Universidade Federal de Pernambuco
Departamento de Economia
PIMES - Programa de Pós-Graduação em Economia

"The Decentralization of Primary Public Schools in Brazil: An Empirical Analysis of the Educational Performance after the Implementation of FUNDEF"

Natasha de Andrade Falcão

Recife, agosto de 2013

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Orientador: *Prof. Dr. Raul da Mota Silveira Neto*

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NATASHA DE ANDRADE FALCÃO

A Comissão Examinadora composta pelos professores abaixo, sob a presidência do primeiro, considera a Candidata Natasha de Andrade Falcão **APROVADA.**

Recife, 13/08/2013.

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There can be no keener revelation of a society's soul
than the way in which it treats its children.

—NELSON MANDELA

Resumo

Este estudo busca tratar de forma abrangente o tema da descentralização do ensino público básico no Brasil. Utilizando como referência a implementação do FUNDEF - Fundo de Manutenção e Desenvolvimento do Ensino Fundamental e de Valorização do Magistério -, busca-se verificar os impactos da descentralização sobre a performance dos estudantes, bem como sobre a eficiência das escolas. Para isto, utiliza-se a base de dados em painel do censo escolar entre os anos de 1996 e 2006. Primeiramente, o impacto da descentralização sobre as variáveis de performance estudantil - taxas de reprovação, abandono e distorção idade-série - é estimado através do uso de modelos de diferenças-em-diferenças. E uma análise de como as diferentes condições locais podem afetar estes resultados é também realizada. Em seguida, a eficiência produtiva das escolas municipais e estaduais é comparada utilizando-se um procedimento de bootstrap duplo que leva em consideração o impacto do contexto local sobre essas medidas de eficiência estimadas. Os resultados indicam que houve um aumento nas taxas de reprovação e, mais importante, estes resultados podem ser influenciados por características locais como o tamanho da cidade ou o nível de participação política. Em relação à eficiência, os resultados indicam que as escolas estaduais são relativamente mais eficientes e, condições locais afetariam diferentemente a eficiência dos dois tipos de escola.

Palavras-chave: descentralização, ensino básico, diferenças-em-diferenças, eficiência.

Abstract

This study intends to provide a comprehensive analysis of the decentralization of basic public education in Brazil. It uses as reference the implementation of FUNDEF - Fund for Maintenance and Development of the Fundamental Education and Valorization of Teaching - to identify the impact of the decentralization on the students' performance, as well as on the school's efficiency. For this, a panel data from the school census between 1996 and 2006 is used. First, the impact of decentralization on students' performance - failure, dropout and age-grade distortion rates - is estimated through the use of differences-in-differences models. An analysis on how the different local conditions might affect these results is also presented. After this, the efficiency of municipal and state schools is compared using a double bootstrap procedure that takes into account the effects of the local context on the estimated efficiency scores. Results indicate that there was an increase in failure rates and, more importantly, these results might be affected by local characteristics such as city size and political participation. Related to the efficiency estimations, results indicate that state schools are relatively more efficient and, local conditions would impact differently the efficiency of these two school types.

Keywords: decentralization, basic education, differences-in-differences, efficiency.

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1 Introduction

The main purpose of this thesis is to investigate the effects of the decentralization of primary public education in Brazil. Since the implementation of FUNDEF[1] - Fund for Maintenance and Development of the Fundamental Education and Valorization of Teaching - there was a change in the way municipal schools would finance their activities and we intend to understand how the process of schools' municipalization affected the quality of education.

We make use of panel data available from the schools census from 1996 to 2006. This data allows us to follow schools from some years before the implementation of the program, in 1998, until 2006 - its last year, when it was replaced by a more comprehensive fund, the FUNDEB[2] - Fund for the Development of Basic Education and Appreciation of the Teaching Profession. It also gives us the opportunity to identify the year when the school was adopted by the municipality, and then, verify if schools that were adopted or have always been under state's administration were following the same trend, so the effect of decentralization can be correctly captured.

Finally, for a more complete overview of the process of municipalization, we explore the efficiency of municipal and state schools. Using three points in time - before FUNDEF's implementation, some years after it, and by the end, just before the next educational program -, we want to compare the efficiency of these two different administrations. Moreover, we explore how these efficiency measures are related to the political,

[1] From the Portuguese acronym, Fundo de Manutenção e Desenvolvimento do Ensino Fundamental e de Valorização do Magistério

[2] From the Portuguese acronym, Fundo de Manutenção e Desenvolvimento da Educação Básica e de Valorização dos Profissionais da Educação

economic and social context in which these schools are inserted.

1.1 Problem Statement

The importance of education is well understood not only by its private returns but also because of its effects on several other dimensions in life. Differences in educational levels are the most important factor explaining income inequality[3], which makes a more inclusive educational system so desirable in the fight against poverty and for the reduction of inequality of opportunities. In addition, more quality education is important in other aspects of life, as it has been related to reduction in criminality rates, increases in political awareness and decreases in fertility rates due to better family planning[4].

Following this reasoning, the funding reform represented by the FUNDEF allowed even poorer municipalities to have resources to promote its educational system and then, cope with its responsibility in the supply of fundamental education. It represented a redistributive scheme, and our main question here is whether it has contributed or not to improve the quality of education. In theory, there are advantages and disadvantages in any decentralization process, and we would like to explore the benefits or losses represented by the FUNDEF, measuring its effects and trying to identify the local characteristics that might be affecting these results.

1.2 Overview of Proposed Solution

Two identification procedures are proposed here. First, as commonly used in the literature, we explore the differences-in-differences methodology, comparing schools that have been decentralized - have switched from state to municipal management - to schools that have always been under state's administration. The panel data structure helps us to control for school's unobservable characteristics that might affect students' performance and to check for selection bias in the decentralization choice.

Secondly, the effectiveness of both administrations are compared over time. The intention here is to compare the performance of these two school types and to observe if

[3] See Barros and Mendonca (1996) and Gregorio and Lee (2002) for results about the relation between education and income inequality.

[4] See Barros et al. (2000) and Hanushek and Luque (2003).

there was any change in their efficiency during this period of FUNDEF's implementation. In addition, we explore how different is the relation between some exogenous variables and the efficiency scores estimated for each school administration type.

1.3 Out of Scope

The main limitation in this study is represented by the lack of data. Even if the panel data at school level is an improvement compared to previous works found in the literature, we still lack data for identifying schools before the year 1996. This would be useful because we can only count as treated schools the ones that have been decentralized from 1996 to 1997 and on, but we are dropping from our treatment or control groups schools that have always been under the city's management. In other words, if a school was decentralized before 1997, it will not be captured in our sample.

We would also like to compare schools from treatment and control groups before the decentralization has occurred, and this lack of previous data shortens our analysis' scope. We try to tackle this by using the data structure that allows us to identify the year when decentralization started. So we perform some robustness checks using the data for schools that have been decentralized later on time.

Finally, we would like to have information the students family background for every school, but this is not available in the schools census data. In this way, we depend on data at the municipality level from the population census, in order to control some characteristics like literacy, income per capita, inequality and child work.

1.4 Statement of the Contributions

There is still not a final conclusion about the impact of decentralization on the quality of education in Brazil. Studies show a mixed set of results, where most of them find no significant impact, and some find positive changes in school's resources availability but a worsening - or lower improvement - in student's performance indicators. Thus, we want to provide a comprehensive analysis that helps summarize these results through the use of well established methodologies and more adequate data.

The main contribution is to control for school's characteristics over time, generated by merging schools' register data to the schools' census data. Other studies have used data aggregated at the municipality level for schools under state or city administration in which the composition of these groups is not constant over time. We could find only two previous studies that have panel data at the school level, for instance, Madeira (2007) and Razo et al. (2005). But their scope is limited, respectively, to São Paulo and other four Brazilian states - Santa Catarina, Ceará, Minas Gerais and Bahia.

Finally, there are studies that compare schools' efficiency by region and states in Brazil, and also between private and public schools. However, in this study we are interest in the comparison between public schools, when administered by the city or by the state government. In the literature, there is one study by Machado (2013) that compares these types of schools (to which I contributed and learned from), using the average of school's resources and outcomes for the period of 1996 to 1999. One improvement related to other works is the method used, which incorporates environmental variables into the efficiency analysis. These external variables - for example, population literacy levels - might affect the way schools take advantage of its resources and might impact their efficiency measurement. Thus, in this work, we intend to use this methodology and to extend the analysis over different points in time to capture any effects of the decentralization of education on the efficiency of these two types of school.

1.5 Outline

The remainder of this study is organized as follows. We start with a brief discussion about the advantages and disadvantages of decentralization. The intention is to give an overview on how the local characteristics are related to the impacts that decentralization might generate. In this same chapter, we also provide some evidences found in the literature, as well as a description of the FUNDEF program and decentralization patterns.

On the next chapter, differences-in-differences models and corresponding results are presented. We begin by describing the empirical strategy. We then proceed by presenting the data used and descriptive statistics. We follow with the results from the basic models. Finally, the discussion on how these results are affected by different circumstances that characterize the municipalities is presented.

The last chapter corresponds to the efficiency analysis comparing municipal and state

schools. It starts with a review of the literature on the efficiency of education in Brazil, followed by the description of the estimation procedures. We then present the results for the efficiency scores and finish by discussing how the social, economic and political context might differently impact the efficiency estimates for both types of school.

2

Decentralization: Context and Evidences

2.1 Decentralization Advantages and Disadvantages

Whenever the central government is in charge of the administration of revenues and expenditures, efficiency gains arise due to economies of scale in the supply of public goods and services. However, some disadvantages might exist related to the lack of information about the most specific needs from local administrations (Oates, 1972; Lockwood, 2002). Thus, decentralization is seen as an alternative to reduce central government control, introducing more competition and efficiency, and improving the quality and speed of public policies regarding local needs. In other words, under decentralization one of the main advantages is to explore information and control in public service delivery.

However, the incentives generated by decentralization must be analyzed for every particular situation. As long as countries face different levels of inequality, poverty, management capacity, corruption, fiscal structure and so on, several of those conditions might interfere in the way the decision power is used when transferred to region, municipality or district control. One of the main disadvantages of decentralization is to be under political favoritism. Local democracies might not work correctly if political authorities are under the influence of privileged population groups. When a public service is transferred to the local government - which might be under fiscalization of local residents - the correct functioning of this mechanism depends also on other variables. Indeed, the level of exposure to corruption might be correlated to local inequality, poverty and the level of political participation.

There is a huge literature on decentralization, usually related to fiscal federalism,

basically in the United States and, more recently, in the European Union. However, the structure of incentives and institutional context differ from what is generally found in developing countries. For example, according to the model proposed by Tiebout (1956) apud Bardhan (2002), local governments offer different sets of public goods and, as individuals can migrate without restrictions, they could move to communities that better satisfy their preferences. In developing countries, the hypothesis of this model does not necessarily hold. First, there is no perfect mobility - when perfectly informed citizens could answer according to differences in the performance of local administrations. Second, information and control systems are less efficient in poorer countries. Moreover, we have to add that the levels of corruption are higher in those countries exactly because they are exposed to a worse institutional design[1].

Thus, while another advantage from decentralization is the political control that might be exercised by the population - increasing incentives to local administration to use their better knowledge of local conditions - this result depends on the political context of the city. In the local scenario, electorate can be more proactive. In the upper level of administration - i.e., president or governor - the electorate is bigger and specific matters have lower (if at all) influence in the final results of an election. In other words, centralization brings some costs in terms of accountability because it reduces the probability that the well being of a specific community might influence the re-election of a politician at an upper administrative level. However, as discussed in Bardhan (2002), even in more democratic societies, mechanisms of political control might be inefficient and, regardless of the main purpose of decentralization being to effectively reach the poor, the adequate delivery of public services have to deal with problems related to corruption and control by local elites. The author argues that: "in the traditional discussion of decentralization and federalism, the focus is on checks and balances, on how to restrain the central government's power, whereas in many situations in developing countries, the poor and the minorities, oppressed by the local power groups, may be looking to the central state for protection and relief"(Bardhan, 2002, pg. 188).

Another point to be discussed in the case of developing countries relates to the concentration of natural resources, human capital, infrastructure and economies of agglomeration. Economic conditions are different and so is the ability to generate revenues and satisfy local needs. Besides the improvement in the revenues, policies to

[1] See Chetwynd et al. (2003) for a discussion on the relation between corruption and poverty.

enhance distribution of federal funds should be taken in consideration.

According to Bardhan and Mookherjee (2006), decentralization effects depend on the local funding mechanisms. After analyzing three specific cases, they conclude that:

1. Complete autonomy involving unrestricted local taxes generates the expansion of services to all users. However, smaller users in general finance bigger users and results depend on the local level of corruption;

2. When local governments finance their services through local taxes, they reduce the regressive character of transfers, but in general, the richer are still in better situation than the poor;

3. When local services are financed by central government transfers, restrictions in the relations between central and local governments might lead to inadequate levels of local service delivery. The level of services provided is lower than in the other two financing alternatives, but the distribution of services is more equitable.

They conclude that services tend to be expanded whenever governments finance themselves and this effect increases with the level of fiscal autonomy. So, local financing through user taxes might generate the highest level of efficiency and equity, increasing fiscal autonomy and leading to service allocation that is sensitive to local needs and specific costs. Besides that, while avoiding information asymmetries and distortions related to bargain power from local governments, a higher level of services delivery is reached when compared to other financing alternatives.

Related to the city general context, the level of technical capacity in local administrations - because of the lack of interaction with other more qualified professionals or lack of training - is usually lower. So, there is a trade-off, in the sense that the central government might not understand the local demands, but the local authorities might not have the technical capacity to satisfy those needs. In general, decentralization is better when preferences are heterogeneous and no externalities are generated across municipalities. In the presence of externalities and when regions are more homogeneous, a central government delivering a common level of public goods and services to all jurisdictions is more efficient (Oates, 1972). Moreover, the type of service being provided must be considered: central governments explore better the economies of scale in the construction

of general installations; but in terms of administration and maintenance, those economies are not important anymore and they can be kept by local authorities.

Therefore, following this literature, we intend to provide empirical evidences that the effects of decentralization of education in Brazil are not necessarily homogeneous. The characteristics found in each Brazilian municipality - captured here by variables such as poverty, inequality, literacy and voter turnout - might result in different impacts of decentralization on students' performance and schools' efficiency.

2.2 Evidences from the Literature

The purpose of this literature review is to present evidences about decentralization outcomes and, more specifically, its impact on educational provision and student performance indicators. This set of evidences will therefore serve as reference to methods, data used and results expected in this study.

2.2.1 International Evidence

Araujo et al. (2008) give a good example on how the municipality technical capacity or inequality level might affect the results from decentralization. For a simple model of project selection in Ecuador, they provide evidence of local elite capture related to the choice of investment projects financed with resources from the Social Investment Fund. Based on different project options, such as schooling, health or infrastructure, they found that poorer villages were more likely to receive projects providing excludable (private) goods to the poor, in this case, latrines. However, after controlling for the level of poverty, more unequal communities were less likely to receive those projects. They interpreted these results as evidence of the concentration of power in the hands of richer people, who do not need new latrines. And, "to the extent that such choice reflects differences in power, rather than need, it constitutes capture of the program"(Araujo et al., 2008, pg. 4).

Faguet and Sanchez (2008) studied the impacts of decentralization policies in two other Latin American countries, Bolivia and Colombia. They show that investment shifted from infrastructure to primary social services such as education and health, and that the driver of these changes was the behavior of smaller, poorer and more rural municipalities. In Bolivia the government became more responsive to areas of greatest

need, with a massive shift of resources to previously neglected areas. For the particular case of education, it is shown that investment rises where civil institutions are more vigorous, but falls where the private sector is stronger. This is interpreted as a sign of local political competition: with grass roots civic support for better education services in one side, and private firms lobbying for resources to flow to other more profitable sectors on the other. In Colombia, since the 1991 Constitution, governors started to be elected by popular vote and responsibilities and additional resources were transferred from the central government to municipalities. Authors find that decentralization increased the overall level of local expenditures, but the main result is the rise in education and health spending. Also, there was an increase in enrollment and this effect is stronger where voters are engaged and participate in politics.

Jimenez and Sawada (1998) measure the effects of decentralizing education responsibility to communities and schools using the example of El Salvador's Community-Managed Schools Program (EDUCO, from the Spanish acronym, *Educacion con Participacion de la Comunidad*). In the 1980s, due to the country's civil war, schools could not be extended to rural areas. Thus, communities took the initiative to organize and finance their own schools. This was interpreted as a demonstration of a demand for educational services and, more than this, a desire in participating in the administration of these services. As a result, the EDUCO project was launched, strengthening direct involvement and participation of parents and community groups, which rapidly expanded rural education. After controlling the students characteristics and selection bias, results indicate that the expansion promoted by the program has not adversely affected student performance and has diminished student absenteeism, which may have longer-term effects on achievement.

Finally, in a study for Argentina, Galiani et al. (2008) analyze a political experiment in which the central government, between 1992 and 1994, transferred all secondary schools to the province control and then, several of those provinces transferred decision responsibility to local schools and communities. For a database of 3,456 public schools, between 1994 and 1999, they compare, using a differences-in-differences model, the change in the results for student's achievement tests between schools that have been transferred to the province control and those that have always been under province responsibility. Moreover, they also analyze the quality of provincial government and find that decentralization only had a positive effect on schools located in non-poor municipalities

in well-managed provinces. And there was no impact on rich municipalities with bad management, nor on poor municipalities with good management. But test scores did fall in schools that have been transferred in poor municipalities located in weakly managed provinces.

2.2.2 Decentralization of Education in Brazil

FUNDEF

The Brazilian Constitution of 1988 mandates that municipalities and states must spend at least 25% of their tax revenues and transfers on their educational systems. However, these expenditures were not linked to any specific area. Some of the problems included: (i) richer states and municipalities could spend more for each student when compared to their poorer counterparts, and this pattern did not necessarily reflect local major demands; (ii) governments with smaller revenues could allocate resources to lower levels of education, where costs used to be lower too. These distortions led the Federal Government to implement the FUNDEF, which is a financing reform of public education in Brazil, approved at the National Congress in 1996 and implemented in January of 1998. In particular, the FUNDEF played a major role in shaping the public resources earmarked to education and its main characteristics were:

- To create a national fund with resources collected from states and municipalities, where each of them must contribute 15% of their tax and transfer revenues;
- To redistribute those resources among states and municipalities according to the number of students enrolled in their primary and secondary education systems (based on school census data);
- To create a commission to annually set a minimum monetary value per pupil to be distributed. This minimum value is based on an estimate of school management costs. Due to the characteristics of various types of schools, this minimum can be different for primary and secondary schools. If for some states, the resources per pupil collected by the fund are smaller than the minimum set value, the federal government must provide the difference;

- To established that states and municipalities must spend at least 60% of the fund on teacher wages.

According to Orellano et al. (2011), there were two distinct decentralization periods in the Brazilian education. The first one started with the Constitution of 1988, when municipalities were made responsible for the fundamental education level. And the second period was after FUNDEF's implementation, in which the decentralization of expenditures became feasible with the redistribution of resources.

Thus, the FUNDEF assured to municipalities the funds needed to maintain the schools, since those resources were distributed in order to keep expenditures per student constant. Now, local governments could finance their basic education. More specifically, there was a process of municipalization driven by the change in the financing structure of the Brazilian public fundamental education. Table 2.1 presents the fund impact among Brazilian regions, showing for 1998 how the fund transferred resources to the benefit of municipalities.

Table 2.1 FUNDEF Financial Impact by Brazilian Regions - 1998 (R$ Millions)

Region	State Government				
	Contribution to FUNDEF (A)	Revenues from FUNDEF			B - A
		Principal	Federal Compl.	Total (B)	
N	731.7	655.6	66	721.6	(10)
NE	1,810.6	1,203.2	157.9	1,361.3	(449.5)
SE	4,327.7	4,500.2	-	4,500.2	173.2
S	1,283.4	1,152.5	-	1,152.5	(130.9)
CO	452.0	446.3	-	446.3	(5.7)
Brazil	8,604.7	7,957.8	223.9	8,181.7	(423.0)
Region	Municipal Government				
	Contribution to FUNDEF (A)	Revenues from FUNDEF			B - A
		Principal	Federal Compl.	Total (B)	
N	262.5	338.5	46.6	385.1	122.6
NE	966.1	1,573.8	216.1	1,789.9	823.8
SE	1,973.3	1,799.9	-	1,799.9	(173.4)
S	717.2	848.1		848.1	130.9
CO	247.0	252.5	-	252.5	5.5
Brazil	4,166.1	4,818.8	262.7	5,075.5	909.4

Source: Education Secretary - MEC apud Menezes-Filho and Pazello (2004).
Notes: Parenthesis stand for negative values.

This study focus basically on the period related to FUNDEF, from 1998 to 2006. From 2007 onwards, it was replaced by the FUNDEB, that is a more general version of the

previous fund. The idea behind the new plan was to finance all the basic education levels and, for example, some resources had youth and adult programs as targets. Furthermore, the new fund increased ten times the investments from Federal Government and its main goal was to promote an even more comprehensive redistribution of educational expenditures[2].

The Decentralization Process

In order to analyze the decentralization of education we start by defining its meaning. In this study we refer to decentralization or municipalization as the process represented by the increase in the proportion of students in the public educational system that are enrolled in municipal schools. And, another relevant choice is given by what we call municipal or state managed school. As correctly pointed by Soares and Souza (2003), we can have a school functioning in a private building with their teachers' salaries paid by the State and whose utilities are paid by the municipal government. Thus, to deal with arrangements like this, we follow the definition used by the Ministry of Education in Brazil, defining a municipal school when its director is appointed by the Mayor or Municipal Education Secretary. And the same rule is valid for State schools, where their director is appointed by the Governor or State Education Secretary.

In the end of the 1990s, there was an important increase in the enrollment in municipal schools. As shown in Table 2.2, enrollment in fundamental level has been quite constant along the decade of reference used in this study, but there was a switch in the proportion of enrollment in state and municipal schools. While in 1996, 56% of the students were enrolled in state schools and only 33% of them in municipality managed institutions, in 2006 these numbers were inverted, 36% and 54% for state and municipal schools, respectively. It is also important to notice that in the case of high school level, there was a considerate increase in total enrollment, which was absorbed mainly by the state administered schools. This pattern is expected in the sense that the Constitution of 1988 determines that municipalities should be responsible for the supply of lower educational levels, while states should be responsible for the secondary level. The main provider of college education is the federal government.

Additionally, Table 2.3 presents the share of schools by administrative level, but

[2]More details are available at http://portal.mec.gov.br

Table 2.2 Total Enrollment by School's Administrative Level

Year	Fundamental Level								
	Total	Federal	(%)	State	(%)	Municipal	(%)	Private	(%)
1996	33,131,270	33,564	0	18,468,772	56	10,921,037	33	3,707,897	11
1997	34,229,388	30,569	0	18,098,544	53	12,436,528	36	3,663,747	11
1998	35,792,554	29,181	0	17,266,355	48	15,113,669	42	3,383,349	9
1999	36,059,742	28,571	0	16,589,455	46	16,164,369	45	3,277,347	9
2000	35,717,948	27,810	0	15,806,726	44	16,694,171	47	3,189,241	9
2001	35,298,089	27,416	0	14,917,534	42	17,144,853	49	3,208,286	9
2002	35,150,362	26,422	0	14,236,020	41	17,653,143	50	3,234,777	9
2003	34,438,749	25,997	0	13,272,739	39	17,863,888	52	3,276,125	10
2004	34,012,434	24,633	0	12,695,895	37	17,960,426	53	3,331,480	10
2005	33,534,561	25,728	0	12,145,494	36	17,986,570	54	3,376,769	10
2006	33,282,663	25,031	0	11,825,112	36	17,964,543	54	3,467,977	10
Year	High School								
	Total	Federal	(%)	State	(%)	Municipal	(%)	Private	(%)
1996	5,739,077	113,091	2	4,137,324	72	312,143	5	1,176,519	21
1997	6,405,057	131,278	2	4,644,671	73	362,043	6	1,267,065	20
1998	6,968,531	122,927	2	5,301,475	76	317,488	5	1,226,641	18
1999	7,769,199	121,673	2	6,141,907	79	281,255	4	1,224,364	16
2000	8,192,948	112,343	1	6,662,727	81	264,459	3	1,153,419	14
2001	8,398,008	88,537	1	6,962,330	83	232,661	3	1,114,480	13
2002	8,710,584	79,874	1	7,297,179	84	210,631	2	1,122,900	13
2003	9,072,942	74,344	1	7,667,713	85	203,368	2	1,127,517	12
2004	9,169,357	67,652	1	7,800,983	85	189,331	2	1,111,391	12
2005	9,031,302	68,651	1	7,682,995	85	182,067	2	1,097,589	12
2006	8,906,820	67,650	1	7,584,391	85	186,045	2	1,068,734	12

Source: MEC/INEP.

separating them among those that have always been under state or municipal management (at least since our first year of observation - 1996) and indicating the ones that have decentralized. It can be noticed a decrease in the number of state schools, both by the adoption by municipalities or the end of schools' activities. There is also an increase in the number of schools that have always been under municipal management, corresponding to the creation of new municipal schools. And, in the last two columns, it can be seen that the decentralization was higher in the years just before FUNDEF's implementation, in 1998. And after it, there is always a slightly increase in the share of decentralized schools.

Table 2.3 Number of Schools Decentralized Over Time

year	always state	(%)	always municipal	(%)	year of decentralization	(%)	have decentralized	(%)
1996	32,738	26.30	91,735	73.70	0	0.00	0	0.00
1997	30,723	23.42	98,663	75.20	1,727	1.32	1,727	1.32
1998	25,465	19.00	102,335	76.36	4,378	3.27	6,064	4.53
1999	24,668	18.11	105,008	77.11	358	0.26	6,270	4.60
2000	23,700	17.22	106,956	77.73	482	0.35	6,704	4.87
2001	24,239	16.28	117,570	78.96	213	0.14	6,810	4.57
2002	23,089	16.18	112,455	78.83	173	0.12	6,846	4.80
2003	22,171	16.01	108,949	78.69	276	0.20	6,975	5.04
2004	21,047	15.54	106,940	78.97	246	0.18	7,041	5.20
2005	19,381	14.75	104,023	79.19	758	0.58	7,578	5.77
2006	18,558	14.58	100,827	79.21	245	0.19	7,535	5.92

Source: Censo escolar, 1996 to 2006, MEC/INEP.

According to Soares and Souza (2003), one can exclude two main possible sources of the increase in municipal enrollment: (i) an increase in demographic pressures, and (ii) changes in the flow of students into our grades of interest. Figure 2.1 shows that the number of children at age seven (the age in which they should be entering the first fundamental grade) increased until the beginning of the 1990s, but went down after this. Therefore, it is not possible to justify the increase in municipal school's enrollment due to demographic pressures. Secondly, from Table 2.2 one can also verify that the total enrollment in fundamental level has increased a little bit around 2000, however in the final years considered it came back to its initial level. Soares and Souza (2003) study the process of municipalization and describe that this observed increase was related basically to the rise in enrollment in grades 5th to 8th. During the first four grades enrollment has gone down and after 2002, its decreasing pattern made the change in enrollment in

fundamental level become negative.

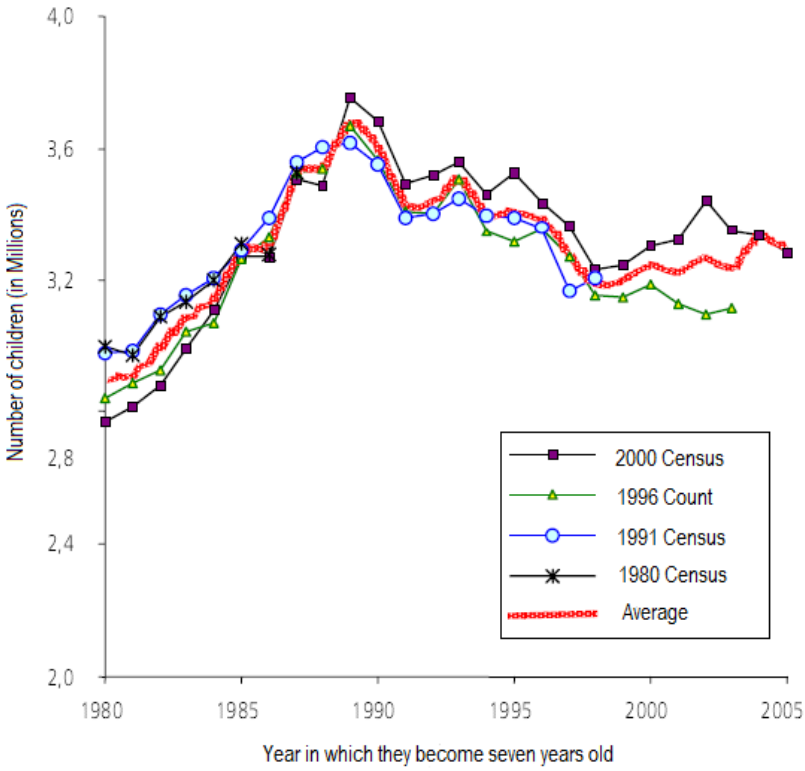

Figure 2.1 Cohorts by Age When Child was Seven Years Old (in Millions of Children) Source: Demographic Census from 1980, 1991 and 2000, and Population Count from 1996, apud Soares and Souza (2003).

So, this work focus on state and municipal schools, during the four first grades of the fundamental level. Enrollment in federal schools is kept as residual and they are not included in our analysis. Also, students enrolled in these institutions are selected by a competitive process, what makes them not comparable to other public schools' students. Private school enrollment is constant through the years. In that sense, we will not account for private enrollment in our analysis.

2.2.3 National Evidence

In Brazil, decentralization is related to the transfer of fundamental education to municipalities control. During the 1990s, some laws consolidated this decentralization process,

and the FUNDEF had an important rule in establishing the investment in fundamental education at the municipality level. One of the main accomplishments of FUNDEF was to guarantee that at least 60% of its funds should be spent in teachers' wages. Even poorer municipalities would have funds, depending on their enrollment, to pay for the teachers in fundamental education. About this particular policy, Menezes-Filho and Pazello (2007) use a differences-in-differences model to identify the effect of teachers' wages on the proficiency of the students in the public school system. They use the data from SAEB - *Sistema de Avaliação da Educação Básica* - for 1997 and 1999, and find that an increase in relative wages generated a positive effect on the observed average proficiency.

Estevan (2009) explores how the variation in public financing affected private enrollment. She tests the hypothesis that private school enrollment is the household's answer to the low quality of public schools. She finds that while redistributing funds to municipalities and consequently improving public school resources, the positive impact of FUNDEF reform - increase in teachers' level of qualification and improvements in school infrastructure - is associated with a reduction in the share of private enrollment for the first grade of primary education. It is argued that these results confirm the intuition that parents may be reluctant to switch schools after the beginning of their child's schooling track.

About the impact of decentralization of public education on students performance, D'atri (2007) analyzes FUNDEF's effects using the school census data for 1998 and 2004, using both first-differences and differences-in-differences models with data aggregated at the municipal level. Results are inconclusive on average, and two reasons are given for the small or insignificant impact of municipalization: first, the municipalities were not prepared to the increase in the number of students; and second, the impact of this process might have been captured by state schools, which in the end had their class sizes reduced.

On the other hand, Madeira (2007) uses a eight-year panel of school census data, from 1996 to 2003, for primary schools in the state of São Paulo, to identify the effects of municipalization on performance indicators and school resources. In order to construct the panel, the author maps the schools (using Brazilian census data) and finds that the decentralization process increased dropout and failure rates, even with the increase in the level of resources available. Finally, he finds evidence that these effects are worse for

schools located in poorer and rural areas, but that administrative experience is unrelated to these findings.

Cassuce et al. (2011) analyze the municipalization effects on the educational quality for students in the 4th grade of primary education in the city of Ponte Nova, Minas Gerais. Following three schools from 1990 to 2005, and using a fixed effects model, they find that the increase in the number of teachers with college degree and the incentive to reading activities improved average approval rates. However, decentralization impacted performance on the opposite direction.

Razo et al. (2005) select the four states where the proportion of schools that have been adopted by the municipal government was higher in 1997 and 1998: Santa Catarina, Ceará, Bahia and Minas Gerais (Espírito Santo and Pará were dropped from the analysis), to perform a differences-in-differences model with propensity score matching to evaluate the municipalization between 1996 and 2002. For these first three states, there was no impact on the average school delay or on the age-grade distortion rates. Only in Minas Gerais the municipalization negatively impacted on these indicators in the first four grades of primary education.

Paredes et al. (2010) also analyze the impact of FUNDEF, in this case, on the change in students' achievement in two different evaluations. Through a fixed effects panel data analysis they calculate the difference in performance from public schools that remained under state control and those that migrated by the time of the second test. They construct four panels, one for each school assessment cohort and, considering only students in fourth grade, they find no evidence of change in their performance.

Another study of interest, Orellano et al. (2011), propose different measures of decentralization and evaluate its impacts on performance variables obtained from a panel data set from the school census aggregated at municipality level from 1999 to 2006. The two different measures of decentralization used are: one administrative - or level of municipalization -, and the other is related to fiscal decentralization. The first refers to the proportion of municipal schools and municipal enrollment in the fundamental education in the municipality and they find no significant impact of these indicators on students' performance. For the second indicator - measured as the ratio of FUNDEF transfers to total expenditures in education and culture -, they find that a higher dependence on FUNDEF transfers is correlated to higher failure and dropout rates.

Finally, Firpo et al. (2012) analyze the relation between municipalization and electoral

accountability. School accountability that establishes incentives to teachers and managers might affect positively the students. However, in Brazil, Federal government cannot enforce the adoption of those incentives. Indeed, at the local level, mayors became responsible for public fundamental education. In 2008, after the publication of the results of a national evaluation of public schools, the authors found they became electorally accountable for not improving the quality of their schools. Better results in the tests are found to be related to a higher probability of re-election, and this effect is greater in poorer municipalities or where the fraction of children at school age is higher.

3

Decentralization and the Quality of Education in Brazil

In this chapter we measure the impact of decentralization on selected school outcomes. The Educational Funding Reform we investigate in this study - FUNDEF - was launched in 1998, and we take advantage of the fact that the school's adoption (from state to municipal management) was gradual. Also, we have a panel data before and after the decentralization and access to time-varying control variables that might affect the mayor's choice to decentralize the schools.

We would like to observe schools that were transferred to the municipal administration if they have stayed as state schools. As explained in Angrist and Pischke (2009), we don't have this counterfactual. For that reason we choose to use the differences-in-differences estimator to capture the effect of decentralization. We compare treated schools - those that have changed from state to municipal control - and the ones that have never been decentralized. The key identifying assumption here is that the performance trends would be the same in both schools in the absence of treatment. A deviation from this common trend would be induced by the treatment. Also, as long as panel data is available, random trends can also be included in the analysis, in order to capture changes over time in unobserved factors at the school level.

In the next section, we explain the estimation options that were made, where the differences-in-differences estimator plays a key role. We stress some of the caveats that arise from the use of this technique to our problem and the solutions we have found to deal with them. After this, we have a brief section to describe the variables available,

their sources and some basic statistics. Finally, we present the results for the different strategies proposed and, in the last section, evaluate how the municipal context might affect the decentralization outcomes.

3.1 Empirical Strategy

3.1.1 Differences-in-Differences Model

Three measures of school performance are used: dropout rates, failure rates and age-grade distortion rates. They were calculated directly from the School Census data for the first to fourth grades (primary education) at municipal and state schools. The dropout and failure rates are given by the share of students who have abandoned or failed, respectively, by the end of the year, among the ones who were approved, reproved, transferred or that dropped out of school. The age-grade distortion rate is given by the share of students that are two years or more behind the ideal age for their grade among all the enrolled students.

The counterfactual we would like to have is to observe the same school under the two types of administration. However, as explained before, this is not possible and we rely on the differences-in-differences method to access the impact of the decentralization on the school performance indicators. In this case, we compare decentralized schools (treatment group) to a control group, formed by the state schools that have never been decentralized. Since we have panel data available for schools before and after the decentralization, and the fact that the change was gradual and not universal, we can verify the quality of the control group, whose indicators should not differ from the ones for the treated schools in the case they had not been decentralized. Also, the panel data structure will allow us to control for schools' unobserved heterogeneity. Furthermore, variables at school and municipality levels will help to control for time-varying factors that might be related to the decentralization decision.

Based on Madeira (2007), we propose two different strategies. The first one is a basic fixed effects model, where we add the possibility of nonlinear decentralization effects:

$$y_{imt} = \alpha_i + \theta_t + \sum_{j=1}^{5} \delta_j D_{it\,j} + \beta X_{it} + \gamma X_{mt} + \mu_{imt} \tag{3.1}$$

where y_{imt} represents a given school performance indicator for school i located on the municipality m in year t, α_i corresponds to school i fixed effects, θ_t denotes year fixed effects, X_{it} corresponds to a vector with school time-variant characteristics, X_{mt} denotes a vector with municipality m time-varying characteristics, μ_{imt} are the transitory mean zero noise terms, and $D_{it\,j}$ is an indicator that assumes value 1 if the school i in year t has been decentralized for j years and zero, otherwise. The index j is allowed to vary from 1 to 5, where $j = 5$ includes all the schools that have been decentralized for 5 or more years. The reason for allocating the schools decentralized for 5 or more years in the same group resides on the fact that the primary schools have four grades, so after five years since decentralization the cohort of first graders pupils at the year of decentralization will be out of the school. The coefficients of interest are the δ_j for $j = \{1,2,\ldots,5\}$ for each of the school performance indicators[1].

However, in the context of the funding reform analyzed here, we should be careful about the selection bias problem. It might be the case that the decision about the decentralization was not exogenous. The Mayors themselves could have been able to decide whether and when to be treated. In order to avoid this selection problem, the use of a random trend model is proposed. Besides, there might be some time-varying characteristics at the school level that can be related to the outcomes from decentralization. This alternative model has been proven more effective in dealing with school selection biases for the São Paulo case studied in Madeira (2007). The model can be stated as:

$$y_{imt} = \alpha_i + g_i t + \theta_t + \sum_{j=1}^{5} \delta_j D_{it\,j} + \beta X_{it} + \gamma X_{mt} + \mu_{imt} \tag{3.2}$$

where $g_i t$ refers to school specific time trends. In order to estimate equation (3.2), the first difference can be taken. The new equation will correspond to the standard fixed effects specification applied to the variables' first difference:

$$\Delta y_{imt} = g_i + \xi_t + \sum_{j=1}^{5} \delta_j \Delta D_{it\,j} + \beta \Delta X_{it} + \gamma \Delta X_{mt} + \varepsilon_{imt} \tag{3.3}$$

[1] In the traditional differences-in-differences model, α_i would be a dummy indicating if the school has been treated or not, θ_t is the year dummy, and the third term in the right hand side of equation (3.1) would be replaced by δD_{it}, a dummy indicating if the school received treatment in the second period of the analysis. Hence, α captures trends affecting treatment and control schools that are fixed over time, θ captures any time trends, and δ would capture the decentralization effect

where the school fixed effect is given now by the growth rate of the school i specific trend (g_i). This model allows the control for some unobserved characteristics at the school level that might be changing over time and, then, can affect the Mayor's decision on whether to be treated or not.

3.2 Data and Descriptive Statistics

The final database used in this study combines data from different sources: the schools' census information, electoral data, social and demographic characteristics for each municipality[2].

3.2.1 School Data

The Brazilian primary educational level comprises four school years, supposed to be attended by children 7 to 10 years old. These children must attend the public (municipal or state) school closest to their household, where the basic subjects offered are Portuguese, Mathematics, Social Studies and Science. The microdata used is the school census obtained from the *Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira* - INEP, for the period from 1996 to 2006. And we are interested in the panel component which allows us to follow all primary - municipal and state schools from first to fourth grades - over this period of FUNDEF's implementation. The performance and resource indicators for each school calculated from this data are the following:

- Age-grade distortion rate[3];

[2]It is important to notice that there is no data on school's decentralization for the state of São Paulo. From the panel data used, schools in this state have been under municipal or state administration only (since 1996). Razo et al. (2005) also use this database and do not have results for São Paulo. This limitation would be solved if we had access to previous panel information. However, after careful comparison of schools codes and names, register data for the year 1995 had to be discarded.

[3]In a grade educational system, there is a theoretical relation between the grade and student age. In the Brazilian case, the children are supposed to enroll in the primary level at the age of 7. Following this, we can identify the corresponding "right" age for each grade and evaluate the percentage of students that are older than this recommendation. From the Brazilian School Census we obtain the enrollment numbers in each grade by year of birth. Considering the data for the year t, grade s, and recommended age of y, the indicator of age-grade distortion will be expressed by the ratio between the number of students that, in year t, become $y+2$ years old or more (were born before $t-[y+1]$) and the total enrollment. The reason is that students that were born in $t-[y+1]$, will be $y+1$ years old in t and, then, at some point in this

- Failure rate;
- Dropout rate[4];
- Dummy for school that offers the next four grades of the fundamental level;
- Number of rooms actually used at school. In the data some schools have more rooms available than currently used and here we intend to capture the actual value;
- Total number of teachers;
- Total number of teachers in primary level;
- Percentage of teachers in primary level who have tertiary education;
- Total number of classes in primary level;
- Total enrollment in primary level;
- Number of students in each primary level class;
- Ratio between the total enrollment and teachers available in primary level;
- Dummy for urban location;
- Dummy for availability of library in school;
- Dummy for availability of computer laboratory in school;
- Dummy for availability of a laboratory of sciences in school;
- Dummy for availability of sports court in school;
- Number of television sets for every hundred primary students;
- Number of computers for every hundred primary students;

year they would still be y years old, in other words, at the right age. And the ones that were born after $t-[y+1]$ become, in t, y years old or less.

[4]In the School Census, the performance information (failure and dropout rates) refers to the previous year. So, the performance variables in t were obtained by the school census in $t+1$. As a consequence, we will have the data for failure and dropout rates as dependent variables from 1996 to 2005.

- Dummy for availability of water supply in school;
- Dummy for availability of electricity;
- Dummy for availability of sewage in school;

The variable "percentage of teachers with college degree" is not available in the census for 1997 and was imputed as the average of the values observed in 1996 and 1998 for each school. After the imputation, it starts as low as 12.57% in 1996, then rises to 13.36% and 13.71% in 1997 and 1998, respectively. These values keep increasing over time and this pattern is consistent with the Law number 9,394 of 1996 for the development of education in Brazil, that stated that primary level teachers should have college degree or training as minimum qualification[5].

3.2.2 Municipal Data

In order to control for exogenous municipal characteristics, we selected a set of variables that might be related to children enrollment and performance in school. We have also included variables like income inequality, distance to the State's capital and voter turnout that, according to the theory on decentralization discussed in Chapter 2 can affect the quality of school services provided. These variables are available in the webpage of the *Instituto de Pesquisa Econômica Aplicada* - IPEA[6] - that organizes Brazilian data from different sources into topics of interest.

An estimate of the population size for every year was available, as well as the GDP for each municipality (which was then used to generate the GDP per capita variable). However, it is not possible to have annual data at the municipal level for all the variables to be included. Whenever this was the case, and as the Census is available every ten years and is representative of each municipality in Brazil, we chose to use the data for 2000, two years after the FUNDEF's start, as the reference. Therefore, Gini coefficients, children population and child work variables were directly calculated using the Population Census microdata. The list of municipal variables includes:

- Total population;

[5]The LDB can be consulted at http://portal.mec.gov.br/seed/arquivos/pdf/tvescola/leis/lein9394.pdf

[6]http://www.ipeadata.gov.br

- Municipal Gross Domestic Product (GDP);
- GDP per capita;
- Women share in the population;
- Share of residents living in rural areas;
- Share of population aged 7 to 10 years old;
- Share of working children when aged 10 to 14 years old;
- Gini's coefficient of Inequality;
- Percentage of people whose household income *per capita* corresponds to less than half of the minimum wage value;
- Distance to the corresponding state's capital, in kilometers (km);
- Transfers from the Municipal Participation Fund (FPM);
- Tax revenues;
- Literacy rate, for people 15 years old or more;
- Voter turnout, which is given by the percentage of those who actually voted among the registered voters;
- Dummy indicating if Mayor and Governor are affiliated to the same party in that specific year.

3.2.3 Descriptive Statistics

On Table 3.1, we have the average and standard deviations for the schools' characteristics under different administrative situations (and decentralization periods). For the outcome variables, decentralized schools have higher rates of failure, higher student dropout and higher age-grade distortion than institutions that have never been decentralized, but these values are smaller than the observed for the schools that have always been under

municipal management. And dropout and age-grade distortion rates have become lower after the schools were adopted.

Considering the variables related to the school size, it is observed that - total enrollment in primary level, the number of rooms actually used, total number of employees, teachers and primary teachers, as well as the total number of classes and if the school offers classes from 5th to 8th grades - they are much lower for decentralized schools than for the ones that have always been under state management.

But it is important to notice that these values are still higher when compared to the schools that have always been under municipal control. As this last group also includes schools created after FUNDEF's implementation, it might be the case that these new institutions are naturally smaller than the ones already available. Another aspect is that, except for total enrollment in primary education, there is an increase on the average values after decentralization.

Municipal and decentralized schools also have a lower percentage of teachers that hold a college degree. This situation improves only for the old state schools, after they have been decentralized. Class sizes are quite the same, no matter the administrative type and, the ratio of students per teacher is a bit smaller for municipal schools - those that started as municipal or that have been decentralized.

Finally, for the other school resources, municipal schools have on average less libraries, sports courts, television sets and computers per students, lower access to water, electricity or sanitation. Resources as computer or science laboratories are almost unavailable. Not differently, they are also concentrated in less urbanized areas. Again, it is important to notice that these numbers improve a little bit after decentralization.

Table 3.2 summarizes the characteristics of the municipalities in our sample of schools. In general, schools that have always been under municipal management or that have been decentralized are located in municipalities in which social and demographic indicators are worse. Besides the fact that these schools are located in smaller cities, they also have lower GDP and higher levels of child work, poverty and illiteracy. They are also more likely to be located in rural areas and farther from the capital of the corresponding state. It is interesting to notice, however, that the Gini index is not different on average from the other schools. About the transfers from the municipal participation fund, municipal schools are located in cities where the value of these transferences is higher, and this is also observed for the state schools that have been decentralized. On the other

Table 3.1 Summary of School Characteristics

	Under State Management	Never Decentralized	Before Decentralization	Year of Decentralization	After Decentralization	Always Municipal School
failure rate	12.01	11.63	14.99	14.52	14.88	18.23
	(11.38)	(11.10)	(12.99)	(12.94)	(12.39)	(14.97)
dropout rate	7.77	7.38	10.84	9.99	8.22	11.93
	(10.38)	(10.06)	(12.18)	(12.26)	(11.22)	(13.58)
age-grade distortion	31.92	30.83	43.67	43.56	34.11	47.22
	(23.72)	(23.32)	(24.84)	(24.20)	(23.10)	(25.90)
enrollment	244.42	255.36	146.74	130.32	126.39	104.03
	(229.78)	(232.54)	(175.40)	(166.41)	(157.44)	(158.79)
rooms used	8.29	8.80	3.76	3.61	4.03	3.33
	(6.00)	(6.02)	(3.38)	(3.35)	(3.69)	(4.02)
# employees	35.18	37.78	11.94	10.77	13.74	11.41
	(32.02)	(32.39)	(14.43)	(13.82)	(16.53)	(18.21)
# teachers	22.18	23.45	7.38	6.45	8.02	6.84
	(20.47)	(20.69)	(8.53)	(8.08)	(9.63)	(11.09)
# primary teachers	8.99	9.42	5.15	4.80	5.40	4.16
	(7.50)	(7.57)	(5.45)	(5.49)	(6.03)	(5.79)
# classes	7.91	8.28	4.58	3.92	4.26	3.11
	(6.82)	(6.83)	(5.72)	(5.35)	(5.43)	(5.35)
class size	29.75	29.64	31.09	32.16	27.55	30.59
	(13.81)	(13.64)	(15.81)	(28.68)	(15.22)	(14.69)
ratio pupil/teacher	25.71	25.71	25.72	25.08	21.99	23.85
	(10.25)	(9.93)	(12.73)	(12.72)	(10.78)	(11.38)
% prof with college	31.50	33.64	12.34	12.05	18.90	12.92
	(34.45)	(34.69)	(25.08)	(24.83)	(31.27)	(27.78)
5th-8th grades	0.55	0.60	0.14	0.13	0.17	0.15
	(0.50)	(0.49)	(0.35)	(0.34)	(0.38)	(0.36)
library	0.47	0.50	0.15	0.15	0.19	0.11
	(0.50)	(0.50)	(0.36)	(0.36)	(0.39)	(0.31)
computer lab	0.13	0.14	0.01	0.01	0.03	0.04
	(0.33)	(0.34)	(0.09)	(0.09)	(0.18)	(0.19)
science lab	0.12	0.13	0.01	0.01	0.01	0.02
	(0.33)	(0.34)	(0.09)	(0.11)	(0.11)	(0.12)
sport court	0.43	0.46	0.12	0.11	0.14	0.10
	(0.49)	(0.50)	(0.32)	(0.31)	(0.35)	(0.30)
# tv sets	1.33	1.39	0.64	0.73	1.01	0.40
	(3.10)	(3.19)	(1.46)	(1.75)	(2.14)	(1.48)
# computers	1.27	1.37	0.14	0.11	0.36	0.25
	(7.70)	(8.01)	(1.00)	(0.82)	(1.68)	(4.07)
water	0.98	0.99	0.93	0.95	0.98	0.94
	(0.13)	(0.11)	(0.26)	(0.21)	(0.14)	(0.23)
electricity	0.93	0.94	0.77	0.80	0.86	0.64
	(0.26)	(0.23)	(0.42)	(0.40)	(0.35)	(0.48)
sewage	0.94	0.95	0.85	0.88	0.93	0.80
	(0.23)	(0.21)	(0.36)	(0.33)	(0.25)	(0.40)
urban	0.72	0.75	0.41	0.36	0.36	0.22
	(0.45)	(0.43)	(0.49)	(0.48)	(0.48)	(0.42)

Source: Own calculations using School Census data
Note: Standard deviations in parenthesis

hand, tax revenues are lower.

Table 3.2 Summary of Municipal Context

	Under State Management	Never Decentralized	Before Decentralization	Year of Decentralization	After Decentralization	Always Municipal School
population	515.20	556.70	144.46	96.45	77.98	166.90
	(1691.87)	(1772.71)	(455.18)	(362.89)	(306.20)	(879.31)
GDP	6642.71	7165.00	909.07	1204.93	469.98	1750.99
	(26041.07)	(27126.08)	(2998.08)	(3378.73)	(1939.50)	(12442.31)
women share	50.27	50.36	49.49	49.38	49.34	49.63
	(1.62)	(1.61)	(1.48)	(1.42)	(1.39)	(1.52)
rural share	28.45	26.95	41.09	42.46	43.05	44.80
	(23.96)	(23.58)	(23.42)	(23.20)	(23.18)	(23.06)
pop share (7 to 10)	8.12	8.07	8.50	8.48	8.48	9.13
	(1.49)	(1.48)	(1.55)	(1.49)	(1.47)	(1.59)
child work (10 to 14)	7.57	7.49	8.34	8.21	8.11	7.26
	(4.03)	(3.91)	(4.88)	(4.81)	(4.79)	(4.91)
distance to the capital	178.92	177.45	192.00	212.85	222.36	249.37
	(167.85)	(168.28)	(163.40)	(168.87)	(172.80)	(188.78)
poverty rate	37.96	37.08	45.82	44.54	44.15	57.45
	(21.66)	(21.68)	(19.78)	(20.39)	(20.72)	(21.43)
Gini index	0.58	0.58	0.57	0.57	0.56	0.58
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
literacy rate	83.76	84.09	80.84	81.05	81.11	72.85
	(11.39)	(11.48)	(10.01)	(10.16)	(10.27)	(12.96)
CP-FPM pc ('000)	136.67	139.83	108.08	141.63	208.21	171.44
	(235.55)	(246.45)	(83.92)	(92.59)	(152.91)	(328.49)
tax revenues pc ('000)	71.97	76.81	28.22	32.85	42.98	37.65
	(118.55)	(120.93)	(82.31)	(50.90)	(88.62)	(87.89)
voter turnout	82.37	82.68	79.61	78.42	82.05	79.25
	(7.38)	(7.23)	(8.06)	(9.88)	(7.98)	(8.56)
allied governor	0.23	0.23	0.26	0.28	0.24	0.25
	(0.42)	(0.42)	(0.44)	(0.45)	(0.43)	(0.43)

Source: Own calculations using the Census microdata for 2000 and IPEA database
Note: Standard deviations in parenthesis

We then compare the behavior of the outcome variables for treatment and control groups. The differences-in-differences methodology intends to control for trends that affect differently control and treatment groups, capturing the actual impact of treatment. In Figure 3.1, we separate groups before and after 1998, the year of FUNDEF's implementation. In general, it can be seen that schools in treatment group have always performed worse than state schools that have never been decentralized. Therefore, this confirms the importance of controlling observable and non-observable characteristics at the school level that might influence their expected outcomes.

For the age-grade distortion rate, it was falling a little bit faster for the control group, but after 1998, this pattern reversed and, in 2004, both of them started to move together. About the dropout rates, they were falling for schools that have never been decentralized and rising on the others. After 1998 and until 2000, we can see an increase for both

groups. Then, there is a harder decline in the treatment group and dropout rates are falling together for both. Finally, failure rates were decreasing faster in the control group, but after FUNDEF's implementation, this trend is reversed in both groups and they start growing together.

These first comparisons indicate that schools in the treatment group were doing worse then schools in the control group, and that this pattern has somehow changed. In other words, treated schools still present the worse indicators, but differences have become smaller. These evidences indicate that the identification hypothesis of the differences-in-differences estimator is not strictly satisfied. However, the purpose of these graphs is more descriptive and schools have not been decentralized at once. Thus, we keep the final answers for the models' estimations. We now turn to the results of both fixed effects and random trend models, and some robustness checks in order to verify their adequacy in controlling for this school selection bias.

3.3 Results

In this section we discuss the results of the estimation for the two models proposed, as well as some robustness checks used to test the adequacy of these models[7]. It seems that decentralization was bad in the way it increased failure rates, but good when we observe the decrease in dropout and age-grade distortion rates. However, these results change according to the specification used and robustness checks would indicate which of them yields more reliable results.

3.3.1 Fixed Effects Model

Table 3.3 presents the results for the fixed effects model. Each column represents a different regression. So, we have the basic model first, for the effects of decentralization, school characteristics and year dummies. We then include some city controls and, finally, add indicators of school infrastructure that are available in the sample only after 1997.

In the case of failure rates, decentralization seems to have a positive and significant impact. In column 3, that includes all regressors, decentralization is indicated to generate

[7] To account for serial correlation in the error term related to the use of panel data, as discussed in Bertrand et al. (2004), we decide to use standard errors clustered by municipalities in all the models estimated here.

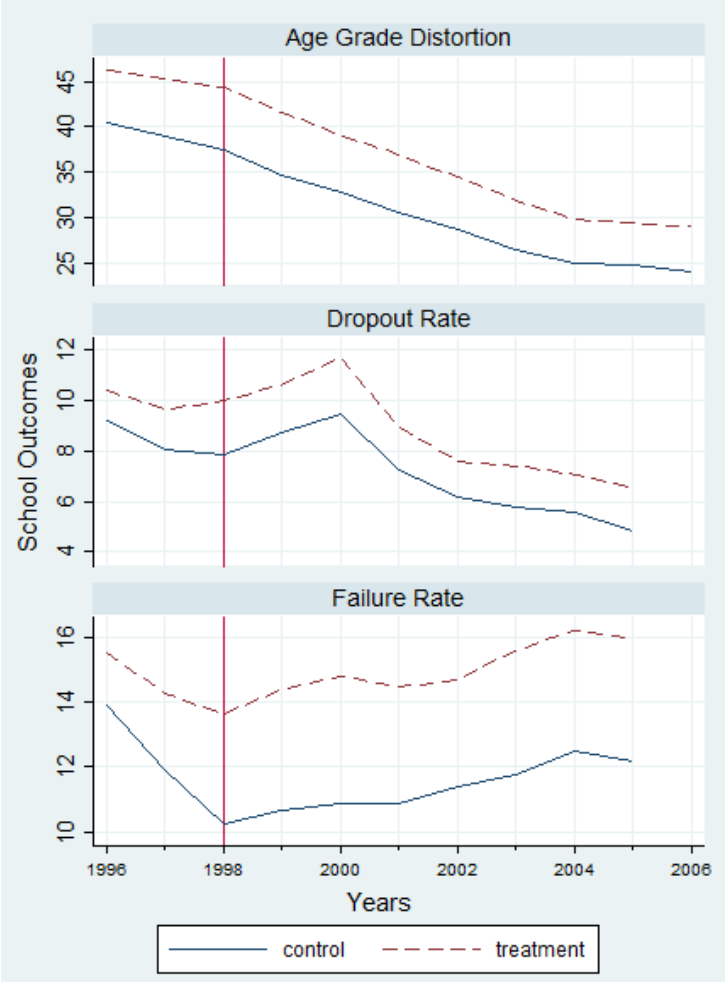

Figure 3.1 Evolution of Educational Outcomes for Treatment and Control Groups

an increase of 1.8 percentage points (p.p.) in the failure rates. Students enrolled in these "now" municipal schools are repeating grades more than if these schools have not been decentralized. And after two or more years since decentralization, this impact represents failure rates around 3 p.p. higher.

However, for dropout and age-grade distortion rates, results frequently show that the decentralization was good. Actually, a small effect on dropout rates can be seem only after four years of decentralization. But for the distortion rates, estimated coefficients are significant and not linear. Their magnitudes increase with the years of decentralization and become even two percentage points higher after adding the controls for school

infrastructure. In column 9, one year of decentralization reduces age-grade distortion rates in 2.3 p.p., and this impact becomes stronger over time. After 5 years or more since decentralization, these rates are reduced on average by 6.1 p.p..

Some interesting results from the control variables are also found. Being located in urban areas seems to decrease dropout rates by 0.8 p.p.. And a higher share of teachers holding a college degree is shown to reduce dropout and failure rates. In richer cities, represented here by higher GDP per capita and tax revenues, also present lower rates of age-grade distortion.

These results should be analyzed carefully, especially in this case where the school census data does not have information, for example, on the students background. One interpretation arises when we observe that the quality of these schools that decentralized has improved. From the descriptive statistics it has been shown that these "now" municipal schools are usually smaller when compared to the control group, but their indicators such as the number of teachers, class size or number of employees have improved. And, in order to have access to the resources from the FUNDEF, which is based on enrollment, there might have been an increase in the access to school, reducing the age grade distortion rates. But these new students are also failing more, which might be related to their background that we cannot control perfectly with the municipal data used here (it is the same for state or municipal schools, except for the urban area indicator).

3.3.2 Random Trend Model

On Table 3.4 the random trend estimates are presented. After controlling for time-varying characteristics of schools that might be related to the decentralization decision, results are quite different from the ones found for the fixed effects model, except for the impact on failure rates.

Again, decentralization seems to have a positive impact on failure rates, but the magnitude of this effect is lower when compared to the previous specification. It rises failure rates by 1.3 p.p. in the first year, but reaches no more than 2.4 p.p. after four years since decentralization. For the dropout rates, the coefficients are negative and higher. They become significant after the third year since decentralization and, as shown in column 6, might represent a reduction of 1.7 p.p. in dropout rates in the case of 5 years or more since decentralization. However, the impact on age-grade distortion rates

Table 3.3 The Impact of Decentralization on School Performance Indicators: Fixed Effects Model

	Failure Rate			Dropout Rate			Age-Grade Distortion		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Decentralization									
1 year	0.014***	0.019***	0.018***	0.002	0.003	0.003	-0.013***	-0.011***	-0.023***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.005)
2 years	0.030***	0.032***	0.031***	-0.006**	-0.004	-0.004	-0.023***	-0.015***	-0.030***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.005)
3 years	0.032***	0.032***	0.030***	-0.006	-0.003	-0.003	-0.030***	-0.019***	-0.037***
	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.006)	(0.004)	(0.006)
4 years	0.034***	0.033***	0.032***	-0.010***	-0.008***	-0.008**	-0.033***	-0.024***	-0.042***
	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.006)	(0.004)	(0.006)
5 years or more	0.032***	0.031***	0.029***	-0.009***	-0.007***	-0.008**	-0.046***	-0.041***	-0.061***
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)	(0.005)	(0.007)
urban dummy	-0.003	-0.003	-0.002	-0.006***	-0.008***	-0.008***	-0.002	-0.004	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
5th-8th grades	0.004**	0.005***	0.007***	0.002	0.004*	0.004	-0.005*	0.000	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)
enrollment	-0.003	-0.003	-0.004**	0.014***	0.018***	0.021***	0.011**	0.012***	0.015***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.005)	(0.004)	(0.004)
class size	-0.011***	-0.013***	-0.014***	0.009***	0.007***	0.006***	0.001	0.004	0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)
ratio pupil/teacher	0.009***	0.011***	0.010***	0.004**	0.002	0.003	0.005*	0.007***	0.006**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
# employees	-0.003*	-0.005**	-0.005**	0.002	-0.001	-0.002	0.003	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
% prof with college	-0.006***	-0.006***	-0.003	-0.006***	-0.006***	-0.004**	-0.003	-0.004	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
library			-0.001			-0.000			-0.004***
			(0.001)			(0.001)			(0.001)
computer lab			-0.008***			0.001			0.015***
			(0.001)			(0.001)			(0.002)
science lab			-0.002			0.000			0.001
			(0.001)			(0.001)			(0.002)
sports court			0.002**			0.001			0.006***
			(0.001)			(0.001)			(0.002)
population size		-0.025**	-0.011		-0.011	-0.014		-0.011	-0.012
		(0.011)	(0.012)		(0.008)	(0.009)		(0.017)	(0.018)
GDP per capita		0.002	0.002		-0.003	-0.008*		-0.021***	-0.023***
		(0.005)	(0.005)		(0.003)	(0.004)		(0.006)	(0.007)
tax revenues		0.001	0.002		-0.004***	-0.004***		-0.019***	-0.016***
		(0.001)	(0.001)		(0.001)	(0.001)		(0.002)	(0.002)
CP-FPM		0.001	0.001		0.003**	0.002*		0.001	0.001
		(0.001)	(0.001)		(0.001)	(0.001)		(0.002)	(0.002)
voter turnout		-0.014	0.010		0.027*	0.038**		-0.194***	-0.181***
		(0.019)	(0.017)		(0.014)	(0.015)		(0.022)	(0.023)
allied governor		0.002	0.002		-0.001	-0.001		0.002	0.003
		(0.002)	(0.002)		(0.001)	(0.001)		(0.002)	(0.002)
Constant	0.180***	0.409***	0.248*	-0.017	0.093	0.095	0.362***	0.846***	0.751***
	(0.011)	(0.113)	(0.128)	(0.017)	(0.082)	(0.104)	(0.020)	(0.180)	(0.194)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
# Obs	117,384	94,847	84,742	117,384	94,847	84,742	119,451	96,902	86,583
R-squared	0.023	0.024	0.023	0.063	0.064	0.067	0.265	0.257	0.210
# Schools	15,973	13,990	13,131	15,973	13,990	13,131	16,422	14,313	13,223

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
City Controls: population size, GDP per capita, share of children at work, Gini index, poverty rate, literacy rate, distance to the state capital, tax revenues, CP-FPM, voter turnout and dummy for same party as the Governor

is not significant anymore.

On the control variables we notice that increases in enrollment and class size reduce failure rates but represent an increase in dropout and age-grade distortion. And that in more populated and richer cities the effect on failure rates is also positive.

3.3.3 Robustness Check

In order to access which of these previous models yields more reliable results, we perform two different robustness tests. The first one consists of running the same fixed and random trend models over a reduced sample. This new sample consists only of the schools from the treatment group, those which have been decentralized. The purpose is to compare the effects of decentralization when the control group consists of these same schools, but in the years before their adoption by the municipal administration. If control and treatment groups used in the previous estimations are comparable, results using this new sample should not be different.

Table 3.5 presents these new estimations. Overall, results for the fixed effects specification are quite different, except for failure rates. After the second year since decentralization, failure rates are shown to be around 3 p.p. higher. But the coefficients for the impact on dropout rates are not significant anymore, except for results in column 4, without city controls and none of the variables for school infrastructure. For the age-grade distortion rates, coefficients are not significant when we add municipal controls (column 8). And for the complete model shown in column 9, there seems to be a decrease in age-grade distortion but these effects are smaller than the ones presented on Table 3.3. They represent no more than 3.3 p.p. for 5 years or more since decentralization.

Results for the random trend model are quite the same using this new sample. Decentralization is responsible for an increase in failure rates by around 1.5 p.p. in the first year, but reaches no more than 2.3 p.p. after four years since decentralization. The coefficients for the impact on dropout rates are negative and a little bit higher. They become significant after the third year since decentralization and, as shown in column 6, might represent a reduction of up to 2 p.p. in dropout rates in the case of 4 years or more since decentralization. And, as before, the impact on age-grade distortion rates is not significant.

The second robustness check employed consists of reducing the sample to keep only

Table 3.4 The Impact of Decentralization on School Performance Indicators: Random Trend Model

	Failure Rate			Dropout Rate			Age-Grade Distortion		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Decentralization									
1 year	0.008**	0.014***	0.013***	0.000	0.003	0.004	0.003	-0.002	-0.002
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)	(0.005)	(0.005)
2 years	0.021***	0.024***	0.022***	-0.008*	-0.005	-0.003	0.002	-0.002	-0.002
	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)	(0.006)
3 years	0.021***	0.025***	0.022***	-0.011**	-0.012***	-0.009*	0.004	-0.003	-0.003
	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.007)	(0.007)
4 years	0.022***	0.028***	0.024***	-0.018***	-0.019***	-0.015***	0.005	-0.004	-0.004
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
5 years or more	0.014*	0.021***	0.015**	-0.021***	-0.022***	-0.017**	0.003	-0.008	-0.008
	(0.007)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)	(0.008)	(0.008)	(0.008)
urban dummy	-0.003	-0.003	-0.002	-0.004	-0.005	-0.005	-0.001	-0.000	-0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)
5th-8th grades	0.002	-0.003	-0.002	0.002	0.005*	0.005	0.006**	0.010***	0.010***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
enrollment	-0.008***	-0.008***	-0.011***	0.049***	0.049***	0.055***	0.023***	0.028***	0.028***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)
class size	-0.012***	-0.013***	-0.010***	0.005***	0.004***	0.005***	0.015***	0.016***	0.016***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
ratio pupil/teacher	0.008***	0.009***	0.008***	0.003*	0.003	0.003	0.004**	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
# employees	-0.003	-0.003	-0.001	0.001	-0.002	-0.004	0.005*	0.003	0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)
% prof with college	0.002	0.003	0.003	0.001	0.002	0.002	0.004**	0.004**	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
library			-0.002			0.001			-0.002
			(0.001)			(0.001)			(0.001)
computer lab			0.002			-0.002			0.001
			(0.001)			(0.001)			(0.001)
science lab			-0.002			0.001			0.001
			(0.002)			(0.001)			(0.002)
sports court			0.002*			-0.002**			-0.002*
			(0.001)			(0.001)			(0.001)
population size		0.027**	0.041**		0.016	0.020		0.025*	0.025*
		(0.012)	(0.017)		(0.016)	(0.020)		(0.013)	(0.013)
GDP per capita		0.012***	0.012**		-0.008*	-0.009*		0.002	0.002
		(0.004)	(0.005)		(0.005)	(0.005)		(0.004)	(0.004)
tax revenues		0.003**	0.003**		-0.003**	-0.002		0.002	0.002
		(0.001)	(0.001)		(0.001)	(0.002)		(0.002)	(0.002)
CP-FPM		-0.001	-0.002		0.001	0.001		-0.000	-0.000
		(0.001)	(0.001)		(0.001)	(0.001)		(0.002)	(0.002)
voter turnout		0.066***	0.066***		0.089***	0.089***		-0.008	-0.008
		(0.017)	(0.017)		(0.018)	(0.018)		(0.016)	(0.016)
allied governor		0.001	0.001		-0.002	-0.002		-0.002	-0.002
		(0.002)	(0.002)		(0.001)	(0.001)		(0.001)	(0.001)
Constant	-0.002***	-0.002***	-0.000	-0.002***	-0.003***	-0.002***	-0.015***	-0.014***	-0.014***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
# Obs	98,991	76,248	67,642	98,991	76,248	67,642	89,170	70,675	70,675
R-squared	0.012	0.014	0.008	0.031	0.030	0.034	0.017	0.019	0.019
# Schools	13,972	11,969	11,550	13,972	11,969	11,550	13,783	11,826	11,826

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
City Controls: population size, GDP per capita, share of children at work, Gini index, poverty rate, literacy rate, distance to the state capital, tax revenues, CP-FPM, voter turnout and dummy for same party as the Governor

Table 3.5 Fixed Effects and Random Trend Models: Robustness Check 1

	Failure Rate			Dropout Rate			Age-Grade Distortion		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Fixed Effects Model									
Decentralization									
1 year	0.013***	0.020***	0.020***	-0.000	0.003	0.005	-0.007*	-0.005	-0.015***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)
2 years	0.026***	0.032***	0.031***	-0.013**	-0.006	-0.004	-0.014***	-0.007	-0.020***
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)
3 years	0.024***	0.028***	0.027***	-0.014*	-0.005	-0.003	-0.013**	-0.003	-0.020***
	(0.005)	(0.005)	(0.005)	(0.008)	(0.005)	(0.005)	(0.006)	(0.006)	(0.007)
4 years	0.026***	0.031***	0.030***	-0.019**	-0.009*	-0.007	-0.010	-0.003	-0.022***
	(0.005)	(0.005)	(0.005)	(0.009)	(0.005)	(0.005)	(0.007)	(0.007)	(0.008)
5 years or more	0.023***	0.029***	0.028***	-0.017*	-0.005	-0.003	-0.011	-0.008	-0.033***
	(0.005)	(0.005)	(0.005)	(0.009)	(0.005)	(0.005)	(0.008)	(0.008)	(0.010)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
# Obs	43,318	36,765	33,138	43,318	36,765	33,138	43,960	37,484	33,828
R-squared	0.026	0.031	0.033	0.065	0.065	0.069	0.321	0.314	0.272
# Schools	5,823	5,447	5,257	5,823	5,447	5,257	5,888	5,493	5,268
Random Trend Model									
	Failure Rate			Dropout Rate			Age-Grade Distortion		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Decentralization									
1 year	0.008*	0.015***	0.015***	0.001	0.004	0.005	0.002	-0.003	-0.003
	(0.005)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.006)	(0.005)	(0.005)
2 years	0.020***	0.024***	0.023***	-0.010*	-0.004	-0.003	-0.002	-0.005	-0.005
	(0.006)	(0.005)	(0.005)	(0.006)	(0.004)	(0.005)	(0.006)	(0.006)	(0.006)
3 years	0.017**	0.022***	0.020***	-0.014*	-0.013**	-0.012*	0.002	-0.004	-0.005
	(0.007)	(0.005)	(0.006)	(0.008)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)
4 years	0.018**	0.026***	0.023***	-0.022***	-0.022***	-0.020***	0.002	-0.006	-0.007
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)	(0.007)	(0.008)	(0.008)
5 years or more	0.010	0.020**	0.017*	-0.021***	-0.022***	-0.020**	-0.002	-0.012	-0.012
	(0.010)	(0.008)	(0.009)	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)	(0.009)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
# Obs	36,027	28,900	25,852	36,027	28,900	25,852	32,730	27,049	27,049
R-squared	0.014	0.016	0.010	0.032	0.031	0.037	0.021	0.025	0.025
# Schools	5,091	4,635	4,501	5,091	4,635	4,501	4,967	4,562	4,562

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
City Controls: population size, GDP per capita, share of children at work, Gini index, poverty rate, literacy rate, distance to the state capital, tax revenues, CP-FPM, voter turnout and dummy for same party as the Governor

the schools that have been decentralized after the year 2000 and those from the control group. The idea is to reduce the sample to have only schools that have always been under state management and those which have been decentralized but before their adoption year - in this case, after 2000. So, the sample covers the period from 1996 to 1999 and contains schools that have not been adopted and those adopted but before their municipalization. Coefficients are not supposed to be different from zero.

Table 3.6 shows the results for this second robustness check. For the fixed effects model, coefficients go in the opposite direction of the previous findings. For the schools in the treatment group but before treatment, failure rates are 1.3 p.p. smaller even after adding municipal controls. In its turn, dropout rates are at least 1.5 p.p. higher. Only for age-grade distortion rates results are not so significant. Without municipal controls, they are 1.4 p.p. higher at the 10% significance level, and not different from zero after controlling for city characteristics.

The random trend model seems to control better for the school selection bias. The treatment coefficients are not different from zero in almost all the the cases. Dropout rates would be 1.2 p.p. lower (at the 10% significance level) only when including city controls. Therefore, for the distributional analysis that follows, we rely on the random trend model to understand the relation between the city context and the impact of decentralization on the schools' performance indicators.

3.4 Differences in Municipal Context

In this section, the impact of differences in the municipal context is incorporated in the analysis. According to the theory on decentralization discussed in Chapter 2, there might be differences in the way decentralization affects students' outcomes depending on the local environment represented, for example, by the poverty level or the literacy of its population.

3.4.1 Population Size and Location

In order to capture scale effects, the sample was separated by population size. In this way, we consider cities up to 25 thousand residents, then cities with a population size of 25 to 100 thousand residents and, finally, cities with more than 100 thousand residents.

Table 3.6 Fixed Effects and Random Trend Models: Robustness Check 2

Fixed Effects Model						
	Failure Rate		Dropout Rate		Age-Grade Distortion	
	(1)	(2)	(3)	(4)	(5)	(6)
Decentralization Effect	-0.017**	-0.013**	0.023**	0.015**	0.014*	-0.000
	(0.007)	(0.006)	(0.009)	(0.007)	(0.008)	(0.007)
# Obs	18,749	13,365	18,749	13,365	19,379	13,782
R-squared	0.086	0.052	0.020	0.013	0.158	0.183
# Schools	10,581	8,328	10,581	8,328	10,821	8,514
Random Trend Model						
	Failure Rate		Dropout Rate		Age-Grade Distortion	
	(1)	(2)	(3)	(4)	(5)	(6)
Decentralization Effect	0.011	-0.001	-0.007	-0.012*	-0.002	0.000
	(0.008)	(0.007)	(0.007)	(0.006)	(0.004)	(0.004)
# Obs	17,728	12,648	17,728	12,648	22,544	17,170
R-squared	0.028	0.027	0.034	0.030	0.008	0.017
# Schools	9,812	7,715	9,812	7,715	12,116	10,039

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
City Controls: population size, GDP per capita, share of children at work,
Gini index, poverty rate, literacy rate, distance to the state capital,
tax revenues, CP-FPM, voter turnout and dummy for same party as the Governor

Table 3.7 presents the results for these different city sizes.

The effect on failure rates is negative but not significant in the case of more populated cities. However, decentralization seems to have a positive impact on failure rates in smaller cities, and this effect is even stronger in the smaller ones.

On the other hand, dropout rates are negatively affected after four years since decentralization in municipalities with no more than 25 thousand residents. And age-grade distortion falls with decentralization, but only in more populated places. In cities with more than 100 thousand residents, the age-grade distortion rates might fall by almost 6 p.p. after the fourth year of decentralization.

These results seem to indicate that scale matters. In smaller cities, decentralization contributes to an increase in failure rates. And in more populated places, age-grade distortion might fall.

Table 3.8 shows the results for the sample of schools located in rural and urban areas, separately. Coefficients are not significant for the sample of schools located in rural areas. And for schools in urbanized places, impact is positive and significant only for failure rates up to the fourth year of decentralization.

Table 3.7 Decentralization and School Performance: Population Size Effects

Random Trend Model by Population Size									
	Failure Rate			Dropout Rate			Age-Grade Distortion		
Population Size ('000)	0-25	25-50	100+	0-25	25-50	100+	0-25	25-50	100+
Decentralization									
1 year	0.018***	0.011*	-0.004	0.005	0.001	0.007	0.003	0.006	-0.021***
	(0.004)	(0.006)	(0.009)	(0.004)	(0.006)	(0.008)	(0.009)	(0.008)	(0.007)
2 years	0.032***	0.019**	-0.012	0.001	-0.010	0.008	0.006	0.006	-0.031***
	(0.005)	(0.009)	(0.015)	(0.005)	(0.008)	(0.010)	(0.010)	(0.009)	(0.009)
3 years	0.027***	0.023**	-0.009	-0.006	-0.013	-0.010	0.006	0.006	-0.038***
	(0.006)	(0.010)	(0.017)	(0.006)	(0.009)	(0.012)	(0.011)	(0.011)	(0.011)
4 years	0.026***	0.031***	-0.017	-0.013*	-0.021*	-0.016	0.009	0.004	-0.058***
	(0.008)	(0.011)	(0.020)	(0.007)	(0.011)	(0.013)	(0.012)	(0.013)	(0.012)
5 years or more	0.015*	0.027**	-0.019	-0.018**	-0.020	-0.018	0.005	0.001	-0.059***
	(0.009)	(0.012)	(0.023)	(0.008)	(0.012)	(0.016)	(0.013)	(0.014)	(0.015)
# Obs	29,331	22,602	15,709	29,331	22,602	15,709	30,384	23,665	16,626
R-squared	0.010	0.009	0.014	0.030	0.044	0.030	0.025	0.029	0.013
# Schools	5,340	4,233	2,645	5,340	4,233	2,645	5,417	4,295	2,780

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
City Controls: GDP per capita, share of children at work, Gini index, poverty rate, literacy rate,
distance to the state capital, tax revenues, CP-FPM, voter turnout and dummy for same party as the Governor

Table 3.8 Decentralization and School Performance: Locational Effects

Random Trend Model by Location						
	Failure Rate		Dropout Rate		Age-Grade Distortion	
Location	rural	urban	rural	urban	rural	urban
Decentralization						
1 year	0.007	0.013***	0.006	0.004	0.010	-0.005
	(0.007)	(0.003)	(0.006)	(0.004)	(0.013)	(0.005)
2 years	0.008	0.024***	0.003	-0.000	0.012	-0.005
	(0.011)	(0.005)	(0.008)	(0.005)	(0.015)	(0.006)
3 years	0.007	0.023***	0.003	-0.007	0.010	-0.005
	(0.012)	(0.006)	(0.010)	(0.006)	(0.016)	(0.007)
4 years	0.018	0.019***	-0.008	-0.008	0.006	-0.006
	(0.014)	(0.006)	(0.011)	(0.007)	(0.017)	(0.008)
5 years or more	0.011	0.010	-0.009	-0.011	-0.003	-0.007
	(0.016)	(0.007)	(0.012)	(0.008)	(0.018)	(0.009)
# Obs	15,320	52,322	15,320	52,322	16,136	54,539
R-squared	0.006	0.011	0.039	0.034	0.023	0.022
# Schools	3,550	8,711	3,550	8,711	3,645	8,911

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
City Controls: population size, GDP per capita, share of children at work,
Gini index, poverty rate, literacy rate, distance to the state capital,
tax revenues, CP-FPM, voter turnout and dummy for same party as the Governor

3.4.2 Poverty and Inequality

Poverty levels also seem to affect the impact of decentralization. On Table 3.9 we consider municipalities in three different ranges of poverty rates: up to 25%, between 25% and 50%, and over 50%.

Results are sensitive to variations in the poverty level. In the case of cities where the poverty level is lower decentralization increases failure rates up to 3.4 percentage points (after 4 years since decentralization). And its impact starts to become lower and less significant with the increase in poverty levels. This might indicate that the selection bias is stronger in the case of richer places - the difference among the schools that remain under state management and the ones that have been decentralized.

The impact on dropout and age-grade distortion rates is negative and significant in places where poverty rates are lower. But for age-grade distortion, the coefficients become insignificant over time.

Table 3.9 Decentralization and School Performance: Poverty Effects

Random Trend Model by Poverty Levels									
	Failure Rate			Dropout Rate			Age-Grade Distortion		
Poverty Rate	0-0.25	0.25-0.5	0.5+	0-0.25	0.25-0.5	0.5+	0-0.25	0.25-0.5	0.5+
Decentralization									
1 year	0.028***	0.025***	0.004	-0.007*	0.010*	0.002	-0.022***	-0.005	0.011
	(0.007)	(0.006)	(0.005)	(0.004)	(0.006)	(0.005)	(0.006)	(0.006)	(0.009)
2 years	0.030***	0.030***	0.017***	-0.012**	0.004	-0.007	-0.020**	-0.006	0.007
	(0.008)	(0.010)	(0.006)	(0.005)	(0.007)	(0.007)	(0.008)	(0.007)	(0.010)
3 years	0.025***	0.030***	0.017**	-0.021***	-0.007	-0.010	-0.018*	-0.007	0.006
	(0.009)	(0.011)	(0.008)	(0.007)	(0.008)	(0.009)	(0.010)	(0.008)	(0.012)
4 years	0.034***	0.027**	0.016*	-0.023***	-0.008	-0.019*	-0.020*	-0.011	0.007
	(0.011)	(0.011)	(0.010)	(0.009)	(0.009)	(0.011)	(0.011)	(0.010)	(0.013)
5 years or more	0.026**	0.016	0.006	-0.021**	-0.008	-0.024*	-0.015	-0.015	-0.000
	(0.012)	(0.013)	(0.011)	(0.009)	(0.011)	(0.012)	(0.011)	(0.011)	(0.015)
# Obs	22,317	23,501	21,824	22,317	23,501	21,824	22,837	24,535	23,303
R-squared	0.010	0.011	0.015	0.024	0.034	0.044	0.016	0.020	0.030
# Schools	3,319	3,927	4,304	3,319	3,927	4,304	3,346	4,012	4,468

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
City Controls: population size, GDP per capita, share of children at work, Gini index, literacy rate, distance to the state capital, tax revenues, CP-FPM, voter turnout and dummy for same party as the Governor

In this study, inequality is measured using the Gini index, where a higher value means a more unequal income distribution. Table 3.10 presents the impact of decentralization for municipalities whose Gini index is under or above 0.600.

Outcomes were expected to deteriorate in more unequal places. However, for the

threshold of 0.600, failure rates increase where the income is better distributed. On the other hand, dropout rates fall where the Gini index is lower, after the third year since decentralization. The impact on age-grade distortion rates is not significant.

Table 3.10 Decentralization and School Performance: Inequality Effects

Random Trend Model by Inequality Level						
	Failure Rate		Dropout Rate		Age-Grade Distortion	
Gini index	0-0.600	0.600+	0-0.600	0.600+	0-0.600	0.600+
Decentralization						
1 year	0.013***	0.011*	0.006*	-0.002	0.000	-0.005
	(0.004)	(0.006)	(0.003)	(0.008)	(0.006)	(0.009)
2 years	0.024***	0.015	-0.000	-0.008	-0.001	-0.001
	(0.005)	(0.011)	(0.004)	(0.009)	(0.007)	(0.012)
3 years	0.022***	0.019	-0.005	-0.018*	-0.002	-0.005
	(0.006)	(0.012)	(0.005)	(0.011)	(0.007)	(0.014)
4 years	0.025***	0.018	-0.008	-0.031**	-0.003	-0.004
	(0.007)	(0.013)	(0.006)	(0.013)	(0.008)	(0.016)
5 years or more	0.015**	0.011	-0.010	-0.032**	-0.008	-0.008
	(0.008)	(0.015)	(0.007)	(0.015)	(0.009)	(0.019)
# Obs	51,216	16,426	51,216	16,426	53,291	17,384
R-squared	0.008	0.012	0.031	0.044	0.017	0.032
# Schools	8,537	3,013	8,537	3,013	8,717	3,109

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
City Controls: population size, GDP per capita, share of children at work, poverty rate, literacy rate, distance to the state capital, tax revenues, CP-FPM, voter turnout and dummy for same party as the Governor

3.4.3 Political Participation and Party Affiliation

Finally, we try to explore if the political context influence the results from decentralization. First, the sample is split between cities where voter turnout is lower or higher than 80%.

Results are shown in Table 3.11, where estimates indicate that, with the increase in the years since decentralization, the positive impact on failure rates becomes higher in cities with lower voter turnout. In the case of dropout rates, in the first year of decentralization, there is a 1.1 p.p. increase in municipalities with lower voter turnout. Over time, this impact becomes negative and significant (after 3 years of decentralization) in cities with higher voter turnout rates. The impact on age-grade distortion rates is shown not significant in any of the samples.

Another comparison is made by separating municipalities where the Mayor and Governor are from the same party or not. From Table 3.12 it can be seem that decentralization

Table 3.11 Decentralization and School Performance: Political Participation Effects

Random Trend Model by Voter Turnout Level						
	Failure Rate		Dropout Rate		Age-Grade Distortion	
Voter turnout	0-0.80	0.80+	0-0.80	0.80+	0-0.80	0.80+
Decentralization						
1 year	0.003	0.025***	0.011**	-0.002	0.006	-0.008
	(0.005)	(0.004)	(0.005)	(0.004)	(0.010)	(0.006)
2 years	0.020**	0.027***	0.007	-0.009	0.000	-0.007
	(0.008)	(0.006)	(0.008)	(0.005)	(0.011)	(0.007)
3 years	0.035***	0.023***	-0.007	-0.011*	-0.010	-0.005
	(0.011)	(0.007)	(0.012)	(0.006)	(0.014)	(0.008)
4 years	0.039**	0.023***	-0.014	-0.017**	-0.015	-0.004
	(0.016)	(0.008)	(0.015)	(0.008)	(0.017)	(0.009)
5 years or more	0.030*	0.012	-0.011	-0.017**	-0.028	-0.003
	(0.018)	(0.009)	(0.017)	(0.009)	(0.018)	(0.009)
# Obs	19,547	48,212	19,547	48,212	18,798	51,881
R-squared	0.019	0.006	0.043	0.030	0.038	0.015
# Schools	5,922	9,828	5,922	9,828	6,171	10,188

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
City Controls: population size, GDP per capita, share of children at work, Gini index, poverty rate, literacy rate, distance to the state capital, tax revenues, CP-FPM and dummy for same party as the Governor

has a positive impact on failure rates in both samples. However, the coefficients are lower in the case where Mayor and Governor are affiliated to different parties. These results might reflect an incentive Mayors have to show that these schools under their administration will perform better than if these institutions had stayed under the administration of the Governor from a different party.

In the case of dropout rates, however, the impact is mostly insignificant, becoming negative only after three or four years of decentralization when Mayor and Governor are allied or not, respectively. And for the age-grade distortion rates, the impact is not different from zero in almost all the cases.

Table 3.12 Decentralization and School Performance: Party Affiliation Effects

Random Trend Model by Political Affiliation						
	Failure Rate		Dropout Rate		Age-Grade Distortion	
Party is the same	yes	no	yes	no	yes	no
Decentralization						
1 year	0.016**	0.014***	-0.001	0.005	-0.017	-0.003
	(0.008)	(0.004)	(0.007)	(0.004)	(0.012)	(0.006)
2 years	0.035***	0.023***	-0.013	0.001	-0.025	0.002
	(0.012)	(0.006)	(0.011)	(0.005)	(0.017)	(0.007)
3 years	0.034**	0.024***	-0.026*	-0.006	-0.036*	0.002
	(0.015)	(0.007)	(0.015)	(0.006)	(0.021)	(0.008)
4 years	0.037*	0.027***	-0.036*	-0.014*	-0.039	-0.001
	(0.020)	(0.008)	(0.020)	(0.007)	(0.025)	(0.009)
5 years or more	0.023	0.018**	-0.036*	-0.016**	-0.039	-0.004
	(0.022)	(0.009)	(0.021)	(0.008)	(0.027)	(0.010)
# Obs	15,026	52,728	15,026	52,728	15,342	55,409
R-squared	0.012	0.008	0.037	0.033	0.027	0.019
# Schools	5,599	10,849	5,599	10,849	6,161	11,316

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
City Controls: population size, GDP per capita, share of children at work, Gini index, poverty rate, literacy rate, distance to the state capital, tax revenues, CP-FPM, voter turnout

4

Efficiency Analysis

The study of the effectiveness in the public provision of education is justified by the importance of education to economic growth and because most of the students are enrolled in public provided schools. In 1998, when FUNDEF was implemented, the share of schools according to the register data from INEP was the following: 19.7% of state schools, 0.1% of federal schools, 69.7% of municipal schools and only 10.5% of schools were privately provided. Since then, participation of state schools has been falling, but public schools still account for the majority of educational provisions in Brazil, with a share of 83% of the total number of schools available in 2006.

However, there is always a question about the quality of the service delivered. The share of municipal schools increased, in which the decentralization played an important role, but if its quality has improved too still need to be answered. The focus of this chapter is on the effectiveness in the public provision of education. The previous chapter dealt with the impact of decentralization on student's performance at the school level. In this chapter, we intend to measure the difference in the efficiency between state and municipal schools. Our focus is on how these two school types have performed over time, comparing their efficiency in the beginning, during and at the end of our reference period.

4.1 Literature Review

In this section we summarize some results found in the literature. Albernaz et al. (2002) estimate an educational production function for the basic level in Brazil. They consider

the impact of several characteristics - students, their family background, teachers, and other school variables - on the performance in test scores. As previous works in the literature of education in Brazil, they find that the socioeconomic background is the most important factor behind students' results. However, schools characteristics are also important and private schools are more efficient than their public counterparts.

Sampaio and Guimaraes (2009) also compare public and private schools. Given the differences observed in their performance they analyze the comparative efficiency of public and private schools using a methodology that decomposes efficiency into two components: one attributed to the school and the other exclusively to the student. They use a sample of students in the Metropolitan Region of Recife - in the Brazilian state of Pernambuco - that concluded the high school level in 2005. The efficiency frontier is determined only by private schools. And among the public institutions, the federal schools are more efficient than the state ones. Schools were further analyzed with respect to the equity performance considering the different performance obtained by each student. This result showed that there is no difference between federal public and private schools. With respect to state schools, they showed relatively lower efficiency for the best students compared to average students.

Thus, it is well known that private schools are more efficient than public schools. However, there are still differences in performance when we consider only public institutions. In other words, there seems to be a lot of variance among them, too. For example, Delgado (2008) applies a semi-parametric two-stage data envelopment analysis methodology to estimate the efficiency frontier of public schools administered by the state of Minas Gerais. The second stage of this method allows the identification of the variables that influence the efficiency estimates but that are not under control of school's administration. He finds that schools located in richer areas are more likely to be efficient and deliver a better educational service. And that there is space for improving the state's education, through higher efficiency.

Comparing the efficiency of schools among Brazilian states, Benegas (2012) evaluates the technical efficiency of public expenditures in education for the years 2001, 2003 and 2005. The methodology considers the educational process occurring in two stages: the first, through the budget allocation in order to acquire physical and human resources; and the second, related to the use of these resources to generate effectiveness, in this case, better test scores. He finds that Rio Grande do Sul is the most efficient state, for both

fundamental or high school levels. And, for the fundamental education, the efficiency in the second stage is, on average, higher than the efficiency in the first stage.

Finally, the analysis developed here is based on the work of Machado (2013), who compares the performance of municipal and state managed schools in terms of their levels of inputs and the efficiency of service delivery using non-parametric data envelopment analysis (DEA). This study tries to evaluate if in communities characterized by poverty, low levels of education and inequality, the decentralization has led to lower accountability and higher susceptibility to political capture. Exploring the fact that in Brazilian municipalities primary education is provided by schools under municipal as well as under state management, her results suggest that, indeed, there are drawbacks to decentralization in municipalities where inequality is higher and education and political participation are lower. Her analysis will be reinforced by the use of the microdata available from the school census, which guarantees that our outcome variables come from the same database as our output measures. Also, we extend the analysis over time, in this case, before, during and by the replacement of the FUNDEF program.

4.2 Estimation Strategy

As long as public expenditures in services such as education represent an important share of the national product in developing countries, whether those resources have been used efficiently or not is an important question addressed in this study. More specifically, we want to compare efficiency across public schools at different administrative levels, considering the implementation of FUNDEF and the resulting municipalization process.

In order to measure the efficiency of the units studied, one can rely in parametric or non-parametric methods. We opted to use the two-stages semi-parametric approach developed in Simar and Wilson (2007), which is based on the non-parametric Data Envelopment Analysis (DEA) and a double bootstrap procedure.

Parametric estimations are limited because they require the researcher to specify a particular production function that is unknown a priori. Usually, the literature on efficiency of public expenditures in Brazil is based on the non-parametric DEA methodology. Given the data on inputs and outputs, the production frontier is built based on these observations. No specific production function is assumed, but the frontier is calculated by comparing the observations and, in theory, a bigger sample leads to more precise

comparisons.

In general, models that intend to measure efficiency estimate the production frontier, where the maximum product is obtained given a specific set of inputs. In this study we chose this product-oriented approach because of the focus on students' performance given schools' resources and municipal conditions. In the alternative approach, the production cost is reduced to its minimum for a given output level. And, in any of them, the (in)efficiency will be measured by the distance from the estimated frontier[1].

As discussed in Greene (2005), this technique is seriously dependent on the sample used, transferring to this measure all the impacts that any other external factors might have. In the literature, it is usual to use the efficiency estimates and try to explain them through exogenous variables that are related to the heterogeneity among those observational units. Greene (2005) considers that (observable) characteristics can shift the production/cost function and then interfere in the distribution of the efficiency frontier. In other words, these characteristics are specific to each observation, as if each one of them had a particular frontier, conditional on those exogenous variables.

Efficiency estimations that do not take into account these exogenous factors are likely to introduce a bias that will be included in a second stage, when trying to explain these (in)efficiency estimates. Thus, he concludes that these observable exogenous sources of heterogeneity should have been included in the estimation of the (in)efficiency in the first stage.

We intend to consider these exogenous sources of variation in the estimation of efficiencies following the method proposed by Simar and Wilson (2007). Their method consists in applying a bootstrap to approximate asymptotically the distribution of the efficiency estimators. According to these authors, the bootstrap technique used for the sensitivity analysis related to sample choice is able to produce confidence intervals and corrections to the bias related to the use of DEA methodology. It allows us to generate more reliable estimates, as well as to construct confidence intervals. And the second stage proposed estimates the relationship between the efficiency scores and the exogenous variables of interest. This is an important feature of this method, since we are also interested in the effect of these variables on the efficiency of the two types of schools analyzed.

[1] Another point considered is the shape of the frontier, given by the type of returns. We follow the literature on this and accept that the educational production function has variable returns to scale

More specifically, Simar and Wilson (2007) describe a data generating process (DGP) that is consistent with the regressions of the non-parametric estimations from DEA to some exogenous variables in a second stage. Moreover, it is possible to improve the efficiency of the estimator in the second step through the use of a double bootstrap procedure. In this way, we will estimate the efficiency of municipal and state schools in the Brazilian municipalities and provide new evidences to the literature while considering the double bootstrap procedure to include exogenous variation into the efficiency estimation. This is particularly important given the diversity of contexts found in Brazilian municipalities during the decentralization process.

The model proposed is then defined. Let $x \in \mathbb{R}_+^p$ be a vector of inputs $(1 \times p)$, $y \in \mathbb{R}_+^q$ denote a vector of outputs $(1 \times q)$, and $z \in \mathbb{R}^r$ denote a vector of exogenous or environmental variables $(1 \times r)$. The sample observations (x_i, y_i, z_i) in φ_n are realizations of identically, independently distributed (iid) random variables with probability density function $f(x,y,z)$ which has support over $P \times \mathbb{R}^r$, where $P \subset \mathbb{R}_+^{p+q}$ is a production set defined by:

$$P = \{(x,y) \mid x \textit{ can produce } y\} \tag{4.1}$$

In the case where z is not independent in relation to (x,y), otherwise there would not matter for the second stage in the regression. The boundary of P is referred to as the production or technology frontier, where inefficient observations are located in the interior of P, while efficient units are located somewhere along the boundary. Thus, the efficiency measure, δ, for a point $(x_0, y_0) \in \mathbb{R}_+^{p+q}$ can be defined as:

$$\delta_0 = \delta(x_0, y_0|P) \equiv sup\{\delta|(x_0, \delta y_0) \in P, \delta > 0\} \tag{4.2}$$

Note that δ_0 provides a measure of Euclidean distance from the point $(x_0, y_0) \in \mathbb{R}_+^{p+q}$ to the boundary of P in a direction parallel to the output axes and orthogonal to the input axes. Since P is fixed, y_0 can be characterized in terms of its polar coordinates as (η_0, δ_0), where $\eta_0 = [\eta_{0,1} \ldots \eta_{0,q-1}]$ and $\delta_0 = \delta(x_0, y_0|P)$[2]. The joint density $f(x,y,z)$ can be described as a sequence of conditional densities and in terms of its coordinates:

[2]Respectively, the angular and radial coordinates. In the polar system, each point on a plane is determined by a distance from a fixed point and an angle from a fixed direction.

$$f(x_i, \eta_i, \delta_i, z_i) = f(x_i, \eta_i | \delta_i, z_i) f(\delta_i | z_i) f(z_i) \tag{4.3}$$

The sequential nature of the DGP is reflected in the right side of equation (4.3), in which the observation i is faced with exogenous variables drawn from $f(z)$. Given z_i, the efficiency level δ_i is obtained from $f(\delta_i|z_i)$, and x_i and η_i are drawn from $f(x_i, \eta_i|\delta_i, z_i)$. This results in a observation (x_i, y_i, z_i) of the joint density function after transforming the polar coordinates (η_i, δ_i) to Cartesian coordinates y_i.

The relationship in $f(\delta_i|z_i)$ operates according to the following mechanism:

$$\delta_i = \psi(z_i, \beta) + \varepsilon_i \geq 1, \tag{4.4}$$

where ψ is a smooth, continuous function, β is a vector of parameters, and ε_i is a continuous iid random variable, independent of z_i.

In general, efficiency analysis in two stages use the observations (x_i, y_i) in φ_n to estimate δ_i for each $i = 1, \ldots, n$. Then, replace the non-observed values for δ_i by the calculated estimates, and perform a censored regression or, in a few cases, OLS:

$$\widehat{\delta}_i = z_i \beta + \xi_i \geq 1 \tag{4.5}$$

The step described above presents inference problems because the efficiencies are not observed, and their estimated values are serially correlated. These estimates depend on all the observations (x_i, y_i) in φ_n through $\widehat{P}$ and, consequently, also the error term ξ_i in equation (4.5). More than this, x_i and y_i are correlated with z_i and, thus, the error term ξ_i is correlated with z_i.

The correlation among the ξ_i's as well as the correlation between ξ_i and z_i disappear asymptotically. This way, the estimates of β using maximum likelihood in the second stage would be consistent. However, the convergence rate is slow, it will not have the usual, parametric convergence rate of $n^{-1/2}$ and for $p+q > 3$ the correlation among the ξ_i's does not disappear quickly enough for standard approaches to inference be valid. The use of bootstrap is, therefore, indicated to approximate the asymptotic distribution of the estimators of the distance function in a multivariate context, where $p+q > 2$.

Still, there might be another problem. The δ_i estimator can be written as:

$$\widehat{\delta}_i = E(\widehat{\delta}_i) + u_i, \tag{4.6}$$

where $E(\widehat{\delta}_i) = 0$. Additionally, the bias of this estimator is defined by:

$$BIAS(\widehat{\delta}_i) \equiv E(\widehat{\delta}_i) - \delta_i \tag{4.7}$$

Or, in other terms:

$$\delta_i = \widehat{\delta}_i - BIAS(\widehat{\delta}_i) - u_i \tag{4.8}$$

$$\widehat{\delta}_i - BIAS(\widehat{\delta}_i) - u_i = z_i\beta + \varepsilon_i \geq 1 \tag{4.9}$$

The u_i are unknown and cannot be estimated, but the bias term cam be calculated by bootstrap methods. The bootstrap estimate of the bias will be given by its true value plus a residual term:

$$\widehat{BIAS(\widehat{\delta}_i)} = BIAS(\widehat{\delta}_i) + v_i \tag{4.10}$$

The variance of the residual term v_i diminishes as $n \to \infty$, and its value is typically smaller than the magnitude of the bias for reasonable sample sizes. The bootstrap estimator can be used to construct the non-biased estimator of δ:

$$\widehat{\widehat{\delta}}_i = \widehat{\delta}_i - \widehat{BIAS(\widehat{\delta}_i)} \tag{4.11}$$

From previous equations:

$$\widehat{\widehat{\delta}}_i + v_i - u_i = z_i\beta + \varepsilon_i \geq 1 \tag{4.12}$$

And, as both terms v_i and u_i become negligible asymptotically, the maximum likelihood estimate:

$$\widehat{\widehat{\delta}}_i \approx z_i\beta + \varepsilon_i \geq 1, \tag{4.13}$$

will produce consistent estimates.

Thus, the objective of the double bootstrap procedure is to consistently estimate the

effect of exogenous variables on efficiency levels, but not their direct effect on input levels. The double bootstrap procedure proposed by Simar and Wilson (2007) can be summarized as follows:

1. Estimate efficiency scores, $\hat{\delta}_i$, using DEA based on the observed inputs and outputs in the sample;
2. Estimate $\hat{\beta}$ and $\hat{\delta}$, by running a truncated normal regression of $\hat{\delta}_i$ on z_i on the subset of observations satisfying $\hat{\delta}_i > 1$;
3. Generate a set of b_1 bootstrap estimates of $\hat{\delta}_i^*$ by repeating the following steps:

   Draw ε_i from $N(0;\hat{\varepsilon^2})$ left-truncated at $1 - z_i\hat{\beta}$ for each i;

   Compute $\delta_i^* = z_i\hat{\beta} + \varepsilon_i$;

   Define $x_i^* = x_i$ and $y_i^* = y_i\frac{\hat{\delta}}{\hat{\delta^*}}$;

   Estimate efficiency scores $\hat{\delta^*}$ using DEA and replacing the actual observations with x^* and y^* as the bounds of the constraints, but maintaining the original observations otherwise;
4. Compute bias-corrected estimates $\hat{\hat{\delta}}_i$ where $\widehat{bias} = \hat{\delta} - \hat{\delta^*}$;
5. Estimate $\hat{\hat{\beta}}$ and $\hat{\hat{\delta}}$, by running a truncated normal regression of $\hat{\hat{\delta}}_i$ on z_i;
6. Generate a set of b_2 bootstrap estimates of $(\hat{\beta^*};\hat{\varepsilon^*})$ by repeating the following steps:

   Draw ε_i from $N(0;\hat{\hat{\varepsilon^2}})$ left-truncated at $1 - z_i\hat{\hat{\beta}}$ for each i;

   Compute $\delta_i^{**} = z_i\hat{\hat{\beta}} + \varepsilon_i$;

   Estimate $\hat{\hat{\beta}}^*$ and $\hat{\hat{\varepsilon}}^*$, by running a truncated normal regression of δ_i^{**} on z_i.
7. Build confidence intervals based on the distribution of the estimates $(\hat{\hat{\beta}}^*;\hat{\hat{\varepsilon}}^*)$

In Appendix A the code for running this algorithm is presented. Data Envelopment Analysis can be easily performed using the R statistical software. In this study, the data was prepared in the Stata software (version 12.1) and then inputted into R. Observations with missing values were still omitted and the efficiency scores were calculated using the

FEAR package, which is freely available online. The truncated regression models were then performed in Stata. Also, we used 100 bootstrap replications for b_1 and b_2.

The next section will present some comparisons between the estimated (in)efficiencies and their bias-corrected values. It will also compare the (in)efficiency over time between schools under state and municipal administration, and how different municipal characteristics might be affecting these results.

4.3 Results

For this efficiency analysis we use the microdata from the schools census aggregated for each school type within a municipality. So, we will have two observations (one for municipal and the other for state schools) for every Brazilian city. These school variables will serve as inputs and outputs in our analysis. More specifically, the inputs are the class size, the percentage of primary teachers who pursue a college degree and the ratio of students per teacher. Table 4.1 presents the descriptive statistics for these inputs and outputs, by year and type of school.

Table 4.1 Summary of Variables for Efficiency Analysis

	Municipal Schools			State Schools		
	1996	2000	2004	1996	2000	2004
failure rate	20.28	15.12	15.81	14.18	11.22	12.40
	(11.08)	(9.42)	(9.26)	(8.45)	(8.03)	(9.37)
dropout rate	13.29	11.48	7.08	10.63	10.63	5.90
	(10.40)	(10.36)	(7.45)	(7.41)	(10.90)	(6.93)
age-grade distortion	51.95	41.22	28.83	45.38	35.99	25.99
	(25.25)	(21.75)	(17.17)	(21.95)	(21.72)	(17.37)
ratio pupil/teacher	20.49	21.57	19.13	27.88	25.94	22.94
	(8.13)	(7.25)	(6.59)	(9.10)	(8.39)	(7.90)
class size	26.89	27.86	25.27	29.21	26.98	25.88
	(10.79)	(9.50)	(8.14)	(6.55)	(6.04)	(6.68)
% prof with college	6.23	11.29	26.84	19.19	23.74	39.99
	(14.00)	(18.26)	(27.19)	(24.41)	(26.90)	(30.94)

Source: Own calculations using School Census data
Note: Standard deviations in parenthesis

The environmental variables at the municipal level will be the enrollment share in municipal schools (over total enrollment in public schools), the share of schools located in urban areas, the natural logarithm of population size, the natural logarithm of the distance to the capital of the corresponding state in 1998, the poverty rate in 2000, the Gini index in 2000, literacy rate in 2000, and voter turnout[3]. In order to capture any differences between municipal and state schools, we include the interactions of all these environmental variables with a dummy indicating if the observation corresponds to municipal schools or not.

After keeping only municipalities that have both types of schools, our sample starts with 3907 municipalities in 1996, 3630 in 2000 and 3372 in 2004. In order to calculate the efficiencies, some of the variables were modified. For the outputs, we replaced failure by approval rates, dropout by the "permanence" rate and the age-grade distortion by the share of students that are no more than two years behind the age that corresponds to their grade. These three output measures were then considered together to generate the efficiency estimates. In other words, we have a vector of outputs, and we are interested on how schools can achieve a better performance considering the three of them.

It is important to note that the efficiency is computed as the ratio between the estimated frontier output (the maximum output one can achieve given the set of inputs) and the actual output of a given unit. Therefore, it can take values that are equal to or greater than 1, with the unit value meaning the observation is on the frontier and is, then, fully efficient. This means that covariates that are negatively associated with the efficiency measures are in fact contributing to more efficiency. For example, if the efficiency estimates are higher for higher levels of poverty, this means that poorer municipalities are associated with less efficient schools.

Other variables that were rescaled are class size and the ratio of students per teacher. They were both reversed, in a way that taking their minimum and maximum values, its position was reversed within the distribution. We consider that smaller classes or fewer students per teacher are supposed to improve pupils' performance.

[3] After verifying that GDP per capita and poverty have a correlation rate higher than 82% in any of the years, we used the AIC and BIC to chose which of them should be kept in the model. In this way, we decided to keep the poverty rate as one of the exogenous variables

4.3.1 Efficiency Analysis

We begin comparing the efficiency scores estimated. Table 4.2 shows the average values of the efficiency scores with and without bias correction. The correlation among them was also calculated, reaching more than 99.7% for all the years in the sample.

Table 4.2 Ineficiency Estimates: Original $(\hat{\delta})$ and Bias-Corrected Results $(\hat{\hat{\delta}})$

Year	Municipal Schools		State Schools	
	Without Correction	Bias-Corrected	Without Correction	Bias-Corrected
1996	1.136	1.141	1.101	1.106
2000	1.100	1.102	1.076	1.078
2004	1.068	1.069	1.056	1.058

Thus, they do not seem to differ from each other, which might be expected due to our sample size. Even so, we still use the corrected scores in order to compare the efficiency between the two types of schools. As long as we do not have all the municipalities in Brazil represented in our sample, comparisons were organized by the average within states. Moreover, we evaluate how these differences evolve over time.

For all the three years, state schools show lower scores when compared to their municipal counterparts. In other words, they are on average more efficient. Figure 4.1, Figure 4.2 and Figure 4.3 also show that schools located in the South region are more efficient than schools from the North and Northern regions. More specifically, he South and Southeast regions stand as the more efficient for any school types, and the Northeast region concentrates the states with the worst efficiency indicators.

In the South region, the state of Rio Grande do Sul is shown as the most efficient for both school types and for all the years analyzed. In the Southeast region, the states of São Paulo and Minas Gerais stand as the more efficient. The states with highest (worst) scores are located mostly in the North and Northeast region, where Amazonas, Pará, Sergipe and Alagoas appear as examples of inefficiency. Not only these are the poorest regions in the country, but they are also the most inefficient in the use of the resources available. We will further explore how some characteristics found in these regions might be affecting these results.

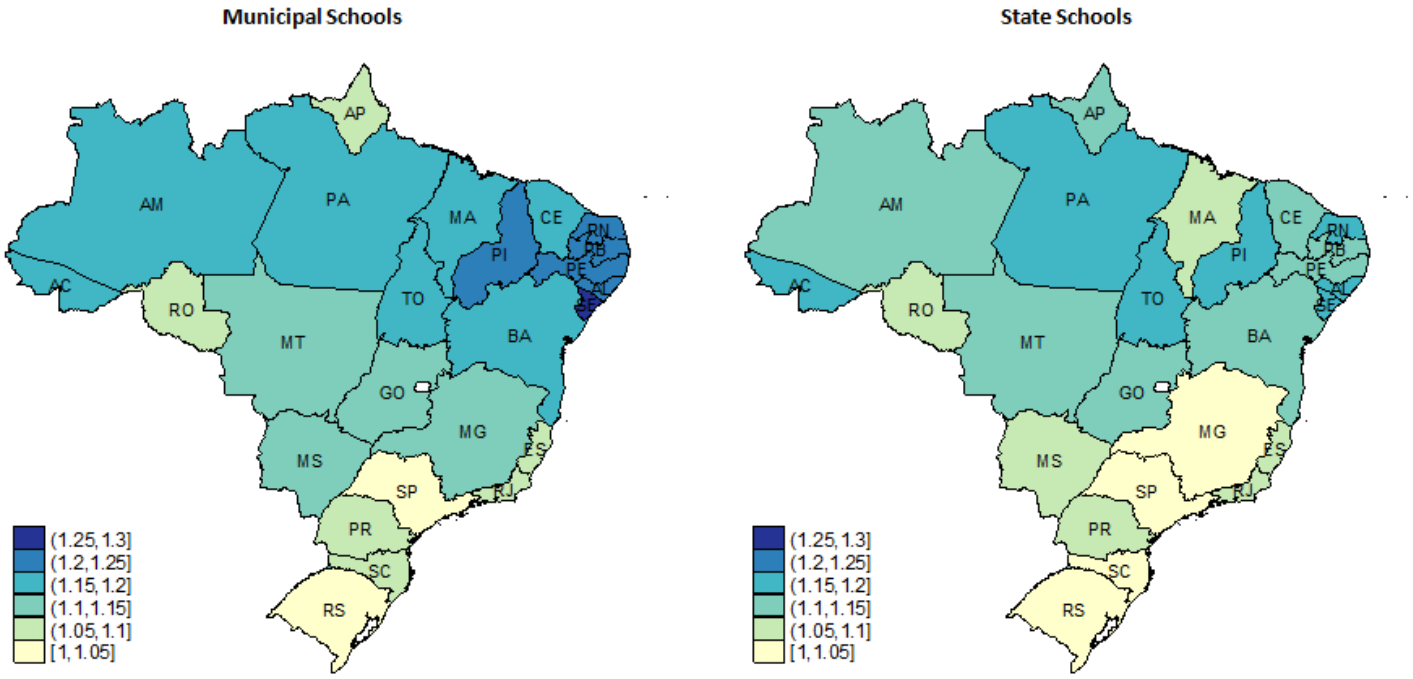

Figure 4.1 Bias-Corrected Inefficiency Estimates - 1996
Note: Higher values correspond to higher inefficiency.

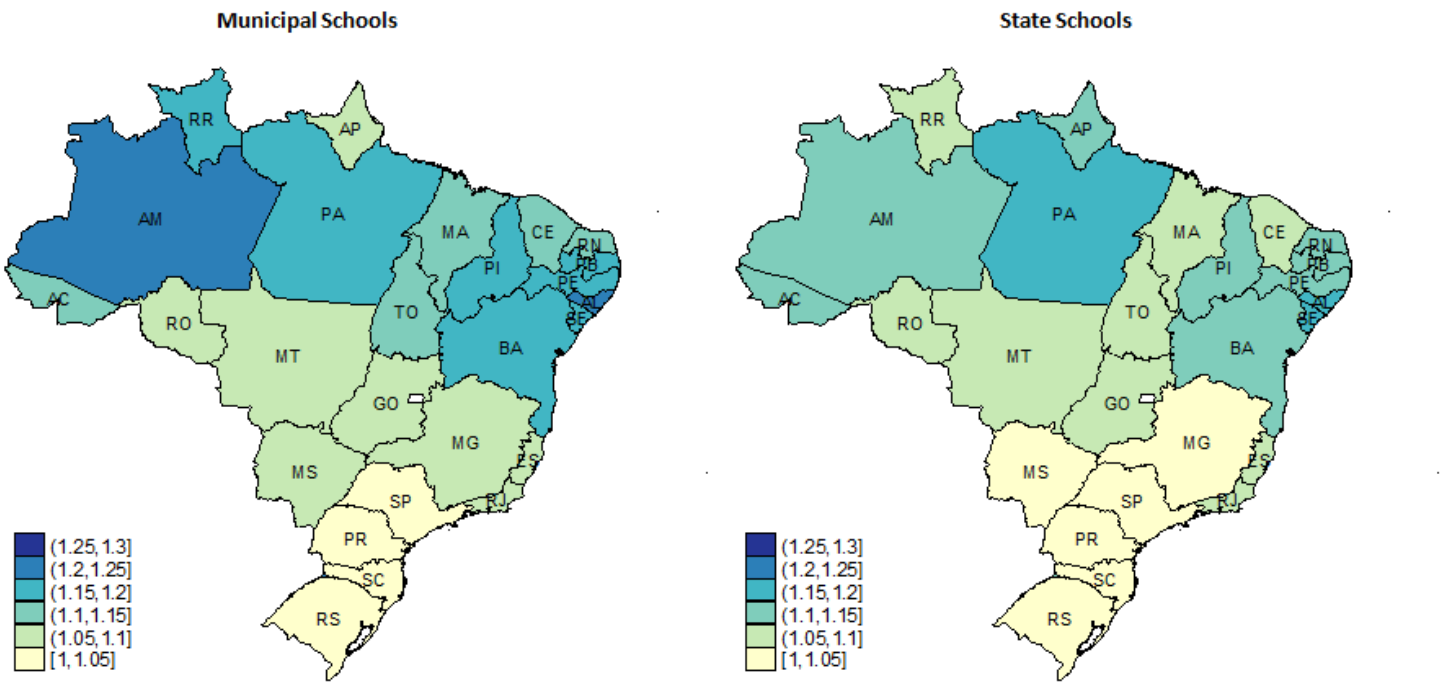

Figure 4.2 Bias-Corrected Inefficiency Estimates - 2000
Note: Higher values correspond to higher inefficiency.

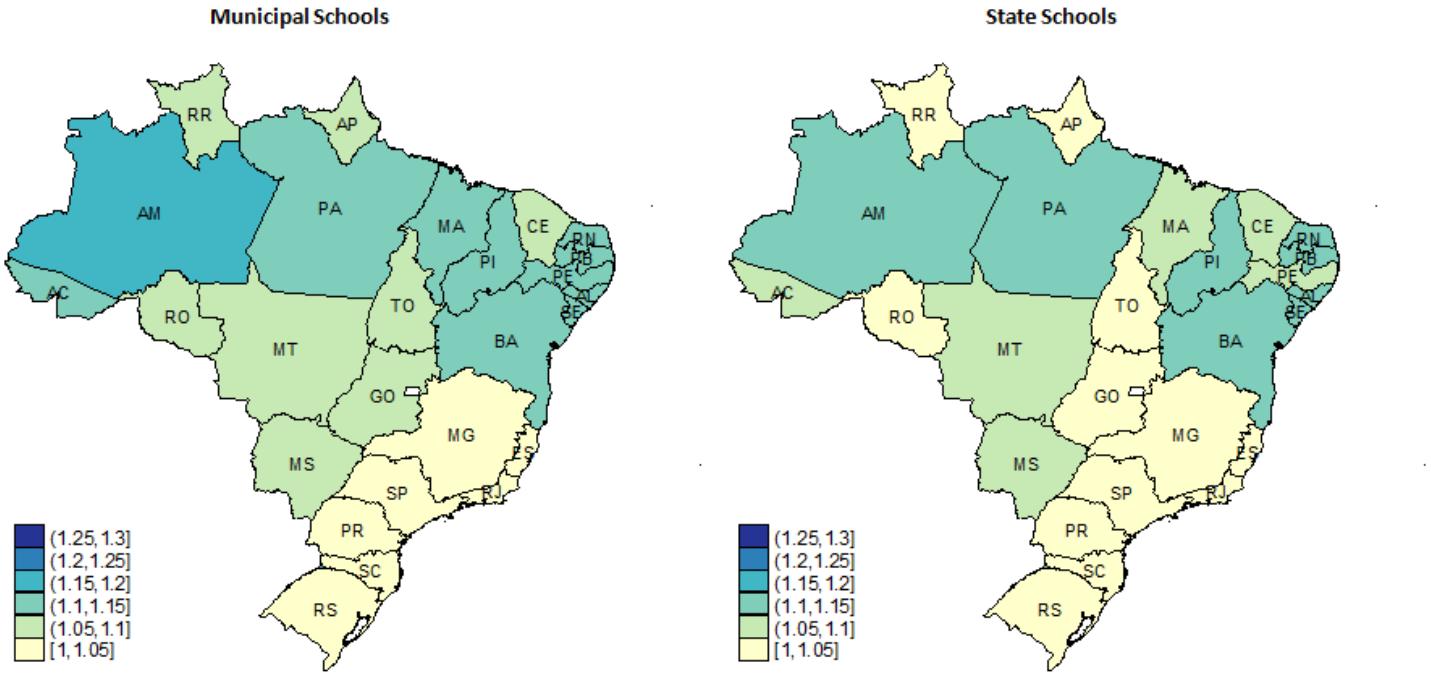

Figure 4.3 Bias-Corrected Inefficiency Estimates - 2004
Note: Higher values correspond to higher inefficiency.

In order to facilitate any comparisons, Figure 4.4 also explores the differences on the efficiency scores estimated for both types of schools. In general, the higher incidence of negative values show that municipal schools are more inefficient. And that Maranhão and Amazonas are the states where this difference is more accentuated for any year.

In three states, Pará, Tocantins and Goiás, the gap became bigger, while in Ceará, it became smaller in 2004. Another interesting fact is that in Sergipe, Rio de Janeiro and Piauí, this pattern was reversed, and state schools became on average less efficient. Finally, in Santa Catarina, Amapá, Rio Grande do Sul, Paraná, Espírito Santo and São Paulo, the differences do not seem to be significant, therefore, municipal would be as efficient as state schools.

4.3.2 Environmental Variables

After comparing efficiency scores between state and municipal schools, another main question is how environmental variables impact these efficiency measures. This context information is particularly interesting in the way it allows us to understand the channels through which decentralization may affect efficiency. These variables might have a different impact depending on the administrative level the school is subordinated.

Figure 4.5, Figure 4.6 and Figure 4.7[4] present the averages for the results from the bootstrapped coefficients of a truncated regression of the bias-corrected efficiency scores on a set of exogenous variables - that are not under control of the schools' directors.

Starting by the enrollment share represented by municipal schools over all public enrollment, it seems that only for state establishments, the results are slightly negative. This might be an indication of competition among schools so they could keep/attract students and maintain the flow of resources. Or, as discussed in D'atri (2007), it can be the case of selection, where the worse students migrated to municipal schools closer to their households.

Being located in urban or rural areas does not seem to have a significant impact on efficiency, except for the case of state schools where, at least until the year 2000 it helped increase the efficiency. In its turn, distance to the state capital improves the results in the case of state schools more than for municipal schools. The directors in the state system are nominated by the Governor, hence, they have incentives to become more accountable

[4] A table with the results for the truncated regressions can be found in Appendix B

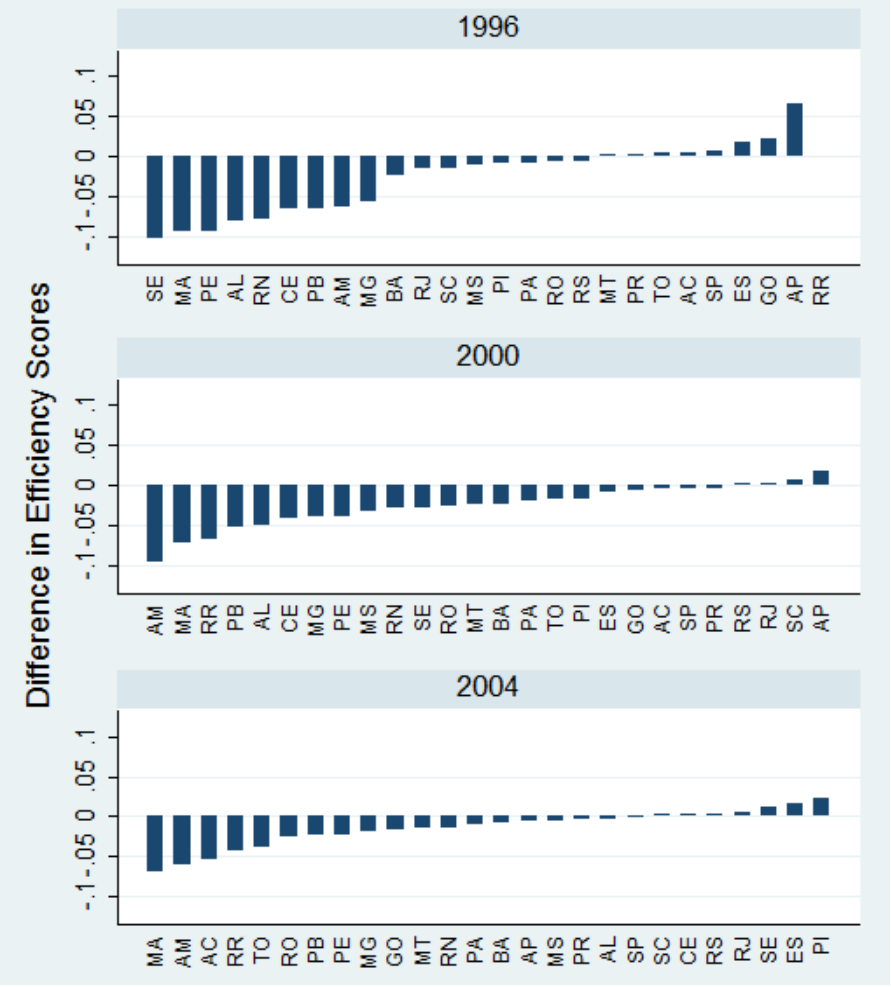

Figure 4.4 Differences in Efficiency Scores (State minus Municipal Results)

with the distance to the center where decisions are made. And for municipal schools, the local visibility might be more relevant and thus, unrelated to the distance to the capital.

Population size has a positive impact, indicating that more populated are more inefficient, but these results are not statistically different from zero except for the set of municipal schools.

On the other hand, poverty rates are always significant and higher levels of poverty are related to higher inefficiency on the provision of public education. Moreover, coefficients increase for more recent years and in 2004, municipal schools have become more sensitive to poverty than their state peers. In poorer areas, then, municipal establishments

would be more inefficient than the state ones. And this result might be reflecting lower levels of technical capacity in these poorer cities.

The coefficients estimated for the inequality measure used in this study, the Gini index, are positive in 1996, but they start to become insignificant later on. So, higher inequality is related to more inefficiency in education. However, as suggested by Araujo et al. (2008), it might be interesting to try other inequality measures and analyze the sensitivity to changes in different areas of the income distribution.

Another variable of interest is the local educational level. Better educated individuals are more likely to be more productive and proactive. Both characteristics would increase the efficiency and this is shown in the results for the three years considered in this analysis. Higher literacy rates improve efficiency.

Finally, voter turnout has also a negative impact on the estimated scores, meaning that an increase in political participation would improve efficiency. And more interesting, in 1996, this was more important for state schools, but this result was reversed and, in 2004, the efficiency of municipal schools became more sensitive to this political variable. According to the theory on decentralization this is expected in the way that Mayors have become more accountable for the quality of the education service provided.

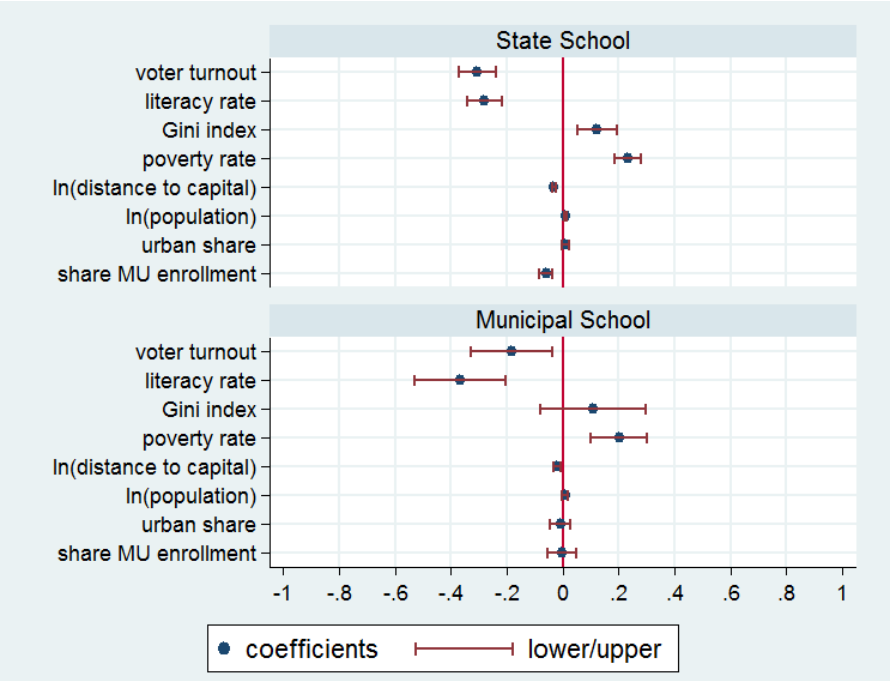

Figure 4.5 Estimated Coefficients for Environmental Variables - 1996
Note: Bootstrapped coefficients from truncated regression using 1996 data.

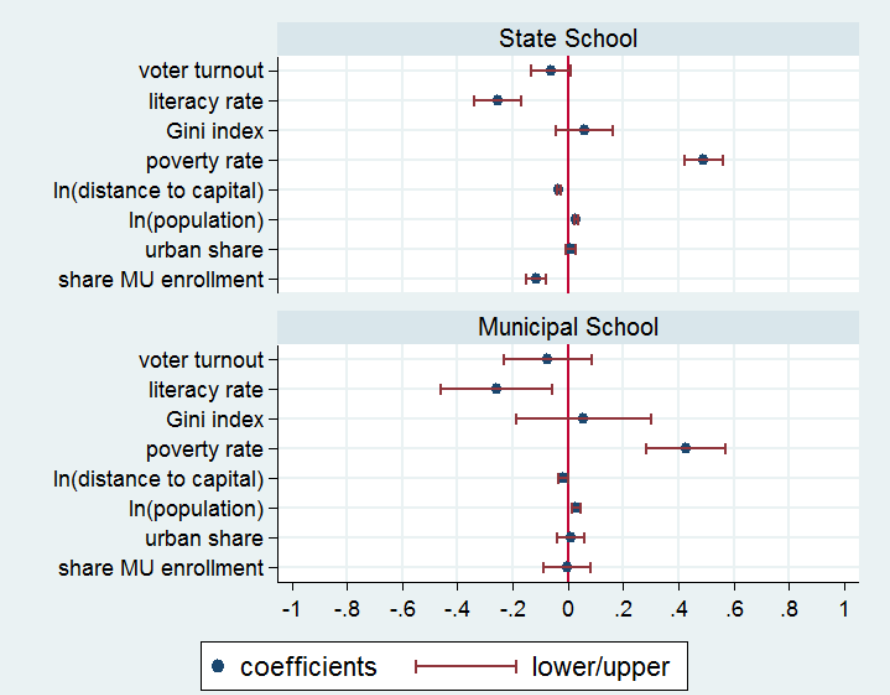

Figure 4.6 Estimated Coefficients for Environmental Variables - 2000
Note: Bootstrapped coefficients from truncated regression using 2000 data.

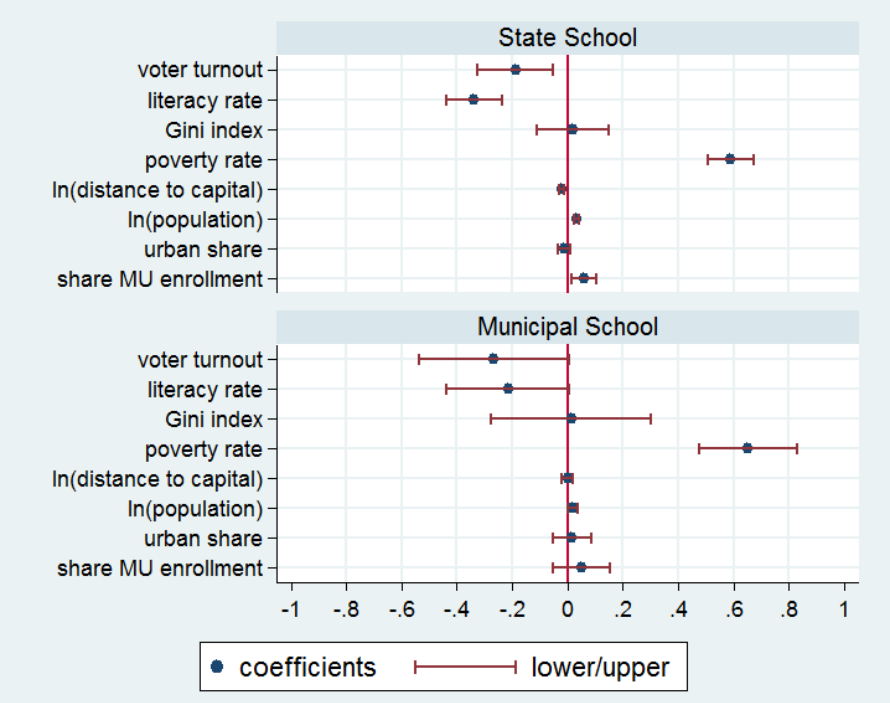

Figure 4.7 Estimated Coefficients for Environmental Variables - 2004
Note: Bootstrapped coefficients from truncated regression using 2004 data.

5
Conclusions

In this study we explore the impacts of the decentralization of primary public education in Brazil on schools' performance indicators during the period of implementation of the FUNDEF. Decentralization is supposed to increase the incentives of local administration to use their better knowledge of local conditions and effectively reach the poor. However, an adequate delivery of public services depends also on the technical capacity of the local administration and on the influence of local elites.

Thus, we provide evidence of the impact of decentralization on the quality of education in Brazil, exploring the differences related to the characteristics of the city where these schools are located. We make use of the panel data available from the schools census from 1996 to 2006, following schools over time and identifying the year when the school was adopted by the municipality. The first strategy is to use differences-in-differences models to capture non-linear effects of decentralization on three school performance indicators calculated from the census data: failure, dropout and age-grade distortion rates.

A random trend model seems to be more adequate to control for time-varying characteristics of the schools that might be related to the decentralization decision. According to the results from this model, decentralization generated an increase in failure rates of around 2.4 percentage points after four years since decentralization. For the dropout rates, coefficients are negative and significant after the third year since decentralization, representing a reduction of 1.7 percentage points in dropout rates in the case of 5 years or more after the school adoption by the municipal government. However, the impact on age-grade distortion rates is not significant.

These results were also compared in the case of different municipal scenarios. Coefficients for the random trend model applied to different samples were estimated. One interesting result is the evidence that scale matters. In smaller cities, decentralization contributes to an increase in failure rates. In more populated places, age-grade distortion might fall.

In the cities where the poverty level is lower, decentralization increases failure rates up to 3.4 percentage points (after 4 years since decentralization). Its impact starts to become lower and less significant with the increase in poverty levels. This might indicate that the selection bias is stronger in the case of richer places - the difference among the schools that remain under state management and the ones that have been decentralized.

Also, with the increase in the years since decentralization, the positive impact on failure rates becomes higher in cities with lower voter turnout. In the case of dropout rates, in the first year of decentralization, there is a 1.1 percentage point increase in municipalities with lower voter turnout, but this impact becomes negative and significant (after 3 years of decentralization) in cities with higher voter turnout rates.

Finally, for a more complete overview of the process of municipalization, we explore the efficiency of municipal and state schools over time, and how these efficiency measures are related to the political, economic and social context in which these schools are inserted.

We use the microdata from the schools census aggregated for each school type within a municipality and provide some evidence that state schools are more efficient when compared to their municipal counterparts. Additionally, schools located in the South region are more efficient than schools from the North and Northern regions. More specifically, the South and Southeast regions stand as the more efficient for any school types, while the Northeast region concentrates the states with the worst efficiency indicators.

From the regressions of the efficiency scores on some municipal characteristics, results show that the population size has a positive impact, indicating that schools located in more populated cities are more inefficient, but these results are not statistically different from zero except for the set of municipal schools.

Higher levels of poverty are related to higher inefficiency on the provision of public education. Besides, coefficients increase for more recent years and in 2004, municipal schools have become more sensitive to poverty than their state peers. In poorer areas,

then, municipal establishments would be more inefficient than the state ones. This result might be reflecting lower levels of technical capacity in these poorer cities.

Another variable of interest is the local educational level. Better educated individuals are more likely to be more productive and proactive. Both characteristics would increase the efficiency and this is shown in the results for the three years considered in this analysis. Higher literacy rates improve efficiency.

Finally, voter turnout has also a negative impact on the estimated scores, meaning that an increase in political participation would improve efficiency. More interesting, in 1996, this was more important for state schools, but this result was reversed and, in 2004, the efficiency of municipal schools became more sensitive to this political variable. According to the theory on decentralization this is expected in the way that Mayors have become more accountable for the quality of the education service provided.

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Appendix

A

Code for Efficiency Estimation

In this appendix the code for running the algorithm #2 proposed in Simar and Wilson (2007) is presented. It is based on the code described in Machado (2013) for use with the R statistical software. L1 and L2 correspond to the number of bootstrap replications.

```
library(FEAR)
library(foreign)
library(msm)

#1.DEA estimation

dhat <- 1/(dea(XOBS=inputs,YOBS=outputs,ORIENTATION=2))
dhatm <- cbind(id,dhat)

#2.Estimates of bhat with MLE of dhat>1 on environmental vars (indepvars)

g1 <- which(dhat>1)
% Coefficients (bhat1) and sigma (sigma1) values calculated from a truncated regression
% of dhat in the subsample g1 on the independent variables (using Stata).

#3. Bootstrap to get bias-corrected efficiency estimates

n.obs <- nrow(indep)
zb <- as.matrix(indep)%*%bhat1
t1 <- matrix(1-zb)
dstar.hat <- matrix(NA,ncol=L1,nrow=n.obs) # matrix to collect results

for (i in 1:L1){
#3.1 draw error for each obs independently
eps <- rtnorm(n.obs,sd=sigma1,lower=t1)

#3.2 estimate delta star with zb
dstar <- zb + eps
```

```
#3.3 change inputs by weighing each by dhat/dstar and re-estimate DEA
outputs.star <- t(t(outputs)*c(dhat/dstar))
dstar.hat[,i] <- 1/(dea(XOBS=inputs,YOBS=outputs,XREF=inputs,
YREF=outputs.star,ORIENTATION=2))
}

#4. Compute bias corrected efficiency estimates using boot estimates

dhat.bc <- (2*dhat)-apply(dstar.hat,1,mean)
dhat.bcm <- cbind(id,dhat.bc)

#5. Compute MLE on bias-corrected estimates and get estimates of beta and sigma

% Coefficients (bhat2) and sigma (sigma2) values calculated from a truncated regression
% of dhat.bc on the independent variables (using Stata).

#6. Loop again, this time the last step is the MLE to get estimates of beta
with boot confidence intervals

n.est <- (3*ncol(indep))+1
boot.bhat <- matrix(NA,ncol=n.est,nrow=L2) # matrix to collect beta estimates

for (i in 1:L2){
#6.1 draw error for each observation independently
eps <- rtnorm(n.obs,sd=sigma2,lower=t1)

#6.2 estimate delta star with zb
dstar2 <- zb + eps

#6.3 estimate MLE and collect coefficients

% Generate bootstraped results from the truncated regression
% of dstar2 on the independent variables (using Stata).
```

B

Truncated Regression Results

Table B.1 shows the bootstrapped results from the truncated regression of the bias-corrected efficiency scores on the environmental variables. The observations are given by municipality and administration type. A municipal dummy was generated, assuming value one if the observation corresponds to the data for municipal schools and interactions were used to capture how differently these variables affect the efficiency depending on the school type.

Table B.1 Truncated Regression Results

	1996	2000	2004
constant	1.460***	1.081***	0.974***
	(0.042)	(0.053)	(0.058)
share MU enrollment	-0.066***	-0.041***	0.134***
	(0.011)	(0.013)	(0.019)
urban share	0.020***	-0.004	-0.031***
	(0.008)	(0.008)	(0.011)
ln(population)	0.001	0.013***	0.006*
	(0.003)	(0.002)	(0.003)
ln(distance to capital)	-0.033***	-0.022***	-0.014***
	(0.003)	(0.003)	(0.003)
poverty rate	0.187***	0.300***	0.350***
	(0.021)	(0.026)	(0.026)
Gini index	0.109***	-0.042	-0.035
	(0.040)	(0.034)	(0.045)
literacy rate	-0.227***	-0.177***	-0.224***
	(0.031)	(0.043)	(0.037)
voter turnout	-0.309***	-0.063**	-0.059
	(0.025)	(0.032)	(0.048)
Interactions with Municipal			
share MU enrollment	0.053***	0.016	-0.125***
	(0.016)	(0.018)	(0.025)
urban share	-0.020**	0.014	0.038***
	(0.010)	(0.011)	(0.014)
ln(population)	-0.001	0.002	0.005
	(0.003)	(0.003)	(0.004)
ln(distance to capital)	0.019***	0.014***	0.012***
	(0.004)	(0.004)	(0.005)
poverty rate	-0.025	-0.006	0.084***
	(0.024)	(0.029)	(0.030)
Gini index	-0.073	0.102**	-0.026
	(0.055)	(0.049)	(0.057)
literacy rate	-0.187***	-0.101**	-0.037
	(0.038)	(0.048)	(0.052)
voter turnout	0.223***	-0.039	-0.021
	(0.027)	(0.043)	(0.049)
sigma	0.089***	0.089***	0.084***
	(0.001)	(0.001)	(0.002)
# Obs	7217	7007	6507

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1