HIGHER SALARIES, MORE TEACHING, BETTER PERFORMANCE?

The effects of the introduction of the minimum salary for teachers in Brazil

Geraldo Andrade da Silva Filho - INEP

Cristine Campos de Xavier Pinto (Advisor)

São Paulo School of Economics - FGV

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Outline

Motivation - Literature findings

- Teacher quality is one of the most important determinants of pupils' outcomes
  - Rockoff (2004); Rivkin et al (2005); Aaronson et al (2007); Chetty, Friedman and Rockoff (2013)
- There is no consensus on how public school systems could improve teacher quality
- How to improve teachers' quality?
  - Offering higher salaries?
    - Gift-exchange theory (Fehr et al, 2009)
    - Adverse selection: Mansky (1987); Delfgaawn and Dur (2007); and Behrman, Tincani, Todd and Wolpin (forthcoming)
    - Experiment shows that higher salaries attract better applicants (IQ, personality and public service motivation): Dal Bó, Finan and Rossi (2013)

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Motivation - Literature findings (cont)

- Positive effect of salary based on performance on educational outcomes in developing countries: Lavy (2002 and 2009) in Israel; Glewwe et al. (2010) in Kenya; Muralidharan (2012) and Muralidharan and Sundararaman (2011) in India; Rau and Contreras (2011) in Chile; and Scorzafave and Oshiro (2015) in Brazil
- Salaries explain part of the retention/drop out of teachers and attraction to teaching: Chevalier et al (2007), Dolton and van der Klaauw (1995 e 1999), and Dolton and Mavromaras (1994) for the United Kindom; Stinebrickner (1998), Brewer (1996), Ehrenberg and Brewer (1994), Rees (1991), Mont and Rees (1996), Murnane and Olsen (1989 e 1990), Theobald (1990), and Theobald and Gritz (1996), Hendricks (2014) for the United States; and Falch (2011) for Norway

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Motivation - Literature findings (cont)

- Effects of unconditional salary increases on proficiency is controversial
  - Loeb and Page (2000): 10% of relative salary raise would reduce high school dropout rates by between 3% and 6% after 10 years
  - Hanushek et al (1999): exploring district salary differences in Texas, find small effect on teachers move, some effect on performance in teachers' certification, but no effect on pupils' learning
  - Pugatch and Schroeder (2014): geographic discontinuity in Gambian salary policy (salary premium of 30-40% to primary school teachers located in remote areas) - increased the proportion of certified teachers in remote schools, but found no effects of the policy on average student performance
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- Metzler and Woessmann (2012): one of the few attributes of teachers that is correlated with the performance of students are their academic skills (performance on standardized tests)
  - Guimarães et al (2013) and Fernandes (2014) corroborate for the Brazilian context.
- Higher salary attracts better high school students to profession related courses: Leigh (2012)
  - 1% rise in salary boosts the average aptitude of potentially future teachers by 0.6 percentile ranks.
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- First chapter:
  - to assess the impact of the introduction of the minimum salary on teachers' salaries and
  - to assess the impact of teachers' salaries hikes on teachers move
- Second chapter: To assess the impact of higher teachers' salary on pupils' performance
- Third chapter: Do unconditional higher salaries schemes yield better teachers?
  - Changing teachers' behavior - devoting more time to teaching
  - Recruiting/Retaining more effective teachers - teacher quality proxied by the score in ENADE
  - Attracting better students into College courses related to teaching profession - student quality proxied by the score in Enem

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Institutional Background
Teacher salary of municipal school systems

- Federal funding scheme (imposition of resource-expenditure linkage and states Fundeb fund)
- Brazilian public education system: decentralized nature with organizational autonomy
- Municipal teachers' salaries as a decision of the municipality

Institutional Background
Structure of Teacher Salary

- Several different workloads
- Typically, teacher salary consists of two parts:
  - base salary: established according to the teacher's workload
  - an additional part: based on teacher's seniority and graduate degrees teacher has
    - Generally these rewards are calculated as a percentage of the base salary
  - *ceteris paribus*, if the base salary grows, all the schedule of teacher salary increases in the same proportion

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National Minimum Salary for Teachers

- Federal Law No.11,738, of July 16th, 2008: institution of a national minimum salary for teachers
- R$ 950 monthly for a 40h per week base-salary (2013: R$1,567/month)
  - January 2009: school systems which were paying less than the minimum must raise salaries, filling at least 2/3 of the gap to the minimum salary
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Dataset

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- Variable of interest
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- Dependent variables
  - Pupils' test scores and characteristics: *Prova Brasil* 2007/2009/2011
    - test scores in Mathematics and Portuguese of 5th grade pupils
  - proportion of full time teachers: self reported in *Prova Brasil* questionnaires
  - teachers move: teachers panel (School Census 2007-2011)
  - average teachers test scores in Enade 2005, 2008, 2011
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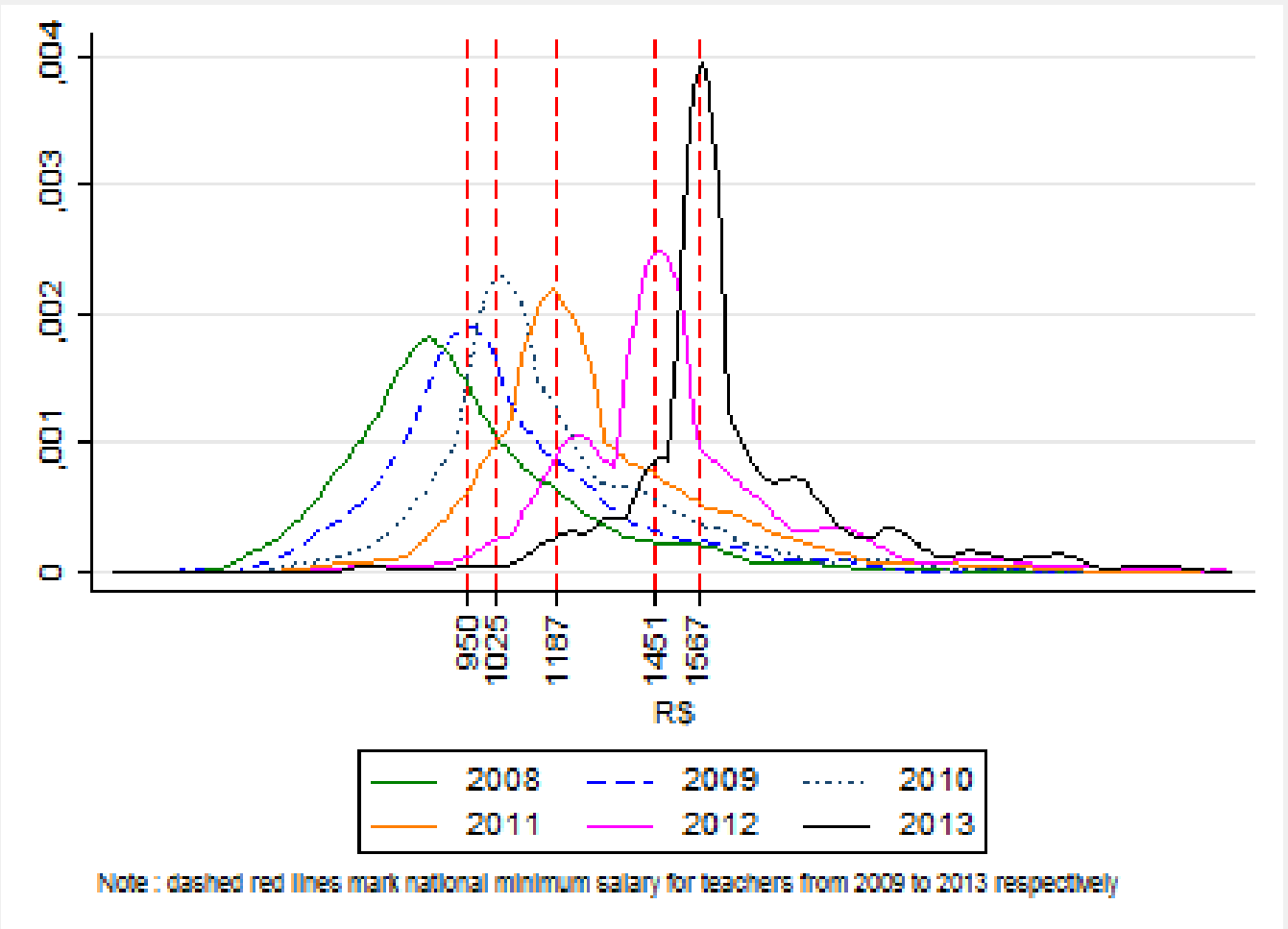
Figure: Minimum base salary densities

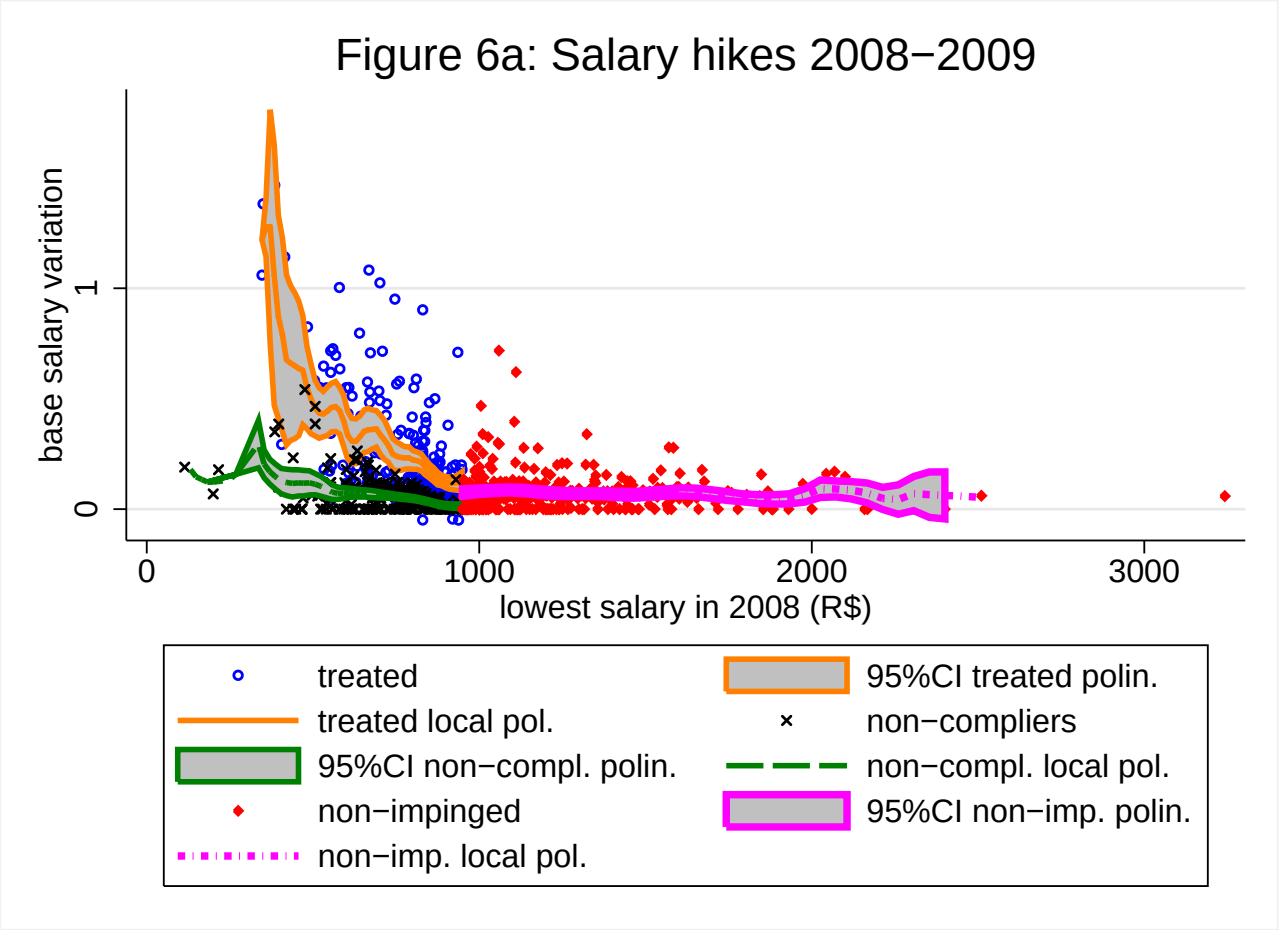


Salaries and Economic Indicators, Brazil (2008-2013)

Year	Economy minimum salary		National minimum base salary for teachers		Municipal teachers' base salary			Total Salaries (RAIS)								
								municipal teachers			private teachers' total salary			individuals with college diploma		
	R$	Var	R$	Var	Brazil	Treated	Untreated	Brazil	Treated	Untreated	Brazil	Treated	Untreated	Brazil	Treated	Untreated
2008	415.00				1,037.35	904.66	1,517.98	1,469.51	1,146.47	1,989.80	1,586.34	1,106.38	1,940.28	2,419.46	2,147.68	2,990.18
2009	465.00	12.0%	950.00													
2010	510.00	9.7%	1,024.67	7.9%												
2011	545.00	6.9%	1,187.14	15.9%												
2012	622.00	14.1%	1,450.75	22.2%												
2013	678.00	9.0%	1,567.00	8.0%	1,822.82	1,829.87	2,278.64	2,698.35	2,395.15	3,126.35	2,440.99	1,859.37	2,946.40	3,388.28	3,253.39	3,755.35
Variation (2008-2013)		63.4%		64.9%	75.7%	102.3%	50.1%	83.6%	108.9%	57.1%	53.9%	68.1%	51.9%	40.0%	51.5%	25.6%
Annual variation		10.3%		13.3%	11.9%	15.1%	8.5%	12.9%	15.9%	9.5%	9.0%	10.9%	8.7%	7.0%	8.7%	4.7%
Average inflation rate per year															5.7%	

Salary Increases 2008-2009

Figure: Salary Increases 2008-2009



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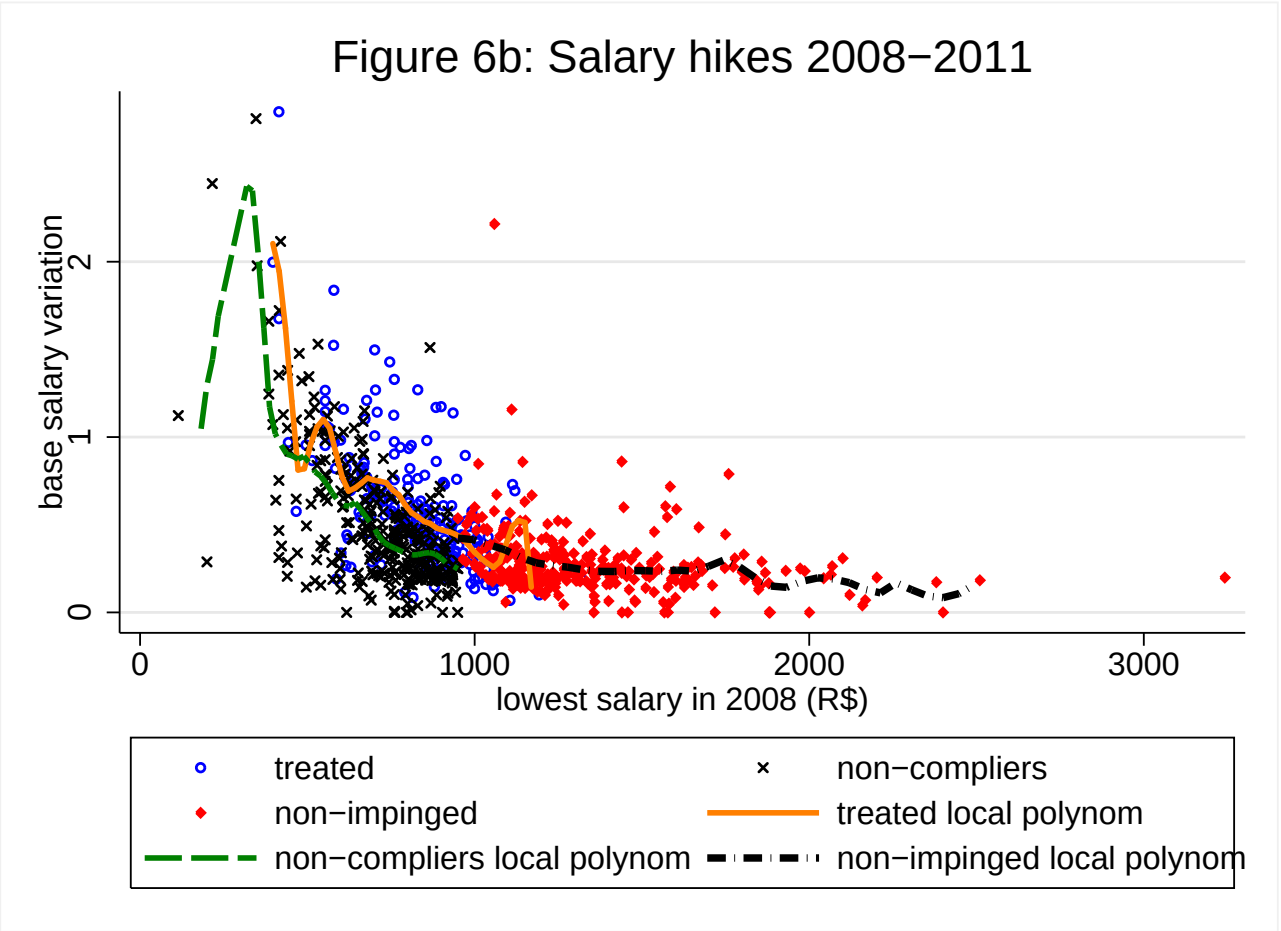
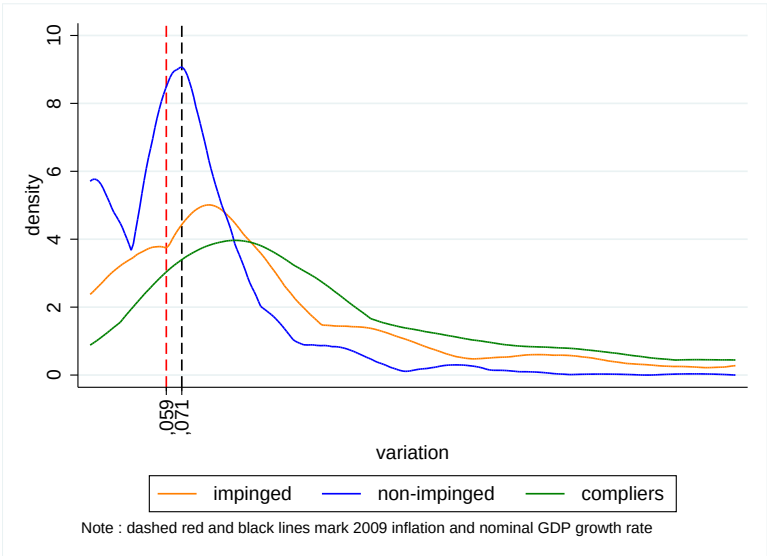


Figure: Characterizing Treatment



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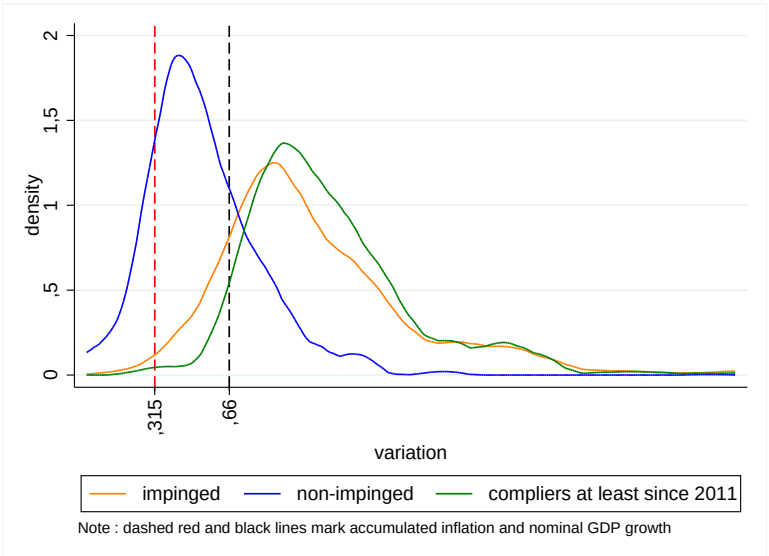

(b) 2008-2013

Characterizing Treatment
First year of the policy (2009)

- Treatment: increase salaries in order to comply with the law

- Treated
  - municipalities which comply with the law in 2009
  - average base-salary variation: R$ 861.35→ R$ 1,044.76 (23.8%)
- Control
  - not impinged by the law
  - average base-salary variation: R$ 1,344.68 → R$ 1,438.02 (7.1%)
- Average salary increase:
  - 16.7 p.p. (or R$ 90.07) higher in treated units

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  - average base-salary variation: R$ 1,344.68 → R$ 1,438.02 (7.1%)
- Average salary increase:
  - 16.7 p.p. (or R$ 90.07) higher in treated units

Characterizing Treatment
First year of the policy (2009)

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Characterizing Treatment
After three years (2011)

- Treated
  - municipalities which comply with the law at least one year during 2009-2011 period
  - average base-salary variation: R$ 905.32 $\rightarrow$ R$ 1,417.08 (61.0%)
- Control
  - never impinged until 2011
  - average base-salary variation: R$ 1,419.43 $\rightarrow$ R$ 1,781.18 (27.0%)

- Average salary increase:
  - on average 34 p.p. (or R$ 149.91) more among treated than untreated

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After five years (2013)

- Treated
  - municipalities which comply with the law at least one year during 2009-2011 period
  - average base-salary variation: R$ 905.32 → R$ 1,831.15 (108.4%)
  - average total salary variation: R$ 1,146.47→ R$ 2,395.15 (108.9%)
  - private teachers salary var.: R$ 1,106.38→ R$ 1,859.37 (68.1%)
- Control
  - never impinged until 2013
  - average base-salary variation: R$ 1,419.43 → R$ 2,108.30 (51.2%)
  - average total salary variation: R$ 1,989.80→ R$ 3,126.35 (57.1%)
  - private teachers salary var.: R$ 1,940.28→ R$ 2,946.40 (51.9%)
- Average salary increase:
  - base salary: on average 57.2 p.p. (or R$ 236.96) more among treated than untreated
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Characterizing Treatment

Figure: Groups of Treatment and Control

	Treated		Untreated
	main	alternative	
1st year of the policy (2007-2009)	compliers in 2009 n = 276 units	compliers in 2009 or in 2010 n = 371 units	not impinged by the law in 2008 n = 395 units
3rd year of the policy (2007-2011)	compliers since 2009, 2010 or 2011 n = 221 units		not impinged by the law in 2008, 2009 and 2010 n = 294 units
5th year of the policy (2007-2013)	compliers since 2009, 2010 or 2011 n = 221 units		not impinged by the law in 2008, 2009, 2010, 2011 and 2012 n = 202 units

Salary Variation 2008-2013

Figure: Salary Variation 2008-2013 x Instrument

	(1)	(2)	(3)	(4)
Distance	0,0009186 ***	0,0009138 ***	0,0013221 ***	0,0004326 ***
Squared distance			0,0000008 ***	0,0000039 ***
Constant	0,8654723 ***	1,036025 ***	0,7707572 ***	0,7103264 ***
Municipality characteristics and fiscal covariates		Yes		
# Obs	906	904	906	906
R^2	0,3448	0,423	0,4672	0,5089
F	(1, 904) = 188.28	(34, 869) = 13.65	(2, 903) = 157.67	(2, 903) = 256.28
Prob > F	0,0000	0,0000	0,0000	0,0000

- The instrument is the distance from the 2009 national minimum salary to 2008 municipal base salary
- In model (3) the squared distance is introduced into the equation; in model (4) is included the squared distance only for positive values, i.e., only for municipalities impinged by the law enactment

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Figure: Aggregate municipal teachers proportion

Table 1 Aggregate municipal teachers' proportions according to their status as stayers, droppers, entrants, fresh, former private teacher and College graduated

Teachers proportions	Year	Treated			Untreated			Dif-in-Dif
		mean	[95% Conf.	Interval]	mean	[95% Conf.	Interval]	
Stayers	2011	83,0%	81,5%	84,4%	82,4%	81,2%	83,7%	
	2008	79,7%	77,8%	81,5%	78,3%	76,5%	80,2%	
	Diff (p.p.)	3,3			4,1			-0,8
Droppers	2011	15,5%	14,2%	16,7%	16,8%	15,4%	18,2%	
	2008	16,7%	15,3%	18,1%	17,0%	15,3%	18,7%	
	Diff (p.p.)	-1,2			-0,2			-1,1
Entrants	2011	17,0%	15,6%	18,5%	17,6%	16,3%	18,8%	
	2008	20,3%	18,5%	22,2%	21,7%	19,8%	23,5%	
	Diff (p.p.)	-3,3			-4,1			0,8
Fresh	2011	5,6%	4,9%	6,3%	5,8%	5,0%	6,6%	
	2008	20,2%	18,2%	22,1%	21,6%	19,8%	23,5%	
	Diff (p.p.)	-14,6			-15,8			1,3
Former private	2011	0,9%	0,6%	1,2%	1,1%	0,8%	1,3%	
	2008	0,8%	0,6%	1,0%	1,5%	1,2%	1,8%	
	Diff (p.p.)	0,1			-0,4			0,6
College graduated	2011	64,9%	61,8%	68,0%	76,7%	73,4%	80,0%	
	2008	51,6%	48,5%	54,6%	65,7%	61,4%	69,9%	
	Diff (p.p.)	13,4			11,1			2,3

DID+selection on observables+complex survey design

- Potential outcomes determined by the following model:

$$Y_{it} = \alpha + \beta d_i + \delta \mathrm{I}\{\mathrm{t} = \mathrm{T}_1\} + \tau \mathrm{I}\{\mathrm{t} = \mathrm{T}_1\} d_i + \rho' X_{it} + \varepsilon_{it} \qquad (1)$$

  where:
  - t=2007, 2009(2011/2013)
  - Y_{it}, the mean of the 5th graders' test score of municipality i;
  - β, that captures difference between groups that is fixed in time;
  - δ, the common effect of the passage of time;
  - the parameter of interest, τ, that captures the average effect of the treatment on the treated;
  - X_i: characteristics of the municipality/its school system/pupils/teachers

- **selection on observables**: propensity score weights (IPTW) and survey weights are multiplied to form a new weight for the regression
  - $weight_i = iptw_i \cdot sampleweight_i$; where $iptw_i = d_i + \left[\frac{(1-d_i)\hat{p}_i}{1-\hat{p}_i}\right]$

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Instrumental Variable in a model of first differences

$$\begin{cases} Y_{it} = \alpha + \beta X_{it} + \gamma D_{it} + \varepsilon_{it} \\ D_{it} = (\overline{D} - D_{i,2008}) + \beta X_{it} + \eta_{it} \end{cases} \tag{2}$$

- D_i is the variation of teachers' beginning salary of municipality i, instrumentalized by $Z_i = (\overline{D} - D_{i,2008})$, the distance between national minimum salary and municipality salary
- X_{it} is the vector of socioeconomic characteristics of pupils, teachers observed characteristics, and characteristics of the municipality i in period t
- γ captures the average effect of teachers' salary variation on pupils proficiency variation

Triple Differences

$$\hat{\gamma}_{DDD} = [(\overline{y}_{m_T,G_T,1} - \overline{y}_{m_T,G_T,0}) - (\overline{y}_{m_U,G_T,1} - \overline{y}_{m_U,G_T,0})] - \\ - [(\overline{y}_{m_T,G_U,1}) - \overline{y}_{m_T,G_U,0}) - (\overline{y}_{m_U,G_U,1} - \overline{y}_{m_U,G_U,0})] \quad (3)$$

- With this procedure we control for two kinds of potentially confounding trends:
  1. (i) changes in the performance of (potential future) teachers across municipalities unrelated to the policy and
  2. (ii) changes in performance of all teachers (students) living in the policy-change municipality, possibly due to other municipal policies or to the conditions of the offer of job positions (higher education vacancies) that affect every teacher's (student's) performance in Enade (Enem), or municipality-specific changes in the education or economy that affect every teacher's (student's) performance.

Results - Chapter 1

- impact of the introduction of the minimum salary on teachers' salaries
- impact of teachers' salaries hikes on teachers move

Explaining teacher salary variability across municipalities

- What do explain the variability of municipal teacher salary
  - The state where the municipal school system is located (36.6%)
  - School infrastructure and facilities (21.1%)
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Explaining compliance with the law

- Linear probability model:
  - All covariates explained only 44.1% of the probability of compliance in 2009 and
  - 47.1% of the probability of compliance in 2009 or 2010

  - Institutional characteristics of the school system explain: 15.3%
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Impact of salary increase on teachers' move

Figure: Aggregate municipal teachers move 2010

VARIABLES	(1) Stayers	(2) Stayers Full	(3) Stayers Full	(4) Exits	(5) Exits Full	(6) Exits Full	(7) Entrants	(8) Entrants Full	(9) Entrants Full	(10) Freshers	(11) Freshers Full	(12) Freshers Full	(13) Former private	(14) Former private Full	(15) Former private Full	(16) College graduated	(17) College graduated Full	(18) College graduated Full
ATT	0.00509	0.0115	-0.0186	0.00371	-0.000444	-0.0141	-0.00509	-0.0115	0.0186	-0.00313	-0.0123	-0.0156	0.00437*	0.00215	0.00137	0.00974	-0.0344	0.0202
	(0.0143)	(0.0142)	(0.0153)	(0.0143)	(0.0140)	(0.0161)	(0.0143)	(0.0142)	(0.0153)	(0.0123)	(0.0133)	(0.0139)	(0.00233)	(0.00253)	(0.00320)	(0.0393)	(0.0230)	(0.0290)
treat_2009_10	0.0125	-0.0186*	-0.0149	-0.0155	-0.00397	0.0179*	-0.0125	0.0186*	0.0149	-0.0101	0.0230**	0.0314***	-0.00539***	0.00116	-0.00276	-0.132***	0.00744	-0.0609***
	(0.0110)	(0.0111)	(0.01000)	(0.00947)	(0.0100)	(0.0107)	(0.0110)	(0.0111)	(0.01000)	(0.0111)	(0.0117)	(0.0105)	(0.00176)	(0.00187)	(0.00241)	(0.0256)	(0.0171)	(0.0176)
Time	0.0284***	0.0414	0.0781*	0.0142	-0.0563*	-0.0488	-0.0284***	-0.0414	-0.0781*	-0.127***	-0.132***	-0.212***	-0.00360**	0.00591	0.0112	0.0407	0.0401	-0.0312
	(0.0108)	(0.0394)	(0.0470)	(0.0105)	(0.0302)	(0.0470)	(0.0108)	(0.0394)	(0.0470)	(0.00915)	(0.0363)	(0.0532)	(0.00179)	(0.00590)	(0.0127)	(0.0271)	(0.0522)	(0.103)
Constant	0.783***	1.028***	-0.632	0.175***	0.0156	-0.752	0.217***	-0.0283	1.632	0.213***	0.194	1.989**	0.0142***	0.0221	-0.235	0.647***	0.766***	-0.0398
	(0.00827)	(0.216)	(1.057)	(0.00741)	(0.170)	(0.853)	(0.00827)	(0.216)	(1.057)	(0.00814)	(0.206)	(0.918)	(0.00139)	(0.0342)	(0.168)	(0.0180)	(0.282)	(1.300)
Observations	1,530	1,191	521	1,530	1,191	521	1,530	1,191	521	1,530	1,191	521	1,530	1,191	521	1,530	1,191	521
R-squared	0.022	0.292	0.778	0.009	0.293	0.726	0.022	0.292	0.778	0.275	0.462	0.804	0.012	0.245	0.676	0.060	0.758	0.934
Municipality characteristics		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES
School system characteristics		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES
School Infrastructure		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES
Pupils' characteristics		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES
Weights			IPTW			IPTW			IPTW			IPTW			IPTW			IPTW

Standard errors in parentheses

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

Impact of salary increase on teachers' move

Figure: Aggregate municipal teachers move 2011

VARIABLES	(1) Stayers	(2) Stayers Full	(3) Stayers Full	(4) Exits	(5) Exits Full	(6) Exits Full	(7) Entrants	(8) Entrants Full	(9) Entrants Full	(10) Freshers	(11) Freshers Full	(12) Freshers Full	(13) Former private	(14) Former private Full	(15) Former private Full	(16) College graduated	(17) College graduated Full	(18) College graduated Full
ATT	-0.00795	-0.00296	-0.00379	-0.0106	-0.0108	-0.0316*	0.00795	0.00296	0.00379	0.0127	-0.000578	-0.00970	0.00578**	0.00492	0.00533	0.0230	-0.0160	0.0170
	(0.0177)	(0.0167)	(0.0170)	(0.0157)	(0.0152)	(0.0171)	(0.0177)	(0.0167)	(0.0170)	(0.0155)	(0.0160)	(0.0154)	(0.00258)	(0.00330)	(0.00357)	(0.0470)	(0.0256)	(0.0268)
Treated	0.0132	-0.0247*	-0.0232**	-0.00287	0.0211*	0.0220**	-0.0132	0.0247*	0.0232**	-0.0147	0.0267*	0.0327***	-0.00716***	-0.00154	-0.00440*	-0.141***	-0.0208	-0.0471**
	(0.0135)	(0.0135)	(0.0107)	(0.0117)	(0.0117)	(0.0107)	(0.0135)	(0.0135)	(0.0107)	(0.0141)	(0.0144)	(0.0109)	(0.00206)	(0.00225)	(0.00243)	(0.0300)	(0.0205)	(0.0195)
Time	0.0409***	0.0382	0.103**	-0.00185	-0.0270	-0.102**	-0.0409***	-0.0382	-0.103**	-0.158***	-0.127***	-0.260***	-0.00449**	0.00223	-0.00513	0.111***	0.137**	0.0841
	(0.0119)	(0.0392)	(0.0493)	(0.0116)	(0.0349)	(0.0517)	(0.0119)	(0.0392)	(0.0493)	(0.00108)	(0.0395)	(0.0497)	(0.00215)	(0.00885)	(0.0115)	(0.0328)	(0.0661)	(0.0933)
Constant	0.783***	-0.314	-0.650	0.170***	1.703***	2.247**	0.217***	1.314***	1.650*	0.216***	1.479***	1.753*	0.0151***	-0.0956	0.0139	0.657***	2.557***	1.224
	(0.00956)	(0.437)	(0.888)	(0.00869)	(0.547)	(1.119)	(0.00956)	(0.437)	(0.888)	(0.000978)	(0.481)	(0.925)	(0.00166)	(0.0993)	(0.150)	(0.0219)	(0.713)	(1.225)
Observations	1,030	828	540	1,030	828	540	1,030	828	540	1,030	828	540	1,030	828	540	1,030	828	540
R-squared	0.026	0.385	0.733	0.004	0.388	0.713	0.026	0.385	0.733	0.341	0.551	0.802	0.018	0.319	0.644	0.114	0.751	0.930
Municipality characteristics		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES
School system characteristics		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES
School Infrastructure		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES
Pupils' characteristics		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES		YES	YES
Weights			IPTW			IPTW			IPTW			IPTW			IPTW			IPTW

Standard errors in parentheses

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

Results - Chapter 2

- impact of higher teachers' salary on pupils' performance

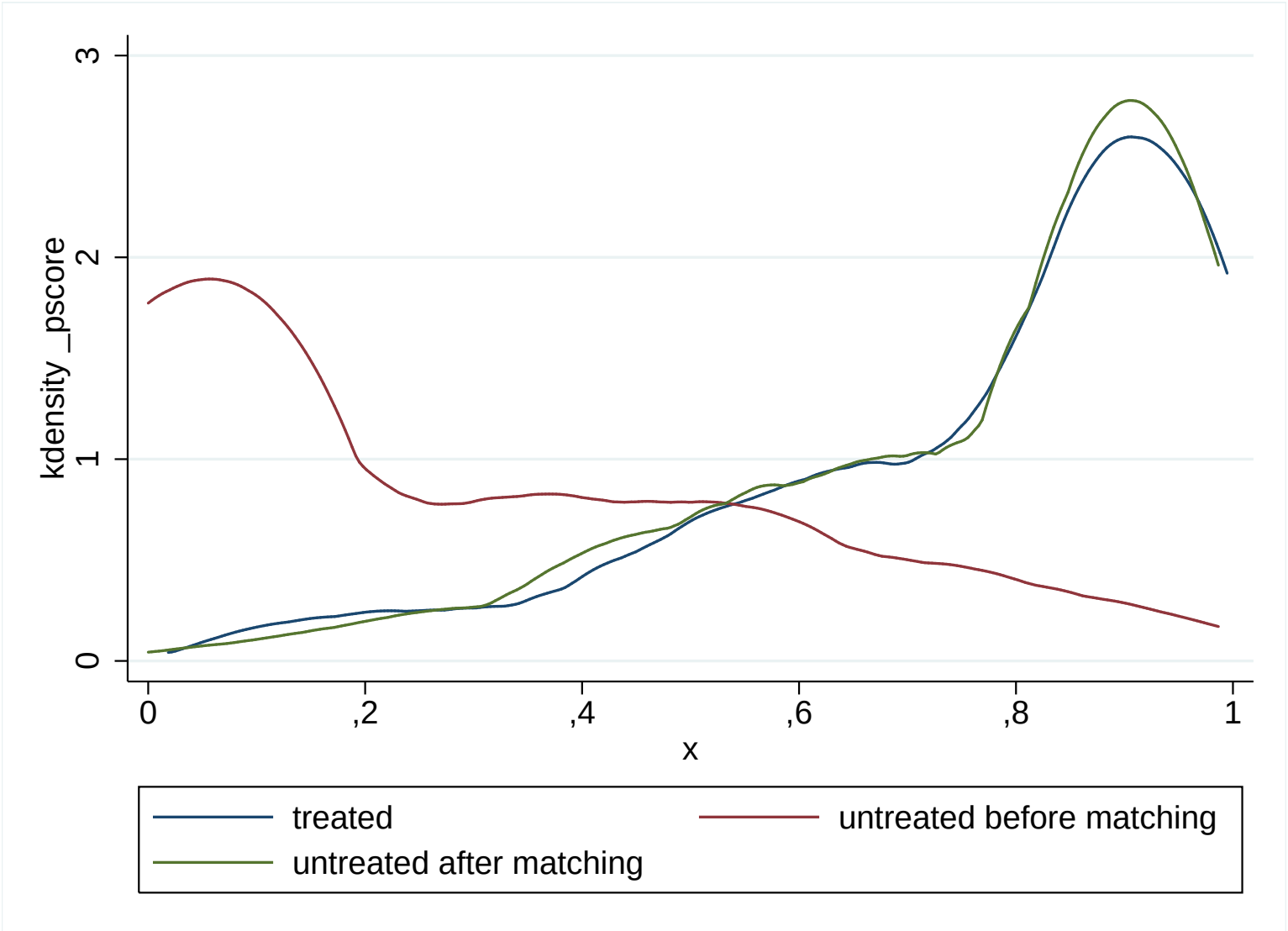
Impact of salary increase on pupils' proficiency

Figure: ATT and ITT for pupils' test scores 2009

Variables	ATT								ITT			
	Portuguese				Math				Portuguese		Math	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ATT	-0.327	0.945	2.022	2.513	-2.636	-1.127	0.654	2.417	2.686*	2.062	1.218	1.537
	(2.102)	(3.827)	(1.657)	(2.291)	(2.557)	(4.662)	(2.118)	(2.763)	(1.446)	(2.100)	(1.905)	(2.572)
Treated	-14.08***	-14.65***	-0.569	1.199	-16.14***	-16.35***	0.649	2.131	-1.457	0.768	0.128	1.774
	(1.486)	(2.264)	(1.498)	(1.601)	(1.808)	(2.650)	(1.884)	(2.173)	(1.173)	(1.467)	(1.455)	(1.873)
Time	9.445***	9.709***	8.896***	6.305***	12.94***	13.81***	12.70***	7.869***	8.373***	6.536***	11.81***	8.942***
	(1.337)	(2.750)	(1.260)	(2.211)	(1.627)	(3.262)	(1.643)	(2.507)	(1.210)	(2.191)	(1.593)	(2.498)
Constant	178.4***	178.8***	107.5***	91.42***	197.9***	199.0***	92.05***	72.76***	102.4***	99.12***	89.70***	87.67***
	(0.945)	(1.620)	(17.59)	(22.10)	(1.150)	(1.863)	(22.48)	(25.38)	(16.49)	(19.79)	(22.41)	(23.37)
Observations	944	872	872	800	944	872	872	800	1,144	910	1,144	910
R-squared	0.220	0.192	0.793	0.768	0.228	0.191	0.770	0.739	0.778	0.761	0.746	0.736
Sample weights		Yes	Yes	IPTW		Yes	Yes	IPTW	Yes	IPTW	Yes	IPTW
Municipality characteristics			Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
Fiscal covariates			Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
Pupils' characteristics			Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
School Infrastructure			Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
School system characteristics			Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes

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

Matching Balance



Impact of salary increase on pupils' proficiency

Figure: ATT for pupils' test scores 2011 and 2013

Variables	Portuguese						Math					
	2011			2013			2011			2013		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ATT	-0.257	0.983	-1.332	-1.922	0.997	0.615	-2.098	0.631	-3.901	-4.055	-1.668	-1.328
	(2.221)	(1.820)	(2.763)	(4.137)	(1.864)	(2.358)	(2.660)	(2.173)	(3.984)	(4.774)	(2.402)	(2.685)
Treated	-14.01***	-3.315**	-2.543	-16.29***	-0.0153	0.965	-15.63***	-2.553	-1.089	-18.01***	1.505	1.902
	(1.572)	(1.446)	(1.843)	(2.126)	(1.400)	(1.495)	(1.883)	(1.740)	(2.825)	(2.500)	(1.691)	(1.670)
Time	16.26***	10.45***	12.56***	19.96***	9.704**	13.84*	18.43***	11.46***	16.44***	18.65***	4.778	8.932
	(1.458)	(1.515)	(3.219)	(3.050)	(4.591)	(7.151)	(1.752)	(1.975)	(4.580)	(3.617)	(5.569)	(8.013)
Constant	180.0***	112.3***	106.1***	180.7***	154.5***	223.9*	199.5***	116.6***	138.2***	201.2***	198.6***	295.6**
	(1.033)	(18.60)	(29.60)	(1.556)	(51.49)	(114.3)	(1.240)	(22.39)	(37.16)	(1.845)	(63.91)	(119.2)
Observations	854	775	538	850	764	540	846	766	534	850	764	540
R-squared	0.308	0.788	0.855	0.297	0.861	0.923	0.284	0.759	0.798	0.247	0.815	0.897
Sample weights		Yes	IPTW	Yes	Yes	IPTW Kernel		Yes	IPTW	Yes	Yes	IPTW Kernel
Municipality characteristics		Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes
Fiscal covariates		Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes
Pupils' characteristics		Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes
School Infrastructure		Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes
School system characteristics		Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes

Robust standard errors in parentheses.

Results - Chapter 3

- Do unconditional higher salaries schemes yield better teachers?

Data - Teacher Quality

- Teachers in School Census 2008 and 2014 found in ENADE database (2005, 2008, 2011)
  - about 3% of all the school system-teacher matches in 2008 and about 4% in 2014 are composed by teachers found in ENADE database
  - Scores in ENADE normalized in each year (2005, 2008, 2011)

Impact of teachers salary increase on teacher quality

Figure: ENADE

Group	Year	Major-Specific Component					General Formation Component				
		Average score	Std. Dev.	Linearized Std. Err.	[95% Conf. Interval]		Average score	Std. Dev.	Linearized Std. Err.	[95% Conf. Interval]	
Municipal teachers	2014	4.954	1.575	0.032	4.891	5.017	4.902	1.688	0.037	4.829	4.974
in treated	2008	4.634	1.448	0.044	4.548	4.721	4.558	1.593	0.050	4.459	4.657
Diff (2014-2008)		0.320					0.344				
Municipal teachers	2014	5.545	2.379	0.020	5.505	5.585	5.420	2.419	0.021	5.378	5.462
in untreated	2008	4.961	2.457	0.039	4.885	5.038	4.799	2.482	0.041	4.718	4.880
Diff (2014-2008)		0.583					0.620				
Diff-in-Diff		-0.263					-0.277				
Private teachers in	2014	5.262	2.005	0.042	5.179	5.344	5.244	2.145	0.046	5.153	5.335
treated	2008	5.319	2.398	0.077	5.168	5.471	5.160	2.418	0.081	5.001	5.319
Diff (2014-2008)		-0.058					0.084				
Private teachers in	2014	5.245	2.581	0.018	5.210	5.281	5.244	2.730	0.019	5.206	5.282
untreated	2008	5.048	2.957	0.034	4.982	5.113	4.970	3.011	0.035	4.901	5.039
Diff (2014-2008)		0.198					0.274				
Diff-in-Diff		-0.255					-0.190				
DDD		**-0.008**					**-0.087**				

Note: all statistics considered complex survey design.

Impact of teachers salary increase on teacher quality

Figure: ENADE Pedagogy-Specific Component - Triple difference

Variables	Pedagogy - Major-specific component											
	All non-municipal teachers as control						Only private teachers as control					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ATT (γ)	-0.0601	-0.0601	-0.0786	-0.00174	0.0243	0.0396	0.0781	0.0781	0.0437	0.151	0.198*	0.221**
	(0.0866)	(0.112)	(0.0965)	(0.0910)	(0.0918)	(0.0908)	(0.0960)	(0.120)	(0.103)	(0.0999)	(0.102)	(0.101)
Municipal teachers in treated	-0.214***	-0.214	-0.165	-0.210	-0.230	-0.251*	-0.376***	-0.376**	-0.312*	-0.392**	-0.408**	-0.425***
	(0.0726)	(0.172)	(0.147)	(0.143)	(0.141)	(0.140)	(0.0823)	(0.182)	(0.164)	(0.163)	(0.161)	(0.160)
Time-FE on teachers	0.197***	0.197**	0.153**	0.0705	0.0821	0.0722	0.255***	0.255***	0.221***	0.104	0.124*	0.112*
	(0.0418)	(0.0841)	(0.0653)	(0.0611)	(0.0613)	(0.0597)	(0.0425)	(0.0860)	(0.0653)	(0.0630)	(0.0634)	(0.0602)
Time-FE on treated	-0.0685	-0.0685	0.00395	-0.0295	-0.0121	-0.0184	-0.207***	-0.207**	-0.114	-0.169*	-0.173*	-0.184*
	(0.0662)	(0.0632)	(0.0667)	(0.0688)	(0.0745)	(0.0751)	(0.0777)	(0.0862)	(0.0868)	(0.0884)	(0.0965)	(0.0949)
Municipal teachers	0.0432	0.0432	0.0677	0.146	0.157	0.181*	0.0472	0.0472	0.0791	0.201	0.206	0.233*
	(0.0367)	(0.141)	(0.113)	(0.115)	(0.113)	(0.109)	(0.0371)	(0.148)	(0.122)	(0.128)	(0.126)	(0.121)
Treated	0.127**	0.127	0.0435	0.150	0.143	0.153	0.289***	0.289***	0.192*	0.339**	0.324**	0.332**
	(0.0557)	(0.0849)	(0.0821)	(0.107)	(0.105)	(0.104)	(0.0676)	(0.108)	(0.111)	(0.136)	(0.134)	(0.133)
Time	0.100***	0.100***	-0.0528	-0.0269	-0.186***	-0.181***	0.0431*	0.0431	-0.120**	-0.0716	-0.246***	-0.227***
	(0.0249)	(0.0330)	(0.0512)	(0.0432)	(0.0529)	(0.0552)	(0.0261)	(0.0315)	(0.0554)	(0.0516)	(0.0624)	(0.0635)
Constant	0.0179	0.0179	0.735***	0.800***	0.855***	0.675***	0.0139	0.0139	0.718***	0.762***	0.817***	0.503**
	(0.0218)	(0.0594)	(0.0999)	(0.129)	(0.131)	(0.199)	(0.0224)	(0.0682)	(0.113)	(0.144)	(0.146)	(0.218)
# Obs	65,250	65,250	65,250	65,250	65,144	65,136	57,542	57,542	57,542	57,542	57,454	57,448
R-squared	0.009	0.009	0.068	0.076	0.078	0.080	0.011	0.011	0.070	0.078	0.081	0.083
Cluster	No	Munic	Munic	Munic	Munic	Munic	No	Munic	Munic	Munic	Munic	Munic
Individual charact.	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Market salaries (RAIS)	No	No	No	No	Yes	Yes	No	No	No	No	Yes	Yes
Municipal charact.	No	No	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
School system charact.	No	No	No	No	No	Yes	No	No	No	No	No	Yes
Complex sample design	Yes	No	No	No	No	No	Yes	No	No	No	No	No

Standard errors in parentheses

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

Impact of teachers salary increase on teacher quality

Figure: ENADE General Formation Component (Pedagogy) - Triple difference

Variables	Pedagogy - General Formation component											
	All non-municipal teachers as control						Only private teachers as control					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ATT (γ)	-0.200	-0.200	-0.194	-0.0724	-0.0431	-0.0242	0.0241	0.0241	0.0173	0.194	0.262*	0.292*
	(0.152)	(0.159)	(0.142)	(0.129)	(0.129)	(0.128)	(0.168)	(0.173)	(0.157)	(0.147)	(0.150)	(0.149)
Municipal teachers in treated	-0.128	-0.128	-0.0793	-0.136	-0.160	-0.185	-0.369***	-0.369	-0.312	-0.428*	-0.457**	-0.481**
	(0.127)	(0.245)	(0.216)	(0.205)	(0.202)	(0.201)	(0.142)	(0.259)	(0.237)	(0.233)	(0.231)	(0.230)
Time-FE on teachers	0.344***	0.344***	0.267***	0.135*	0.149*	0.138*	0.398***	0.398***	0.329***	0.140*	0.166**	0.151**
	(0.0691)	(0.113)	(0.0944)	(0.0791)	(0.0772)	(0.0760)	(0.0711)	(0.114)	(0.0964)	(0.0792)	(0.0784)	(0.0752)
Time-FE on treated	-0.0867	-0.0867	-0.0183	-0.0233	0.0109	0.000533	-0.311**	-0.311**	-0.224	-0.273*	-0.276*	-0.294**
	(0.116)	(0.104)	(0.109)	(0.113)	(0.115)	(0.116)	(0.136)	(0.139)	(0.145)	(0.146)	(0.151)	(0.149)
Municipal teachers	-0.0708	-0.0708	-0.0217	0.0985	0.114	0.142	-0.0781	-0.0781	-0.00974	0.183	0.191	0.224
	(0.0602)	(0.186)	(0.150)	(0.149)	(0.146)	(0.141)	(0.0616)	(0.195)	(0.157)	(0.164)	(0.160)	(0.154)
Treated	0.139	0.139	0.0583	0.133	0.119	0.131	0.381***	0.381**	0.291*	0.419**	0.404**	0.416**
	(0.0971)	(0.128)	(0.129)	(0.159)	(0.159)	(0.158)	(0.116)	(0.161)	(0.169)	(0.202)	(0.202)	(0.201)
Time	0.215***	0.215***	0.0415	0.0301	-0.189**	-0.193**	0.160***	0.160***	-0.00945	0.0212	-0.219**	-0.208**
	(0.0410)	(0.0616)	(0.0860)	(0.0734)	(0.0887)	(0.0948)	(0.0444)	(0.0541)	(0.0922)	(0.0798)	(0.101)	(0.105)
Constant	4.931***	4.931***	6.126***	6.322***	6.426***	6.310***	4.938***	4.938***	6.162***	6.315***	6.425***	6.160***
	(0.0353)	(0.0812)	(0.152)	(0.199)	(0.201)	(0.325)	(0.0376)	(0.0870)	(0.183)	(0.229)	(0.231)	(0.358)
# Obs	62,915	62,915	62,915	62,915	62,811	62,803	55,415	55,415	55,415	55,415	55,329	55,323
R-squared	0.007	0.007	0.045	0.054	0.055	0.056	0.008	0.008	0.045	0.055	0.056	0.057
Cluster	No	Munic	Munic	Munic	Munic	Munic	No	Munic	Munic	Munic	Munic	Munic
Individual charact.	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Market salaries (RAIS)	No	No	No	No	Yes	Yes	No	No	No	No	Yes	Yes
Municipal charact.	No	No	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
School system charact.	No	No	No	No	No	Yes	No	No	No	No	No	Yes
Complex sample design	Yes	No	No	No	No	No	Yes	No	No	No	No	No

Institutional Background
College entrance in Brazil

- Entrance into higher education: competitive process, there are not enough vacancies to all
- Observed salary or perceived relative salary, considering other careers, is a relevant factor in explaining college major decision or any course attractiveness
- It is arguable that in more attractive careers, that are more competitive,the minimum entry standard for that course is higher.
- We infer the effect of salary increase on attractiveness of the docent career using entrance exam scores of students in teaching related courses and its relation to other courses

Data - Attractiveness of Teaching Career

- College freshmen in 2010 and 2013 found in ENEM database (2009, 2012)
  - about 55% of 2010 entrants took Enem in 2009 and 64% of 2013 entrants took Enem in 2012
  - Scores in IRT, allowing comparison between years

Achievement distribution of college attenders by ability

Figure: Achievement distribution of attenders of courses related to teaching by ability (Enem scores) - treated and untreated

Quartil ou decil	2010				2013				Var (2013-2010) em p.p.	Diff-in-diff
	Nota provas objetivas		Alunos oriundos de cada quartil ou decil		Nota provas objetivas		Alunos oriundos de cada quartil ou decil			
	mínima	máxima	%	quantidade	mínima	máxima	%	quantidade		
Pedagogia				37,240				49,685		
1º quartil	317.3	450.4	45.4%	16,896	324.2	441.1	44.9%	22,302	-0.48	
Tratados			48.7%	1,143			31.2%	1,181	-17.56	-26.48
Controles			36.3%	3,295			45.2%	4,368	8.92	
2º quartil	450.4	497.7	32.3%	12,017	441.1	485.6	31.6%	15,715	-0.64	
Tratados			32.4%	759			52.2%	1,977	19.81	19.58
Controles			33.9%	3,078			34.1%	3,297	0.23	
3º quartil	497.7	545.1	18.5%	6,893	485.6	530.3	19.1%	9,472	0.55	
Tratados			16.1%	378			14.0%	531	-2.10	3.71
Controles			23.1%	2,102			17.3%	1,674	-5.82	
4º quartil	545.1	802.4	3.9%	1,434	530.3	744.8	4.4%	2,196	0.57	
Tratados			2.8%	66			2.7%	101	-0.15	3.18
Controles			6.7%	613			3.4%	330	-3.33	
10º decil	584.0	802.4	0.4%	153	565.4	744.8	0.5%	273	0.14	
Tratados			0.2%	4			0.1%	3	-0.09	0.36
Controles			0.8%	77			0.4%	38	-0.45	

Impact of teachers salary increase on the attractiveness of teaching profession

Figure: Enem objective tests and writing

Group	Year	Objective tests					Writing				
		Average score	Std. Dev.	Linearized Std. Err.	[95% Conf. Interval]		Average score	Std. Dev.	Linearized Std. Err.	[95% Conf. Interval]	
teaching	2012	512.02	53.51	0.56	510.93	513.11	538.20	121.31	1.29	535.68	540.72
careers	2009	513.29	54.95	0.77	511.78	514.80	623.63	116.58	1.65	620.39	626.87
Diff (2012-2009)		-1.27					-85.43				
teaching	2012	518.11	71.60	0.50	517.13	519.08	537.26	154.38	1.12	535.06	539.46
careers	2009	539.47	79.14	0.51	538.48	540.46	634.40	159.70	1.07	632.31	636.49
Diff (2012-2009)		-21.36					-97.14				
Diff-in-Diff		20.10					11.71				
other	2012	534.87	70.56	0.29	534.30	535.45	561.76	146.32	0.63	560.52	562.99
careers	2009	542.42	73.32	0.48	541.48	543.35	636.22	140.65	0.95	634.37	638.08
Diff (2012-2009)		-7.55					-74.47				
other	2012	544.72	86.44	0.19	544.35	545.09	561.02	170.93	0.39	560.26	561.77
careers	2009	561.49	95.30	0.23	561.03	561.95	631.80	176.78	0.44	630.93	632.67
Diff (2012-2009)		-16.77					-70.78				
Diff-in-Diff		9.23					-3.69				
DDD		**10.87**					**15.40**				

Note: all statistics considered complex survey design. Inep addopts IRT for Enem sc

Source: Author's estimates based on *Enem* database.

Impact of teachers salary increase on the attractiveness of teaching profession

Figure: Enem objective tests and writing - Triple difference

VARIABLES	Objective tests					Writing				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ATT	10.87***	9.956***	10.94***	9.420**	8.832**	15.40***	17.71***	21.47***	22.61***	21.97***
	(2.967)	(2.706)	(3.467)	(3.899)	(3.771)	(5.287)	(5.720)	(6.141)	(6.776)	(6.699)
Teaching in treated	-7.105**	-7.272**	-5.378	-5.729*	-5.306*	-15.19***	-14.68***	-14.69***	-17.05***	-16.52***
	(2.791)	(2.974)	(3.342)	(3.170)	(3.173)	(4.275)	(4.869)	(5.259)	(5.143)	(5.058)
Time-FE on treated	9.225	8.634*	11.52**	-1.785	-0.332	-3.686	-7.659	-8.097	-18.98***	-17.98***
	(6.166)	(5.090)	(5.257)	(4.214)	(3.252)	(9.422)	(8.635)	(8.183)	(7.046)	(6.493)
Time-FE on Teaching students	-4.591***	-5.696***	-3.201*	-2.009	-2.048	-26.35***	-24.96***	-23.87***	-23.00***	-22.72***
	(1.495)	(1.495)	(1.700)	(1.532)	(1.541)	(2.842)	(3.054)	(3.286)	(3.300)	(3.269)
Treated	-19.08***	-21.18***	-18.26***	-0.304	-1.202	4.424	4.982	10.95	13.76*	11.98*
	(6.565)	(5.340)	(5.986)	(4.163)	(3.449)	(5.764)	(5.470)	(6.711)	(7.160)	(6.381)
Teaching major	-22.02***	-14.89***	-14.46***	-12.02***	-11.81***	2.596	0.891	2.496	3.592*	3.752*
	(1.455)	(1.422)	(1.652)	(1.549)	(1.678)	(1.746)	(2.162)	(2.320)	(2.175)	(2.159)
Time	-16.77***	-22.20***	-42.77***	-26.24***	-25.26***	-70.78***	-71.80***	-91.86***	-82.01***	-84.64***
	(5.297)	(4.055)	(7.081)	(3.828)	(3.339)	(5.002)	(4.301)	(7.697)	(6.247)	(6.318)
Constant	561.5***	567.4***	556.6***	554.8***	560.8***	631.8***	627.6***	618.1***	621.6***	651.4***
	(5.307)	(3.600)	(5.989)	(4.621)	(9.072)	(3.596)	(3.716)	(6.251)	(7.167)	(12.92)
# Obs	877,838	593,080	485,867	485,867	485,794	877,838	593,080	485,867	485,867	485,794
R-squared	0.028	0.073	0.087	0.114	0.117	0.051	0.056	0.056	0.062	0.063
Cluster	Munic	Munic	Munic	Munic	Munic	Munic	Munic	Munic	Munic	Munic
# Municipalities	515	515	410	410	409	515	515	410	410	409
Individual charact.	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Market salaries (RAIS)	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Municipality charact.	No	No	No	Yes	Yes	No	No	No	Yes	Yes
School system characteristics	No	No	No	No	Yes	No	No	No	No	Yes

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

Concluding remarks

- Our survey brings unique information about Brazilian municipal base teachers' salaries and other information about municipal teacher career structure in the period 2008-2013.
- Our survey indicates that about 60% of Brazilian municipal school systems were impinged by the introduction of the minimum salary for teachers.
- About 1/3 still remained on the margin of the law in 2013.
- Treated municipal school systems increased the absolute and relative teachers' salaries considerably more than untreated ones.
- Our results corroborate the main finding of the empirical literature that unconditional salary increase does not trigger better performance of students in the short run (five years).

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Concluding remarks (cont)

- Teachers have not made more effort correcting pupils' homework and have not interrupted their participation in other concurrent working activities, what contradicts gift-exchange models of employee behavior.
- Although teachers' salaries have increased sharply, teacher salaries are still lower than in alternative occupations.
- There are promising signs of teacher quality enhancement:
  - We found mild positive statistically significant effects of municipal teachers salary increase on teachers quality (Enade scores) and on the attractiveness of college courses related to teaching profession
  - In fact it seems that salary hikes actually avoid the deterioration of teacher quality and the quality of students of College courses related to the teaching profession, more than improve them

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