an objective which would be more realistic for advanced grades' pupils. On the other hand, a more pessimistic reading would consider that students are more heterogeneous in preliminary stages in Brazil, because selection – and its usual corollary: drop out – have not yet fully intervened. Indeed, drop out is less severe a problem in less advanced grades (as the figures in previous sections reveal).

Table 3: Inequality across grades, according to GE(0)

		Mathematics			Reading		
Grade	Year	GE(0)	Ranking	Ratio (4th/N(h)	GE(0)	Ranking	Ratio (4th/N(h)
4th	1995	0.0219858	3	1	0.0323891	3	1
8th		0.018303	2	1.20	0.023086	2	1.40
11th		0.0177719	1	1.24	0.0195005	1	1.66
4th	1997	0.0258336	3	1	0.0304152	3	1
8th		0.0202355	1	1.28	0.0215027	2	1.41
11th		0.0209434	2	1.23	0.0207661	1	1.46
4th	1999	0.0253769	3	1	0.0344817	3	1
8th		0.0186683	1	1.36	0.0198462	1	1.74
11th		0.0196061	2	1.29	0.0202691	2	1.70
4th	2001	0.0342039	3	1	0.0464863	3	1
8th		0.0205947	2	1.66	0.0245373	2	1.89
11th		0.0197557	1	1.73	0.0215447	1	2.16
4th	2003	0.0324836	3	1	0.0405682	3	1
8th		0.0216727	2	1.50	0.024203	2	1.68
11th		0.0208752	1	1.56	0.0202472	1	2.00

What is worrying is the serious likeliness that the selection is a *socio-economic one*, such that the probability of dropping out is correlated with pupils' socio-economic characteristics. As a quick check of that hypothesis, we compared across grades, the average level of pupils' mother's educational level, which is a usual indicator of socio-economic status in the economics of education literature. For pupils who passed the math exam in 2001, average mother's education increases with the grade. In a scale which ranges from 1 (not studied) to 5 (college education), we have average mother's education levels of: 2.73 for the 4th grade; 2.90 for the 8th grade; and 3.04 for the 11th grade, which gives some credit to the hypothesis that the selection process is socio-economically biased.[6]

6.1.2. Inequalities over time

Descriptive statistics showed that for a given grade and subject, average scores do not vary very much across the five waves (1995 through 2003). Let us now understand how scores *inequalities* have evolved over the years, by trying to establish 6 time-series rankings (3 grades x 2 subjects). This is an interesting question, because the enrolment rates have increased in the 1990s, leading to more socio-economic heterogeneity of students, and presumably to increased inequality in achievement.

Once again, we first search for dominance relations by turning to pair-wise comparisons of distributions using Lorenz curves.[7] In mathematics, out of 30 pair-wise Lorenz comparisons (10 per grade), 19 show dominance. The distribution of 2003 is the most frequently

[6] A rigorous check would require another kind of analysis (inference), which is out of the scope of this study.
[7] Results of across-years comparisons should be taken cautiously, because of the limited coverage of samples.

dominated, in 8 out of 12 pair-wise comparisons (3 times its Lorenz curve crosses; and once, for the 4th grade, it dominates 2001). In reading, out of 30 pair-wise Lorenz comparisons only 13 indicate dominance, 8 of which in the 4th grade. The 2001 and 2003 samples are more frequently dominated, while 1995, 1997, and 1999 dominate more frequently.

We report in Table 4 the values obtained with a specific inequality index, GE(0), as well as, for each grade and subject, the ranking of the five waves.

Table 4: Inequality across years, according to GE(0)

Year	Math	Ranking	Reading	Ranking
4th grade				
1995	0.0219858	1	0.0323891	2
1997	0.0258336	3	0.0304152	1
1999	0.0253769	2	0.0344817	3
2001	0.0342039	5	0.0464863	5
2003	0.0324836	4	0.0405682	4
8th grade				
1995	0.0183030	1	0.0230860	3
1997	0.0202355	3	0.0215027	2
1999	0.0186683	2	0.0198462	1
2001	0.0205947	4	0.0245373	5
2003	0.0216727	5	0.0242030	4
11th grade				
1995	0.0177719	1	0.0195005	1
1997	0.0209434	5	0.0207661	4
1999	0.0196061	2	0.0202691	3
2001	0.0197557	3	0.0215447	5
2003	0.0208752	4	0.0202472	2

We cannot identify a clear pattern of increasing or decreasing inequality over time for the 8th and the 11th grades, since the indices for different years oscillate very slightly from one year to another. However, for the 4th grade, we identify a net increase in the extent of inequality when we move from older distributions (1995-1999) to more recent ones (2001-2003). *This result suggests the high inequality in achievement that Brazil presents* - attested by comparisons with other countries that took part in the PISA exams, already mentioned in this article – *is persistent over time*.

Combining the results of this subsection with those from the previous one, we can conclude that the analysis of distributions of education quality in Brazil shows, not only that the 4th grade is the most unequal one, but also that inequality in that level is larger in most recent years. This is bad news right now and also for the coming years, given that a highly unequal group of pupils is evolving through the system. The good news, to the extent that there is one, is the fact that the peak of inequality in the 4th grade occurred in 2001, and has fallen from then to 2003 (a result which is confirmed by other indices). With future SAEB waves, it will be interesting to check if such trend is confirmed.

Summing up, we confirm the quality of education, as expressed by test scores, in Brazil is deficient. Such deficiency expresses itself not only through low average performance, but also through high inequalities. There has been no improvement in recent years and there is no expectation of a decrease in the levels of inequality in the system as a whole in the close future, since the less-advanced grade is the most unequal one and will most probably, either carries out and accumulates inequality through the system, or “eliminates it” through drop out.

6.2. Sub-national inequalities in Brazil

We now report inequalities within subsets of the Brazilian territory, in order to identify more precisely where in the country the problems are more severe. Most often, we measure scores inequality in the five macro-regions and in the 27 states.

We have already alluded to intra-country inequalities in Brazil when we argued that the “quantitative revolution” that has been taking place in Brazil’s education in recent decades has not been homogeneous across the country. However, it is important to remember that these are just particular examples of a vast phenomenon of intra-country inequalities in Brazil, as depicted, for example, by Mendonça (2006). To illustrate our point, we present in Table 5 the population share and the GDP share of the five geographic regions in 2000, together with the average scores obtained in the SAEB (2001-math-8th grade exam), and the ranking of regions in terms of these average scores.

Table 5: Regional indicators. Brazil 2000-2001.

Region	Population*	Population share*	GDP share*	Scores**	Ranking
South-East	72,412,411	42.65%	57.8%	249.72	2
North-East	47,741,711	28.12%	12.9%	228.79	5
South	25,107,616	14.79%	17.6%	255.34	1
North	12,900,704	7.60%	4.6%	231.86	4
Mid-West	11,636,728	6.85%	7.0%	244.83	3
Brazil	169,799,170	100.00%	99.9%	243.38	-

(*) Data concerning 2000: Contas regionais, IBGE. (**) Data concerning 2001: SAEB, Mathematics, 8th grade.

We have also calculated similar rankings of regional average scores for every combination of year, subject and grade (5 years x 2 subjects x 3 grades = 30 rankings). For each year, subject and grade, we have attributed 1 to the highest average score, 2 to the 2^{nd} highest and so on. We then took the average out of the 30 distributions. The average values obtained are the following: South: 1.53; South-East: 1.93; Mid-West: 2.57; North: 4.47; North-East: 4.50. The most frequent ranking reversals are observed between North and North-East, and between South and South-East. According to the average ranking obtained out of these 30 rankings, the 5 regions are classified exactly as the particular ranking of Table 5, showing that 2001-math-8th grade ranking is, in some sense, a representative one.

6.2.1. Decomposing inequality

We have decomposed inequality into between- and within- relevant territorial units, employing GE-class indices. While there is some inequality across Brazilian geographical regions, Panel I in Table 6 indicates that the greatest fraction of measured inequality is observed within each region, accounting for almost 96% of the overall inequality.

Table 6: Inequality decomposition. Brazil, SAEB 2001, Math, 8th grade

Panel I: Inequality across macro-regions

	GE(-1)	GE(0)	GE(1)	GE(2)
Overall	0.02106	0.02059	0.02051	0.02078
Within regions	0.02017	0.01971	0.01963	0.01992
Between regions	0.00089	0.00088	0.00087	0.00087
within/total	95.77%	95.73%	95.71%	95.86%
between/total	4.23%	4.27%	4.24%	4.19%

Panel II: Inequality across states

	GE(-1)	GE(0)	GE(1)	GE(2)
Overall	0.02106	0.02059	0.02051	0.02078
Within regions	0.01999	0.01954	0.01946	0.01974
Between regions	0.00106	0.00106	0.00105	0.00104
within/total	94.92%	94.90%	94.88%	95.00%
between/total	5.03%	5.15%	5.12%	5.00%

Panel III: Inequality across municipalities

	GE(-1)	GE(0)	GE(1)	GE(2)
Overall	0.02106	0.02059	0.02051	0.02078
Within regions	0.01693	0.01644	0.01630	0.01650
Between regions	0.00412	0.00414	0.00419	0.00427
within/total	80.39%	79.84%	79.47%	79.40%
between/total	19.56%	20.11%	20.43%	20.55%

Is the fraction corresponding to between-regions inequality small? To answer that, we would need a basis for a comparison (e.g., studies for other countries), which we do not have. We tend to think it is not so small, given that the groups we are dealing with here (the regions) contain a huge number of pupils, they were likely to present highly heterogeneous performance within them. Yet, around 4% of the overall inequality comes from inter-regional inequality.

Panel II reports inequality decompositions across Brazilian states, and the result is very similar to the one obtained for regions, with an expected increase as the group size is reduced.

In Panel III, in turn, we can see that the fraction of overall inequality observed between municipalities is much larger (around 1/5 of overall inequality).

Inequality within sub-national units are substantial even when we go down to the smallest territorial unit used here. For this reason, it is interesting to compare some of these sub-national units to find out in which of them inequality is more intense.

6.2.2. Regional inequalities

We showed above that the rankings of regional *average scores* were similar for different combinations of year, subject and grade. We also pointed out that a great fraction of inequality is found within sub-national units. Now as a further step in our mapping of educational inequalities, we describe in more detail the phenomenon of intra-country *scores inequalities*, first by ranking Brazil’s regions.

Simply plotting Lorenz curves for Brazil's regions is not very elucidative, given that the five distributions are not sufficiently different in terms of inequality for us to observe their differences graphically. GL curves are also problematic in this respect: the only information we obtain from a visual inspection of GLs is a reproduction of the ranking of average scores for the five regions.

Figure 1: Regional inequalities: dominance rankings. SAEB 2001, Math, 8th grade.

Panel I: Educational welfare: ranking of Brazil’s regions based on deciles of GL curves.

South
||
South-East ----- Mid-West
||
North
||
North-East

Panel II: Educational inequality: ranking of Brazil’s regions based on deciles of Lorenz curves.

Mid-West ----- North ----- South
||
North-East ----- South-East

By comparing deciles of the distribution of Lorenz and GL curves, however, we can establish rankings of educational inequality and educational welfare (Figure 1). Panel I shows educational welfare rankings. The GL curve of the Southern region ranks first, the Northern ranks fourth, and the North-Eastern ranks fifth; South-East and Mid-West GL curves cross. Thus when we take the mean score into account, we can order almost all the distributions, with only one crossing. The drawback of such ranking is that it is essentially driven by the average score, and the importance of inequality is downgraded. As a matter of fact, we observe this ranking is similar to the average score ranking.

The educational inequality ranking (Panel II) shows the crossing of Lorenz curves of three regions - Mid-West, North and South. These three regions Lorenz-dominate the North-East and the South-East, whose Lorenz curves also cross with each other. While a full dominance ranking cannot be established because of crossings of Lorenz curves, we can have an idea of which regions are more unequal than the others. The main result here is that the highly-populated South-East and North-East are the most unequal regions for a wide class of SEFs.

The values of the deciles of both Lorenz and GL curves for Brazil's regions are very similar from one region to another. Possibly, a number of the dominance relations established by means of point estimates comparisons would not be confirmed if statistical inference procedures were applied. In such case, the rankings could be even less complete. This leads us to complement the analysis using specific inequality indices, which allow us to establish complete rankings, at the cost of more normative controversies. However, this procedure allows us to observe the sensitivity of the rankings to shifts in relevant parameters (e.g., inequality aversion, and related ones).

In Table 7 we report inequality indices for the distributions of scores both at the national (first line) and at the regional level (remaining lines). The magnitude of the indices shown in the table is low as compared to those we usually observe with income distribution data. For example, the highest score-Gini found here (0.11737 for the South-Eastern region) is much lower than the income-Gini of any country in recent years, in line with the remark made by Card and Krueger (1996) mentioned above.[8] Brazil's score-Gini index shows an intermediate level of inequality for this grade-year-subject (0.11501), as compared to those of other SAEB samples (not reported here).[9]

When we turn to the additive decomposable GE-class indices, we observe that Brazil's indices are extremely influenced by the highly populated and highly unequal South-Eastern region's indices. Indeed, Brazil's index is always lower than that of the South-East, and higher than that of any other region.

When we compare regions, the ranking is robust to most variations of parameters. The only exception is to be found when we turn to an index which strongly penalizes inequalities

[8] For example, Barros et al. (2000) present Gini indices for around 90 countries for the late 1980s, and the lowest ones (Slovakia, Czech Republic, and Ukraine) oscillated around 0.22-0.25.

[9] The highest score-Gini is the one associated with the 2001-reading-4th-grade sample: 0.1673. The lowest one is for the 1995-reading-11th-grade sample: 0.1054.

among low-performing students, namely, GE(-1). In the latter case, the Northern region (slightly) outperforms the Southern region.

Table 7: Inequality indices for Brazil and its 5 regions. SAEB 2001, Math, 8th grade

						Ranking according to:	
	GE(-1)	GE(0)	GE(1)	GE(2)	Gini	GE(-1)	Other indices
South	0.01696	0.01646	0.01621	0.01620	0.10209	2	1
North	0.01691	0.01661	0.01656	0.01675	0.10339	1	2
Mid-West	0.01769	0.01732	0.01725	0.01746	0.10489	3	3
North-East	0.01983	0.01965	0.01981	0.02033	0.11261	4	4
South-East	0.02211	0.02152	0.02133	0.02154	0.11737	5	5
Brazil	0.02106	0.02059	0.02051	0.02078	0.11501	-	-

The general pattern that emerges from our results allows us to state what follows:

- The rich South-Eastern region, which ranks second in terms of average scores, is the most unequal one according to all indices used here;
- The poor and low-performing North-Eastern region is also one of the most unequal ones, occupying a stable fourth position;
- In addition to presenting the highest average scores, the Southern region is also the least unequal one according to most rankings;
- The Mid-Western region occupies an intermediary position, both in terms of average scores and of scores inequality;
- While its record of average scores is bad, the Northern region shows a relatively egalitarian record in terms of test scores;
- The magnitude of the difference is not negligible, at least between the extreme cases: the most unequal region (SE) is 30.76% more unequal than the least unequal one (S), according to GE(0).

6.2.3. Inequalities in Brazilian states

For a final piece of evidence in our mapping of Brazilian educational inequalities, we compiled rankings of the 27 Brazilian states based on GE-class indices. If a state moves up in the ranking (i.e., it is classified as less unequal) as α moves from -1 to 2 in the GE-class indices, it means that this state has relatively more dispersion at the bottom than at the top. And the opposite holds for those states which move down. The ranking of scores inequality among Brazilian states is reasonably robust to changes[10] in the value of the parameter α. When we move all the way from GE(-1) to GE(2), states occupying extreme positions do not move, and most states move less than 3 positions. The exceptions are: Bahia and Alagoas

[10] A graphic presenting ranking shifts is found in the appendix.

(down 3 positions), Santa Catarina (up 3 positions), Minas Gerais (up 4 positions), Maranhão (down 6 positions), and Tocantins (up 6 positions). Such results correspond to what one would expect: overall more developed states going up; overall less developed states going down. (Tocantins going up is the only somehow unexpected result.)

Table 8 shows the results for GE(0) index, which, as we know, occupies an intermediary normative position in the range of GE-class indices. Among the less unequal states, we find the barely populated Northern states of Amapá, Acre and Rondônia, but also the most important and most populated state of the Southern region, Rio Grande do Sul (around 6% of the country's population). The three states which compose the Southern region are relatively well-placed (i.e., among the eleven less unequal states), as well as most Northern states. The four Mid-Western states are located in intermediary positions, ranging from the 5^{th} to the 16^{th}.

Table 8: Ranking of Brazilian UFs according to GE(0)

UF	Region	Ranking	GE(0)
Amapá	N	1	0.01312
Rio Grande do Sul	S	2	0.01464
Acre	N	3	0.01491
Rondônia	N	4	0.01505
Goiás	MW	5	0.01513
Santa Catarina	S	6	0.01534
Pará	N	7	0.01568
Roraima	N	8	0.01661
Amazonas	N	9	0.01721
Mato Grosso do Sul	MW	10	0.01736
Paraná	S	11	0.01817
Espírito Santo	SE	12	0.01836
Bahia	NE	13	0.01844
Alagoas	NE	14	0.01862
Distrito Federal	MW	15	0.01863
Mato Grosso	MW	16	0.01886
Tocantins	N	17	0.01888
Sergipe	NE	18	0.01901
Maranhão	NE	19	0.01904
Paraíba	NE	20	0.0192
Ceará	NE	21	0.01969
Rio de Janeiro	SE	21	0.01969
Minas Gerais	SE	23	0.01978
Pernambuco	NE	24	0.02002
Piauí	NE	25	0.02118
Rio Grande do Norte	NE	26	0.02174
São Paulo	SE	27	0.02289

The most unequal unit of the federation is São Paulo, the state which responds to the largest share of the country's GDP (around 1/3) and population (around 1/5). The ten most unequal states all belong to only two regions, the South-East and the North-East, previously identified as the most unequal of the country. The range of measured inequality levels in the case of states is much wider than that we found for regions, since the most unequal state is 74.47% more unequal than the least unequal one (30.76% in the case of regions).

These findings have allowed us to map more precisely where in the country score-inequalities are more intense. The most unequal regions are indeed composed of the most unequal state. The results regarding national and sub-national educational inequalities in Brazil provide a basis for future research which would compare the figures reported here with other intra-national, national, and international figures. Future research would also help putting into perspective the importance and magnitude of the inequality levels we have computed (e.g., how high is inequality in Brazil, in its regions, and in its states?). More particularly, given that we have identified the more unequal sub-national units in our mapping exercise, this study can be a useful basis for further research on score-inequality measurement in particular regions, sets of states, states, or even municipalities.

7. Final remarks

While a pervasive improvement in quantitative indicators (access, flow, literacy rates) have taken place recently in Brazil's educational system, there is still room for extending and deepening the improvements in those respects. In particular, the change has not led to a homogeneous situation space-wise.

Besides working on those – important – quantitative aspects, time has come for researchers to care more about qualitative issues too, for a series of reasons explained in Section 3. In terms of quality, Brazil performs poorly in international comparisons, and also according to theoretical achievement standards determined inside the country.

In order to explore distributive issues related to education quality, we have turned to the SAEB test scores database and to inequality and welfare analysis toolbox. Employing such data and tools, we have assessed the intensity of inequalities in terms of education quality in the country, both at the national level, and at relevant sub-national levels.

Our results suggest that distributions of less advanced grades are more unequal than those of more advanced grades, especially in recent years, a situation which is particularly challenging for the coming years.

When we decompose national inequality space-wise, we find that inequality within regions or within states account for a very large fraction of overall inequality (95-96% of overall inequality), while inequality across municipalities is smaller (around 4/5).

In our rankings of scores inequalities, the rich South-East and the poor North-East - the most populated regions of the country - occupy the last positions, that is, they are the most unequal ones. States located in such regions are also the most unequal ones. São Paulo – the richest and most populated of the 27 federal units – is the one showing more inequality, followed by Rio Grande do Norte.

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Appendix: Ranking of Brazilian UFs according to different indices.