Impacts of Grade Configuration on Brazilian Student Outcomes

Marcos Vinicio Wink Junior (FEE)
Luis Henrique Zanandréa Paese (FEE e UFRGS)

Resumo

Este artigo avalia o impacto das configurações de séries das escolas públicas sobre os resultados escolares dos alunos. A partir dos dados do SAEB 2015, nós analisamos o desempenho dos estudantes de 5º ano do Ensino Fundamental de escolas de anos iniciais comparado ao despenho dos alunos de mesma série em escolas de anos iniciais e finais. A estratégia de identificação empregada foi a de *Propensity Score Matching.* Os resultados encontrados apontam que o primeiro grupo apresenta melhores desempenhos em testes padronizados de proficiência em língua portuguesa e matemática. Além disso, há evidências de que tenham maiores taxas de aprovação e menores taxas de abandono. Os efeitos estimados são robustos a identificações alternativas e testes de qualidade do *matching.* Há indícios que práticas pedagógicas alternativas e políticas de gestão escolar para professores podem ser mecanismos que explicam os resultados.
Palavras-chave: configuração das séries, especialização escolar, escolas públicas.

Abstract

In this paper we evaluate the impact of grade span configuration on student outcomes. Using a Brazilian dataset that contains student achievement information and socioeconomic questionnaires, we analyzed 5^{th}-grade students performances of elementary schools (1^{st} to the 5^{th} grade), compared to students of elementary-middle schools (6^{th} to the 9^{th} grade). To do so, we used Propensity Score Matching methodologies to control possible biases. We find that elementary schools have better results in Portuguese language and mathematics standardized score tests, higher passing rates and lower dropout rates than elementary-middle schools. We also ran tests and alternative specifications that indicate the robustness of our estimates. We found evidence that alternative pedagogical practices and school management policies for teachers may explain the findings.
Key-words: grade configuration, school specialization, public schools.
JEL classification: H52, I21, I28.
Área 12 - Economia Social e Demografia Econômica

1 Introduction

Over the last decades, Brazil has been facing a profound change in its demographic structure. While the number of elderly people is increasing, the number of children has been falling due to the reduction in fertility rate. Although this change in the age pyramid is a macroeconomic challenge in the short term, it can provide opportunities to enhance per student expenditure in terms of education to the younger population. Figure **(1)** shows the reduction in enrollment in elementary and middle school in the last 10 years. It is important to note that the attendance rate did not decrease during this period.

Bearing in mind Brazilian demographic phenomenon, the question regarding what to do with schools that have few students enrolled arises. The first and simplest answer to this question would be to close these schools and relocate their students. The second possibility would be to change the school grade span configuration by separating the elementary school (1^{st} to the 5^{th} grade) from the middle school (6^{th} to the 9^{th} grade). The latter proposal has been considered in Brazil during the last years.[1] This issue became even more debated in Brazil with the publication of Decree No. 61672, November 30, 2015, by the Government of the State of São Paulo. The decree authorized the process of grade span configuration for state public schools. This proposal, however, was revoked in May 2016 (Decree No. 61962) due to both the absence of studies measuring the possible impacts of this policy on Brazilian students and public pressure.

The main supporting argument is that the school reorganization would be beneficial by providing more specific pedagogical plans, increasing the specialization of principals and teachers. It is also expected that these schools have students with more homogeneous characteristics. The empirical evidence is that heterogeneous classes negatively affect student's individual achievements (Hanushek et al. (2003); Hattie (2002)).

A similar process occurred in the United States in the mid-20^{th} century. Nowadays most students switch from elementary school to middle school before entering high school. The effects of this transition have been widely studied empirically and evidence shows that switching schools negatively affects school outcomes. Looking thoroughly to academic achievement, studies have shown that this transition negatively affects mathematics and reading scores (Byrnes e Ruby (2007); Offenberg (2001); Rockoff e Lockwood (2010)). The literature also shows that school change affects non-academic outcomes (Schwerdt e West (2013); Weiss e Bearman (2007)). The most discussed mechanism for these findings is the transition period when students are adolescents and several behavioral changes are simultaneously happening. The long-term effects, however, are not considered by this literature. The potential benefits of the grade span configuration on academic achievement may not be immediate. Dove et al. (2010) investigate the effects of this policy on school achievement measured by the Arkansas Benchmark Examination for sixth-grade students. The study reveals that there are positive effects on math proficiency tests after the second year of transition. There is no evidence of effects on the achievement in literacy.

There are two factors common to these studies, however. The first is that they analyze only the case of American schools. The second is that they evaluate students after the transition to middle school. We did not find studies that seek to investigate, before transition, the possible positive

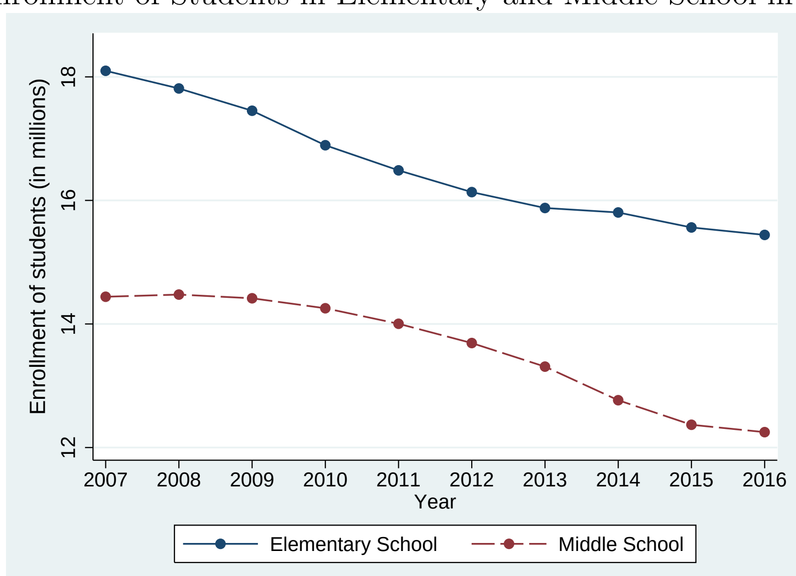
[1] According to the Scholar Census of 2015, elementary schools represent 40% of the total number of schools in Brazil.

effects for early students of elementary school specialization.

In the present study, we use the largest education dataset in Brazil to measure the effect of grade span configuration on 5^{th} grade students enrolled in Brazilian Public School System. We focus our analysis on four different outcomes: achievement in math and reading, passing and dropout rates. We find that achievements are significantly higher as well as passing rate for elementary schools compared to elementary-middle schools. We also find that the dropout rate is smaller for the elementary schools. In order to estimate the causal effects we employ the strategy of Propensity Score Matching to compare outcomes from 5^{th} grade students enrolled in elementary schools and elementary-middle schools. We also run regressions to analyze possible channels through which school specialization may improve school outcomes of 5^{th} grade students. Principals of these schools seem to diversify pedagogical practices and conduct management that benefits teachers. We believe that the findings of this study generate significant impacts for future public policy proposals. This paper also shed some light on the ongoing debate in São Paulo despite further studies are needed.

The paper proceeds as follows. In the next section we describe our data. Section 3 explains the methodology used. Section 4 describes our main findings. In the section 5 we present some tests to check the robustness of the results and section 6 concludes.

Figure 1: Total Enrollment of Students in Elementary and Middle School in Brazil, 2007-2016



Source: Scholar Census, Inep

2 The dataset

For the purpose of this study, we had to classify which schools qualified for treatment or control groups, to do that we used data from the National Institute for Educational Studies and Research (INEP), which is related to the Brazilian Ministry of Education (MEC). In order to define which schools were qualified for the treatment or control groups we gathered from the 2013 and 2015 Scholar Census waves, the number of students enrolled in each grade of each Brazilian school. With this data, we could split our treatment and control groups.

With this data, to classify which group is which, there's some need to understand how the Brazilian educational system works. First of all, home-schooling is not allowed, therefore this analysis of the Census data captured every student present from the 1^{st} to the 9^{th} grade. According to the UNESCO's International Standard Classification of Education (ISCED), Brazilian's Fundamental School (also known as elementary-middle school) is divided into elementary school[2], from the 1^{st} to the 5^{th} grade, and middle school[3], that gathers students from the 6^{th} to the 9^{th} grade. Our definition of treatment and control groups was based in schools that were only elementary schools (treatment group), against schools that were elementary-middle schools (control group).

Having designed the control and treatment groups, we imported, from the same source, the 2013 and 2015 waves of SAEB (Basic Education Assessment System), a biennial survey applied to every student enrolled in public schools, known as Prova Brasil, and in the form of samples for students enrolled in private schools, known as Anresc. This evaluation gives us an idea about the achievement of the students in the 5^{th} and 9^{th} grade. For this study, we analyzed only data from public schools with students that were completing the elementary school, therefore, 5^{th} graders.

All the variables used to gather the results came from this two datasets (SAEB and Scholar Census), except for the variable that defines the *per capita* GDP, which was extracted from the Brazilian Institute of Geography and Statistics (IBGE, in Portuguese).

3 Methodology

We can define Y_{1i} as the outcome of school i if it is treated (elementary school) and Y_{0i} as the outcome of that school if it is not exposed to the treatment (elementary-middle school). The average treatment effect (ATE) for a particular school i can be written as:

$$E[Y_{1i} - Y_{0i}] \tag{1}$$

However, as it is impossible to assign the same school to both conditions, an alternative form of evaluation is the average treatment effect on treated (ATT). Let Z ($Z \in \{0,1\}$) be an indicator variable denoting the treatment received ($Z = 1$ is when the school is treated and $Z = 0$ when it is not). Thus, we denote ATT:

$$E[Y_{1i} - Y_{0i} | Z_i = 1] \tag{2}$$

The ATT is the mean effect of treatment for those schools which actually are only elementary school. For policy purposes, the ATT is of interest rather than the the ATE (Heckman et al. (1997)). The problem arises because we can observe only $Y_{1i}|Z_i = 1$ or $Y_{0i}|Z = 0$. The counterfactual $Y_{0i}|Z_i = 1$ is not observed and $E[Y_{0i}|Z_i = 1] - E[Y_{0i}|Z_i = 0]$ probably be different of

[2] Also known as K-5 schools in the US.

[3] Also known as K 6-9 schools in the US.

zero in non-experimental studies because the covariates that determine the treatment decision also determine the outcomes of interest. Therefore, differences between control and treatment groups remain even in the absence of treatment which is known as self-selection bias. For our purpose, for example, richer municipalities may be more likely to maintain different schools for different school stages and these kind of municipalities have more resources to invest in education.

In response to that, we must rely on some identifying assumptions to solve this selection problem. Rosenbaum e Rubin (1983) defined the following assumptions to ensure that a treatment assignment be strongly ignorable:

$$Unconfoundness \quad (Y_{1i}; Y_{0i}) \perp Z_i | X_i \tag{3}$$

$$Overlap \quad 0 < Pr(Z_i = 1) | X_i < 1 \tag{4}$$

The first assumption says that in a set of observable covariates X which determine the treatment assignment, potential outcomes are independent of treatment status. The second condition ensure that the probability of being both participant and non-participant is bounded away from zero and one. When both unconfoundness and overlap are hold, then the following also holds:

$$Unconfoundness\, given\, PS \quad (Y_{1i}; Y_{0i}) \perp Z_i | P(X_i), \tag{5}$$

where the propensity score $P(X_i)$ is the probability of treatment given the school characteristics X. If the conditions for the strongly ignorable treatment assignment are hold we can use the Propensity Score Matching (PSM) estimator for the ATT as follows:

$$ATT_{PSM} = E_{p(x)|z=1}\{E[Y_1|Z = 1, P(X)] - E[Y_0|Z = 0, P(X)]\} \tag{6}$$

that is, the PSM estimator is the difference between the mean outcome for elementary schools and the mean outcome for elementary-middle schools, weighted by the propensity score distribution. For this analysis, we use a logit model to estimate the probability of each school to be only primary school given X.

In the present study we use four different school outcomes as dependent variable: 5^{th} grade students' average proficiency in Portuguese language and mathematics, average passing rate in elementary school and average dropout rate in elementary school. To select the covariates of the PSM we follow the procedure proposed by Imbens (2015) that allows, in addition to linear terms, second-order terms using an interactive process. All the first-order variables included in the estimation are shown in the table (4) that also shows the test of difference between treated and control groups[4]. The variables that represent characteristics of schools were extracted from the socioeconomic questionnaire of the *Prova Brasil* while the municipal variable (*Per capita* GDP) was taken from IBGE.

To verify the robustness of the results, in addition to the PSM estimation with the data from 2015, we conducted the same estimation with data from 2013 and an alternative methodology

[4]The procedure implemented using the methodology proposed by Imbens (2015) removed only one of the covariates from our estimation, the principals average income.

combining PSM with difference-in-difference between those years. We also ran tests to check the quality of matching.

4 Results

In this section, we present the results obtained by the PSM methodology defined in section (3). Table (8) in the appendix shows the comparative statistics between elementary schools and elementary-middle schools. The descriptive statistics show that, even without any sorts of controls, the elementary school has higher outcomes with better student characteristics.

In table (1) we present the PSM estimates. The main methodology used to verify the outcomes is based on Kernel matching[5]. Following the approach used in Felício et al. (2012) we also consider alternatives PSM methodologies to check the results consistency.

Table 1: PSM estimates of the ATT for different outcomes, Brazil, 2015

	Score of 5th-graders on Portuguese Language	Score of 5th-graders on Math	Average passing rate in elementary school	Average dropout rate in elementary school
	(1)	(2)	(3)	(4)
Epanechnikov Kernel (bandwidth=0.06)	4.25***	5.09***	2.46***	-0.52***
	(0.55)	(0.56)	(0.19)	(0.05)
Nearest Neighbor without replacement	3.19***	3.57**	1.30***	-0.15***
	(0.25)	(0.27)	(0.09)	(0.03)
Nearest Neighbor with replacement	3.09*	4.01**	2.31***	-0.36**
	(1.62)	(1.67)	(0.60)	(0.17)
Nearest 10 Neighbors with replacement	3.19***	3.78***	2.16***	-0.42***
	(0.84)	(0.85)	(0.30)	(0.08)
Caliper 0.1	4.58***	5.46***	2.50***	-0.50***
	(0.45)	(0.46)	(0.16)	(0.04)
Caliper 0.01	3.31	3.97***	2.19***	-0.43***
	0.85	(0.87)	(0.30)	(0.08)
Caliper 0.001	3.38***	3.96***	2.30***	-0.42***
	(0.60)	(0.61)	(0.21)	(0.06)
Caliper 0.0001	2.96***	3.41***	2.09***	-0.39***
	(0.44)	(0.46)	(0.16)	(0.04)

(a) *** significant at 1%; ** significant at 5%; * significant at 10%.
(b) Standard errors in parentheses.
(c) 29963 observations

[5] Following Abadie e Imbens (2006), the standard errors of this estimates were not calculated by bootstrapping, because this values wouldn't be valid while using Nearest Neighbor Matching.

Analyzing the four different outcomes, we can verify that the differences between the treatment and control groups, in our main methodology, are all statistically significant at 1%. The first column show that the mean score on Portuguese Language is 4.25 points higher among students enrolled in elementary schools compared to those who are enrolled in elementary-middle schools. The results are similar for alternative methodologies (estimates range from 2.96 to 4.58). Higher achievements among the treated group can also be verified in mathematics exams. Elementary schools students had their math average score increased in 5.09 points. Considering the alternative methodologies, these estimates range from 3.41 to 5.46. As seen, 5^{th} grade primary schools students perform better in Portuguese language and in mathematics in average than those in elementary-middle school. The dimension of these differences are on order of 0.21-0.22 standard deviations.

As can be seen in the column 3, treatment group students have better chances to go to 6^{th} grade. These results demonstrate that the elementary school had a positive and significant impact on the average passing rate of 5^{th} graders of 2.46 percentage points (estimates range from 1.3 to 2.5). The size of the effect is considerably greater than found in achievements in Portuguese and mathematics, around 0.35 standard deviations.

The last column of the table (1) presents the ATT of dropout rate comparison (after matching) between 5^{th} grade students who are enrolled in elementary schools and those who are enrolled in elementary-middle schools. The PSM estimates indicate that participating in the treated group reduces the dropout rate in 0.52 percentage points (estimates range from 0.15 to 0.52). The size of these difference are on order of 0.25 standard deviations.

Therefore, 5^{th}grade students enrolled in elementary schools compared (after matching) to those from elementary-middle schools present better school outcomes.The results maintain the same direction and significance for different specifications of the models.

Mechanisms

This subsection investigates possible variables that could be the channels that explain the best outcomes for students in the 5^{st} year of elementary schools compared to elementary-middle schools. For example, the grade span configuration can lead to the generation of alternative pedagogical practices focused on the specific needs of students. If this is a mechanism, the principals of these schools would tend to propose policies aimed at school learning, increase of approval rates and reduction of dropout. Another channel that can explain at least part of the findings is school management. Smaller schools may provide principals with more expertise in conducting school management.

The first group of channels tested were those related to pedagogical practices. They are dummy variables assuming value 1 when the school offers specific policies for: achievement reinforcement, approval enhancement, dropout reduction and extracurricular activities. The second group of channels, related to school management, is also formed by dummy variables when the school has: at least 90% of teachers with tenure, teacher training programs, school board meetings at least quarterly. These variables are present in the SAEB database and are answered by school principals. These tests are performed using the same PSM regressions presented in table (1),only replacing the dependent variables (school outcomes) by the dummy variables of the existence of alternative pedagogical practices. The results of the channel tests are shown in the tables (2) and (3).

The results presented in table (2) suggest that elementary schools are more likely to carry out alternative pedagogical policies. This result is not robust only for achievement reinforcement policy. Holding the identification hypothesis of the PSM, we can say that primary schools are more likely, by 11 percentage points, to offer approval enhancement policies. Likewise, they are more likely to offer dropout reduction policies (25 percentage points) and extracurricular activity (5 percentage points). The findings for these three mechanisms are similar for different specifications. Regarding the test of the group of channels related to school management, shown in table (3), the results also indicate that specialized schools tend to have benefits for teachers. There is no evidence, however, that these schools are more likely to have board meetings more often. The results indicate that elementary schools are more likely (10 percentage points) to have at least 90% of their teachers with tenure and more likely (5 percentage points) to offer training programs to their teachers. These findings suggest that both mechanisms (pedagogical practices and school management policies for teachers) may be acting to explain the impacts of grade span configuration in the school outcomes of 5^{st} grade students.

Table 2: PSM estimates of the ATT for the first channel group, Brazil, 2015

	Scholar achievement reinforcement policy	Approval enhancement policy	Dropout reduction policy	Extracurricular activity policy
	(1)	(2)	(1)	(7)
Epanechnikov Kernel	0.01	0.11***	0.25***	0.05***
(bandwidth=0.06)	(0.01)	(0.01)	(0.01)	(0.01)
Nearest Neighbor	0.03***	0.13***	0.28***	0.04***
without replacement	(0.01)	(0.01)	(0.01)	(0.01)
Nearest Neighbor with	-0.01	0.07**	0.28***	0.06*
replacement	(0.02)	(0.04)	(0.04)	(0.03)
Nearest 10 Neighbors	0.00	0.11***	0.24***	0.06***
with replacement	(0.01)	(0.02)	(0.02)	(0.02)
Caliper 0.1	0.01*	0.11***	0.25***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
Caliper 0.01	0.00	0.11***	0.23***	0.06***
	(0.01)	(0.02)	0.02	(0.02)
Caliper 0.001	0.00	0.11***	0.25***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
Caliper 0.0001	0.01*	0.11***	0.26***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)

(a) *** significant at 1%; ** significant at 5%; * significant at 10%.
(b) Standard errors in parentheses.
(c) 29963 observations

Table 3: PSM estimates of the ATT for the second channel group, Brazil, 2015

	At least 90% of teachers with tenure	Teacher training programs	School board meeting at least quarterly
	(1)	(2)	(3)
Epanechnikov Kernel (bandwidth=0.06)	0.10***	0.05***	-0.02
	(0.01)	(0.01)	(0.01)
Nearest Neighbor without replacement	0.15***	0.04***	-0.05
	(0.01)	(0.01)	(0.01)
Nearest Neighbor with replacement	0.13***	0.06*	-0.05
	(0.03)	(0.03)	(0.03)
Nearest 10 Neighbors with replacement	0.09***	0.06***	-0.03
	(0.02)	(0.02)	(0.02)
Caliper 0.1	0.11***	0.05***	-0.02
	(0.01)	(0.01)	(0.01)
Caliper 0.01	0.09***	0.06***	-0.04
	(0.02)	(0.02)	(0.02)
Caliper 0.001	0.09***	0.05***	-0.02
	(0.01)	(0.01)	(0.01)
Caliper 0.0001	0.09***	0.04***	-0.02
	(0.01)	(0.01)	(0.01)

(a) *** significant at 1%; ** significant at 5%; * significant at 10%.
(b) Standard errors in parentheses.
(c) 29963 observations

5 Testing

Matching Quality

For the purpose of checking the quality of PSM, we ran tests to verify if the covariates used in the matching process were properly balanced between treatment and control groups. The tests ran were complementary, to show how the PSM created groups practically equal to each other. The first test, proposed by Rosenbaum e Rubin (1985),consist of a t test to check the differences between the averages of each covariate of treatment and control groups. The results shown in table (4) are based in Kernel PSM, which was chosen as the main methodology of this paper.

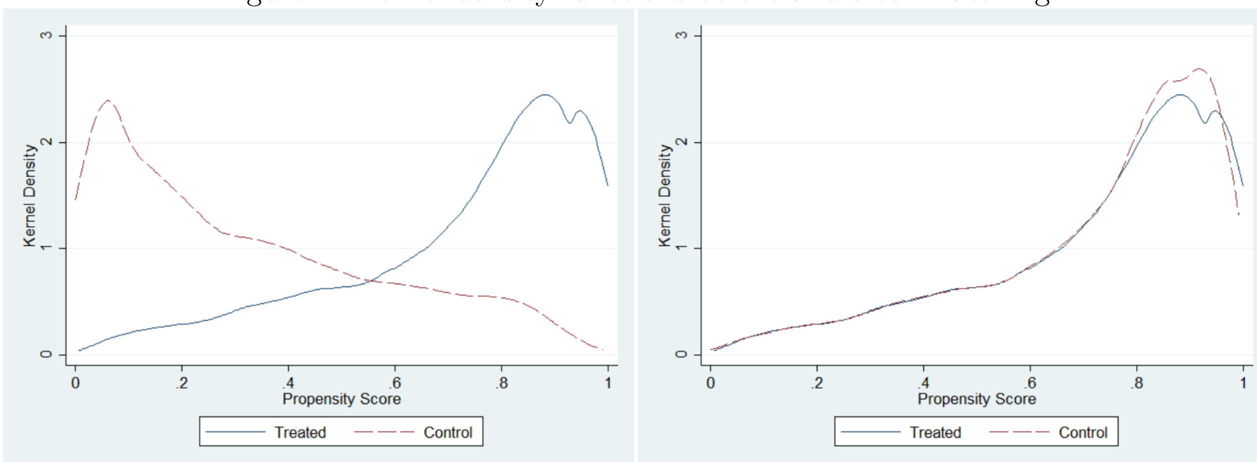
Table 4: Variable Analysis

	Treated	Control	t-statistic after balancing
Dummy representing the location of the school	0.913	0.914	0.646
Dummy representing the administration of the school	0.864	0.862	0.563
Dummy representing the choice of the principal	0.482	0.465	0.001
Percentage of principals with a postgraduate degree	0.828	0.807	0
Percentage of teachers with a postgraduate degree	0.045	0.052	0
Mean years of experience of the principals	4.574	4.794	0
Mean years of experience of the teachers	13.979	14.125	0.006
Mean of teachers income	2,151	2,135	0.148
Dummy of Socioeconomic Level 1	0.003	0.003	0.951
Dummy of Socioeconomic Level 2	0.042	0.042	0.819
Dummy of Socioeconomic Level 4	0.284	0.281	0.586
Dummy of Socioeconomic Level 5	0.383	0.386	0.672
Dummy of Socioeconomic Level 6	0.112	0.112	0.897
Dummy of Socioeconomic Level 7	0.001	0.001	0.177
Percapita GDP	25,908	26,497	0.009

The first two columns of table (4) show the mean value of each covariate for treated and control groups, respectively. The third column, shows the t statistic of the differences between the groups after matching. The t-statistic, shown in the third column, shows that all the p-values for this differences are higher than 10%, indicating that the matching was adequately balanced, this means that the difference of the covariates between the treatment and control groups are not statistically significant at the 10% threshold.

To support the theory that the matching was properly balanced, we also consider Kernel density functions before and after matching to show the overlap of these distributions. Figure 2 show density functions that overlap almost perfectly after matching, indicating a precise balance of the PSM.

Figure 2: Kernel density functions before and after matching



Sensitivity Analysis of the Results to Unobserved Heterogeneity

Even though many controls are used to assure the quality of the PSM, if both control and treatment groups differ on unobserved variables that may affect treatment, or outcome, there is a possibility of the existence of a "hidden bias". This problem, with non-experimental data, cannot be solved since there is no way to measure the effect of this bias against the outcome variables. In order to check the existence of hidden biases, we used the implemented solution suggested by Rosenbaum (2002) that determines how much an unmeasured variable influences the treatment assignment or the outcome.

This issue with non-experimental analysis can also be found in Aakvik (2001), Caliendo et al. (2005) and Caliendo et al. (2008). This implementation can be overall explained as the participation probability of the individual i with the observed characteristics x_i. If the equation that describes this probability includes all the important variables, and there is no hidden bias, we can conclude that γ will be zero and the participation in the treatment will only be determined by the explicit covariates. Following Aakvik (2001) and Caliendo et al. (2008), for the significance of effects, we gradually increased the e^{γ} until the inference about the treatment effect changed. With this we can analyze the strength that unmeasured covariates would require to change the intuition about the treatment effect.

The results shown in table (5) check if the individuals have the same probability of receiving treatment, and this happens when $e^{\gamma} = 1$, therefore $\gamma = 0$. If, the critical value for $e^{\gamma} = 2$, individuals who appear to be similar may differ in their probability of receiving the treatment by a factor of 2. In other words, e^{γ} is a measure of the degree that the propensity is free of hidden bias. This values doesn't represent that the model contain unobserved bias, it simply verifies that in case of the existence of hidden biases, the confidence interval, until the inference was changed, is contained in this values. The results allow us to conclude that even large amounts of unobserved heterogeneity would not alter the inference about the ATT shown in the table (1).

Table 5: Sensitivity Analysis for Unobserved Heterogeneity - Critical value for e^{γ}

	Score of 5th-graders on Portuguese Language	Score of 5th-graders on Math	Average passing rate in elementary school	Average dropout rate in elementary school
	(1)	(2)	(3)	(4)
Epanechnikov Kernel (bandwidth=0.06)	1.4 - 1.45	1.35 - 1.4	2.3 - 2.35	>3
Nearest Neighbor without replacement	1.05 - 1.1	1.05 - 1.1	1.1 - 1.15	1
Nearest Neighbor with replacement	1.1 - 1.15	1.15 - 1.2	1.45 - 1.5	>3
Nearest 10 Neighbors with replacement	1.2 - 1.25	1.15 - 1.2	2 - 2.05	>3
Caliper 0.1	1.45 - 1.5	1.4 - 1.45	2.35 - 2.4	>3
Caliper 0.01	1.25 - 1.3	1.2 - 1.25	2.1 - 2.15	>3
Caliper 0.001	1.2 - 1.25	1.2 - 1.25	2 - 2.05	>3
Caliper 0.0001	1.05 - 1.1	1.05 - 1.1	1.45 - 1.5	>3

Alternative Identification Strategies

In order to check the robustness of the findings, we also ran PSM for the previous year of SAEB, 2013. As seen in table (6), we can conclude that the results can be seen throughout the years and do not qualify as a singular occurrence.

Table 6: PSM estimates of the ATT for different outcomes, Brazil, 2013

	Score of 5th-graders on Portuguese Language	Score of 5th-graders on Math	Average passing rate in elementary school	Average dropout rate in elementary school
	(1)	(2)	(4)	(3)
Epanechnikov Kernel (bandwidth=0.06)	6.47***	7.45***	2.63***	-0.57***
	(0.64)	(0.72)	(0.19)	(0.06)
Nearest Neighbor without replacement	3.58***	4.42***	1.00***	-0.18***
	(0.31)	(0.35)	(0.09)	(0.03)
Nearest Neighbor with replacement	3.95**	5.31***	2.14***	-0.42**
	(1.66)	(1.88)	(0.53)	(0.17)
Nearest 10 Neighbors with replacement	5.47***	6.51***	2.60***	-0.51***
	(0.99)	(1.12)	(0.31)	(0.10)
Caliper 0.1	6.64***	7.69***	2.58***	-0.56***
	(0.52)	(0.60)	(0.16)	(0.05)
Caliper 0.01	4.83***	5.75***	2.43***	-0.48***
	(1.18)	(1.33)	(0.35)	(0.11)
Caliper 0.001	4.76***	5.59***	2.34***	-0.44***
	(0.83)	(0.94)	(0.25)	(0.08)
Caliper 0.0001	4.79***	5.48***	2.15***	-0.41***
	(0.53)	(0.60)	(0.17)	(0.05)

(a) *** significant at 1%; ** significant at 5%; * significant at 10%.
(b) Standard errors in parentheses.
(c) 29922 observations

Another estimation strategy used to check if the results are consistent is the PSM with difference-in-differences between 2013 and 2015. Our treated group are schools that have become elementary schools between 2013 and 2015. The control group are schools that remained elementary-middle schools between the two periods. Although not so strong the results shown in table (7) are similar to those found in tables (1) and (6). Note that in this specification the sample size is reduced. This is because the matching is done only with schools that have changed the grade configuration. Another factor that may explain the reduction of the magnitude of the coefficient is that the effects may be lower in the short term. Changing pedagogical and management practices may take some time.

Table 7: Diff-in-diff estimates of the ATT for different outcomes, Brazil, 2013

	Score of 5th-graders on Portuguese Language	Score of 5th-graders on Math	Average passing rate in elementary school	Average dropout rate in elementary school
	(1)	(2)	(4)	(3)
Epanechnikov Kernel	2.73**	3.46***	2.28***	-0.67***
(bandwidth=0.06)	(1.09)	(1.30)	(0.43)	(0.22)
Nearest Neighbor	0.82	0.57	2.34***	-0.66**
without replacement	(1.59)	(1.94)	(0.65)	(0.28)
Nearest Neighbor with	-6.93	-6.80*	1.63**	-0.59
replacement	(4.27)	(3.79)	(1.63)	(0.62)
Nearest 10 Neighbors	2.23	3.63*	1.42**	-0.23
with replacement	(1.75)	(2.09)	(0.70)	(0.27)
Caliper 0.1	2.88***	3.76***	2.22***	-0.67***
	(1.10)	(1.29)	(0.43)	(0.22)
Caliper 0.01	1.82*	2.17*	2.14***	-0.68***
	(1.09)	(1.30)	(0.44)	(0.22)
Caliper 0.001	1.39	1.50	2.03***	-0.65***
	(1.09)	(1.30)	(0.44)	(0.22)
Caliper 0.0001	1.40	1.53	2.03***	0.66***
	(1.09)	(1.30)	(0.44)	(0.22)

(a) *** significant at 1%; ** significant at 5%; * significant at 10%.
(b) Standard errors in parentheses.
(c) 367 observations

6 Conclusion

The main purpose of this paper was to analyze, given the demographic transition that Brazil is going through, the alternative courses of action given the excess supply in the Brazilian school system. As seen in other countries, this demographic change creates an opportunity to reformulate the educational system. This could be done by closing schools and relocating students, or by specializing schools, splitting the elementary-middle school configuration into elementary and middle schools, in separate sites. This phenomenon was already studied in the United States (Byrnes e Ruby (2007)). Their comparison was among students that passed through a school change in their lives, and how it affected the proficiency outcomes. Even though their results show that this school transition affects negatively the performance of students in standardized tests, their focus was to observe this effect in older students, entering high-school. Our objective was to analyze if this school division, into elementary and middle school, could positively affect the performance of 5^{th}-grade students in Brazil. Our analysis is based on a dataset from the Brazilian

Ministry of Education, which provide information on both standardized test results of students and socioeconomic information of students, teachers and principals.

We estimated the effects of grade span configuration on different outcomes, using the Propensity Score Matching strategy. There are four preliminary findings. First, treated group of school students presented results on standardized tests of Portuguese 0.21 standard deviations higher than those achieved by the control group. Second, students from these schools also present higher achievement in math (0.22 standard deviations). Third, we estimate that the average passing rate is 2.46 percentage points higher in elementary schools compared to elementary-middle schools. This result represents a positive impact of 0.35 standard deviations. Fourth, there is evidence that these schools are also successful in reducing the dropout rate by 0.52 percentage points (0.25 standard deviations). We find evidence that suggests that both alternative pedagogical practices and school management policies for teachers are important mechanisms of the effects of school specialization on student outcomes.

The results presented in this study are statistically significant and robust to different methodological specifications. Therefore, we believe there is evidence that a change in grade span configuration that specializes schools can improve the school outcomes of 5^{th} grade students. These findings have interesting implications for the implementation of public policies. A reorganization of the school structure is favorable in an environment of reduction of enrollments and maintenance of the schools supply.

Finally, this study has the limitation of analyzing only the achievements of 5th grade students. Other studies may contribute to the literature evaluating possible effects for students who switch schools with the change in grade span configuration.

References

Aakvik, A. Bounding a matching estimator: the case of a norwegian training program. *Oxford bulletin of economics and statistics*, 63(1):115–143, 2001.

Abadie, A., e Imbens, G. W. Large sample properties of matching estimators for average treatment effects. *Econometrica*, 74(1):235–267, 2006.

Byrnes, V., e Ruby, A. Comparing achievement between k–8 and middle schools: A large-scale empirical study. *American Journal of Education*, 114(1):101–135, 2007.

Caliendo, M., Hujer, R., e Thomsen, S. L. Individual employment effects of job creation schemes in germany with respect to sectoral heterogeneity. 2005.

Caliendo, M., Hujer, R., e Thomsen, S. L. The employment effects of job-creation schemes in germany: a microeconometric evaluation. In *Modelling and evaluating treatment effects in econometrics*, pages 381–428. Emerald Group Publishing Limited, 2008.

Dove, M. J., Pearson, L. C., e Hooper, H. Relationship between grade span configuration and academic achievement. *Journal of Advanced Academics*, 21(2):272–298, 2010.

Felício, F. d., Terra, R., e Zoghbi, A. C. The effects of early childhood education on literacy scores using data from a new brazilian assessment tool. *Estudos Econômicos (São Paulo)*, 42 (1):97–128, 2012.

Hanushek, E. A., Kain, J. F., Markman, J. M., e Rivkin, S. G. Does peer ability affect student achievement? *Journal of applied econometrics*, 18(5):527–544, 2003.

Hattie, J. A. Classroom composition and peer effects. *International Journal of Educational Research*, 37(5):449–481, 2002.

Heckman, J. J., Ichimura, H., e Todd, P. E. Matching as an econometric evaluation estimator: Evidence from evaluating a job training programme. *The review of economic studies*, 64(4):605–654, 1997.

Imbens, G. W. Matching methods in practice: Three examples. *Journal of Human Resources*, 50(2):373–419, 2015.

Offenberg, R. M. The efficacy of philadelphia's k-to-8 schools compared to middle grades schools. *Middle School Journal*, 32(4):23–29, 2001.

Rockoff, J. E., e Lockwood, B. B. Stuck in the middle: Impacts of grade configuration in public schools. *Journal of public economics*, 94(11):1051–1061, 2010.

Rosenbaum, P. R. Observational studies. In *Observational Studies*, pages 1–17. Springer, 2002.

Rosenbaum, P. R., e Rubin, D. B. The central role of the propensity score in observational studies for causal effects. *Biometrika*, pages 41–55, 1983.

Rosenbaum, P. R., e Rubin, D. B. Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. *The American Statistician*, 39(1): 33–38, 1985.

Schwerdt, G., e West, M. R. The impact of alternative grade configurations on student outcomes through middle and high school. *Journal of Public Economics*, 97:308–326, 2013.

Weiss, C. C., e Bearman, P. S. Fresh starts: Reinvestigating the effects of the transition to high school on student outcomes. *American Journal of Education*, 113(3):395–421, 2007.

Appendix

Table 8: Descriptive Statistics

	Elementary Schools					Elementary-middle Schools				
	Obs (% within category)	Mean Score on Portuguese Language (std.Dev)	Mean Score on Mathematics (std.Dev)	Passing Rate (std.Dev)	Dropout rate (std.Dev)	Obs (% within category)	Mean Score on Portuguese Language (std.Dev)	Mean Score on Mathematics (std.Dev)	Passing Rate (std.Dev)	Dropout rate (std.Dev)
All Schools	16317	210.35	223.45	93.07	0.90	13979	205.60	217.88	91.55	1.16
	(53.86)	(20.10)	(22.49)	(6.78)	(2.03)	(46.14)	(21.94)	(22.28)	(7.71)	(2.14)
State Schools	2214	217.54	230.78	95.85	0.63	4033	214.36	226.12	94.29	0.66
	(7.31)	(17.74)	(20.51)	(5.44)	(1.67)	(13.31)	(17.13)	(17.85)	(6.98)	(1.87)
City Schools	14103	209.22	222.30	92.63	0.95	9946	202.05	214.55	90.44	1.36
	(46.55)	(20.21)	(22.58)	(6.87)	(2.08)	(32.83)	(22.68)	(23.01)	(7.71)	(2.20)
Urban Schools	14876	211.93	224.94	93.38	0.87	11051	210.33	222.11	92.26	1.03
	(49.10)	(19.19)	(21.84)	(6.56)	(2.03)	(36.48)	(19.15)	(20.15)	(7.30)	(1.99)
Country Schools	1441	194.00	207.99	89.90	1.26	2928	187.75	201.94	88.88	1.65
	(4.76)	(21.88)	(23.36)	(8.15)	(2.05)	(9.66)	(22.63)	(22.69)	(8.57)	(2.54)
Socioeconomic Level 1	61	172.68	188.78	85.12	2.03	202	163.81	180.51	84.23	2.39
	(0.20)	(21.26)	(21.24)	(10.13)	(2.35)	(0.67)	(14.20)	(11.60)	(10.21)	(2.95)
Socioeconomic Level 2	691	182.13	196.49	87.13	2.26	1304	181.87	197.00	88.02	2.02
	(2.28)	(18.23)	(20.17)	(8.84)	(2.97)	(4.30)	(23.56)	(24.64)	(9.02)	(2.73)
Socioeconomic Level 3	2852	190.33	202.36	88.92	1.90	2905	190.12	203.16	88.69	2.11
	(9.41)	(16.12)	(17.28)	(7.94)	(2.63)	(9.59)	(18.71)	(19.79)	(8.44)	(2.82)
Socioeconomic Level 4	4629	204.89	216.52	92.20	1.11	3072	203.51	214.74	91.16	1.28
	(15.28)	(14.23)	(16.79)	(6.67)	(2.05)	(10.14)	(14.37)	(15.76)	(7.87)	(2.22)
Socioeconomic Level 5	6240	219.70	233.67	95.14	0.37	4701	215.37	227.09	93.38	0.56
	(20.60)	(11.65)	(15.00)	(4.91)	(1.51)	(15.52)	(12.14)	(13.68)	(6.25)	(1.15)
Socioeconomic Level 6	1831	235.07	249.99	97.16	0.10	1767	230.36	242.11	95.39	0.20
	(6.04)	(10.52)	(13.92)	(2.92)	(0.36)	(5.83)	(11.93)	(13.92)	(3.99)	(0.57)
Socioeconomic Level 7	13	251.09	266.78	98.45	0.00	28	244.70	257.92	98.51	0.04
	(0.04)	(10.00)	(14.44)	(1.55)	(0.00)	(0.09)	(8.83)	(14.20)	(1.54)	(0.19)
North	1814	195.75	206.38	90.53	1.57	1398	186.73	198.70	86.84	2.47
	(5.99)	(17.86)	(18.69)	(7.05)	(2.13)	(4.61)	(20.02)	(18.33)	(8.61)	(2.91)
Northeast	4486	192.86	204.05	88.57	1.99	4218	189.84	202.87	88.23	2.08
	(14.81)	(16.82)	(16.97)	(7.75)	(2.79)	(13.92)	(20.81)	(21.53)	(8.38)	(2.82)
Southeast	6522	221.41	236.09	96.02	0.33	4078	218.00	230.47	94.84	0.56
	(21.53)	(13.47)	(16.07)	(4.86)	(1.43)	(13.46)	(14.03)	(15.58)	(6.07)	(1.16)
South	2396	221.94	237.86	94.93	0.14	3208	217.58	229.66	93.01	0.34
	(7.91)	(13.78)	(16.46)	(4.24)	(0.38)	(10.59)	(14.63)	(15.18)	(5.74)	(0.73)
Central-West	1099	214.86	224.34	94.09	0.46	1077	209.16	218.90	93.90	0.54
	(3.63)	(13.62)	(14.80)	(4.86)	(0.84)	(3.55)	(13.95)	(14.51)	(6.14)	(1.03)