Does money move teachers?[1]

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Abstract

The empirical literature has produced strong evidence that, after controlling for pupils' socioeconomic characteristics, teacher quality is the most important school factor in explaining pupil's performance in standardized tests. However, there is no consensus on how public school systems could improve teacher quality. Brazilian federal government introduced in 2009 a national minimum salary for public school teachers that triggered an exogenous increase in municipal teacher's salaries. The objectives of this paper are twofold. The first objective is to investigate the compliance of municipal school system with the national minimum teacher salary law. We find that unobserved factors are determinant in explaining salary variability among municipalities and the compliance with the law. The second objective is to assess the impact of salary on retention and recruitment of teachers by municipal school systems, exploring the exogenous variation of municipal teacher salary and teacher longitudinal data. Using difference-in-difference methods with selection on observables, we conclude that exogenous salary rise do not move teachers in the first two years of the national teacher minimum salary policy.

Keywords: Impact evaluation; teachers' minimum salary; teachers' labor market.

Resumo

Há, na literatura empírica, fortes evidências de que, após controlar as características socioeconômicas dos alunos, a qualidade do professor é o fator mais importante a explicar a proficiência escolar. Entretanto, não existe consenso em relação a como as redes e sistemas públicos de ensino podem promover a qualidade de seus professores. Com a introdução pelo Governo Federal do piso nacional do magistério público, houve elevação exógena dos salários dos professores do Ensino Fundamental da rede municipal. Os objetivos deste artigo são: (*i*) investigar o cumprimento do piso salarial por parte dos municípios brasileiros; (*ii*) estimar o impacto da elevação salarial sobre a retenção e o recrutamento de professores por parte dos sistemas e redes de ensino municipais, explorando a variação exógena nos salários e um painel de professores. Fatores não observados são determinantes para explicar a variabilidade dos salários entre as redes municipais e também para explicar a propensão a cumprir a lei do piso salarial do magistério. Usando o método de diferença em diferenças aliado a seleção em observáveis, concluímos que a variação exógena dos salários dos professores não afetou o movimento dos professores entre redes de ensino e não reduziu a evasão da profissão nos dois primeiros anos da política.

Palavras-chave: avaliação de impacto; piso nacional do magistério; mercado de trabalho do professor.

JEL Classification: C31; J45; J48; I28.

Área 13 - Economia do Trabalho.

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1 Introduction

Teachers pay is the largest single budget item of any school system. In Brazilian municipalities, for instance, about 60% of the education budget is spent with teachers' payroll or is supposed to be, considering Constitutional imposition[5]. Studies show that improving teacher quality could significantly raise the performance of low-scoring students[6] and after controlling for pupils' socioeconomic background, the most important school factor to explain pupils' performance in standardized tests is teacher quality[7]. Thus, an important policy issue is how countries can increase the quality of teachers.

Studies also concluded that teacher quality is not explained by observable characteristics in terms of experience and schooling, but mainly by unobservable characteristics[8], making it even harder to promote teacher quality, particularly in public schools since public school system salary schedules are generally based on observables. A vast literature shows that higher relative teachers' salaries increase the likelihood that an individual enters into teacher profession and reduce the likelihood that a teacher leaves the profession[9]. Imazeki (2005) found that teacher transfers between school systems respond most strongly when district salaries are increased relative to nearby districts[10].

Intuitively, offering higher salaries and/or better work conditions is a necessary condition for attracting high quality teachers. However, this condition is not sufficient since less motivated workers are induced to apply for the vacancy by higher salaries too. Dal Bó et al (2013), using an experiment in Mexico, find that higher wages attract more able applicants as measured by their IQ, personality, and public service motivation. Thus, their results are against the hypothesis of adverse selection. Besides, they find that distance and worse municipal characteristics strongly decrease acceptance rates, but higher wages help bridge the recruitment gap in municipalities characterized by worse work conditions.

Results from a large empirical literature indicate that salaries paid to teachers are negatively related to their propensities to exit teaching profession and positively related to durations in first teaching positions[11]. More related to our approach, Falch (2011) examines the effect of salaries on teacher leaving decisions using a natural experiment. In Norway, teachers in schools with a lot of prior teacher vacancies received a salary premium of about 10 percent during 1993-94 to 2002-03. Using a school fixed effects model, he finds that the salary premium reduces the probability of voluntary quits by 6 p.p..

There is a vast literature which investigates the effects of the minimum wage on labor market and particularly on labor supply, and is beyond this article objectives review it. But, as far as we know, there is not any study that analyzes and assesses the impact of salary variation on teacher retention, recruitment or exits in the Brazilian context. A pre-requisite to properly address this question is a source of exogenous variation in salaries. We explore the introduction of minimum salary for Brazil's public school teacher as an exogenous shock driving up teachers' salaries in some municipalities. In Brazil, teacher salaries are lower than in alternative occupations, and there is evidence that poor performing students are attracted to the teaching profession (INEP, 2009 and 2010). But after the introduction of the teacher minimum salary in 2008, there has been a noticeable increase in the real salary of municipal teachers. We show evidence of an exogenous increase of teacher salaries due to the introduction of a mandatory teacher minimum salary in 2009 by the Brazilian federal government, and estimate the impact of salary hikes on retention

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[5] According to *Controladoria-Geral da União* (*CGU*), the Brazilian Federal Internal Control Agency, of 124 auditing done (120 municipalities and 4 states), despite the imposition by the Brazilian Constitution, only 83 sub-national governments observe this rule, about 2/3 of those scrutinized school systems, though.

[6] Chetty et al (2013).

[7] Hanushek et al (2005), Rockoff (2004) and Rivkin et al (2005). In the Brazilian context, Moriconi (2012), using value added data for the municipality of São Paulo, concludes that the variation of teacher effectiveness explains about 9% of all the students test scores variability, in a lesser degree than the variability in socioeconomic characteristics (15%), but in a higher degree than the variability in school characteristics (5%).

[8] Hanushek (1986), Hanushek and Rivkin (2006, 2010).

[9] Chevalier et al (2007), Zabalza et al. (1979), Dolton (1990), Dolton and van der Klaauw (1995 e 1999), and Dolton and Mavromaras (1994) for the United Kindom; and Stinebrickner (1998), Brewer (1996), Rees (1991), Mont and Rees (1996), Murnane and Olsen (1989 e 1990), Theobald (1990), and Theobald and Gritz (1996) for the United States.

[10] Furthermore, Leigh (2012) models the relationship between current teacher salaries and the academic aptitude of potentially future teachers, seen as those who were entering teacher education courses and finds that a 1 per cent rise in the salary of a starting teacher boosts the average aptitude of potentially future students by 0.6 percentile ranks.

[11] See Dolton and van der Klaauw (1999) and Behrman et al (forthcoming) for a brief survey on this literature.

and attraction of teachers by municipal school systems. Municipalities whose teachers' salaries were below the national minimum when the law was enacted experienced larger teachers' salary increases than the others between 2008 and 2011.

Thus, the objectives of this article are twofold. First, we aim to investigate the compliance of municipal school system with the national minimum teacher salary law. It is necessary to characterize compliers and non-compliers and investigate the role of selection on observables in explaining compliance with the law. After understanding compliance and characterizing treatment, as the second objective of this work, we estimate the impact of an exogenous salary raise on attraction and retention of teachers in Brazilian municipal school systems using teacher panel constructed with Brazilian School Census. In order to verify whether municipalities are complying with the law and the magnitude of salary variation due to the introduction of minimum salary regulation, we had to carry out a survey with municipal department of education and get information about teacher career structure and base salaries throughout the period since 2008.

The rest of the paper is organized as follows. Section 2 presents some relevant institutional features of Brazilian municipal school systems. Section 3 discusses the data used in this paper and presents our survey methodology. The identification strategy is described in Section 4. Section 5 brings the investigation about compliance with the law. The investigation whether salary hikes move teachers is presented in Section 6 and, finally, Section 7 concludes.

2 Institutional Background

Brazil's Constitution states the responsibilities of each government level in guaranteeing public and free education for all their citizens. More broadly, the Brazilian public basic education system is characterized by a decentralized nature and by a federal funding scheme. Each of these government actors has its own public educational system and is responsible for its maintenance and for the administration of its funds and financial resources.

A federal funding scheme guarantees a minimum amount of resource per pupil in each municipal and state school system. The Constitution reserves 25% of state and municipal taxes and 18% of federal taxes for education. Most part of these resources makes up a fund, *FUNDEB*[12], in each state of the federation. Its resources distribution across public school systems is based on the quantity of pupils in each system[13]. Accordingly to the Constitution, at least 60% of the *FUNDEB* resources have to be spent with salaries of teachers and other professionals directly involved in teaching activity. Furthermore, each municipality is supposed to have a Municipal Council for Social Monitoring and Control of *FUNDEB*, a board composed of members of the government and the civil society which has as its main duty to monitor and to control the distribution, transfer and use of resources from *FUNDEB* in the local context.

Brazilian municipal school systems employ 1.07 million teachers, 471,266 teach in primary school (62.4% of the total primary teachers) and 355,669 teach in lower secondary school (41.2% of the total secondary teachers). Considering that the total amount of all *FUNDEB* funds transferred to municipalities in 2012 summed R$ 64.88 billions, it is presumed that approximately R$ 38.93 bi were paid to municipal school teachers and other school staff directly involved in teaching activities in 2012.

The decentralized nature of Brazilian public basic education system gives great organizational autonomy to sub-national governments in managing their educational systems. The maintenance of the system, including the definition of teacher career and payment structures is decentralized. Therefore municipal teachers' salaries are decided by local governments. Until January 2009, the municipalities had established the salary of teachers independently. After passing the Law No.11738, of July 16th, 2008, the Federal Government began to set the minimum amount to be paid as base salary of teachers of all public

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[12] Portuguese acronym for *Basic Education Maintenance and Development Fund* (*Fundo de Manutenção e Desenvolvimento da Educação Básica e de Valorização dos Profissionais da Educação*). Roughly 20% of municipal and state taxes are allocated to *FUNDEB*. Apart from *FUNDEB*, according to the Brazilian Constitution, municipalities also have to spend in education 25% of their own collected taxes in education, and 5% of the bunch of taxes associated to *FUNDEB*.

[13] Federal government supplements state *FUNDEB* when is necessary to guarantee the minimum national value of resources per pupil. Since 2010, the total amount transferred by federal government to the 27 *FUNDEB* (one fund for each state and the Federal District) corresponds to 10% of the total resources put in *FUNDEB*.

school systems[14]. In October 2008, soon after the minimum wage law was enacted, governors of five states questioned the constitutionality of the law[15]. On April 6th, 2011, the Brazilian Supreme Court (*STF*) decided for the constitutionality of the law. Since this decision became unappealable only on 14th April of 2014, perhaps public officials had not felt themselves obliged to comply with the law beforehand.

According to the new law, every school system that were paying teachers a base salary of less than R$ 950 per 40 hours of work per week[16], or proportionally equivalent, must raise the salary on January 2009 by at least 2/3 of the difference to the established minimum value. The transition to new minimum base salary value should have been completed by January 2010, when the school systems must pay at least the minimum salary as a base salary to their teachers, which was R$ 1,024.67 at the time. According to decision of the Ministry of Education, supported by the *STF*, the teacher minimum salary is yearly adjusted by the predicted rate of increase of the resources from *FUNDEB* per pupil.

Public school system's pay policy is based on salary formulae that reward teacher characteristics such as possessing graduate degrees and master certificates, and, mainly, seniority. Despite its increasing adoption among developed countries, performance-based pay is almost inexistent amongst municipal school systems in Brazil[17]. Typically, teacher salary consists of two parts: (*i*) a base salary, established accordingly to the teacher's workload; and (*ii*) an additional part based on teacher's seniority and number of hours of graduate credits or graduate degrees teacher has. Generally these rewards are calculated as a percentage of the base salary. Thus, if the education and experience of the average teacher in a school system did not change from one year to the next, then average teacher pay would increase by the same percentage as well. When school systems raise the pay of teachers, they normally increase all the cells of these schedules by a fixed percentage.

3 Data and the Survey with Municipal Departments of Education

In Brazil, except for the *Relação Anual de Informações Sociais* (*RAIS*)[18], there is no comprehensive source of information about municipal teacher salary, and there is absolutely no information about their beginning base salary. In order to determine whether municipal school systems comply with the national minimum teacher salary we need a precise source of its teacher base salary. But in *RAIS* we get the employee's final remuneration, including some benefits and rewards for seniority, for instance. Thus, to circumvent limitations of existing database, we carried out a survey with municipal departments of education in partnership with the *National Union of Municipal Secretaries of Education* (*UNDIME*[19]), to get precise information about teachers' beginning salaries and career structures.

3.1) The Survey

The survey questionnaire, which was inserted in a web platform and put into the *UNDIME* website[20], consisted of questions about teacher career and remuneration in every January of the period

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[14] According to the law, the minimum teacher salary is adjusted yearly at the projected increase of *FUNDEB* resources.

[15] Direct Action of Unconstitutionality No. 4,167, of October 2008 by governors of MS, PR, SC, RS and CE.

[16] When introduced, the stipulated minimum base salary of R$ 950 was approximately equivalent to 2.04 minimum salaries in 2009. In 2013, national minimum salary of teachers corresponded to R$ 1,567, or 2.31 minimum salaries (R$ 678).

[17] Only 2.3%, or 22 municipalities, among 955 who answered this survey question, adopt a system of pay based on performance.The state with more municipalities which has this kind of performance-based pay scheme is the state of Ceará, with 5 municipalities, among 39 respondents (12.8%), followed by the state of São Paulo with 7 municipalities (out of 184 respondents). Only 7 of those 22 municipalities have adopted such a scheme of compensation during the period of analysis. This extremely low number makes us confident in rejecting any influence of these schemes on any obtained results.

[18] *RAIS* is an annual, matched employer-employee, administrative data set collected by the Brazilian Ministry of Labor. It is a panel of workers and firms, containing the universe of formal firms and workers.

[19] Acronym in Portuguese for *União Nacional dos Dirigentes Municipais de Educação*, which is a non-profit organization supported by contributions of its members, almost 5,000 municipal departments of Education. Its mission is to coordinate, mobilize and integrate the municipal secretaries of education to improve public education. It organizes and promotes research, meetings, seminars and forums and, in addition, maintains contacts with unions, non-governmental organizations, social movements, and other entities of the civil society.

[20] *UNDIME* often carries out quick surveys about education issues and sometimes carries out broader surveys like ours. When asked to answer the questionnaire, the members of the municipal departments of Education were told that their identity and their municipality identity would not be disclosure and all the information would be displayed through averages or by group of municipalities. Furthermore, no information would be passed on to third parties. Therefore, because respondents were

2008-2013[21]. The survey worked as follows. *UNDIME* sent electronic messages to its mailing list, composed of about 5,000 municipal departments of education and their heads. This message contains a presentation of the research project, an invitation for participation and a link to access the questionnaire in *UNDIME* website. Representatives of each municipal department of education, after registering into the survey web system, informing their name, position and telephone number and e-mail contacts, filled the survey questionnaire. *UNDIME* conditioned the partnership to confidentiality agreement. Municipal department of education was told that their identity would not be unveiled to third parties. Therefore we are not allowed to publicly identify municipalities or its representative in the database.

The first phase of the field research took place between May 17th and July 31st, 2013, and consisted of a pre-test. From *UNDIME* mailing contacts information, we constructed a stratified representative sample of 399 municipalities to participate in the pre-test, whose purpose was, first, to test the collection instrument and indicate further necessary improvements, and, second, to inform us the rate of participation through each sample stratum, taken in consideration to define the final representative sample. The second phase of the research has taken place from September 2013 until February 28th 2014.

Even though *UNDIME* has sent messages to all its contacts and wanted that all its members take part in the survey, we decided to stimulate the participation of municipalities included in a nationwide representative sample of municipal school systems. Based on the experience of the pre-test we have learned that we should check whether municipal departments of education had received the messages from *UNDIME* and, more importantly, we should encourage them into answering the web survey through telephone calls. Thus, to reduce the costs and the time spent in collecting data and to guarantee representativeness of the respondents, we focus on the participation of a nationwide representative sample. In order to guarantee that municipal school systems included in this sample actually had received the the link to the web questionnaire, we tried to contact all of them and also tried subsequent contacts to reassure them the importance of completing the questionnaire until the end of the survey deadline.

In our survey with all municipal departments of education, 1,600 of them entered the questionnaire web system and answered at least one question and 1,111 reached the end of the questionnaire. However, only 905 school systems have informed beginning teacher base salaries of their primary schools observed at least in January 2008 and January 2009 or January 2010, necessary values for assessing salary variation in the period 2008-2010, which is the focus of our analysis.

It is important to clarify that making contact with municipalities from the Northeast region and, mainly, North region was much more difficult than making contact with municipalities of other regions. Facing the challenge of trying to contact municipal departments of education from Northern parts of Brazil, we asked several regional bureaus of *UNDIME* to help us in this task. After that we noticed that participation rate raised in some states but not in others, where *UNDIME*'s mobilizing capacity seems weaker, such as AP, AM, PA, RR, MA, PE, AL and SE. The participation rate of out of the sample municipal department of education can be seen as a proxy of regional bureaus mobilizing capacity[22]. Another factor that helps to explain such timid participation among Northern and Northeastern municipal departments of education is their still restricted internet access and their poorer institutions.[23]

Table 1 shows participation rate amongst Brazilian states, considering the representative sample and out of the sample participants. From the representative sample we got 40.2% of participants. On the other hand, only 8% of the municipalities out of the sample informed their teacher salaries. The huge gap

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answering to their own peers, we believe that the survey brings us accurate information. Even though, we intend to do some consistency checks with other databases.

[21] A copy of the questionnaire used in the survey is available on request from the authors.

[22] Except for regional bureaus of Acre and Rondônia because all of the municipalities of those states have taken part in the sample.

[23] Some anecdotal evidence can be mentioned. Members of some municipal departments of education from Northeast Region have told us that members of the former administration destroyed administrative records about teacher pay, and others, from North, have told us they are having problems with internet access. From one municipal department we have heard that the mayor has suffered an impeachment and all city head departments were dismissed. Few weeks later in a second contact, the situation was still confused and the person we had the mobile-phone number, the only telephone number we had from that department of education, was not working at the department of education anymore.

between those participation rates highlights the importance of our work of contacting municipal departments of education and stimulating their participation in the survey.

Table 1 Regional and State distribution of participant municipalities

| Region/State | # municipalities | sample | | out of sample | | participation rate | | |
		part.	no part.	part.	no part.	sample	out of sample	total
N	**450**	**89**	**168**	**13**	**180**	**34,6%**	**6,7%**	**22,7%**
RO	52	26	26	0	0	50,0%	-	50,0%
AC	22	11	11	0	0	50,0%	-	50,0%
AM	62	6	28	0	28	17,6%	0,0%	9,7%
RR	15	4	9	0	2	30,8%	0,0%	26,7%
PA	143	11	56	1	75	16,4%	1,3%	8,4%
AP	17	3	10	0	4	23,1%	0,0%	17,6%
TO	139	28	28	12	71	50,0%	14,5%	28,8%
NE	**1793**	**158**	**416**	**68**	**1151**	**27,5%**	**5,6%**	**12,6%**
MA	217	14	57	2	144	19,7%	1,4%	7,4%
PI	224	27	38	5	154	41,5%	3,1%	14,3%
CE	184	22	34	7	121	39,3%	5,5%	15,8%
RN	167	22	34	15	96	39,3%	13,5%	22,2%
PB	223	21	35	13	154	37,5%	7,8%	15,2%
PE	184	15	50	5	114	23,1%	4,2%	10,9%
AL	102	7	61	1	33	10,3%	2,9%	7,8%
SE	75	9	47	0	19	16,1%	0,0%	12,0%
BA	417	21	60	20	316	25,9%	6,0%	9,8%
SE	**1668**	**134**	**121**	**136**	**1277**	**52,5%**	**9,6%**	**16,2%**
MG	853	33	29	59	732	53,2%	7,5%	10,8%
ES	78	25	32	3	18	43,9%	14,3%	35,9%
RJ	92	31	25	1	35	55,4%	2,8%	34,8%
SP	645	45	35	73	492	56,3%	12,9%	18,3%
S	**1188**	**105**	**81**	**78**	**924**	**56,5%**	**7,8%**	**15,4%**
PR	399	35	21	18	325	62,5%	5,2%	13,3%
SC	293	26	36	16	215	41,9%	6,9%	14,3%
RS	496	44	24	44	384	64,7%	10,3%	17,7%
MW	**465**	**93**	**76**	**33**	**263**	**55,0%**	**11,1%**	**27,1%**
MS	75	28	26	1	20	51,9%	4,8%	38,7%
MT	144	32	27	14	71	54,2%	16,5%	31,9%
GO	246	33	23	18	172	58,9%	9,5%	20,7%

There are large differences in participation rate amongst Brazilian states and regions. Municipalities from South, Southeast and Mid-West reached higher participation rate, of about 55% of the representative sample against participation rate of 34.6% and 27.5% of Northern and Northeastern municipalities, respectively. Consequently, to restore sample representativeness, we had to calculate sample weights and consider them in order to properly analyze the data.

In addition to our survey information, we gathered teacher longitudinal data obtained from School Census between 2007 and 2010. The Census, which is carried out by the *INEP* yearly, identifies teachers since 2007. It provides among a bunch of information, teachers characteristics such as gender, skin color, whether they are graduated, the year of college graduation, whether they have post graduation diplomas, and schools, grades and classes they teach. Thus we managed to link each year Census and built a teacher panel from 2007 to 2010. Therefore we use the panel to investigate teachers move in and out school systems, identifying their transition between school systems and drop outs. In order to investigate the effect of exogenous salary hikes on teachers move, we calculated yearly proportions of new teachers, teachers who stayed in, teachers who changed employer and teachers who drop out the profession for each municipal school system.

3.2) Sample methodology

Sample size was calculated assuming the following: (*i*) a standard deviation for the average Prova Brasil pupils' achievement test scores per municipality of about 55 points; (*ii*) a statistical power of 80%;

(*iii*) a statistical significance level of 5%; (*iv*) an expected participation rate of 60% (which was adjusted to 50% after the pre-test); (*v*) that the intention of detecting differences of at least 10 points on the average Prova Brasil pupil's achievement test scores per municipality when statistically comparing the group of municipalities that complied with the minimum salary policy in 2009 (group 1) with those which did not complied (group 2)[24]; (*vi*) the selection of municipalities considering stratified simple random sample; and (*vii*) a design effect of 1.

An initial estimated survey sample size was then calculated as 1130 municipalities, with 565 municipalities from each of the considered groups. The sample size for the pre-test was defined as 30% of the sample size estimated for the survey. Note that, after the realization of the pre-test, the survey sample size was inflated to 1212 municipalities, considering the observed participation rate of 50%.

After the sample size estimation, a stratified simple random sample was selected. Municipalities were stratified by states, inclusion or not in the CONVIVA frame[25], and by size with capitals and municipalities with 100 thousand or more inhabitants, according to the 2010 Brazilian census, being classified in a 'large municipality' stratum and the remaining ones in a 'small and medium municipality' stratum. An exception was made for the state of São Paulo, where the criteria for a municipality to be classified in the 'large municipality' *stratum* has been having 200 thousands inhabitants or more.

Sample allocation of municipalities among the strata was aimed to be made uniformly among strata and disproportionally in the strata defined by the inclusion or not in the CONVIVA frame, considering a larger probability of selection for those municipalities listed in the CONVIVA frame. Moreover, municipalities classified in the 'large municipality' *stratum* were selected with certainty (probability of one). Such sample size adjustments guided by the sample allocation over the strata in addition to round procedures (to the next larger integer) in the sample size for each *strata* led to a final sample size of 1441 municipalities.

After survey data collection procedures were concluded, sample survey weights were calculated, for each municipality, accounting for unequal selection probabilities and adjust for unit non response. Therefore, the use of the calculated weights in data analysis procedures compensate for different selection probabilities and non response and guarantees the property that weighted sample moments are consistent for population moments with respect to the joint sampling/non response probability distribution. Non response adjustment procedures adopted in this article assume a missing at random mechanism.

3.3) Descriptive Statistics

Our weighted representative sample represents well the entire population of Brazilian municipalities. Descriptive statistics that compare the weighted sample and the whole population of municipalities in respect to some socioeconomic characteristics, their school system budget, their school infrastructure and pupils' family socioeconomic background are available from the authors upon request. Our sample data recovers almost identical distribution of municipalities through Brazilian Regions and, in terms of municipal socioeconomic characteristics, averages are quite similar between our sample and the population, but adult illiteracy rate. Also average municipal school facilities are similar between our weighted sample and the population municipal school systems. There are statistically significant differences between our sample and the population only in part of the socioeconomic background variables. In sum, although our weighted sample slightly overestimates population socioeconomic status in some dimensions, we argue those differences are relatively small and do not taint the representation of the population of Brazilian municipalities.

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[24] This sample was originally designed to our other article whose objective is to assess the impact of teacher salary raise on pupils' proficiency.

[25] CONVIVA is a web platform, administered by *UNDIME* with partnership of several Brazilian NGOs, whose main objective is to deliver, totally free of charges, information and management tools to Municipal Departments of Education in order to improve local education policies. As the members of Municipal Departments of Education need to inform valid email addresses to participate in the CONVIVA framework, we think that the probability of having our email messages been red, and consequently of receiving the questionnaires back would be higher than in the cases of municipalities that have not signed in CONVIVA's platform. Besides, the involvement in CONVIVA would be a proxy for quality of the department of education.

Figure 1a Histogram of lowest Municipal base salary of beginning teachers in 2008
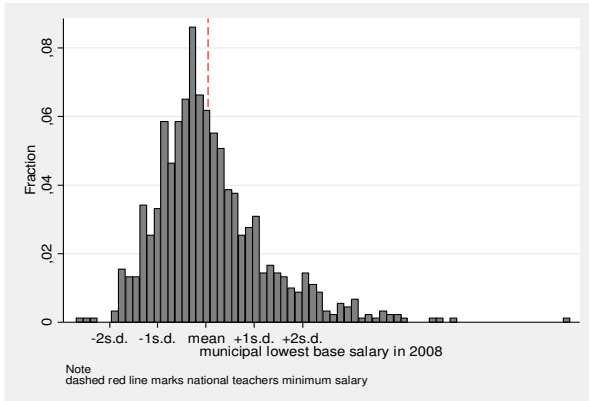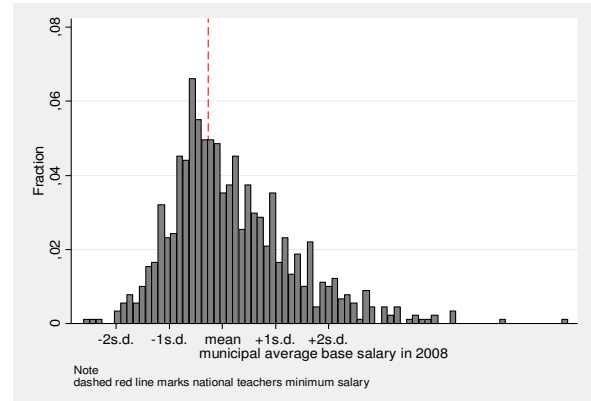
Figure 1b Histogram of Municipal base salary of teachers in 2008

Note
dashed red line marks national teachers minimum salary

Note
dashed red line marks national teachers minimum salary

According to our survey, the majority of Brazilian municipal school systems were impinged by the introduction of the national minimum salary[26]. Salaries are higher in the southern regions of Brazil, where less than half of its municipalities (46.1%) have been impinged by the national minimum teacher salary. Meanwhile, in the northern and mid-western regions 78.3% of its municipalities have been impinged by the law[27]. Figure 1a shows the histogram of the lowest value of each municipal school system base salary of beginning teachers in January 2008[28]. We see that the defined minimum salary (marked by the traced red line) was almost the national average considering the municipalities which informed us their teacher salaries[29]. Figure 1b presents the histogram of municipal average teacher beginning base salaries in January 2008. The histograms show that there is a relatively high dispersion in Brazilian municipal base salary distribution.

Figure 2

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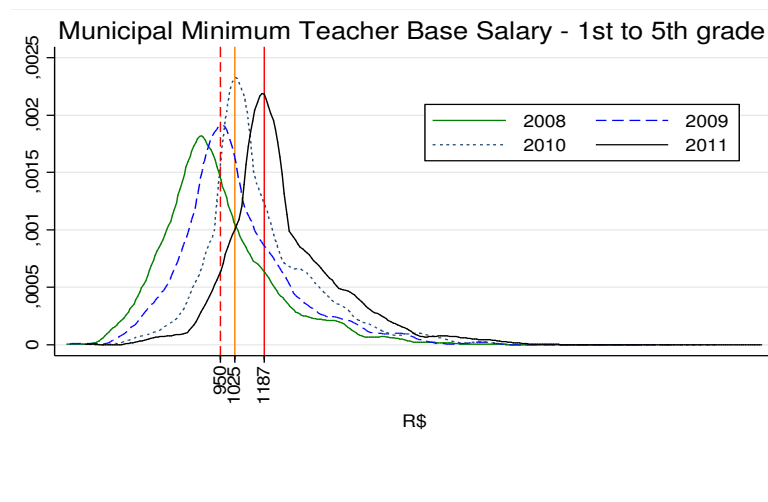
[26] We find that actually 61.2% of the Brazilian municipal school systems had any teacher base salary smaller than R$950 in 2008, and consequently were impinged by the law introduction. In 2011, the percentage of municipal school systems which were paying less than the legal minimum as a base salary fell 26.8 p.p., to 34.4% of Brazilian municipalities. Even though there was a sharp reduction in the proportion of municipalities with minimum salaries below the national minimum, it is still a high proportion of non-compliance with the law. In 2013, 32.9% of Brazilian municipalities remain on the margin of the law. Here we had to assume that base salaries remained constant between January and June of 2008, when the law was enacted or, if it had been raised, the lowest municipal base salary in June would be still below the established national minimum.

[27] Tables with detailed proportions are available from the authors upon request.

[28] Often the lowest base salary in each municipal school system is the one of the beginning teacher without college degree.

[29] Sample weights matter. The average of the municipal minimum base salary obtained applying sample weights (R$ 936.01 in 2008) is statistically different from the simple average (R$ 967.32 in 2008) at 5% level of significance.

The institution of the minimum salary moved partially municipal teacher's salaries as shown by Figure 2. Looking at the distribution density of municipal lowest teacher base salary in the period from 2008 to 2011, we can see a decrease in the mass of municipalities that pay less than the national minimum salary as base salary and, at the same time, an increase in the mass of school systems which paid exactly or nearly around the stipulated minimum from 2009 (dashed red line) to 2010 (orange line) or to 2011 (red line). From 2008 to 2009, Brazilian municipalities raised teacher base salaries on average by 12.9% of variation, what represented a considerable gain in real terms for teachers since Brazilian economy has witnessed an annual inflation rate of 5.9% that year.

Our data reveals that municipal school systems which comply with the law raised salaries sharper than non-impinged ones and non-compliers. As shown in Table 2, compliers raised salaries 16.2 p.p. (113.84 Brazilian Reais) more than the others and 15.0 p.p. (130.31 Brazilian Reais) more than non-compliers. And it is important to mention that we could not reject the null hypothesis that the difference between salary variation of non-impinged and of non-compliers is zero.

Table 2 Average teacher base salary (R$) and base salary increase (R$) and variation by groups (2008-2009) - treated and untreated

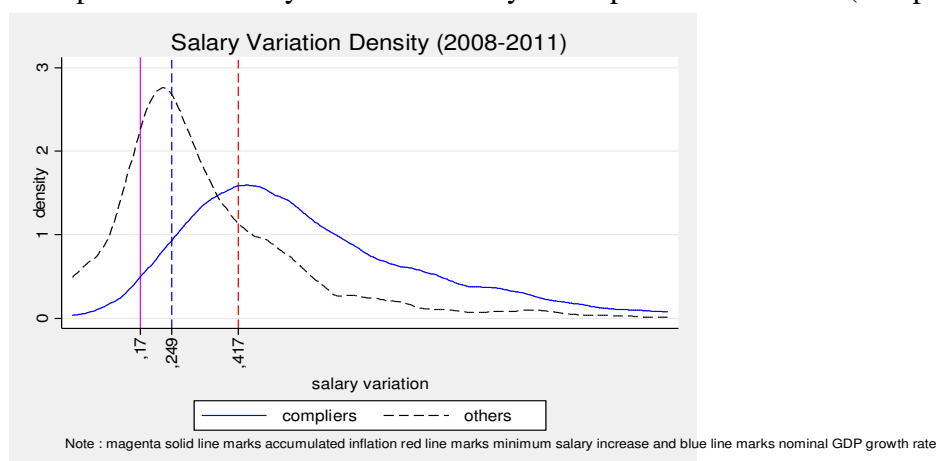|	Compliers (A)	All untreated non-impindged and non-compliers (B)	Only non-compliers (C)	Diff (A)-(B)	Diff (A)-(C)
# obs	180	525	211		
2008 average salary	883,79	1.120,67	820,76	-236,88 ***	63,03 ***
st-dev	149,44	372,85	201,04	19,72	17,77
2009 average salary	1.080,55	1.203,59	887,20	-123,04 ***	193,35 ***
st-dev	173,82	392,12	199,06	21,46	18,86
Salary increase	196,7558	82,91	66,44	113,84 ***	130,31 ***
st-dev	152,1673	86,31	75,29	11,95	12,47
Salary variation	24,4%	8,2%	9,4%	16,2 ***	15,0 ***
st-dev	22,7%	10,4%	13,4%	1,8	1,9

Notes:

(1) Differences in salary variation expressed in p.p.

(2) Salary increase of Broad untreated is higher than of Non-compliers at 5% of statistical significance, but their salary variation are not statistically different from each other.

Enlarging the period of analysis do 2011 reveals the same pattern of comparison between compliers with the law and the others municipal school systems. Between 2008 and 2011 the distribution of teacher salary variation of school systems that do not comply with the national minimum salary has its mode and mean near nominal GDP growth rate (24.9%), considerably smaller than the minimum salary increase in the same period (41.7%), which is a little bit smaller than the mode and the mean of the distribution of the teacher salary variation of municipal school systems that comply with the law at least during one school year in the period (see Figure 3).

Figure 3 - Municipal teacher salary variation density in the period 2008-2011 (compliers *x* others)

Note : magenta solid line marks accumulated inflation red line marks minimum salary increase and blue line marks nominal GDP growth rate

Note: *Others* here represents all other municipal school systems of our base.

Impinged municipalities, split into non-compliers and compliers, are less populated, poorer, have greater illiteracy rates and receive fewer resources from *FUNDEB*[30]. Differences between compliers and non-compliers are milder than differences between each one of these groups and not impinged school systems. Municipalities of school systems that complied with the law (Treatment Group) are different from municipalities of those school systems that did not comply with the minimum teacher salary in terms of per capita GDP, illiteracy rate and whether they have an own retirement system for public servants. Also they are more concentrated in the Northeast Region. On the other hand, non-compliers are more frequent in the South and Mid-West than compliers. However, in terms of school system characteristics, those groups are similar. As expected because compliers are more concentrated in the Northeast, the only significant difference against non-compliers are the higher proportions of school systems that receive resources complementation from federal government and of pupils who study in rural schools. Perhaps surprisingly, school infrastructure is poorer among compliers than in non-compliers, considering some of the informed facilities, and pupils come from a more deprived background. Furthermore, after controlling for states where municipalities are situated, mayors' political party affiliation revealed no significant correlation to compliance with the law[31].

On the other hand, impinged and non-impinged school systems and their municipalities are different in almost every aspect. Thus, to avoid bias when estimating the impact of teacher salary hikes, the utilization of non-impinged municipalities in the construction of a comparison group would require the adoption of a selection on observables method.

As part of our survey, school systems informed about the occurrence of teachers strike during the period between 2009 and 2013. Strikes occurred in 16.1% of the municipalities, and were more frequent in non-compliers (22.0%) than in municipalities whose school system complied with the law (18.2%), however this difference is not statistically significant. On the other hand, municipalities classified as non-impinged suffered less with strikes than both these former groups (12.5%), a difference statistically significant.

Based on the descriptive statistics presented, we can infer that the institution of the minimum salary contributed for an increase in real terms of local teachers' salaries, mainly among impinged municipalities and more profoundly among compliers. Despite this, a significant part of municipalities did not comply with the national teachers' minimum salary, probably due to the absence of disciplinary punishment under the law, the discussion about the constitutionality of the law and the existence of severe budget constraints in some local governments.

There are several ways to characterize treatment and determine whether each school system underwent treatment or not. Unfortunately we could not get salary of each teacher therefore we have to work with the average teacher beginning salary of each municipal school system. As noted before, there is a large range of teacher workloads among Brazilian school systems. Another limitation of the School Census database is that there is no information about teachers' contracts relatively their workload. Thus, in order to construct the average teacher salary, we suppose that each workload, whether more than one existed in a certain school system, represents the same proportion of teachers. We make the simple average of all workloads of teachers distinguishing those with college degree from those without college degree, and, after that, to obtain the school system average salary we calculate the mean weighted by the proportion of teachers with and without college degree, according to the School Census. We argue that this hypothesis does not interfere in the analysis because the salary differences between different workloads are very small whether exist. Teacher salary heterogeneity within school systems is mostly due to college and post-graduation degrees and tenure.

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[30] They receive fewer resources from *FUNDEB* because they tend to be located in poorer states which collect lesser amounts of taxes and contributions. On average, impinged municipalities spent in 2008 a larger proportion of municipal budget in education (29.7% against 27.6%, statistically significant at 1% level), probably because they are poorer and consequently have smaller budget revenues and receive lesser resources from *FUNDEB*. Actually, our data showed a strong negative correlation between municipal per capita GDP and the proportion of municipal budget spent in education.

[31] In the sample there are 23 different political parties, some with a very small number of affiliated mayors. We need to aggregate those parties somehow. We intend to test for measures of party ideological spectrum in a next version.

Table 3 - Teacher beginning base salary of Brazilian municipal school systems in 2008 and 2011, according to their status as compliers, not impinged and non-compliers

	Treated units according to observed years of compliance to the law										Comparison units				TOTAL
	at least 2 years					1 year of compliance to the law				at least one year - total	non-compliers	non-impinged	others [1]	subtotal [2]	
	2009/ 2010/ 2011	2009/ 2010	2009/ 2011	2010/ 2011	total	2009	2010	2011	total						
# units	124	33	21	43	221	32	39	38	109	330	129	263	95	487	904
average amount of salary increase (2008-2011)	514,53	370,56	450,28	623,98	506,62	312,97	441,98	630,64	455,07	490,53	327,40	384,99	315,65	353,46	414,84
s.d	18,79	24,30	27,81	40,58	14,62	25,37	30,63	38,02	22,89	12,47	17,25	17,50	24,89	11,49	8,10
average 2008 salary	896,42	908,13	821,64	839,44	881,41	898,29	782,66	790,21	827,89	864,7085	813,09	1.423,25	1.141,37	1.181,98	1.037,36
s.d	12,80	23,88	25,35	25,17	9,80	28,55	32,27	29,60	19,29	9,14215	22,97	20,29	15,96	16,78	10,49
average 2011 salary	1.410,96	1.278,70	1.271,92	1.463,42	1.388,03	1.211,26	1.224,64	1.420,85	1.282,95	1.355,24	1.140,49	1.808,24	1.457,02	1.535,43	1.452,20
s.d	17,99	21,86	18,66	47,26	14,33	35,95	14,10	34,82	19,46	12,64	23,04	23,20	30,16	20,05	11,91
average salary variation (2008-2011)	60,3%	44,4%	57,3%	77,9%	60,8%	38,7%	63,0%	91,6%	63,2%	61,5%	46,1%	28,4%	28,3%	33,7%	46,3%
s.d	2,9%	4,3%	5,2%	5,1%	2,2%	4,6%	7,0%	11,8%	5,2%	2,2%	3,3%	1,4%	2,2%	1,3%	1,2%
average salary variation rate (2008-2009)	25,7%	20,2%	24,8%	7,1%	21,2%	20,6%	10,3%	14,5%	15,5%	19,4%	9,5%	8,3%	4,5%	7,9%	12,7%
s.d	2,4%	2,8%	4,4%	1,5%	1,6%	4,3%	2,1%	4,4%	2,2%	1,3%	1,0%	0,5%	0,8%	0,4%	0,6%

Notes: (1) Others here represents municipal school systems that were not impinged by the law enactment in 2008, but become impinged after national minimum salary adjustment in subsequent years and eventually becomes non-compliers; (2) Subtotal represents the aggregation of non-compliers, non-impinged and others. Every estimates consider complex sample design.

In characterizing treatment we look at each teacher sub-career (with and without college degree) of each school system and consider as treated units the school systems where at least one of the sub-careers had its salary raised supposedly because of the minimum salary introduction.

As already explained, minimum teacher salary has been adjusted every year since its introduction. Therefore, it is possible, what is actually common, that one school system comply with the law one certain year and in the subsequent, after the minimum salary has been adjusted, the same municipality do not comply with the law. For instance, of the compliers in 2009, about one quarter do not comply with the minimum salary in 2010, and of compliers in 2010, almost 30% do not comply in 2011. Therefore the law is not binding and compliance is not perennial either.

Table 3 summarize the average teacher beginning base salary in Brazilian municipal school systems in 2008 and 2011 as well as the average salary variation and the average amount of increase of teacher base salary in the period according to school system status based on been impinged by the law enactment and compliance with the law. Interestingly, the average salary variation rate and the average amount of salary increase among compliers, independently of how many years municipal school systems comply with the law in the period between 2008 and 2011, are very similar among the groups of compliers. Considering this similar pattern of salary increase among compliers, our treatment group is formed by all compliers when assessing the impact of salaries on teachers move in 2011, and just compliers in 2009 and/or 2010 when assessing the impact on teachers move in 2010. Comparison groups are formed by all other units. We decided to leave the role of selecting controls to our selection on observables model.

3.4) Tests on the confidence of our survey

According to *PNAD* 2011, the average total salary of teachers without college degree employed by Brazilian municipal school systems was R$1,393.77 for a workload of 40h/week. Meanwhile, the average total salary for those who have a college degree was R$2,211.21. Taking the aggregate, we see that 2011 total salaries were on average R$2,171.41. In fact, according to *PNAD*, the average teacher total salary raised 59.3% between 2008 and 2011, 6.2 p.p. higher than the raise of teacher salary in the private sector. These figures show that our survey perhaps underestimates teacher salary variation. Our survey estimate (46.3%) indicates a 13 p.p. lesser salary variation than the self-reported salaries in *PNAD* (see Table 3). One possibility that we need to investigate is that total salaries grew faster than base salary. We plan to do that in the next version of the paper, using *RAIS* and *SIOPE* data.

An alternative explanation is that the weights used in *PNAD* are not adequate to accurately recover teacher salaries and, then, introduce bias in the estimates with different directions in different versions of the household survey. *PNAD* estimates for teacher salary variation in the period vary strongly across states, from -6.5%, in Amazonas, to 128.2%, in Roraima. Meanwhile the estimates recovered by our survey reveal a milder variation across states, from 26,1%, in São Paulo, to 92,6%, in Pernambuco. It is particularly odd that the average salary variation of municipal teachers in the state of São Paulo reaches 106.4% in *PNAD*, about 80 p.p. higher than ours. One last possible explanation to this divergence is that respondents in *PNAD* do inform wrong workloads or consider effective workload inside class instead of real workloads, i.e. defined in labor contracts. We know that there had been occurring changes in teachers' workloads since 2008. In the next version of the paper we will present an analysis on those workload changes and intend to better understand the inconsistencies between our data and *PNAD*.

4) Methodology

Unfortunately we do not have information about each teacher salary. Then we could not link salary to teachers' decision of staying in the job and in the profession. Therefore we had to work with municipal beginning base salaries and had to focus on aggregate movements at the level of municipal school system. With the available information we were able to investigate if school systems which experienced higher teacher salary increases have suffered less with teachers exit and if these school systems have attracted new teachers or teachers from the private sector.

It is difficult to disentangle the impact of the salary hike from effects of other kind of policy. A simple estimator based on the difference in means between treated and untreated groups would be tainted. The salary of teachers should be endogenous with respect to other policies of the school system and

decided simultaneously with other policies. Besides, salary definition happens simultaneously with individuals' decision concerning teacher profession. Hence, in order to deal with the problems associated with endogeneity and simultaneity, the identification of an exogenous source of variation in teacher salaries is required to identify a causal relation. We explore the introduction of the national minimum teacher salary, by federal law, as exogenous variation in teacher's pay.

In the present context, as the introduction of the minimum teacher salary was decided at the federal level and municipal leaders largely did not participate in the decision process, we argue that the salary hikes induced by the minimum salary introduction work as an exogenous source of salary variation. Thus it is possible to exploit this fact to identify the effect of teacher pay on teachers' decision about leaving job or the profession and entries. Besides it can be investigate if higher salaries attract teachers from other school systems, particularly from private sector (Menezes-Filho and Pazello, 2007).

However, as shown in the previous section, due to institutional characteristics of Brazilian school systems and the absence of explicit penalties for disobeying the minimum salary imposition or the existence of judicial appeals against the law, the assignment to treatment is not deterministic. Ultimately, to observe the law is a decision of the local administrators. Thus, not all municipal school system assigned to treatment underwent it. In other words, once assigned to treatment, municipalities self-select themselves to the treatment.

Such a decision can be greatly influenced by observable and unobservable characteristics of the municipality and its school system. Considering what Brazilian Constitution determines, municipal teachers' salaries should be explained by municipal revenues; transfers received from *FUNDEB*, which are based on the number of enrollees in each municipal school system; and the number of teachers employed by the school system. On the other hand, salaries can also be explained by numerous other observed characteristics and even ones that are unobservable by the analyst, as the relative importance given to education by the current ruler of the municipality, or even by his/her predecessors, and the influence and bargaining power of local teachers' unions, just to mention two examples. The important role played by unobserved and unobservable variables in explaining salary differences and treatment status give us support in applying Difference-in-Differences (DID) methods in the estimation of the impacts of salary raises on pupils' performance.

Furthermore, to reduce self-selection bias we rely also on a selection on observables method. The use of an estimated propensity score helps in limiting bias associated to observed characteristics that are correlated to the treatment and to the potential outcome of interest at the same time. According to DuGoff et al (2014), more than just essential for addressing confounding in observational studies, only propensity score methods combined with survey weights may lead to results generalizable to the survey target population when we have complex sample design. Not incorporating the survey weights would compromises external validity, such that outcomes would not be generalized to national figure. That paper clarifies the appropriate inferences for different propensity score methods and suggests guidelines for selecting an appropriate propensity score method based on a researcher's goal. Aiming to obtain consistent estimates, after estimating the propensity score using the nearest neighbor method[32], we calculate the ATT weights, according to Abadie (2005).

We follow the recommendation of DuGoff et al (2014) and include the survey weight as a predictor in the probit model chosen for propensity score estimation. As put by the authors, the survey weight may capture relevant factors, and perhaps variables related to the units probability of responding to the survey and to undergo treatment. Furthermore, we agree that the propensity score model does not need to be survey-weighted, as we are not interested in generalizing the propensity score model to the population. However, in the outcome model we need to incorporate survey weights as we aim to estimate

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[32] Alternatively we use kernel matching as a robustness check. Results remained qualitatively the same. Asymptotically, all different matching techniques produce the same estimate because in large samples they all compare only the exact matches. However, in finite samples, they differ because of the way they construct counterfactual and choose the weights. There is a trade-off between the bias and variance of matching estimators. The nearest-neighbor matching minimizes the bias, as it chooses only the closest comparison group observation and assigns all the weight to it in constructing the counterfactual. In contrast, kernel matching assigns positive weights to several control units, what implies a greater bias. At the same time, kernel matching reduces the variance of the estimate.

Population Average Treatment Effect on the Treated (PATT). The propensity score weights and survey weights are multiplied to form a new weight for the outcome regression. In that way, incorporating the complex survey, we estimate the effect of increasing teacher salary on the entire treated population.

The potential outcomes are determined by a set of covariates in addition to the treatment as in the following model:

$$Y_{it} = \alpha + \beta\, d_i + \delta\, \mathbb{I}\{t = 2011\} + \gamma\mathbb{I}\{t = 2011\} \cdot d_i + \rho'X_{it} + \varepsilon_{it}$$

where the dependent variable, Y_{it}, is a proportion of teachers of the municipal school system i in year t is explained by a constant (α); the treatment group fixed effect captured by the coefficient of an indicator variable which assumes value 1 if the municipal school system were treated and 0 otherwise, d_i; the common effect of the passage of time, represented by δ; the parameter of interest, γ, representing the impact of the treatment, the abnormal teacher salary hike, on the dependent variable; and a vector of covariates X that helps to explain the dependent variable. The model becomes complete with the error term, ε_{it}. The aforementioned municipal school systems teachers' proportions we analyze are: (*i*) the proportion of teachers who stayed in the job of previous year; (*ii*) the proportion of teachers who exit the job of previous year; (*iii*) the proportion of teachers who entered into the profession; (iv) the proportion of teachers who were recruited in the year of reference; (*v*) the proportion of teachers who exit private school and entered municipal school system; and (*vi*) the proportion of teachers who have college degree.

In the OLS regression we weighted each observation using the following weights:

$\text{weight}_i = \text{iptw}_i \cdot \text{sample\_weight}_i$

where: $\text{iptw}_i = d_i + \left[\dfrac{(1-d_i)\widehat{p_i}}{1-\widehat{p_i}}\right]$ and $\widehat{p_i}$ is the estimated propensity score of being treated.

The key identifying assumption is that γ would be zero in the absence of treatment after matching on the propensity score ($E[\varepsilon_{it}|\mathbb{I}\{t = 1\} \cdot d_{it}, p_i] = 0$).

We get OLS estimates for the constant term, α, corresponding to the average performance of the comparison group at baseline; for β, representing time invariant differences between treatment and comparison groups; for δ, summarizing the way both groups are influenced by time; for γ, the average treatment effect (parameter of interest); and for ρ', the parameter vector associated with changes in covariates.

5) Explaining differences in teacher salary and in compliance with the law

How are differences in teacher base salary amongst Brazilian municipal school systems and characteristics of municipalities and municipal school systems related? We test a wide spectrum of covariates. The region and, more specifically, the state where the municipal school system is located is the most important explanatory variable[33] for teacher beginning base salary differences in 2008, before the introduction of the national minimum teacher salary, and respond to 33.1% of the salary variability. Socioeconomic characteristics of the municipality, such as its population, per capita GDP, average individual income, and adult illiteracy rate are also important and explain a bit more than 15.7% of the variability. Those variables, when are put together, explain about 35.4% of the variability in municipal teacher beginning base salary in 2008.

After including school system characteristics, such as the proportion of budget allocated to education, its school infrastructure and facilities, and teachers characteristics, the explained part of the variability in teacher salaries amongst municipal school systems in 2008 increase only to 41.1%. Finally, when pupils' socioeconomic characteristics are included, more 5 percentage points (p.p.) of the variability are explained. Thus, observable characteristics are responsible for about 46.2% of the variability in the level of teacher beginning base salary amongst municipal school systems.

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[33] Here we refer to explanatory variable in statistics and econometrics sense. In Econometrics, we call explanatory variable(s) the variable(s) that is(are) in the right side of a certain equation model. When we say that a variable explain part of the variation or variability of another variable (dependent variable in the model) we mean that the former variable accounts for the variation (dispersion) of a given data set. We are not inferring any causal relation here.

Do those determinants change after the introduction of an exogenous source of salary variation, i.e., after the introduction of the national minimum teacher salary? And do the same determinants explain selection to treatment? When we substitute salaries of 2008 for salaries of 2011 in the OLS regressions, we see a decrease in the proportion of salary variability explained by observables. The variability verified in teacher beginning base salary that is explained by the state where the school system is located reduces year by year since the introduction of the national minimum salary. It falls from 33.1% in 2008 to 26.5% in 2011. Moreover, the contribution of socioeconomic characteristics of municipalities to the variability in salaries falls from 15.7% to 7.6% in 2011, and those two groups of covariates now explain just 28% of the variability amongst Brazilian municipal school systems, 7.4 p.p. less than in 2008. All the observable covariates now explain just 37.4% of the variability in salaries. Therefore the role of unobserved characteristics grew about 9 p.p. in 3 years, from 53.8% in 2008 to 62.6% of the variability in 2011.

Considering a linear probability model, all covariates, including tax revenues variation in the period and the political party of the mayor, explain 34.7% of the treatment status or the probability of being treated or complying with the law. Therefore, unobservable/unobserved variables have an even more crucial role in selecting units into treatment than in explaining salary differences amongst Brazilian municipal school systems.

Trying to unveil at least part of the contribution of unobserved variables in explaining selection into treatment, we further add personal characteristics of Municipal Department of Education heads as explaining covariates. The source of those characteristics is another survey carried out by *INEP* with the partnership of *UNDIME* and UNESCO in 2010, *Perfil dos Dirigentes Municipais de Educação*. When we merge our database with that other base, part of the original sample vanished, reducing the number of municipalities to less than 400. The explained part of the linear probability with this restricted sample raises to 50.3% without characteristics of the head of the municipal departments and to 53.5% after introducing those characteristics into the model. Thus some personal characteristics of the head of the Municipal Department of Education, such as gender, schooling, remuneration, being a politician (whether from a political party that supports the mayor or from an opposition party), being a former school principal, being from any docent career (whether of the same municipality, other municipality, the state system or private school) and being or not a full-time head of department, increase the explained part of the treatment status among municipal school systems by only a little more than 3 p.p..

The important role played by unobserved and unobservable variables in explaining salary differences and compliance with the national minimum salary gives us support in applying Difference-in-Differences methods in the estimation of the impacts of salary raises on teachers move.

6) Estimating the effects of salary on teacher retention

The ultimate objective of the imposition of a national teacher minimum salary was to enhance the quality of the basic education provided by Brazilian public sector. The immediate purpose of the policy was to attract and avoid drop outs of higher ability teachers.

Tables 4 and 5 show that the estimates obtained with DID regressions are not statistically different from zero, considering a statistical significance of 5%, for every teacher proportion we examined. Just for the proportion of teachers who come from private schools raising salaries seems to have a positive effect at 10% of significance, but the result is not robust to other specifications of the selection on observables. Therefore, apparently, salary hikes were not enough to change teachers' exits and transfers to municipal school systems.

Table 4 Investigating the impact of salary raise on teacher retention, drop outs and recruitment - 2009

VARIABLES	(1) Stayers	(2) Stayers Full	(3) Drop outs	(4) Drop outs Full	(5) New comers	(6) New comers Full	(7) Freshers	(8) Freshers Full	(9) Former private	(10) Former private Full	(11) College graduated	(12) College graduated Full
ATT	0.00368	-0.00593	-0.0104	-0.00653	-0.00368	0.00593	-0.00233	0.00717	0.00125	0.000371	-0.00721	-0.0250
	(0.816)	(0.682)	(0.491)	(0.650)	(0.816)	(0.682)	(0.864)	(0.577)	(0.657)	(0.881)	(0.815)	(0.214)
treated	0.00756	0.00929	-0.00311	-0.00291	-0.00756	-0.00929	-0.00354	-0.00849	-0.00105	-0.000453	-0.107***	0.0177
	(0.495)	(0.377)	(0.790)	(0.792)	(0.495)	(0.377)	(0.716)	(0.384)	(0.572)	(0.785)	(2.86e-05)	(0.274)
Time	-0.0273***	-0.0292***	0.0415***	0.0417***	0.0273***	0.0292***	-0.0640***	-0.0616***	0.00122	0.000942	0.0238	0.0252**
	(0.000486)	(2.56e-05)	(3.43e-08)	(1.25e-10)	(0.000486)	(2.56e-05)	(0)	(0)	(0.367)	(0.440)	(0.207)	(0.0135)
Constant	0.784***	0.626***	0.181***	0.296*	0.216***	0.374**	0.194***	0.486***	0.0107***	0.0225	0.611***	-0.127
	(0)	(7.63e-05)	(0)	(0.0718)	(0)	(0.0179)	(0)	(0.00171)	(0)	(0.299)	(0)	(0.531)
Observations	1,640	1,544	1,640	1,544	1,640	1,544	1,640	1,544	1,640	1,544	1,640	1,544
R-squared	0.013	0.239	0.031	0.264	0.013	0.239	0.085	0.257	0.001	0.203	0.035	0.651
Sample weights	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Municipality characteristics		YES		YES		YES		YES		YES		YES
School system chracteristics		YES		YES		YES		YES		YES		YES
School Infrastructure		YES		YES		YES		YES		YES		YES
Pupils' characteristics		YES		YES		YES		YES		YES		YES
Political covariates		YES		YES		YES		YES		YES		YES

pval in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Sample weights considering complex sample

Table 5 Investigating the impact of salary raise on teacher retention, drop outs and recruitment - 2010

VARIABLES	(1) Stayers	(2) Stayers Full	(3) Drop outs	(4) Drop outs Full	(5) New comers	(6) New comers Full	(7) Freshers	(8) Freshers Full	(9) Former private	(10) Former private Full	(11) College graduated	(12) College graduated Full
ATT	-0.00237	-0.00652	-0.00480	-0.00204	0.00237	0.00652	0.000300	0.00431	0.00365	0.00519*	0.00552	0.0170
	(0.905)	(0.687)	(0.830)	(0.903)	(0.905)	(0.687)	(0.986)	(0.774)	(0.250)	(0.0677)	(0.922)	(0.529)
treated	0.0158	0.00888	-0.0168	0.00123	-0.0158	-0.00888	-0.00703	-0.0101	-0.00283	0.000529	-0.133***	-0.00381
	(0.310)	(0.539)	(0.225)	(0.926)	(0.310)	(0.539)	(0.643)	(0.480)	(0.107)	(0.773)	(0.00117)	(0.864)
Time	0.0369***	0.0304**	0.0234*	0.0257*	-0.0369***	-0.0304**	-0.128***	-0.121***	0.00189	-0.000579	0.0559**	0.0288
	(0.000842)	(0.0115)	(0.0514)	(0.0525)	(0.000842)	(0.0115)	(0)	(0)	(0.294)	(0.804)	(0.0370)	(0.195)
Constant	0.789***	0.318**	0.175***	0.596***	0.211***	0.682***	0.191***	0.493***	0.00957***	0.0160	0.595***	-0.315
	(0)	(0.0407)	(0)	(0.000208)	(0)	(1.34e-05)	(0)	(0.000855)	(0)	(0.382)	(0)	(0.200)
Observations	832	789	832	789	832	789	832	789	832	789	832	789
R-squared	0.032	0.317	0.016	0.334	0.032	0.317	0.334	0.490	0.010	0.279	0.058	0.701
Weights	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Municipality characteristics		YES		YES		YES		YES		YES		YES
School system chracteristics		YES		YES		YES		YES		YES		YES
School Infrastructure		YES		YES		YES		YES		YES		YES
Pupils' characteristics		YES		YES		YES		YES		YES		YES
Political covariates		YES		YES		YES		YES		YES		YES

pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1

7) Concluding remarks

Brazilian federal government introduced a national minimum teacher base salary to be observed in every public school system from January 2009. This paper contributes to a better understanding of the policy and its effects. The first objective of this work was to investigate the compliance of municipal school system with the national minimum teacher salary and the effects of the law on teacher salary. We carried out a survey based on a representative sample of municipal department of education to get precise teacher base salaries of each municipal school system. The estimates obtained through our survey reveals that the institution of the minimum salary moved teacher salaries of just part of the municipalities impinged by the law.

Our survey reveals that there are a high proportion of municipalities that do not comply with the law, a proportion similar to the proportion of municipalities that, according to *CGU*, do not observe the obligation of spending at least 60% of *FUNDEB* with teacher pay. According to our estimates, the role of observable characteristics in explaining the compliance with the law is very limited, even when we incorporate some characteristics of the head of the municipal department of education, what leaves considerable place for unobserved characteristics in explaining teacher salaries and the compliance with the law. Therefore, any attempt to assess the impacts of the exogenous salary variation brought by the introduction of the minimum salary, should rely on any method that control for unobservables.

Some inconsistencies found between our estimates and estimates obtained with *PNAD* should be carefully investigated. We have to analyze the consistency of our data on teacher base salary considering information available in RAIS and SIOPE, what we will do next.

The main objective of the policy seems to be to enhance teacher quality in public schools through better remuneration. Since the first year of the policy, municipal school systems which complied with the law raised salaries sharper than non-impinged ones and non-compliers. Thus we tried to answer if compliers perform better than non-compliers and non-impinged municipal school systems in retaining and attracting teachers. However estimates based on DID and selection on observables show null effects of the policy on teachers move in the first two years, 2009 and 2010. As a next step, we will extend our analysis to 2011 and 2012 and we will enhance our identification considering salary increases relative to nearby municipalities.

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