Online Appendix for the paper 'Tax Me, but Spend Wisely? Sources of Public Finance and Government Accountability'

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Abstract

This appendix presents additional results and supplementary material for the paper 'Tax Me, but Spend Wisely? Sources of Public Finance and Government Accountability'. Please see the companion paper for details on the methods used. The first six sections present additional tables and figures following the structure of the paper. Section 6 develops a simple political agency model with endogenous taxation and rent-seeking politicians in which asymmetries of information lead to increases in tax revenues being spent better than increases in non-tax revenues. Finally section 7 discusses the PMAT program in more depth: the context of its creation and the types of investments in tax capacity it financed.

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1 Context and data

1.1 Variable description and sources

Variable	Description	Source
Non-tax revenues per capita, *also called* FPM transfer revenues per capita	Amount of *FPM* transfers received by the municipality divided by municipal population, available for the period 1998-2011.	*Tesouro Nacional* `http://www3.tesouro.gov.br/estados_municipios/transferencias_constitucionais_novosite.asp`
Municipal population	Municipal population estimated by the Brazilian Statistical Institute (*IBGE*) from decennial census and national demographic trends , available for the period 1997-2006 and 2008-2009, and 2011. I construct 2007 and 2010 estimates by linear interpolation.	*IBGE* `ftp://ftp.ibge.gov.br/Estimativas_Projecoes_Populacao`
PMAT application date	Date at which a municipality applies to the *PMAT* program.	Brazilian Development Bank (*BNDES*).
PMAT start date	Date at which a municipality starts a *PMAT* program (receives its first loan).	*BNDES*.
Tax revenues per capita	Amount of tax revenues collected by the municipality divided by municipal population, available for the period 1998-2011.	*Tesouro Nacional, FINBRA* database, `http://www.stn.gov.br/gfm/`
Total public revenues per capita	Total amount of municipal public revenues divided by municipal population, available for the period 1998-2011.	*Tesouro Nacional, FINBRA* database, `http://www.stn.gov.br/gfm/`
Public spending per capita	Total amount of municipal public spending divided by municipal population, available for the period 1998-2011.	*Tesouro Nacional, FINBRA* database, `http://www.stn.gov.br/gfm/`
GDP per capita	Contribution of municipality to national GDP, estimated by the *IBGE*, available for 1998-2011. *IBGE* estimates annually the contribution of each municipality to state GDP growth using surveys of manufacturing and service firms, financial, fiscal and energy data.	*IBGE*, `http://www.ibge.gov.br/home/estatistica/economia/pibmunicipios/2005_2011/default.shtm`
Share of services in GDP	Estimated share of services in GDP estimated by the *IBGE* using the same method as above.	*IBGE*, `http://www.ibge.gov.br/home/estatistica/economia/pibmunicipios/2005_2011/default.shtm`
Political competition	Herfindahl index of political competition constructed from the vote share of all parties running in the last municipal elections. Municipal elections were held in October 1996, 2000, 2004 and 2008, new mayors are sworn in January of the following years.	*Tribunal Superior Eleitoral*: `http://www.tse.jus.br/eleicoes/eleicoes-anteriores/eleicoes-2000`
Mayor's political party	Political party affiliation of the mayor at the time of his/her last election.	*Tribunal Superior Eleitoral*: `http://www.tse.jus.br/eleicoes/eleicoes-anteriores/eleicoes-2000`
Term limit	Indicator equal to 1 if the mayor is in his/her last term in office. The term limit for mayors was extended to two terms in 2000.	*Tribunal Superior Eleitoral*: `http://www.tse.jus.br/eleicoes/eleicoes-anteriores/eleicoes-2000`
Municipal education infrastructure (quantity)	Number of classrooms in use in municipal schools divided by school age population , available for the period 1998-2011. An estimate of under 15 population is obtained from applying the share of under-15 inhabitants in total population measured in the 2000 Census to annual municipal population estimates.	*INEP, Censo Escolar*, `http://portal.inep.gov.br/basica-levantamentos-acessar`

Variable	Description	Source
Municipal education infrastructure (quality)	First principal component from a set of seven municipal school characteristics , available for the period 1998-2011: computer availability, internet connection, presence of sport facilities, library, television/video equipment, connection to sewage and electricity systems.	*INEP, Censo Escolar*, `http://portal.inep.gov.br/basica-levantamentos-acessar`
Municipal health infrastructure	Number of municipal health units (including primary health care units and hospitals), available in 1999, 2002, 2005 and 2009.	*IBGE, Pesquisa de Assistência Médico-Sanitària*, `http://www.ibge.gov.br/home/estatistica/populacao/condicaodevida/ams/2011/`
Corruption: All (LZ)	Number of irregularities reported in the reports from the randomized audits of local governments, scaled by the total amounts audited. Data coded by Stephan Litschig and Yves Zamboni. Municipalities audited over the 2003-2006 period only.	See Litschig and Zamboni (2012) for more details on the construction of this dataset.
Corruption: Diversion (LZ)	Number of irregularities reported in the reports from the randomized audits of local governments that the authors associate with diversion of public resources, scaled by the total amounts audited. Data coded by Stephan Litschig and Yves Zamboni. Municipalities audited over the 2003-2006 period only.	See Litschig and Zamboni (2012) for more details on the construction of this dataset.
Corruption: Mismanagement (LZ)	Number of irregularities reported in the reports from the randomized audits of local governments that the authors associate with mismanagement, scaled by the total amounts audited. Data coded by Stephan Litschig and Yves Zamboni. Municipalities audited over the 2003-2006 period only.	See Litschig and Zamboni (2012) for more details on the construction of this dataset.
Broad Corruption (BNPT)	Indicator equal to 1 if an irregularity that the authors associate with a broad definition of corruption is reported in the reports from the randomized audits of local governments. Data coded by Fernanda Brollo, Tommaso Nannicini, Roberto Perotti and Guido Tabellini. Municipalities audited over the 2003-2008 period with less than 50,000 inhabitants only.	See Brollo et al. (2013) for more details on the construction of this dataset.
Narrow Corruption (BNPT)	Indicator equal to 1 if an irregularity that the authors associate with a narrow definition of corruption is reported in the reports from the randomized audits of local governments. Data coded by Fernanda Brollo, Tommaso Nannicini, Roberto Perotti and Guido Tabellini. Municipalities audited over the 2003-2008 period with less than 50,000 inhabitants only.	See Brollo et al. (2013) for more details on the construction of this dataset.
Urban population	Share of population classified as urban in the Census, available in 2000.	2000 Census, `http://www.ipeadata.gov.br/`
Inequality	Municipal Gini coefficient, available in 2000.	2000 Census, `http://www.ipeadata.gov.br/`
Life expectancy	Life expectancy at birth in the municipality, available in 2000.	2000 Census, `http://www.ipeadata.gov.br/`
Median education level	Median number of years of education in the municipality, available in 2000.	2000 Census, `http://www.ipeadata.gov.br/`
Local radio station	Indicator equal to 1 if there is a local radio station in the municipality in 1998.	*IBGE, Perfil dos Municipios Brasileiros, 1998*, `http://www.ibge.gov.br/home/estatistica/economia/financasmunic`

Variable	Description	Source
Seat local judiciary	Whether there is a branch of the local judiciary in the municipality in 1998.	*IBGE, Perfil dos Municipios Brasileiros, 1998*, `http://www.ibge.gov.br/home/estatistica/economia/financasmunic`

2 Empirical strategy

Table 2 presents, for each population bracket defined by the FPM allocation rule: the FPM coefficients, FPM transfers actually received by municipalities in that bracket over the period 1998-2011 ('real' transfers), the amount municipalities should have received had the FPM allocation rule been exactly applied on the IBGE population estimates ('predicted' transfers), the number of observations in each population bracket, and the number of observations actually used for identification: observations for municipalities that cross a cutoff during the period and whose population is in between 6,792 and 142,633 in any given year. The last two columns present the average number of years a municipality that crosses the cutoff is observed above but close to the cutoff (formally, a municipality is considered above but close to the cutoff in year t if its population in year $t-1$ is above the cutoff but below the mid-point below the cutoff and the cutoff above it - see section 4 in the paper), and below but close to the cutoff (population below the cutoff but above the mid-point between the cutoff and the cutoff below it). This paper uses cutoffs 1 to 14, ie 10,188 to 115,464 in all specifications, as the number of observations around cutoff 15 is too small to observe a clear jump in FPM revenues at that cutoff.

Table 2: FPM coefficients, predicted and real transfer revenues by population bracket

Municipal population	Coefficient	Predicted transfers	Real transfers	Obs	Identifying obs	Years above	Years below
0 - 10188	0.60	1383.10	1472.18	19119	2631	6.4	9.5
		(292.03)	(285.83)				
10189 - 13584	0.80	1863.05	1930.47	6399	4169	6.2	6
		(389.49)	(367.25)				
13585 - 16980	1.00	2376.80	2403.79	4879	3690	8.1	5
		(491.69)	(457.86)				
16981 - 23773	1.20	2851.90	2856.36	6451	3643	6.4	6.6
		(574.97)	(549.68)				
23773 - 30564	1.40	3311.65	3325.72	3743	2774	5.9	5.9
		(673.75)	(644.08)				
30565 - 37356	1.60	3816.09	3817.33	2324	1808	5.3	4.9
		(772.70)	(727.68)				
37357 - 44148	1.80	4268.34	4267.46	1548	1369	5.1	5
		(854.74)	(806.56)				
44149 - 50940	2.00	4717.27	4692.92	995	898	4.3	3.9
		(978.50)	(946.46)				
50941 - 61128	2.20	5188.81	5153.99	1165	963	4.8	5.8
		(1054.29)	(1010.57)				
61129 - 71316	2.40	5653.10	5616.30	947	850	4.4	4.2
		(1148.79)	(1103.55)				
71317 - 815054	2.60	6050.23	6012.27	720	650	3.7	4
		(1269.27)	(1220.94)				
81505 - 91692	2.80	6475.79	6432.48	526	512	3.1	3.7
		(1332.06)	(1297.38)				
91693 - 101880	3.00	7149.85	7073.00	409	361	3	3
		(1412.60)	(1391.51)				
101881 - 115464	3.20	7659.17	7648.95	437	375	3.2	4.3
		(1527.12)	(1493.70)				
115465 - 129048	3.40	7943.96	8112.81	279	231	4.3	4.3
		(1693.41)	(1955.64)				

Notes: Mean (standard deviation) of real and predicted FPM transfers in each population bracket in thousand 2000 Rs. Predicted transfers are obtained by applying the transfer allocation rule to population estimates in the previous year.

2.1 Estimation of the propensity score

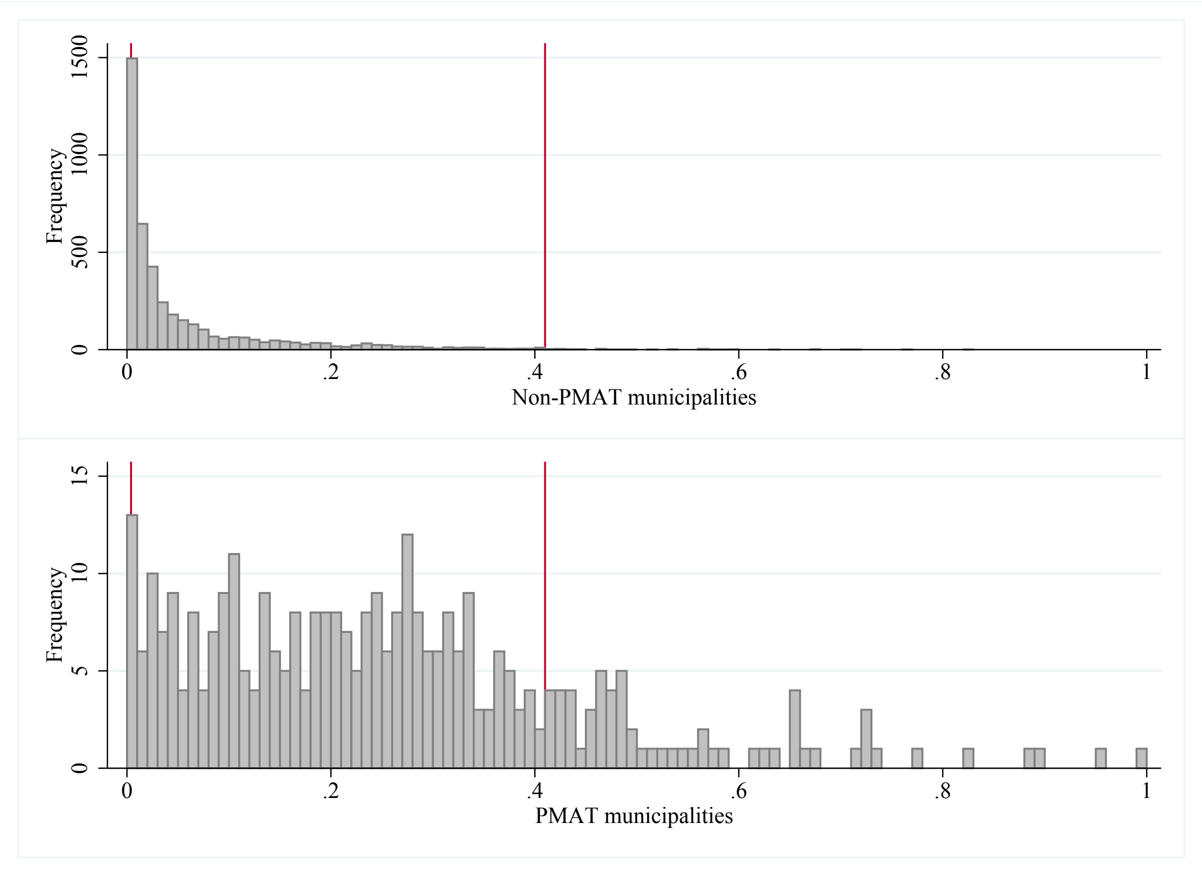
This section presents the method used to implement the weighted difference-in-differences methodology in more detail. I start by estimating a probit model of the probability that a municipality joins a PMAT program between 1999 and 2009 as a function of the pre-program characteristics found to have a significant impact on the probability that a municipality joins the program in the hazard selection model presented in the paper. Table 3 presents the results. This model is then used to predict the propensity (probability) that a municipality will join the program. Figure 1 presents the distribution of propensity scores in PMAT and non-PMAT municipalities. Municipalities outside of the zone delimitated by the two red lines are not in the common support and so are dropped from estimations using only the common support sample.

Table 3: Probit model of the probability of joining a PMAT program between 1999 and 2009

	1
Tax revenues	0.001
	(0.002)
Population	0.283***
	(0.060)
GDP per capita	0.044***
	(0.010)
Share services in GDP	-0.301
	(0.238)
Urban population (%)	0.015***
	(0.002)
Inequality	-1.346**
	(0.627)
Local radio station	0.482***
	(0.067)
Observations	4578

Cluster-robust standard errors in parentheses. The dependent variable is an indicator equal to 1 if the municipality joins a PMAT program between 1999 and 2009, 0 otherwise. Covariates are measured in 1998, except for % urban population and inequality which come from the 2000 Census. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

Figure 1: Distribution of estimated propensity scores



Histogram of estimated propensity scores in PMAT and non-PMAT municipalities. Red lines indicate the limit of the common support

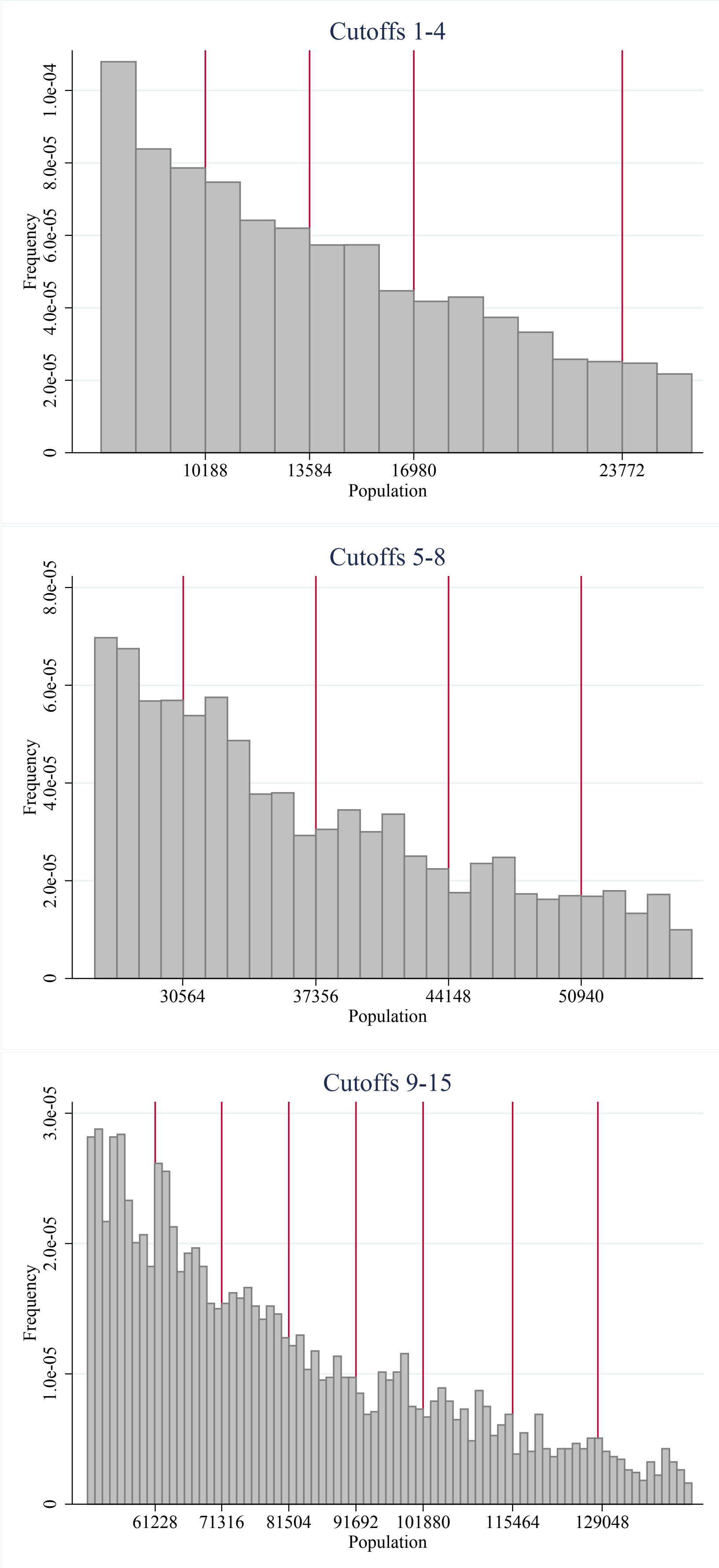
2.2 Tests of the identifying assumption - transfers

The results presented in this paper can be interpreted as the impact of transfer revenues on outcomes under the assumption that the IBGE population estimates used to determine assignment to higher transfers are not precisely manipulated by local governments. This section explains how the population estimates are created and provides several checks for the lack of such manipulative sorting.

The population estimates are constructued by the IBGE, Brazil's statistical institute, which is statutorily independent of the political process. It starts by estimating total population in Brazil every year from key demographic variables, allocates population across states based on growth rates between past Census, and finally allocates states' population across municipalities using the same method. There is evidence that some mayors are able to manipuate the FPM revenues they receive from the federal government, but not by tinkering with the estimation of their municipal population. Manipulation occurs only after the IBGE estimates are released: the Federal Court of Accounts (TCU) is supposed to determine how much FPM transfers each municipality receives based on the IBGE estimates but the estimates they use and those published by the IBGE do not perfectly match (manual checks done by the author on information released by the TCU, see also Brollo et al. (2013)). Litschig (2012) shows that the TCU estimates were manipulated in 1991, with mayors aligned with the party in power at the federal level being more likely to be placed just above the cutoffs. This kind of manipulation can cause mis-assignment around the cutoffs but does not bias the results as long as IBGE and not TCU estimates are used as an instrument.

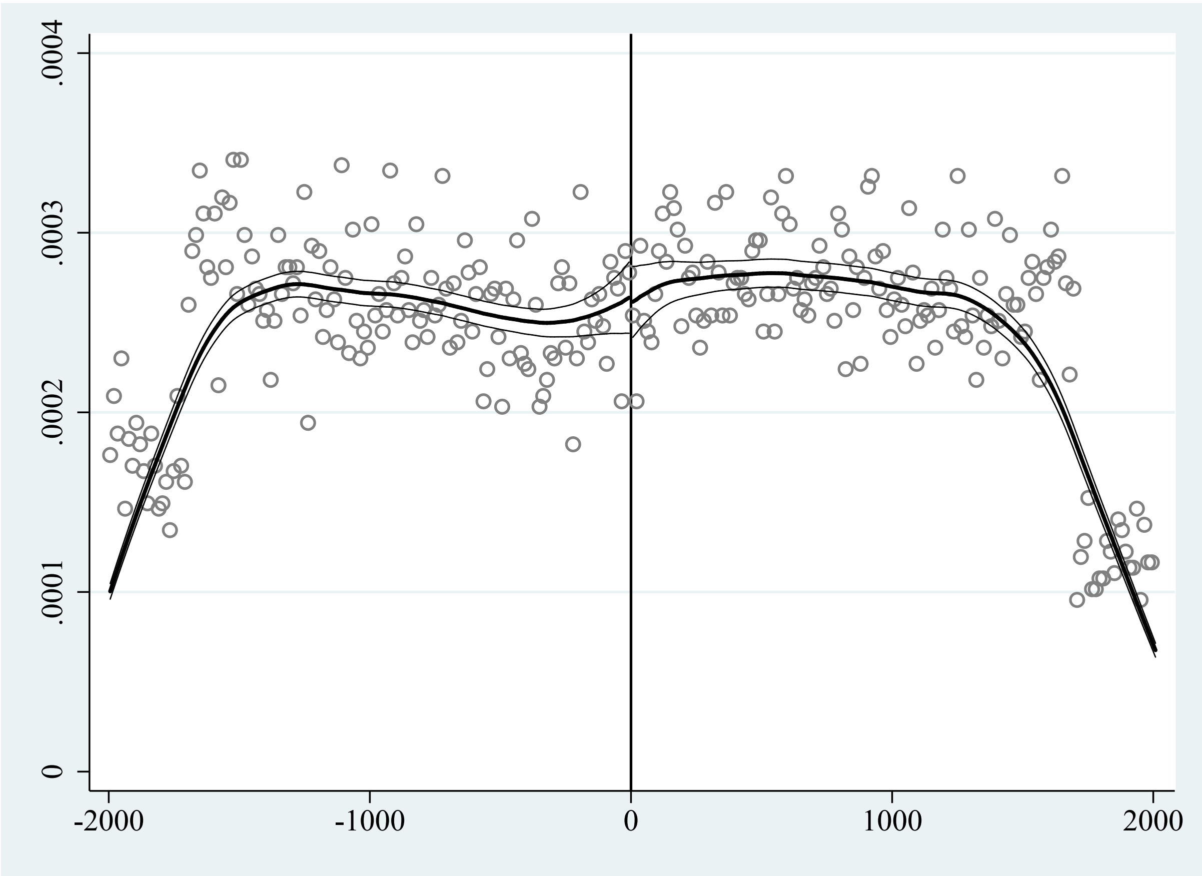
Figure 2 presents the density of municipal population, visual inspection suggests no manipulation of population size around the cutoffs. I implement the formal check for continuous density at the cutoffs suggested by McCrary (2008) both on the pooled sample and for each cutoff separately in Figures 3, 4 and 5. I also run two additional validity checks motivated by the use of within-municipality variations for identification which is new to this paper. I first consider whether the probability of crossing a FPM cutoff is different from the probability of crossing any other population cutoff by plotting population growth rates between years t and $t-1$ as a function of distance to the cutoff at time $t-1$ in Figure 6 and then for each cutoff separately in Figures 7 and 8, and each year separately in Figures 9 and 10. I also check for the balance of pre-treatment characteristics by considering whether municipalities that will cross a threshold at time $t+1$ differ systematically at time t from those that won't along any observable characteristic in Table 4 which estimates equation (9) in the text on lagged municipal characteristics. This specification tests whether municipalities that will cross a threshold in the next year have a different GDP per capita, level of political competition in the last elections, are more likely to have a mayor in their second term, or more likely to have a mayor in the same party as the government. None of these test suggest a violation of the identifying assumption.

Figure 2: Population distribution



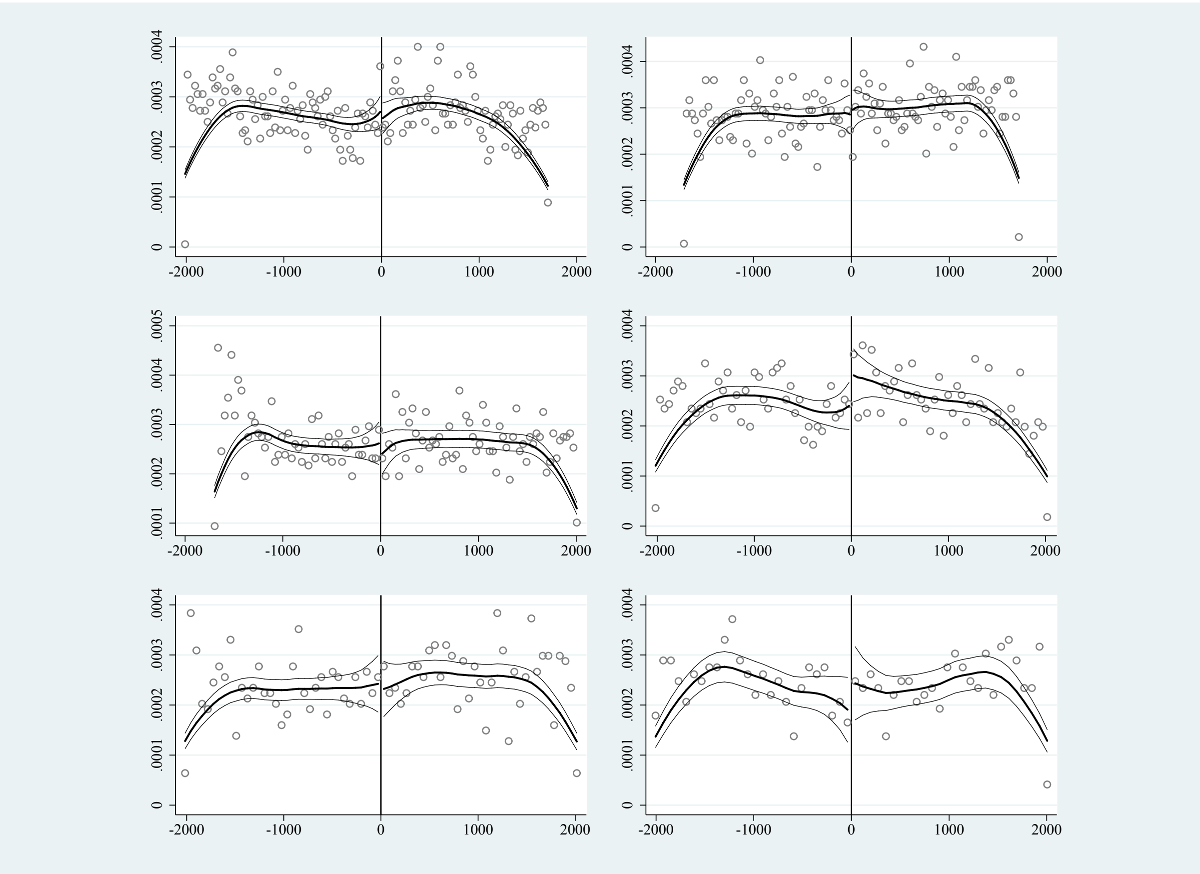
Notes: Frequency of municipalities as a function of population size last year. The sample includes all municipalities that are not state capitals and with less than 142,633 inhabitants and more than 6,792 inhabitants in 1998-2011. The vertical lines identify the FPM cutoffs. Bin-width is 1,132 inhabitants.

Figure 3: McCrary density tests on the whole sample



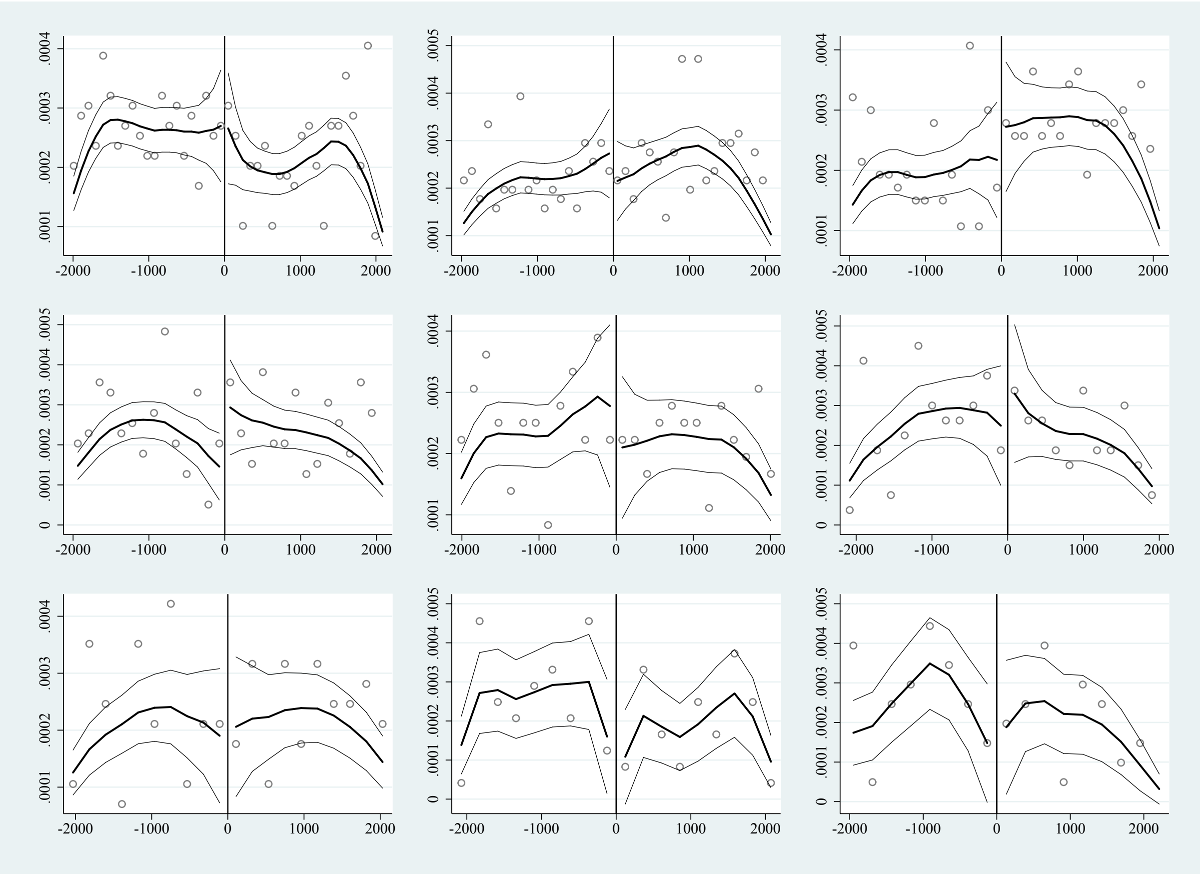
Notes: Weighted kernel estimation of the log density of (normalized) municipal population size, performed separately on each side of the discontinuity. Optimal binwidth and binsize following McCrary (2008). The value of the discontinuity estimate (standard error) is 0.023 (0.056).

Figure 4: McCrary density tests for each cutoff separately, cutoffs 1 to 6



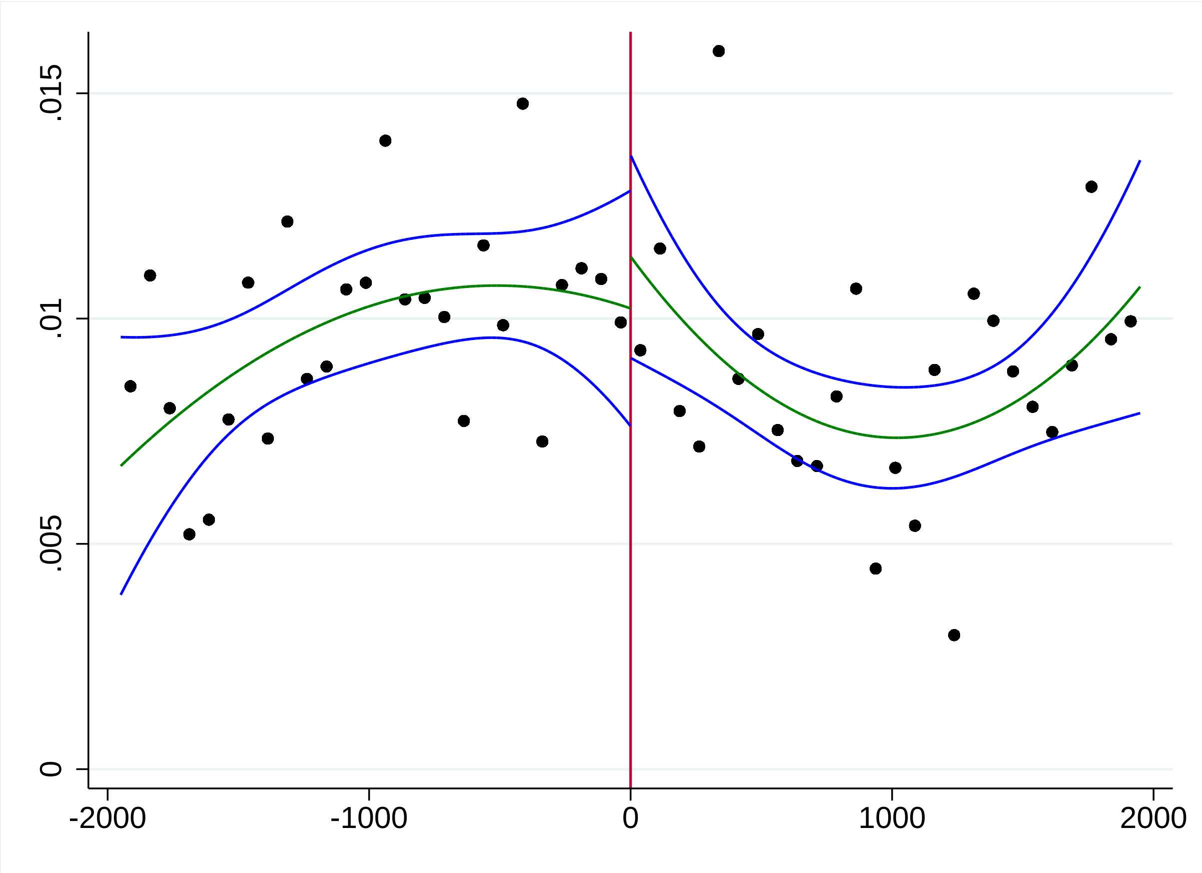
Notes: Weighted kernel estimation of the log density of (normalized) municipal population size, performed separately on each side of the discontinuity, around cutoffs 1 to 6 (from top left to bottom right). Optimal binwidth and binsize following McCrary (2008). The value of the discontinuity estimate (standard error) is 0.03 (0.09) at cutoff 1, 0.09 (0.11) at cutoff 2, 0.013 (0.14) at cutoff 3, -0.07 (0.14) at cutoff 4, -0.15 (0.20) at cutoff 5 and 0.32 (0.31) at cutoff 6.

Figure 5: McCrary density tests for each cutoff separately, cutoffs 7 to 15



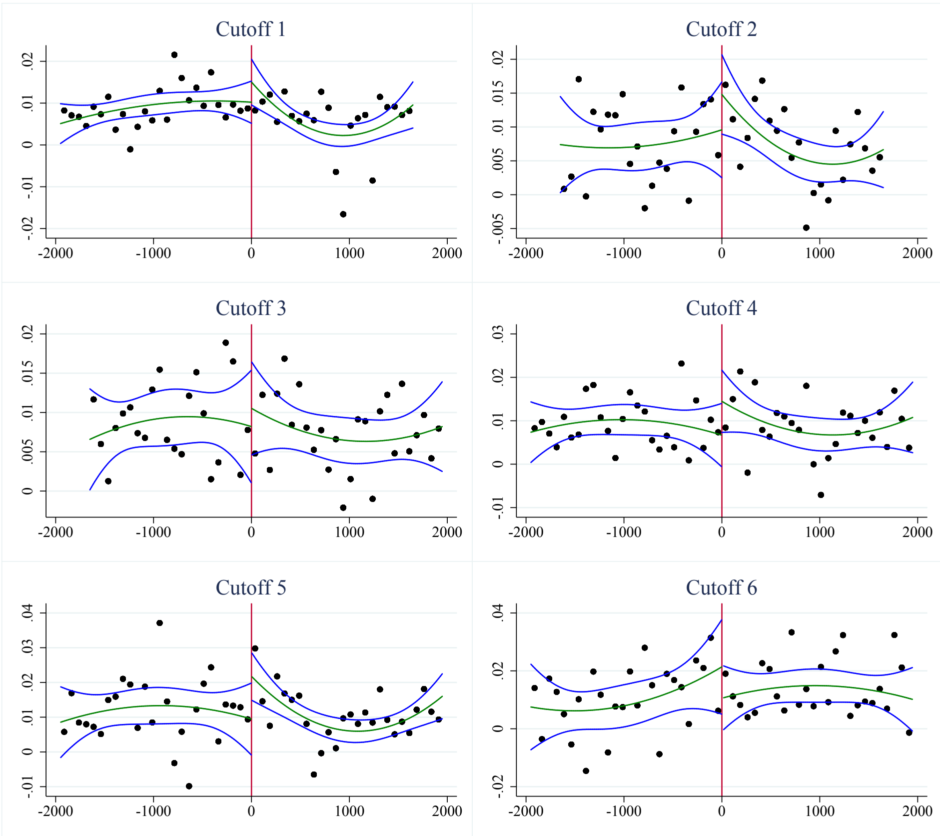
Notes: Weighted kernel estimation of the log density of (normalized) municipal population size, performed separately on each side of the discontinuity, around cutoffs 7 to 15 (from top left to bottom right). Optimal binwidth and binsize following McCrary (2008). The value of the discontinuity estimate (standard error) is 0.08 (0.29) at cutoff 7, -0.25 (0.35) at cutoff 8, 0.44 (0.44) at cutoff 9, 0.40 (0.47) at cutoff 10, 0.09 (0.50) at cutoff 11, 0.50 (0.52) at cutoff 12, 0.11 (0.70) at cutoff 13, 0 at cutoff 14 and 0.89 (1.2) at cutoff 15.

Figure 6: Municipal population growth between t and $t-1$ as a function of population in $t-1$



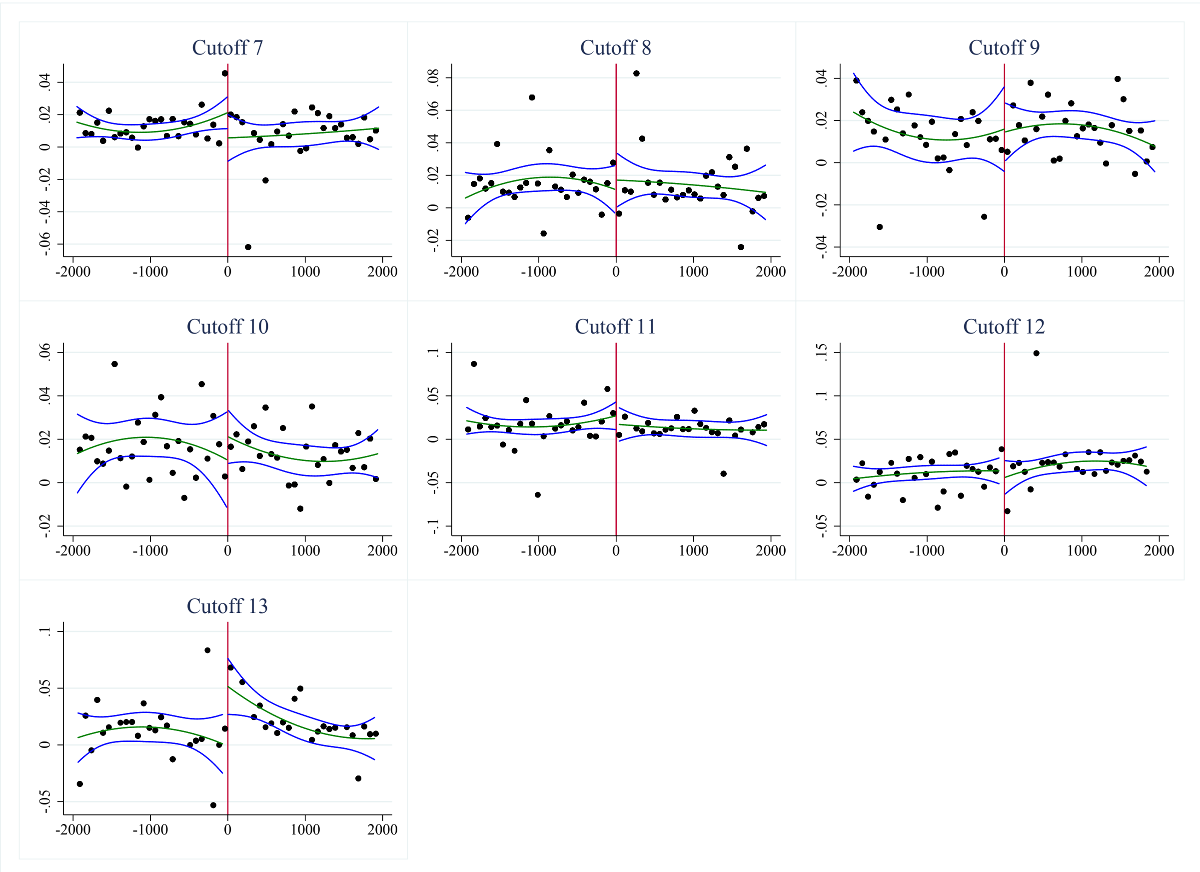
Notes: The green (middle) line is a spline polynomial of population growth between t and $t-1$ as a function of (normalized) population in t, fitted separately on each side of the pooled FPM cutoff at zero. Population size is normalized as the distance from the above or below cutoff. The green (bottom and up) lines are the 95% confidence intervals. Scatter points represent average population growth over intervals of 75 units of normalized population.

Figure 7: Municipal population growth between t and $t-1$ as a function of population in $t-1$, cutoffs 1 to 6



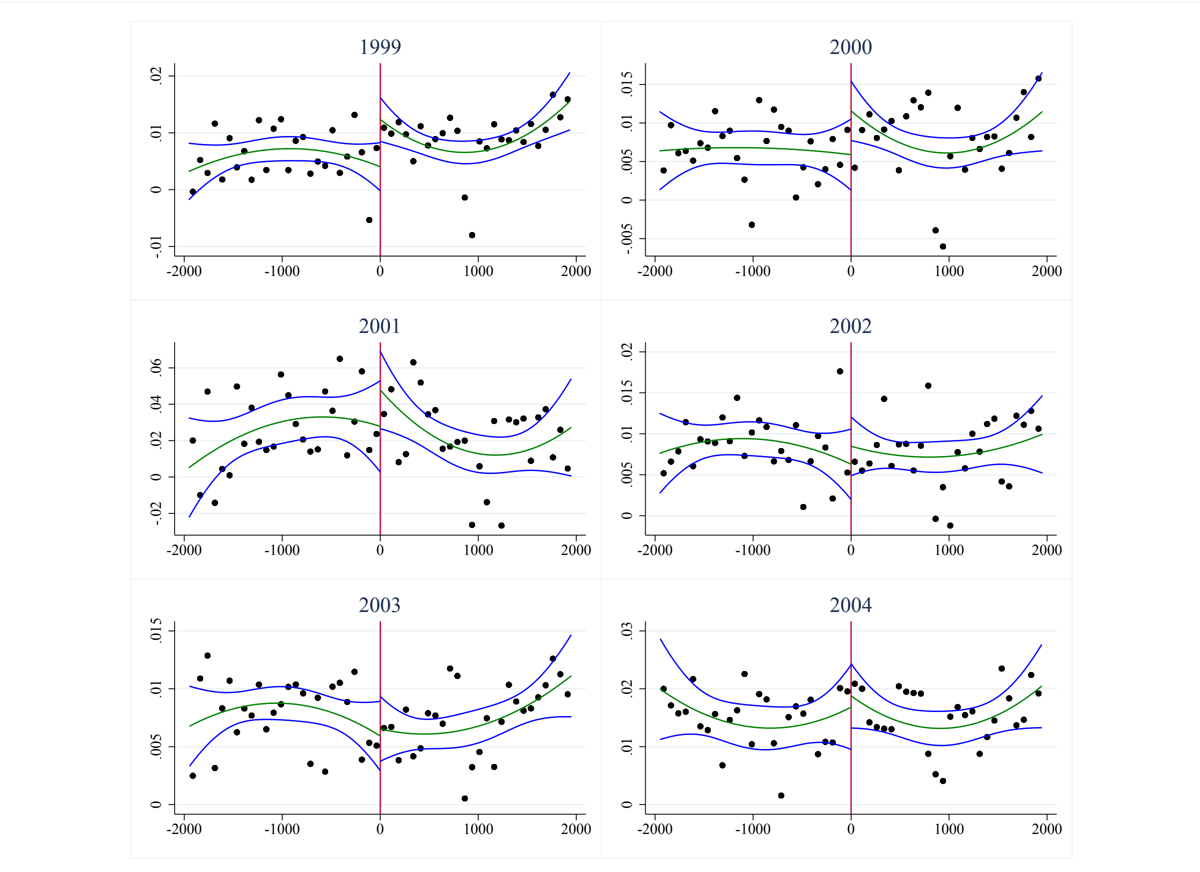
Notes: See notes to Figure 6.

Figure 8: Municipal population growth between t and $t-1$ as a function of population in $t-1$, cutoffs 7 to 14



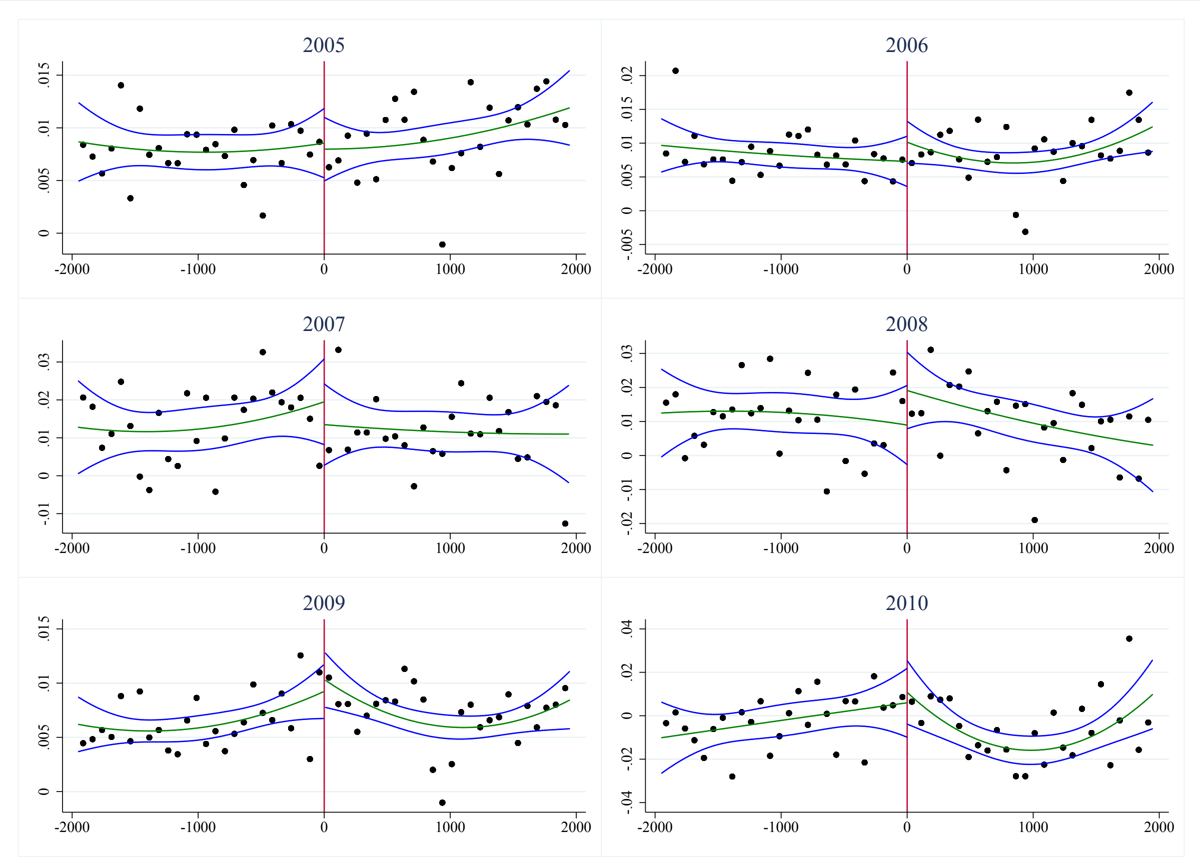
Notes: See notes to Figure 6.

Figure 9: Municipal population growth between t and $t-1$, years 1999 to 2004



Notes: See notes to Figure 6.

Figure 10: Municipal population growth between t and $t-1$, years 2004 to 2010



Notes: See notes to Figure 6.

Table 4: Impact of discontinuity on pre-treatment characteristics

Polynomial specification:	Linear	Linear	Linear	Linear	Third-order
Sample:	2%	2%	5%	5%	All
Covariates:	No	Yes	No	Yes	Yes
Dependent variable : GDP per capita					
All thresholds	0.049	-0.041	0.003	-0.061	-0.143
	(0.264)	(0.095)	(0.168)	(0.057)	(0.084)
Dependent variable : Political competition					
All thresholds	-0.001	0.002	-0.002	0.001	-0.001
	(0.007)	(0.005)	(0.004)	(0.003)	(0.003)
Dependent variable : Mayor in second term					
All thresholds	-0.005	0.011	0.003	-0.003	0.001
	(0.024)	(0.022)	(0.016)	(0.012)	(0.015)
Dependent variable : Mayor in same party as governor					
All thresholds	-0.042	-0.025	-0.032	-0.025	-0.034
	(0.025)	(0.025)	(0.016)	(0.015)	(0.020)

Notes: All dependent variables are lagged. All specifications include year fixed effects and control flexibly for population size, using local linear regressions in columns 1-4 and a spline third-order polynomial in the last column. The sample includes all municipalities within a 2% bandwidth of a population cutoff in the first two columns, a 5% bandwidth in columns 3 and 4 and all municipalities within the bracket mid-points around a cutoff in the last column. Standard errors in parentheses are clustered at the municipality level. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

3 Results (A: Impact of tax revenues)

Table 5 presents results allowing for the impact of the program on tax revenues to vary with the amount of time a municipality had to wait between applying to and starting the program. The first column reproduces the baseline estimate in Table 3 in the paper, results in the next four columns restrict the sample of municipalities that participate to the program to municipalities that waited for a given number of years. Table 6 presents the impact of extra tax revenues

Table 5: Impact of tax capacity program on taxes by waiting period

Waiting time	(1) All	(2) 0 years	(3) 1 year	(4) 2 years	(5) 3 years or more
Program	11.630***	12.403***	9.593***	13.113***	8.640
	(2.558)	(3.814)	(3.533)	(4.690)	(8.050)
Has applied	0.417	0.000	0.829	0.395	-2.253
	(2.167)	(.)	(1.829)	(2.756)	(7.181)
Covariates	Yes	Yes	Yes	Yes	Yes
Observations	57507	53890	55349	53686	53303
Clusters	4578	4312	4417	4296	4270

Notes: The dependent variable is municipal tax revenues per capita. The first column reproduces the baseline result in Table 3, column 2 in the text, the following columns exclude all municipalities that join the program at some point in the period except for those that waited 0 years between applying to and starting the program (col 2), 1 year (col 3), 2 years (col 4) and 3 years or more (col 5). There are 73 municipalities that wait 0 years, 178 that wait 1 year, 57 that wait 2 years, and 31 that wait more than 3 years. All specifications include an indicator for having applied to the program, year fixed effects, municipality fixed effects, and time-varying controls. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

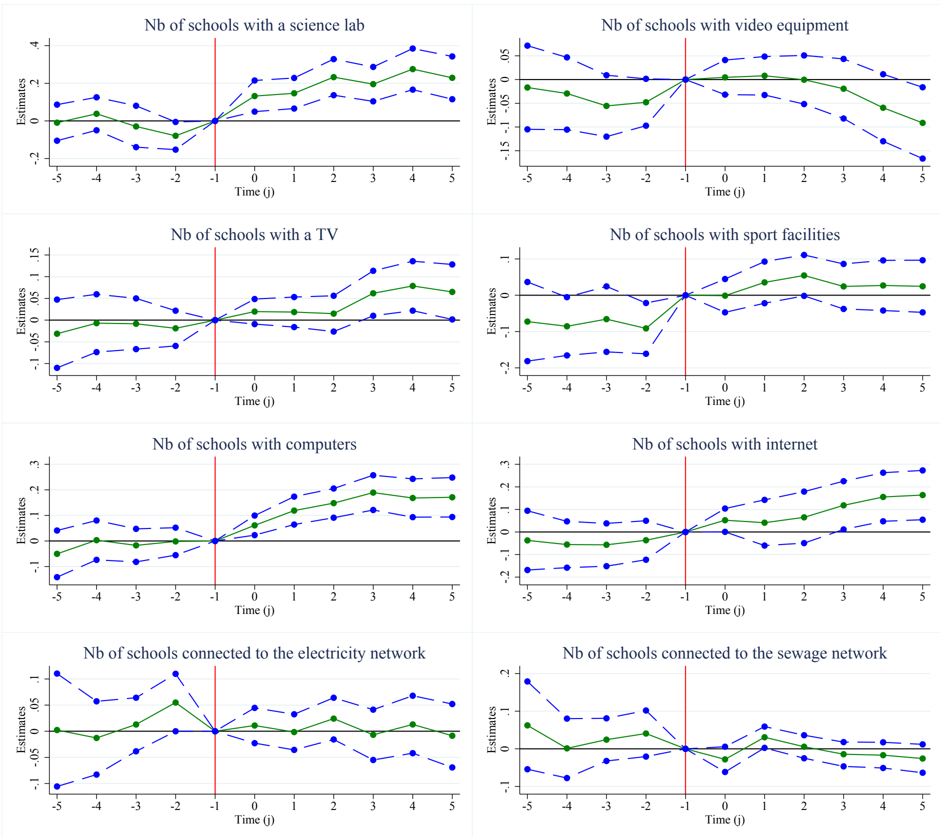
on the number of municipal school employees per thousand school-age inhabitants. Program participation is used as an instrument for tax revenues. Figure 11 shows the reduced form impact of the PMAT program on all the measures of municipal school quality used to construct the index for education infrastructure quality, following the specification of equation (5) in the paper.

Table 6: Impact of tax revenues on additional education inputs: number of municipal school employees

	(1) Whole sample	(2) Whole sample	(3) Common support	(4) Mayor fixed effect
Tax revenue per capita	-0.424	0.130	0.305	0.918
	(0.421)	(0.503)	(0.541)	(0.775)
Has applied	-0.323	-0.618	-0.559	0.045
	(0.536)	(0.494)	(0.501)	(0.027)
Covariates	No	Yes	Yes	Yes
Observations	57650	57507	46661	57118
Clusters	4578	4578	3724	12757

Notes: The dependent variable is the number of municipal school employees per thousand school-age inhabitants. An indicator for program participation is used as an instrument for tax revenues per capita, tax revenues are per capita and in units of 10 Rs. All specifications include an indicator for having applied to the program and year fixed effects, columns 1-3 include municipality fixed effects, column 4 municipal administration fixed effects and columns 2-4 include time-varying controls. The sample in column 3 is the common support sample and non-PMAT municipalities are weighted by a function of their estimated propensity score. Standard errors in parentheses are clustered at the municipality level. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

Figure 11: Evolution of municipal school quality indicators in PMAT vs non-PMAT municipalities



Notes: Each point on the solid (green) line represents the impact on the dependent variable of having been in the program for j years (for $j > 0$) or of starting the program in j years (for $j < 0$), estimated following specification (5) in the paper. The red vertical line at $j = -1$ indicates the reference year. The points on the dashed (blue) lines represent the 95% confidence interval for the estimates.

3.1 Impact on census outcomes: literacy rates in 2000 and 2010

This section considers whether the tax capacity program affected the one type of education outcome for which data is available both before and after the start of the program. The Brazilian population census, conducted every 10 years, collects data on literacy rates which is available by age groups at the municipality level. Municipalities primarily manage pre-schools, in which students aged 2 to 6 are (optionally) enrolled and schools covering the first to fourth grades of ensino fundamental (primary school), in which children aged 6 to 10 are enrolled. I therefore consider literacy rates of individuals aged 5-9, 10-14 and 15-20 in 2010 and 2000: those individuals in 2010 were of pre-school and primary school age during the 2000-2010 period. I also consider as a placebo the evolution from 2000 to 2010 of literacy rates of individuals aged 20-30, most of which were too old to attend primary school during that period in the spirit of Duflo (2004).[1]

Table 7 presents descriptive statistics of these variables for municipalities that join PMAT in 2001-2010 (municipalities that join before 2001 are excluded from the sample) and municipalities that never join: all municipalities in column 2 and only common support municipalities, weighted by a function of their propensity score, in column 3. We see that literacy rates were already very high in PMAT municipalities in 2000 (first panel): for all age groups above 9 literacy rates are above 96%, leaving little room for improvement over the next decade. Municipalities that never join the program have lower literacy rates for all age groups in 2000, but this is no longer the case when restricting that group to the common support sample and re-weighting.

Table 7: Literacy rates (%) in the 2000 and 2010 Census

	PMAT	Non-PMAT	Common support
2000 Census			
Ages 5-9	60.2	51.2	58.9
	(9.5)	(16.1)	(11.1)
Ages 10-14	97.1	92.4	95.9
	(4.1)	(8.6)	(5.6)
Ages 15-19	97.6	93.8	96.7
	(3.1)	(6.6)	(4.3)
Ages 20-29	96.1	89.7	94.7
	(5.1)	(9.7)	(6.5)
2010 Census			
Ages 5-9	78.0	68.2	74.6
	(7.7)	(14.9)	(10.5)
Ages 10-14	98.5	95.9	97.4
	(1.8)	(4.6)	(2.9)
Ages 15-19	98.8	97.5	98.4
	(3.2)	(2.8)	(1.7)
Ages 20-29	98.3	95.9	97.8
	(2.0)	(4.0)	(2.0)

Notes: The sample includes the 315 municipalities that join the PMAT program between 2001 and 2010 (column 1),4239 non PMAT municipalities (column 2) and 3448 non PMAT municipalities in the common support sample (column 3).

Table 8 presents the reduced form impact of the program on literacy rates. Note that in these regressions there are only two observations (one for 2000 and one for 2010) per municipality.

[1]Data from the 2000 and 2010 census is extracted from the IBGE's SIDRA database.

Results in Panel A are obtained using the whole sample: we see no impact of the program on the literacy rate of age group 5-9, the only variable which was not already close to 100% in PMAT municipalities in 2000, and a negative (though rarely statistically significant) impact of the program amongst other age groups, including the age group 20-30 which covers individuals who most likely did not attend municipal schools over the period. These negative effects are probably due to the fact that literacy rates were already close to 100% in PMAT municipalities in 2000 and non PMAT municipalities caught up over the 2000-2010 period - see the last panel of Table 7. To circumvent this issue Panel B presents results obtained using the common support sample: in this sample municipalities that never join the PMAT program have literacy rates in 2000 that are similar to those of municipalities that eventually join the program. Here we see a small (1 percentage point) and marginally statistically significant impact of the program on literacy rates for the age group 5-9, but again no effect in older age groups.

These results suggest there was a slight improvement in education levels of children in municipalities that joined the program in 2000-2010. Given the data available this effect can only really be measured for the one variable which can still be improved in those municipalities after 2000 - literacy rates amongst the youngest age group.

Table 8: Reduced form impact of the tax capacity program on literacy rates

A: Whole sample				
Age group:	5-9	10-14	15-19	20-30
Program	0.447	-0.071	-0.403*	-0.443
	(0.374)	(0.188)	(0.160)	(0.241)
Observations	9108	9108	9108	9108
Clusters	4554	4554	4554	4554
B: Common support sample (weighted)				
Age group:	5-9	10-14	15-19	20-30
Program	1.042*	0.092	-0.205	-0.123
	(0.516)	(0.205)	(0.171)	(0.255)
Observations	7526	7526	7526	7526
Clusters	3763	3763	3763	3763

Notes: The sample includes all municipalities in the years 2000 and 2010 for which literacy data is available in both Census. Dependent variables are literacy rates in that year for different age groups. All specifications include year and municipality fixed effects and time-varying controls. The sample in panel B is the common support sample and non-PMAT municipalities are weighted by a function of their estimated propensity score. Standard errors in parentheses are clustered at the municipality level. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

4 Results (B: Impact of non-tax revenues)

Tables 9, 10 and 11 present the estimates of 1) the impact of the population cutoffs on FPM revenues per capita 2) the impact of FPM revenues per capita on municipal school infrastructure using the population cutoffs as an instrument for FPM revenues. The first line in each Table presents the pooled estimates (equation (9) in the paper), the second line the pooled estimates obtained when excluding cutoffs 1,8 and 13 close to which the wage of local councillors jump, and the remaining lines show the estimates for each cutoff separately (equations 6 and 7 in the paper). Graphical evidence on the reduced form impact of the cutoffs on outcomes is given in Figures 12 to 20.

Finally Table 12 presents the impact of FPM revenues per capita on the number of municipal school employees per thousand school age inhabitants using the population cutoffs as an instrument.

Table 9: Impact of cutoffs on non-tax revenues per capita

Polynomial specification: Sample: Covariates and municipality FE:	Linear 2% No	Linear 2% Yes	Linear 5% No	Linear 5% Yes	Third-order All Yes
All cutoffs	12.501*** (0.991)	11.928*** (0.761)	13.632*** (0.668)	12.995*** (0.511)	14.382*** (0.710)
Without cutoffs 1,8 and 13	11.249*** (0.954)	11.176*** (0.733)	12.295*** (0.661)	12.026*** (0.475)	12.597*** (0.635)
Cutoff 1	21.877*** (4.004)	23.699*** (2.732)	22.685*** (2.520)	23.408*** (2.137)	24.676*** (1.880)
Cutoff 2	21.739*** (2.687)	21.017*** (2.124)	23.107*** (1.863)	20.866*** (1.366)	19.180*** (1.598)
Cutoff 3	12.632*** (2.629)	14.278*** (2.099)	16.218*** (1.779)	16.909*** (1.138)	16.293*** (1.539)
Cutoff 4	11.197*** (2.200)	13.118*** (1.426)	12.244*** (1.506)	13.253*** (0.910)	13.242*** (1.046)
Cutoff 5	10.527*** (2.028)	9.805*** (1.460)	9.148*** (1.462)	8.801*** (0.905)	8.313*** (1.127)
Cutoff 6	6.920** (2.565)	7.214*** (1.324)	6.771*** (1.888)	6.651*** (0.945)	6.094*** (1.200)
Cutoff 7	5.769** (1.818)	7.116*** (1.093)	6.903*** (1.386)	6.815*** (0.875)	5.234*** (1.224)
Cutoff 8	6.679** (2.226)	5.771*** (1.036)	7.965*** (1.847)	6.019*** (0.828)	6.323*** (1.019)
Cutoff 9	7.319*** (1.814)	4.879*** (1.285)	6.944*** (1.281)	5.592*** (0.776)	4.502*** (1.148)
Cutoff 10	6.127* (2.331)	4.588*** (1.072)	5.634*** (1.330)	5.865*** (0.814)	4.961*** (1.079)
Cutoff 11	4.465* (2.139)	5.689*** (1.164)	4.616*** (1.356)	4.371*** (0.950)	4.299** (1.392)
Cutoff 12	5.015* (2.135)	3.342** (1.027)	3.905* (1.550)	4.946*** (0.458)	3.115*** (0.758)
Cutoff 13	2.203 (2.181)	3.801** (1.162)	2.834* (1.275)	4.081*** (0.646)	3.657*** (0.988)
Cutoff 14	6.462 (3.228)	5.394*** (1.348)	4.955* (2.314)	5.807*** (1.250)	5.444*** (1.444)

Notes: The dependent variable is FPM revenues per capita. All specifications include year fixed effects and control flexibly for population size, using local linear regressions in columns 1-4 and a spline third-order polynomial in the last column. Covariates are municipality fixed effects, GDP per capita, the share of agriculture and services in GDP, municipal population and political characteristics of the municipality. The sample includes all municipalities within a 2% bandwidth of a population cutoff in the first two columns, a 5% bandwidth in columns 3 and 4 and all municipalities within the bracket mid-points around a cutoff in the last column. The first line presents results obtained when pooling all thresholds. Standard errors in parentheses are clustered at the municipality level. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***. The sample includes all 4792 municipalities that are not state capitals and with a population of less than 142,633 inhabitants over the period 1998-2011.

Table 10: Impact of non-tax revenues on municipal school infrastructure (quantity)

Polynomial specification:	Linear	Linear	Linear	Linear	Third-order
Sample:	2%	2%	5%	5%	All
Covariates and municipality FE:	No	Yes	No	Yes	Yes
All cutoffs	0.195	-0.084	0.022	-0.045	-0.068
	(0.191)	(0.085)	(0.127)	(0.056)	(0.071)
Without cutoffs 1,8 and 13	0.155	-0.115	0.034	-0.067	-0.117
	(0.280)	(0.117)	(0.199)	(0.083)	(0.123)
Cutoff 1	0.367	-0.137	0.014	-0.016	-0.165
	(0.464)	(0.146)	(0.329)	(0.110)	(0.111)
Cutoff 2	0.289	0.339*	-0.134	0.001	-0.050
	(0.325)	(0.142)	(0.226)	(0.103)	(0.144)
Cutoff 3	-0.156	0.016	-0.140	0.222	0.216
	(0.443)	(0.226)	(0.277)	(0.144)	(0.172)
Cutoff 4	0.251	0.176	0.467	-0.090	-0.001
	(0.543)	(0.158)	(0.394)	(0.118)	(0.171)
Cutoff 5	-0.127	-0.087	0.649	0.092	0.179
	(0.675)	(0.259)	(0.451)	(0.185)	(0.348)
Cutoff 6	-0.324	-2.182*	-0.684	-0.846	-0.710
	(1.435)	(0.856)	(0.812)	(0.440)	(0.644)
Cutoff 7	-0.145	-0.430	-0.828	-0.516	-0.258
	(1.468)	(0.516)	(1.006)	(0.460)	(0.582)
Cutoff 8	-0.245	0.026	0.305	0.042	0.545
	(1.027)	(0.279)	(0.695)	(0.224)	(0.387)
Cutoff 9	0.095	1.850*	0.418	-0.633	-0.382
	(1.107)	(0.914)	(0.946)	(0.408)	(0.704)
Cutoff 10	-0.142	-0.173	-0.922	0.003	0.405
	(1.738)	(0.585)	(1.178)	(0.292)	(0.587)
Cutoff 11	0.885	-1.434**	0.355	-0.111	-1.090
	(1.491)	(0.515)	(0.916)	(0.381)	(0.803)
Cutoff 12	-2.831	-2.079	0.088	-0.053	-1.371
	(2.202)	(2.075)	(1.141)	(0.358)	(1.766)
Cutoff 13	2.970	-0.385	0.777	-0.496	-0.498
	(6.085)	(0.683)	(3.006)	(0.566)	(0.896)
Cutoff 14	-1.257	-0.836	-0.149	-0.847*	0.029
	(1.921)	(0.962)	(2.233)	(0.404)	(0.772)

Notes: The dependent variable is the number of classrooms in municipal schools per thousand school-age inhabitants. An indicator equal to one if lagged population is above a population cutoff is used as an instrument for non-tax revenue. Transfer revenues are per capita and in units of 10 Rs. See notes to Table 10.

Table 11: Impact of non-tax revenues on municipal school infrastructure (quality)

Polynomial specification:	Linear	Linear	Linear	Linear	Third-order
Sample:	2%	2%	5%	5%	All
Covariates and municipality FE:	No	Yes	No	Yes	Yes
All cutoffs	0.050	0.036	-0.036	-0.011	-0.005
	(0.061)	(0.026)	(0.038)	(0.016)	(0.019)
Without cutoffs 1,8 and 13	0.039	0.019	-0.089	-0.017	0.008
	(0.099)	(0.041)	(0.067)	(0.027)	(0.035)
Cutoff 1	0.012	0.034	0.031	0.001	-0.018
	(0.098)	(0.039)	(0.069)	(0.026)	(0.028)
Cutoff 2	0.026	-0.011	0.018	0.001	0.000
	(0.103)	(0.044)	(0.069)	(0.032)	(0.040)
Cutoff 3	-0.009	0.073	-0.056	0.012	0.031
	(0.152)	(0.057)	(0.086)	(0.033)	(0.041)
Cutoff 4	-0.303	0.035	-0.195	-0.036	-0.047
	(0.171)	(0.070)	(0.112)	(0.047)	(0.057)
Cutoff 5	0.411	-0.073	-0.081	0.030	0.037
	(0.251)	(0.096)	(0.175)	(0.067)	(0.092)
Cutoff 6	0.926	0.044	-0.040	0.099	0.310
	(0.626)	(0.169)	(0.388)	(0.135)	(0.188)
Cutoff 7	-0.598	0.018	-0.440	-0.202	0.035
	(0.516)	(0.124)	(0.305)	(0.115)	(0.170)
Cutoff 8	0.385	0.303	-0.094	-0.069	0.293
	(0.493)	(0.171)	(0.214)	(0.124)	(0.216)
Cutoff 9	-0.650	-0.052	-0.320	0.135	-0.108
	(0.408)	(0.306)	(0.300)	(0.169)	(0.285)
Cutoff 10	0.322	0.095	-0.290	-0.261	0.032
	(0.719)	(0.332)	(0.480)	(0.155)	(0.236)
Cutoff 11	1.373	0.348	0.527	0.107	0.222
	(1.023)	(0.209)	(0.517)	(0.142)	(0.347)
Cutoff 12	-0.566	-0.864	-0.828	-0.103	-0.244
	(0.633)	(0.816)	(0.695)	(0.190)	(0.872)
Cutoff 13	3.266	0.601	0.795	-0.414	-0.192
	(3.551)	(0.605)	(1.297)	(0.442)	(0.673)
Cutoff 14	-0.030	0.947***	1.426	0.102	0.258
	(1.004)	(0.241)	(1.261)	(0.307)	(0.517)

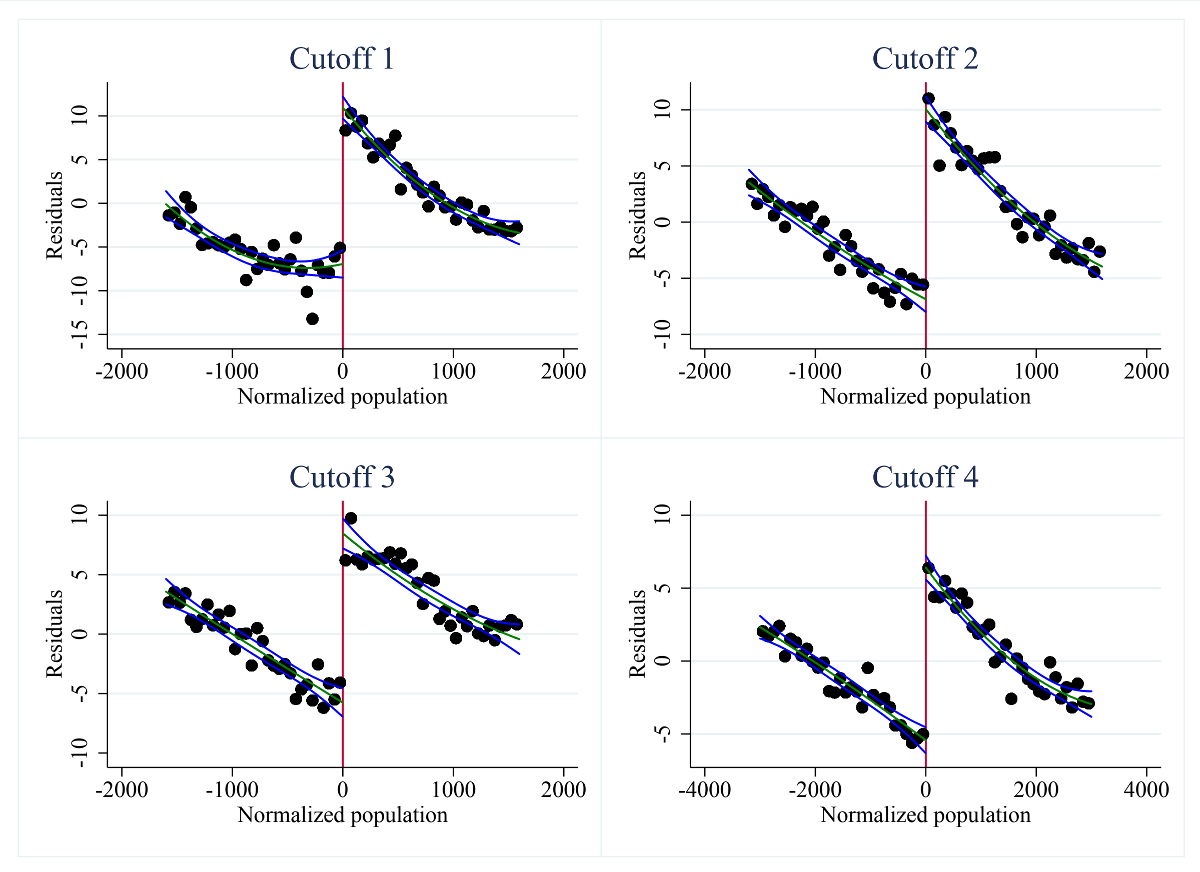
Notes: The dependent variable is the index of quality of municipal school infrastructure. An indicator equal to one if lagged population is above a population cutoff is used as an instrument for non-tax revenue. Transfer revenues are per capita and in units of 10 Rs. See notes to Table 10.

Table 12: Impact of non-tax revenues on municipal school employees

Polynomial specification:	Linear	Linear	Linear	Linear	Third-order
Sample:	2%	2%	5%	5%	All
Covariates and municipality FE:	No	Yes	No	Yes	Yes
All cutoffs	0.633	-0.023	0.019	0.032	-0.110
	(0.727)	(0.438)	(0.449)	(0.224)	(0.256)
Cutoff 1	1.265	0.144	0.123	0.280	-0.051
	(1.704)	(0.686)	(1.039)	(0.437)	(0.404)
Cutoff 2	0.894	0.369	-0.380	0.029	0.124
	(1.207)	(0.498)	(0.741)	(0.332)	(0.448)
Cutoff 3	-0.065	0.498	-1.051	0.596	0.583
	(1.941)	(2.147)	(1.141)	(0.749)	(0.809)
Cutoff 4	1.527	1.101	1.666	0.037	0.203
	(2.003)	(0.617)	(1.342)	(0.456)	(0.557)
Cutoff 5	1.519	-0.840	1.847	-0.520	-0.650
	(2.225)	(0.832)	(1.567)	(0.685)	(1.042)
Cutoff 6	-2.991	-4.982*	-2.498	-1.073	-0.728
	(6.071)	(2.335)	(3.905)	(1.414)	(2.017)
Cutoff 7	-7.414	-3.548*	-0.386	-1.929	-2.719
	(5.299)	(1.773)	(3.606)	(1.370)	(1.883)
Cutoff 8	-2.743	-0.862	-0.667	-0.856	-1.088
	(4.943)	(2.713)	(3.356)	(1.833)	(2.052)
Cutoff 9	2.332	-5.110	2.551	-0.989	0.799
	(4.079)	(2.737)	(3.557)	(1.373)	(2.524)
Cutoff 10	0.600	1.237	-0.681	1.529	1.633
	(6.861)	(2.238)	(5.546)	(1.471)	(2.516)
Cutoff 11	3.908	-3.461	2.403	0.595	-4.511
	(9.305)	(1.983)	(5.393)	(1.515)	(4.181)
Cutoff 12	-10.685	-3.648	-2.577	1.650	-4.186
	(9.045)	(4.014)	(6.280)	(1.357)	(3.968)
Cutoff 13	17.813	1.625	7.932	0.607	-1.801
	(31.788)	(2.791)	(12.856)	(2.066)	(4.062)
Cutoff 14	-13.252	-0.475	-7.907	-1.770	-1.384
	(9.662)	(3.233)	(8.492)	(1.573)	(2.731)

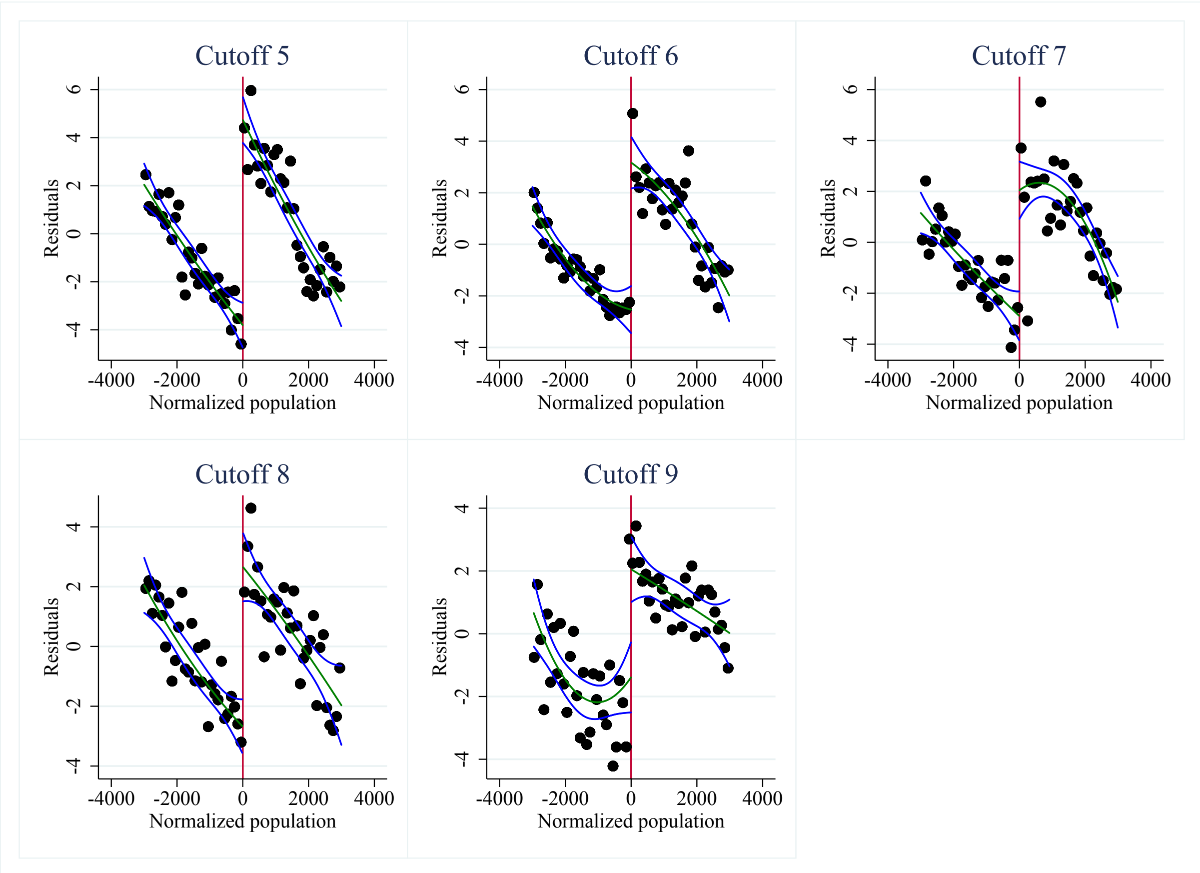
Notes: The dependent variable is the number of municipal school employees per thousand school-age inhabitans. An indicator equal to one if lagged population is above a population cutoff is used as an instrument for non-tax revenue. Transfer revenues are per capita and in units of 10 Rs. See notes to Table 10.

Figure 12: Non-tax revenues per capita as a function of municipal population: cutoffs 1 to 5



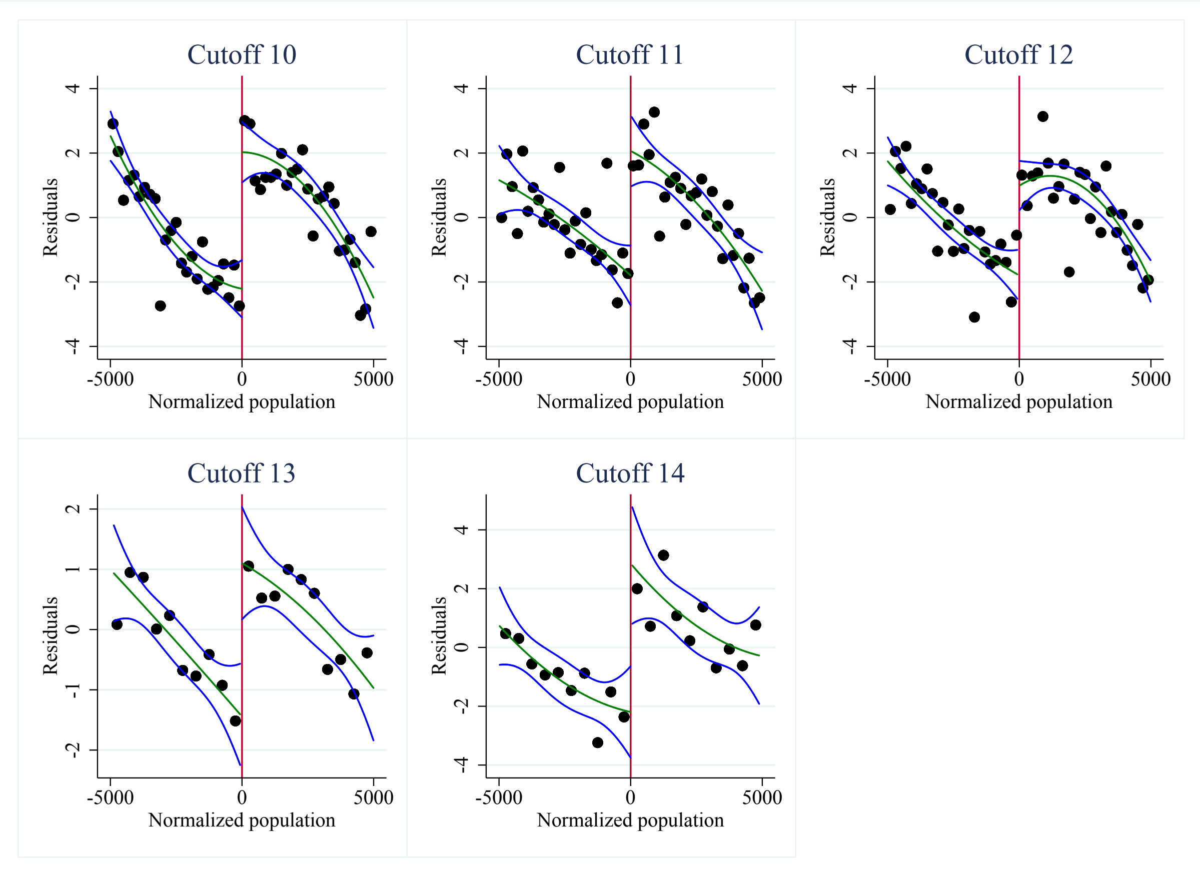
Notes: Each point represents residual FPM transfer revenues per capita as a function of normalized municipal population in the previous year averaged over 50 inhabitant bins (cutoffs 1 to 3) or 100 inhabitant bins (cutoffs 4 and 5). Population size is normalized as the distance from the above or below threshold; symmetric intervals with no municipality in more than one interval. The central (green) line is a spline polynomial in population size fitted separately on each side of the cutoff at zero, the top and bottom (blue) lines are the 95% confidence interval. In each graph the sample includes all municipalities in symmetric intervals around the cutoff (no municipality is in two intervals) and excludes state capitals. Sample sizes are 11,299 (cutoff 1) 6,723 (cutoff 2) 7,165(cutoff 3) 5,333 (cutoff 4) and 3,5952 (cutoff 5).

Figure 13: Non-tax revenues per capita as a function of municipal population: cutoffs 6 to 10



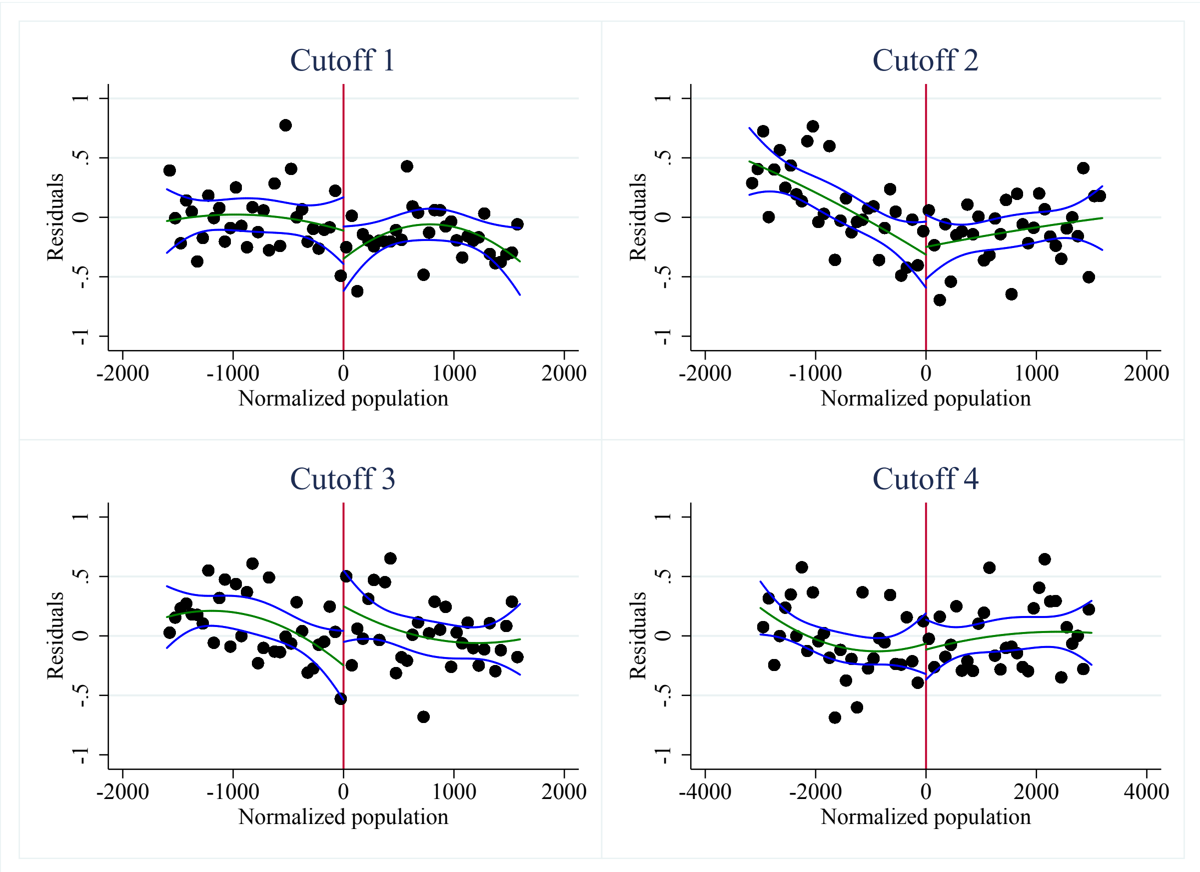
Notes: Each point represents FPM transfer revenues per capita as a function of normalized municipal population in the previous year averaged over 100 inhabitant bins (cutoffs 6 to 9) or 200 inhabitant bins (cutoff 10). Sample sizes are 2,114 (cutoff 6) 1,875 (cutoff 7) 1,023 (cutoff 8) 1,350 (cutoff 9) and 892 (cutoff 10). See notes to Figure 12.

Figure 14: Non-tax revenues per capita as a function of municipal population: cutoffs 11 to 15



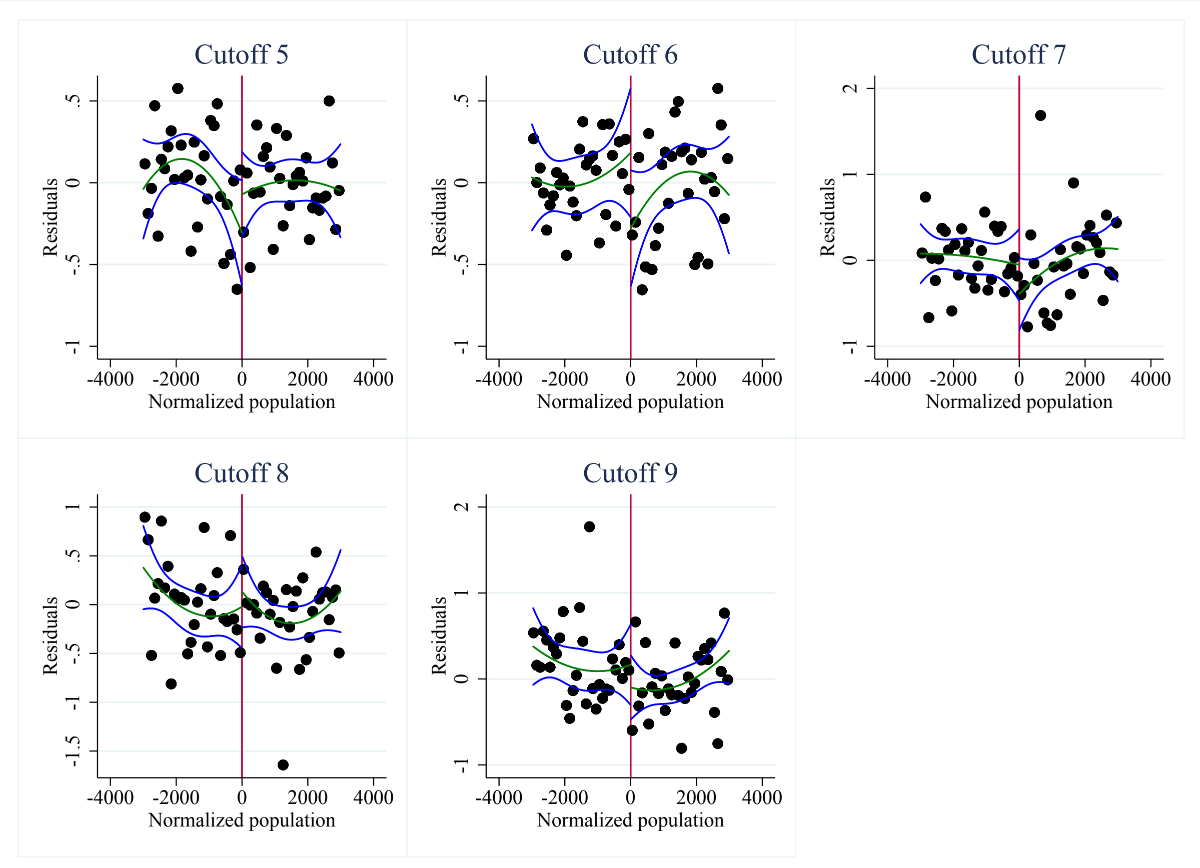
Notes: Each point represents FPM transfer revenues per capita as a function of normalized municipal population in the previous year averaged over 200 inhabitant bins (cutoffs 11 and 12) or 500 inhabitant bins (cutoffs 13 to 15). Sample sizes are 721 (cutoff 11) 502 (cutoff 12) 493 (cutoff 13) 401 (cutoff 14) and 353 (cutoff 15). See notes to Figure 12.

Figure 15: Municipal education infrastructure (quantity) as a function of municipal population: cutoffs 1 to 4



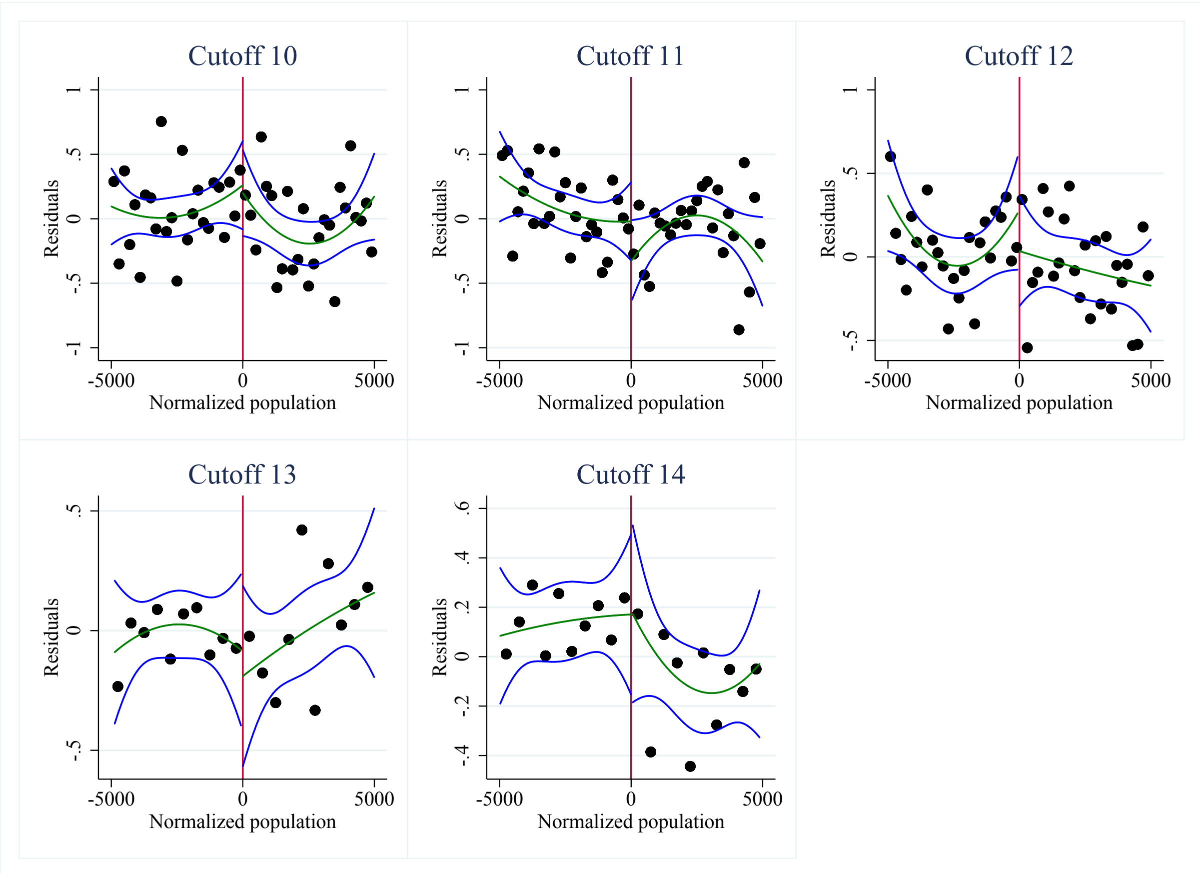
Notes: Each point represents the number of municipal classrooms per thousand school-age inhabitants as a function of normalized municipal population in the previous year averaged over 50 inhabitant bins (cutoffs 1 to 3) or 100 inhabitant bins (cutoffs 4 and 5). Sample sizes are 11,299 (cutoff 1) 6,723 (cutoff 2) 7,165(cutoff 3) 5,333 (cutoff 4) and 3,5952 (cutoff 5). See notes to Figure 12.

Figure 16: Municipal education infrastructure (quantity) as a function of municipal population: cutoffs 5 to 9



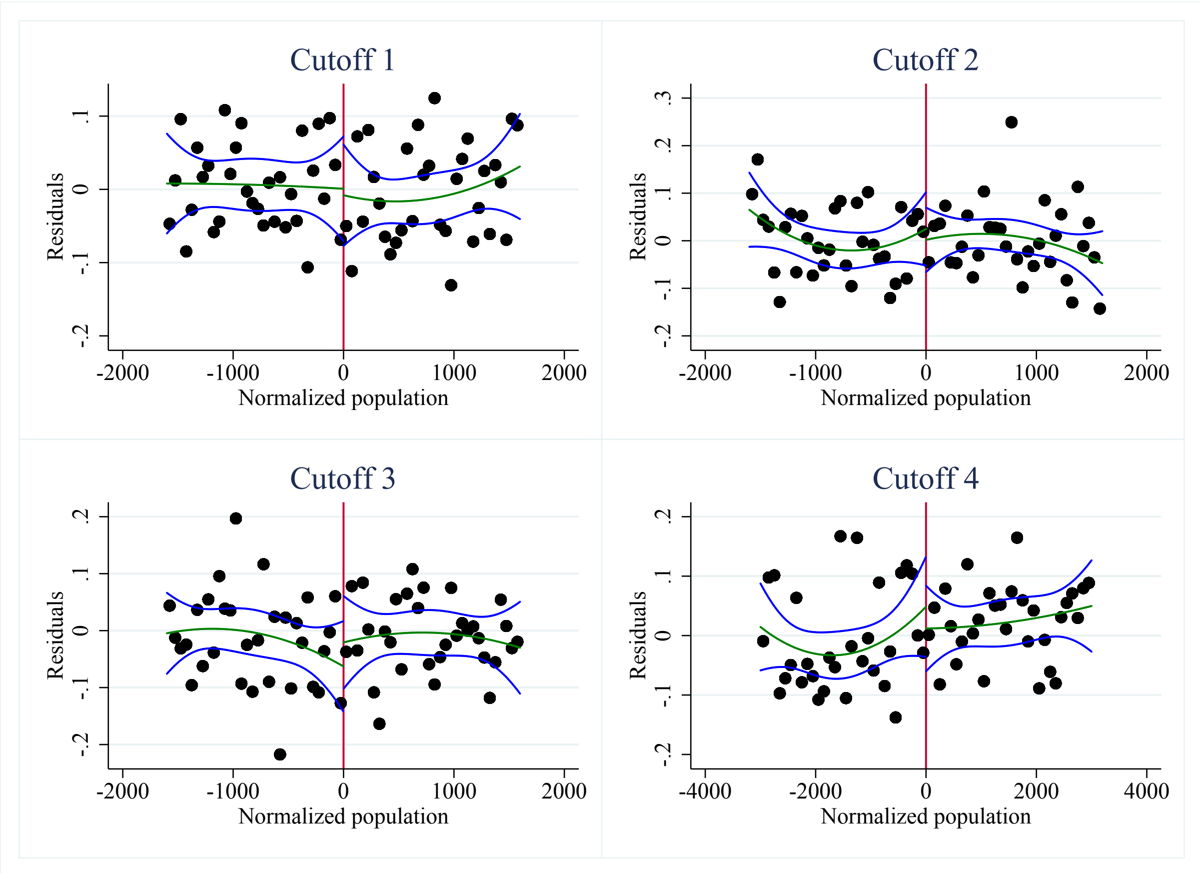
Notes: Each point represents the number of municipal classrooms per thousand school-age inhabitants as a function of normalized municipal population in the previous year averaged over 100 inhabitant bins (cutoffs 6 to 9) or 200 inhabitant bins (cutoff 10). Sample sizes are 2,114 (cutoff 6) 1,875 (cutoff 7) 1,023 (cutoff 8) 1,350 (cutoff 9) and 892 (cutoff 10). See notes to Figure 12.

Figure 17: Municipal education infrastructure (quantity) as a function of municipal population: cutoffs 10 to 14



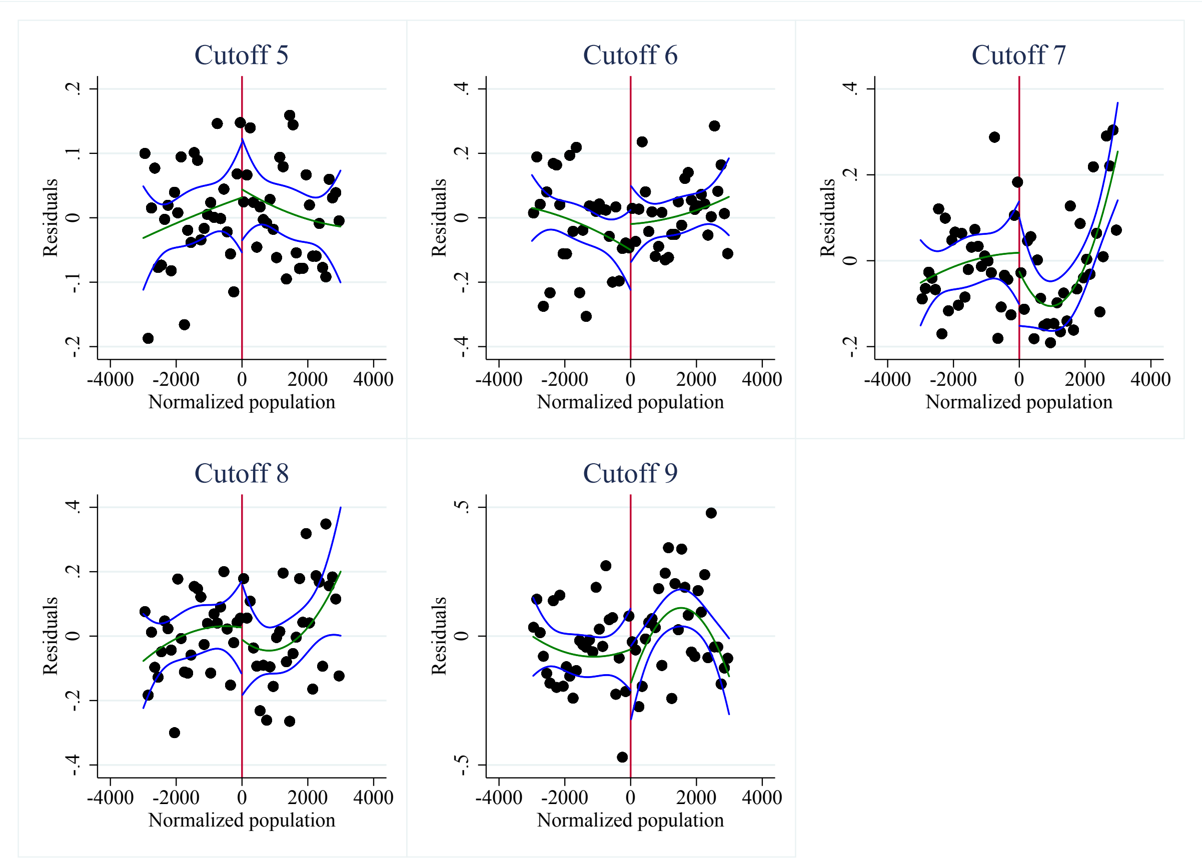
Notes: Each point represents the number of municipal classrooms per thousand school-age inhabitants per capita as a function of normalized municipal population in the previous year averaged over 200 inhabitant bins (cutoffs 11 and 12) or 500 inhabitant bins (cutoffs 13 to 15). Sample sizes are 721 (cutoff 11) 502 (cutoff 12) 493 (cutoff 13) 401 (cutoff 14) and 353 (cutoff 15). See notes to Figure 12.

Figure 18: Municipal education infrastructure (quality) as a function of municipal population: cutoffs 1 to 4



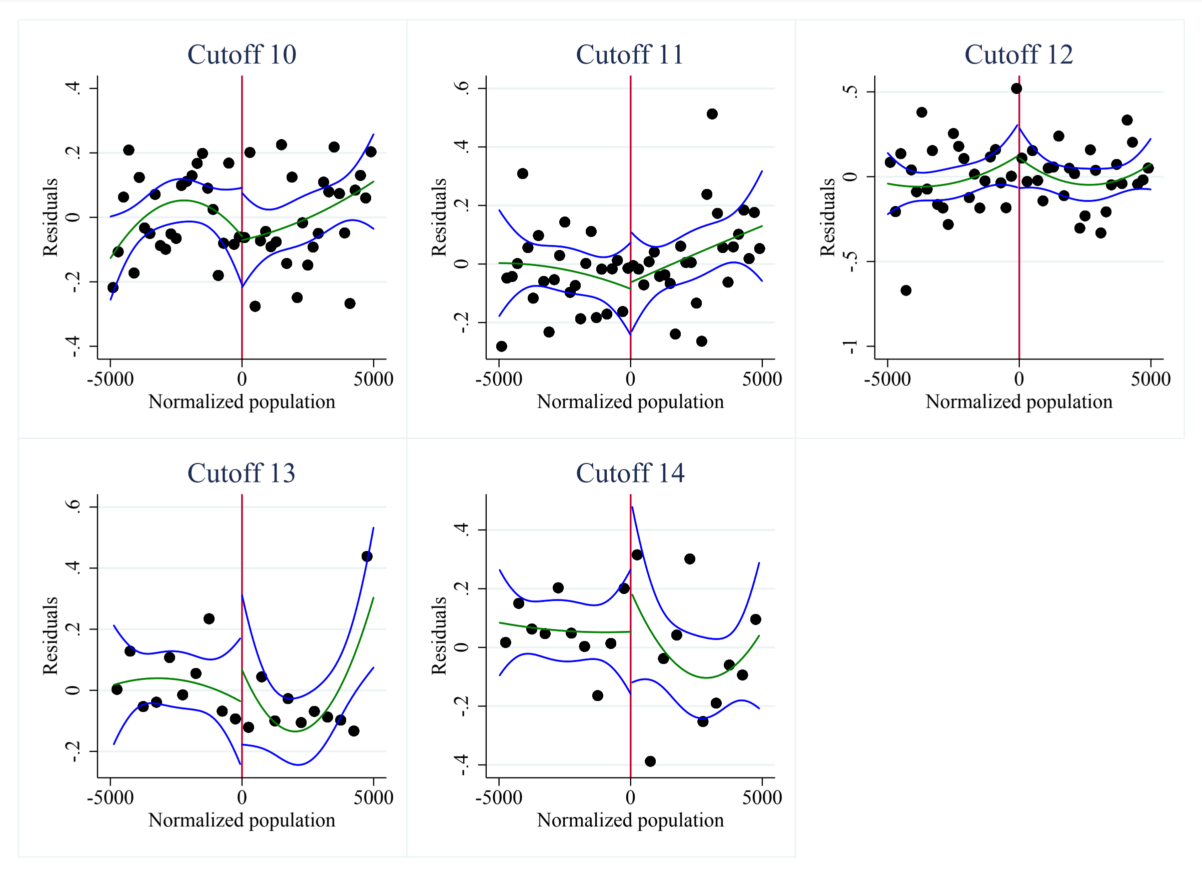
Notes: Each point represents the index of municipal education infrastructure quality as a function of normalized municipal population in the previous year averaged over 50 inhabitant bins (cutoffs 1 to 3) or 100 inhabitant bins (cutoffs 4 and 5). Sample sizes are 11,299 (cutoff 1) 6,723 (cutoff 2) 7,165(cutoff 3) 5,333 (cutoff 4) and 3,5952 (cutoff 5). See notes to Figure 12.

Figure 19: Municipal education infrastructure (quality) as a function of municipal population: cutoffs 5 to 9



Notes: Each point represents the index of municipal education infrastructure quality as a function of normalized municipal population in the previous year averaged over 100 inhabitant bins (cutoffs 6 to 9) or 200 inhabitant bins (cutoff 10). Sample sizes are 2,114 (cutoff 6) 1,875 (cutoff 7) 1,023 (cutoff 8) 1,350 (cutoff 9) and 892 (cutoff 10). See notes to Figure 12.

Figure 20: Municipal education infrastructure (quality) as a function of municipal population: cutoffs 10 to 14



Notes: Each point represents the index of municipal education infrastructure quality as a function of normalized municipal population in the previous year averaged over 200 inhabitant bins (cutoffs 11 and 12) or 500 inhabitant bins (cutoffs 13 to 15). Sample sizes are 721 (cutoff 11) 502 (cutoff 12) 493 (cutoff 13) 401 (cutoff 14) and 353 (cutoff 15). See notes to Figure 12.

4.1 Comparison with Litschig and Morrison (2013)

This section replicates the empirical strategy used by Litschig and Morrison (2013) to consider the impact of higher transfer revenues in the 1980s for the 2000s. Litschig and Morrison (2013) study the impact of higher transfer revenues over the period 1982-1985 on education outcomes measured in the 1990 Census. They only consider municipalities around the first three cutoffs. The amount of FPM transfers received in 1982, 1983, 1984 and 1985 was determined by population estimates in 1980. The transfer allocation rule applied to these estimates therefore has a very large and statistically significant impact on cumulated log total municipal spending per capita in 1982-1985 as being above a threshold in 1980 leads to a higher amount of transfers each year during the following five years, and transfers in that period represented 50% of total revenues: Table 4 in Litschig and Morrison (2013) shows that total spending in 1982-1985 increases by 15-20% when a municipality is above the population cutoff in 1980.

Table 13 looks for the effect of being above a population cutoff in 2000 on FPM revenues and total public spending in 2002-2005. Following the specifications used in Table 4 in Litschig and Morrison (2013) all specifications include state fixed effects and control flexibly for population size, using local linear regressions in columns 1-8 and a spline third-order polynomial in the last column. The sample includes all municipalities within a 2% bandwidth of a population cutoff in the first column, a 3% bandwidth in column 2, a 4% bandwidth in column 3 and a 15% bandwidth in the last column. Covariates are, following Litschig and Morrison (2013), municipal GDP per capita, median education level, poverty rates, literacy rates and urbanization rates all measured in 2000. The first part in each panel presents results obtained when pooling the first three cutoffs, the second part results obtained for each of these cutoffs separately.

The first panel shows that being above one of the first three cutoffs in 2000 does have a positive impact on total FPM transfer revenues received in 2002 to 2005, but this impact is noisy: the magnitude of the estimates vary across specifications and are not always statistically significant when considering each cutoff separately. This is because the population estimates for 2000 were only used to determine transfers for 2001, transfers in 2002 were determined by estimates for 2001, transfers in 2003 by estimates for 2002 etc. As municipal population grows over time many municipalities change population bracket between 2000 and 2004, so population estimates in 2000 have a noisy impact on transfers received in the 2002-2005 period. When looking at each cutoff separately we see that the allocation rule applied to the 2000 population never has a statistically significant impact around the first cutoff, and only has a consistently statistically significant (but noisy) impact around the third cutoff. The second panel of Table 13 uses total municipal spending over the period 2002-2005 as an outcome variable. We see that being above a population cutoff in 2000 has no impact on this variable when considering all three cutoffs together: the estimates change sign across specification and are far from statistically significant. This can be explained by i) the imprecise impact of the cutoffs on transfer revenues seen in the first panel and ii) the fact that transfers per capita represent a much smaller (27%) share of total revenues in the early 2000s than in the early 1980s. Finally the last panel of Table 13 replicates the results in Litschig and Morrison (2013) Table 4 for the 2000 period by using log total expenditure per capita as the outcome variable. The estimates obtained on the full sample are positive but far from statistically significant and again vary substantially across specifications.

Table 14 replicates the estimation strategy in Litschig and Morrison (2013) to look for an impact of the population discontinuities in 2000 on education outcomes measured in the 2010 census. The first panel looks at the impact on the literacy rate of 20 to 29 year-olds in 2010 and should be compared to Table 7 in Litschig and Morrison (2013) which considers the impact on the literacy rate of 19 to 28 year-olds in 1991 (the exact same variable is not available in the 2010 census). Litschig and Morrison (2013) also consider the impact of the population discontinuities on the average years of schooling of 19 to 28 year-olds in 1991, this variable is not available in the 2010 Census which does not disclose years of schooling by age group, instead I use the share of population with no primary education in 2010 in the second panel. The estimates vary strongly depending on the specification used and are never significantly positive.

The difference between the results presented in the main body of the paper and those in Litschig and Morrison (2013) cannot therefore be due to the use of different outcomes, empirical strategy, or time lag between the increase in transfers and the measure of outcomes: even when replicating, as best as possible given the available data, Litschig and Morrison (2013)'s empirical strategy I do not find an impact of FPM transfers on outcomes. The difference is more likely explained by three differences between their setting (the 1980s and early 1990s) and the 1998-2011 period studied here. First, their object of study is small municipalities (those around the first 3 population thresholds) in the 1980s, a period during which Brazilian local governments had a lot less revenues than in the 2000s, and hardly any tax revenues.[2] FPM revenues played a larger role in relaxing government's budget constraints back in the 1980s. Second, and perhaps most importantly, they study an extremely large increase in transfer revenues of a magnitude and stability over time never observed since 1985. They consider cumulated transfers in the 1982-1985 period which were determined by municipal population measured in the 1980 census. From 1985 onwards population estimates were revised annually, leading to a much smaller effect on cumulated future transfer revenues of being above a population cutoff in any given year. The increase in FPM revenues they study thus represents 2.5% of local GDP in rural areas (1.4% in urban areas) compared to less than 0.3% of GDP in the 1998-2011 period.

These two elements help explain why we do not see an impact of population discontinuities in 2000 on total spending in 2002-2005. Note that a third element may play a role. Their main outcome of interest - literacy in adults aged 19 to 28, ie cohorts that would have been exposed to the higher transfers in the period they consider - is still low in the 1990 census they consider (78%) but much higher in the 2010 census (close to 90%), leaving less room for improvement - see descriptive statistics for literacy rates in Table 7.

[2]In particular, the large grants earmarked for education that municipalities currently receive were all created after the mid-1990s.

Table 13: Comparison with Litschig and Morrison (2013): transfers and public spending

Polynomial specification:	Linear	Linear	Linear	Linear	Linear	Linear	Third-order
Sample:	2%	2%	3%	3%	4%	4%	15%
Covariates:	No	Yes	No	Yes	No	Yes	Yes
Impact of the 2000 cutoffs on transfer revenues per capita in 2002-2005							
Pooled cutoffs 1-3	39.962	52.361*	36.206*	45.053**	37.046**	44.633**	43.401**
	(20.904)	(22.194)	(14.960)	(15.267)	(13.288)	(19.167)	(15.634)
Observations	190	190	272	272	355	355	1540
Cutoff 1	24.283	47.420	5.519	26.296	19.757	50.469	38.769
	(37.673)	(40.243)	(32.013)	(35.331)	(29.875)	(30.754)	(23.027)
Observations	70	70	96	96	116	116	781
Cutoff 2	54.251	72.162	52.784*	68.733*	34.176	37.319	34.533
	(32.448)	(37.111)	(25.736)	(28.291)	(20.306)	(21.371)	(21.892)
Observations	69	69	98	98	135	135	366
Cutoff 3	87.355**	101.881**	69.068**	68.184**	47.689*	49.994*	56.839**
	(28.987)	(31.385)	(21.814)	(24.040)	(19.800)	(20.847)	(19.910)
Observations	51	51	78	78	104	104	393
Impact of the 2000 cutoffs on public spending per capita in 2002-2005							
Pooled cutoffs 1-3	109.096	125.269	40.585	55.804	-34.987	-43.173	27.773
	(73.180)	(73.524)	(60.775)	(59.882)	(100.002)	(66.378)	(66.551)
Observations	190	190	272	272	355	355	1540
Cutoff 1	-21.430	-6.651	-160.840	-98.729	-120.118	-32.290	-22.826
	(127.822)	(141.527)	(119.680)	(124.345)	(99.616)	(97.469)	(96.873)
Observations	70	70	96	96	116	116	781
Cutoff 2	157.258	155.684	103.773	109.762	54.589	38.986	101.141
	(127.550)	(142.420)	(100.308)	(112.411)	(78.174)	(82.656)	(132.692)
Observations	69	69	98	98	135	135	366
Cutoff 3	356.770**	356.210**	181.895	117.027	91.636	52.244	90.574
	(127.926)	(122.091)	(105.376)	(97.839)	(94.405)	(86.444)	(98.272)
Observations	51	51	78	78	104	104	393
Impact of the 2000 cutoffs on log public spending per capita in 2002-2005							
Pooled cutoffs 1-3	0.803	1.088	0.316	0.593	0.214	0.476	0.433
	(0.615)	(0.630)	(0.511)	(0.521)	(0.427)	(0.420)	(0.347)
Observations	190	190	272	272	355	355	1540
Cutoff 1	-0.370	0.384	-1.533	-0.831	-0.861	0.076	-0.237
	(1.017)	(1.106)	(0.945)	(1.044)	(0.805)	(0.821)	(0.488)
Observations	70	70	96	96	116	116	781
Cutoff 2	0.946	1.386	0.725	1.256	0.246	0.477	0.738
	(1.217)	(1.381)	(0.945)	(1.054)	(0.690)	(0.738)	(0.698)
Observations	69	69	98	98	135	135	366
Cutoff 3	2.765**	2.705**	1.709*	1.283	0.900	0.750	1.086
	(0.831)	(0.843)	(0.803)	(0.799)	(0.754)	(0.757)	(0.725)
Observations	51	51	78	78	104	104	393

Notes: This table replicates the empirical strategy used by Litschig and Morrison (2013) on data twenty years later, see in particular their Table 4. The dependent variables are in the first panel cumulated municipal FPM revenue per capita over the period 2002-2005, in the middle panel cumulated municipal spending per capita over 2002-2005 and in the bottom panel log cumulated municipal spending per capita over 2002-2005. All specifications include state fixed effects and control flexibly for population size, using local linear regressions in columns 1-8 and a spline third-order polynomial in the last column.Covariates are, following Litschig and Morrison (2013), municipal GDP per capita, median education level, poverty rates, literacy rates and urbanization rates all measured in 2000. The sample includes all municipalities within a 2% bandwidth of a population cutoff in the first two columns, a 3% bandwidth in columns 3 and 4 , 4% bandwidth in columns 5 and 6 and a 15% bandwidth in columns 7 and 8. The first line in each panel presents results obtained when pooling the first three cutoffs, the remaining lines results obtained for each of the first three cutoffs separately. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

Table 14: Comparison with Litschig and Morrison (2013):education outcomes

Polynomial specification:	Linear	Linear	Linear	Linear	Linear	Linear	Third-order
Sample:	2%	2%	3%	3%	4%	4%	15%
Covariates:	No	Yes	No	Yes	No	Yes	Yes
Dependent variable: literacy rate of 20-29 years old							
All cutoffs	0.001	0.006	-0.002	0.003	-0.002	0.004	0.006
	(0.007)	(0.005)	(0.005)	(0.004)	(0.005)	(0.004)	(0.003)
Observations	190	190	272	272	355	355	1540
Cutoff 1	-0.001	0.007	-0.007	0.004	-0.001	0.010	0.008
	(0.011)	(0.010)	(0.009)	(0.007)	(0.007)	(0.006)	(0.005)
Observations	70	70	96	96	116	116	781
Cutoff 2	0.006	-0.005	0.003	-0.001	-0.002	-0.003	0.001
	(0.014)	(0.011)	(0.011)	(0.008)	(0.010)	(0.007)	(0.007)
Observations	69	69	98	98	135	135	366
Cutoff 3	0.000	0.010	0.000	0.005	0.004	0.006	0.009
	(0.013)	(0.009)	(0.009)	(0.006)	(0.009)	(0.006)	(0.006)
Observations	51	51	78	78	104	104	393
Dependent variable: share of population with no primary education							
All cutoffs	1.899	0.803	0.649	0.075	0.457	-0.143	0.112
	(1.781)	(1.051)	(1.408)	(0.806)	(1.268)	(0.655)	(0.656)
Observations	190	190	272	272	355	355	1540
Cutoff 1	3.857	0.249	2.509	0.039	1.689	-1.137	-0.205
	(3.030)	(2.312)	(2.260)	(1.624)	(2.091)	(1.328)	(0.978)
Observations	70	70	96	96	116	116	781
Cutoff 2	-3.358	2.881	-2.686	1.230	-1.025	0.805	-0.007
	(3.157)	(1.883)	(2.668)	(1.608)	(2.320)	(1.175)	(1.317)
Observations	69	69	98	98	135	135	366
Cutoff 3	2.117	0.868	0.999	0.672	-0.090	0.136	0.612
	(3.799)	(2.009)	(2.906)	(1.413)	(2.423)	(1.157)	(1.232)
Observations	51	51	78	78	104	104	393

Notes: This table replicates the empirical strategy used by Litschig and Morrison (2013) on data twenty years later, see in particular their Tables 5 and 7 . The dependent variables are in the first panel the municipal literacy rate amongst 20-29 years old and in the second panel the share of municipal population with no primary education , both measured in the 2010 Census. All specifications include state fixed effects and control flexibly for population size, using local linear regressions in columns 1-8 and a spline third-order polynomial in the last column.Covariates are, following Litschig and Morrison (2013), municipal GDP per capita, median education level, poverty rates, literacy rates and urbanization rates all measured in 2000. The sample includes all municipalities within a 2% bandwidth of a population cutoff in the first two columns, a 3% bandwidth in columns 3 and 4 , 4% bandwidth in columns 5 and 6 and a 15% bandwidth in columns 7 and 8. The first line in each panel presents results obtained when pooling the first three cutoffs, the remaining lines results obtained for each of the first three cutoffs separately. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

5 Comparison: Taxes vs non-tax revenues

Table 15 presents the first stage results for the second stage results presented in Table 5 in the paper.

Table 15: First stage for Table 5 (IV results)

	(1) Whole sample	(2) Mayor fixed effect	(3) Close to cutoffs only	(4) Common support
Dependent variable: Tax revenues per capita				
Program	10.900***	9.888***	9.700**	10.839***
	(4.036)	(2.366)	(4.336)	(3.633)
All cutoffs	1.392	0.634	1.052	1.332
	(1.466)	(2.351)	(2.390)	(1.537)
Observations	35426	35426	13193	34747
Clusters	2930	8024	2000	2858
Dependent variable: FPM revenues per capita				
Program	0.261	0.835	-0.936	0.257
	(0.760)	(0.599)	(0.762)	(0.769)
All cutoffs	13.356***	12.685***	13.179***	11.410***
	(0.711)	(0.638)	(0.692)	(0.869)
Observations	35426	35426	13193	34747
Clusters	2930	8024	2000	2858

Notes: The dependent variables are total tax revenues per capita (first panel) and FPM revenues per capita (second panel). The coefficients for the excluded instruments in Table 5 are reported, these are program participation and an indicator equal to one if lagged population is above a population cutoff. All specifications include year and time-varying controls as well as an indicator equal to 1 if the municipality has applied to the program but not started yet, columns 1,3 and 4 include municipality fixed effects and column 2 municipal administration fixed effect.All specifications exclude municipalities not affected by the transfer allocation rule. Columns 1 and 2 use the entire sample, column 3 all municipalities within a 5% bandwidth of the population thresholds and column 4 the common support sample. In Column 4 non-PMAT municipalities are weighted by a function of their estimated propensity score. Column 3 controls for population linearly on both sides of each cutoff, other columns include spline cubic polynomial in population size which allow for different slopes on both sides of each cutoff. Standard errors in parentheses are clustered at the municipality level. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

Table 16 shows 1998 characteristics of municipalities by population bracket. The last column is the average weight of municipalities in a population bracket, where weights are a function of municipalities' estimated propensity to join the program. Municipalities with higher weights are more comparable to PMAT municipalities and given more weight in specifications that use the common support sample.

Table 16: Descriptive statistics in 1998 by FPM segments around the cutoffs

	Total rev	Tax rev	Pop	Educ quantity	Educ quality	Health infra	GDP	Educ level	Inequality	Urban pop	Weight
1	408.1	28.13	0.0915	14.96	-1.294	39.37	3.482	3.999	0.555	57.76	0.0778
2	383.6	30.57	0.137	13.96	-1.146	34.91	3.496	4.031	0.560	60.46	0.128
3	364.4	35.02	0.178	12.98	-1.418	31.44	3.575	3.967	0.571	61.59	0.130
4	359.4	40.73	0.238	12.08	-1.330	28.62	3.954	4.218	0.576	66.67	0.216
5	349.1	51.51	0.306	11.08	-1.200	27.49	3.782	4.544	0.570	72.06	0.269
6	350.3	51.50	0.377	11.06	-1.078	25.65	4.040	4.621	0.576	76.94	0.342
7	349.5	54.46	0.445	9.969	-1.181	24.69	4.052	4.751	0.564	76.75	0.438
8	337.6	52.79	0.515	10.84	-1.356	23.94	4.048	4.800	0.571	77.51	0.527
9	371.1	77.69	0.609	9.343	-0.596	22.34	4.715	5.357	0.569	80.60	0.542
10	359.9	64.15	0.734	8.499	-0.668	23.54	5.963	5.540	0.572	86.32	0.636
11	367.2	75.56	0.836	7.763	-0.0819	17.06	6.038	5.775	0.540	88.14	0.733
12	396.2	81.56	0.935	7.137	0.0403	15.98	5.780	5.948	0.552	90.86	0.651
13	490.3	121.5	1.037	7.781	-0.0438	13.62	6.758	6.087	0.551	92.52	0.749
14	326.1	70.42	1.181	6.027	-0.501	15.42	5.102	5.810	0.551	93.74	0.658

Notes: Each cell reports the average value of the variable, taken in 1998 (total and tax revenue, education infrastructure, GDP, population), 1999 (health infrastructure) or 2000 (median education, inequality, urban population) for the segment of municipalities with population in a symmetric interval around each cutoff, or among PMAT municipalities in the last line. The segments are constructed so that each observation figures once and only once in each segment. The last column reports the average weight of municipalities in the segment, where weights are constructed from the estimated probability that the municipality joins the program, as explained in the text. The sample includes all 4792 municipalities that are not state capitals and with a population of less than 142,633 inhabitants.

5.1 Discussion

Table 17 presents the impact of the PMAT program on an index of municipal corruption, estimated using a difference-in-differences specification outlined in the paper. The first two columns use as dependent variables the broad and narrow definitions of corruption computed by Brollo et al. (2013), the next three columns use the corruption indexes computed by Litschig and Zamboni (2012). The first panel allocates a corruption index to the year in which it was measured (its 'lottery year'). The next two panels consider alternative ways to allocate a corruption measure: to the year prior the lottery or two years prior to the lottery.

Table 18 considers the impact of non-tax revenues on outcomes excluding from the sample municipalities that experience a decrease in FPM transfers over the period. Tables 19 and 20 present estimates separately for each state, excluding Brazil's smallest five states for which not enough observations are available. Table 21 considers whether there is any lagged impact of FPM transfers on outcomes and Table 22 tests whether the difference between how taxes and transfer revenues are spent varies when there is a local ration station in the municipality. Finally Table 23 looks for a potential impact of participating in the tax capacity program on the probability that the mayor is re-elected in the 2000, 2004 or 2008 municipal elections.

Table 17: Impact of a 10 Rs increase in tax revenues on the corruption index

Dependent variable	Broad(BNPT)	Narrow(BNPT)	All(LZ)	Diversion(LZ)	Mismanagement(LZ)
Irregularity measure allocated to the year of the lottery					
Tax revenue per capita	-0.034	0.013	-1.690	-0.101	-0.195
	(0.024)	(0.017)	(4.280)	(0.237)	(1.544)
Joins 1999-2009	0.145	-0.119	5.281	0.147	1.154
	(0.098)	(0.070)	(12.928)	(0.812)	(4.608)
Observations	816	816	774	774	774
Irregularity measure allocated to the year before the lottery					
Tax revenues	-0.034	0.013	-1.691	-0.101	-0.196
	(0.024)	(0.017)	(4.279)	(0.237)	(1.544)
Joins 1999-2009	0.145	-0.119	5.283	0.147	1.156
	(0.098)	(0.070)	(12.924)	(0.812)	(4.607)
Observations	816	816	774	774	774
Irregularity measure allocated to two years before the lottery					
Tax revenues	-0.025	0.018	4.840	0.547	0.843
	(0.021)	(0.021)	(23.569)	(2.511)	(5.300)
Joins 1999-2009	0.106	-0.126	-16.765	-2.099	-2.481
	(0.078)	(0.075)	(83.701)	(8.999)	(18.905)
Observations	816	816	774	774	774

Notes: See data appendix for a description of the variables used. Tax revenues are per capita and in units of 10 Rs.Program participation is used as an instrument for tax revenue per capita. All specifications include year and state fixed effects and control for an indicator equal to 1 if the municipality joins a PMAT program at any time, GDP per capita, the share of agriculture and services in GDP, municipal population and political characteristics of the municipality and a set of time-invariant characteristics from the 2000 census. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

Table 18: Impact of non-tax revenues, excluding decreases

Polynomial specification:	Linear	Linear	Linear	Linear	Third-order
Sample:	2%	2%	5%	5%	All
Covariates and municipality FE:	No	Yes	No	Yes	Yes
First stage: Impact of the cutoffs on transfer revenues					
All cutoffs	12.686***	11.922***	13.687***	12.838***	15.244***
	(1.034)	(0.774)	(0.688)	(0.525)	(0.738)
IV: Impact of transfer revenues on the quantity of education infrastructure					
Transfer revenues	0.089	-0.087	-0.033	-0.032	-0.060
	(0.178)	(0.085)	(0.121)	(0.057)	(0.070)
IV: Impact of transfer revenues on the quality of education infrastructure					
Transfer revenues	0.067	0.040	-0.040	-0.012	-0.016
	(0.062)	(0.027)	(0.038)	(0.017)	(0.019)

Notes: Dependent variables are top panel) municipal FPM revenue per capita, middle panel) number of classrooms in municipal schools per thousand school-age inhabitants, bottom apanel) index of quality of municipal school infrastructure. An indicator equal to one if lagged population is above a population cutoff is used as an instrument for non-tax revenue. Transfer revenues in the bottom two panels are per capita and in units of 10 Rs. All specifications include year fixed effects and control flexibly for population size, using local linear regressions in columns 1-4 and a spline third-order polynomial in the last column. Additional covariates are municipality fixed effects, GDP per capita, the share of agriculture and services in GDP, municipal population and political characteristics of the municipality. The sample includes all municipalities within a 2% bandwidth of a population cutoff in the first two columns, a 5% bandwidth in columns 3 and 4 and all municipalities within the bracket mid-points around a cutoff in the last column. The first line presents results obtained when pooling all thresholds. The sample includes only municipalities that never drop to a lower threshold over the period 1998-2011: 4081 municipalities, 53,862 observations. Standard errors in parentheses are clustered at the municipality level. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

Table 19: Impact of non-tax revenues on municipal school infrastructure (quantity), state by state

Polynomial specification:	Linear	Linear	Linear	Linear	Third-order
Sample:	2%	2%	5%	5%	All
Covariates and municipality FE:	No	Yes	No	Yes	Yes
State:BA	0.682	0.525	-0.172	0.043	0.166
	(0.489)	(0.301)	(0.310)	(0.169)	(0.209)
State:CE	0.061	0.321	0.062	-0.050	0.141
	(0.335)	(0.259)	(0.250)	(0.189)	(0.259)
State:ES	-0.866	0.494	0.034	0.078	-0.327
	(0.456)	(0.266)	(0.431)	(0.380)	(0.546)
State:GO	0.753	0.433	-0.237	-0.244	0.545*
	(0.853)	(0.346)	(0.544)	(0.167)	(0.268)
State:MA	0.563	0.495	0.466	0.042	0.123
	(1.040)	(0.287)	(0.764)	(0.249)	(0.361)
State:MG	0.183	0.138	-0.196	-0.060	0.002
	(0.349)	(0.158)	(0.249)	(0.102)	(0.121)
State:MS	0.012	0.039	-0.132	-0.112	-0.127
	(0.269)	(0.156)	(0.199)	(0.130)	(0.156)
State:MT	2.143	0.211	-0.214	-0.758	-0.235
	(1.331)	(0.546)	(0.981)	(0.509)	(0.381)
State:PA	-5.897*	0.729	-3.206	0.324	0.041
	(2.827)	(0.800)	(1.944)	(0.690)	(0.814)
State:PB	0.408	-0.096	-0.049	-0.229	-0.276
	(0.427)	(0.209)	(0.308)	(0.148)	(0.184)
State:PE	-0.755	0.115	-0.302	0.014	0.146
	(0.704)	(0.287)	(0.291)	(0.168)	(0.229)
State:PI	14.597	0.632	3.621	0.513	0.676
	(129.746)	(0.376)	(3.196)	(0.533)	(2.335)
State:PR	0.001	-0.127	0.443*	-0.014	0.100
	(0.293)	(0.129)	(0.225)	(0.130)	(0.166)
State:RJ	2.538	-2.401	2.938*	0.501	0.418
	(1.345)	(1.497)	(1.329)	(0.800)	(0.660)
State:RS	-0.800	-0.178	-0.350	0.021	0.154
	(0.567)	(0.197)	(0.444)	(0.151)	(0.175)
State:SC	0.449	-0.666	-0.041	-0.001	-0.092
	(0.568)	(0.345)	(0.384)	(0.200)	(0.267)
State:SP	0.015	-0.734**	-0.002	-0.360*	0.123
	(0.395)	(0.259)	(0.218)	(0.144)	(0.283)

Notes: The dependent variable is the number of classrooms in municipal schools per thousand school-age inhabitants. Each line corresponds to estimates obtained using all municipalities that are not state capitals and with a population of less than 142,633 inhabitants in a given state. See notes to Table 10.

Table 20: Impact of non-tax revenues on municipal school infrastructure (quality), state by state

Polynomial specification:	Linear	Linear	Linear	Linear	Third-order
Sample:	2%	2%	5%	5%	All
Covariates and municipality FE:	No	Yes	No	Yes	Yes
State:BA	0.074	0.114*	-0.045	-0.063	0.087
	(0.072)	(0.051)	(0.043)	(0.042)	(0.064)
State:CE	-0.021	-0.088	0.047	-0.043	0.001
	(0.105)	(0.061)	(0.071)	(0.036)	(0.039)
State:ES	-0.092	-0.067	-0.158	-0.128	0.137
	(0.157)	(0.071)	(0.089)	(0.083)	(0.141)
State:GO	0.139	-0.172	0.007	0.036	0.041
	(0.245)	(0.143)	(0.124)	(0.082)	(0.123)
State:MA	-0.061	-0.065	-0.026	0.012	-0.011
	(0.079)	(0.036)	(0.049)	(0.029)	(0.041)
State:MG	0.076	-0.009	0.004	0.022	-0.045
	(0.127)	(0.055)	(0.085)	(0.036)	(0.043)
State:MS	0.098	-0.018	0.053	-0.037	-0.026
	(0.136)	(0.055)	(0.082)	(0.050)	(0.058)
State:MT	0.320	0.602	-0.419	0.007	-0.118
State:PA	-0.339	0.078***	-0.695	-0.174	-0.294
	(0.432)	(0.000)	(0.376)	(0.160)	(0.162)
State:PB	0.006	0.089	0.095	0.037	0.081
	(0.101)	(0.053)	(0.054)	(0.032)	(0.047)
State:PE	0.173	-0.069	0.092	0.020	-0.016
	(0.106)	(0.040)	(0.052)	(0.026)	(0.035)
State:PI	-1.568	0.047	-0.229	-0.084	-0.080
	(14.163)	(0.061)	(0.236)	(0.049)	(0.252)
State:PR	-0.097	0.007	0.017	-0.012	-0.034
	(0.118)	(0.055)	(0.082)	(0.045)	(0.056)
State:RJ	-0.221	0.194	-0.537**	0.124	-0.030
	(0.177)	(0.216)	(0.190)	(0.100)	(0.120)
State:RS	-0.104	0.059	-0.291*	0.085	0.055
	(0.199)	(0.101)	(0.142)	(0.066)	(0.064)
State:SC	-0.147	0.108	-0.073	-0.053	0.009
	(0.200)	(0.091)	(0.122)	(0.053)	(0.063)
State:SP	0.148	0.000	0.014	-0.072	-0.062
	(0.136)	(0.072)	(0.077)	(0.048)	(0.056)

Notes: The dependent variable is the index of quality of municipal school infrastructure. Each line corresponds to estimates obtained using all municipalities that are not state capitals and with a population of less than 142,633 inhabitants in a given state.See notes to Table 10.

Table 21: Impact of non-tax revenues on municipal school infrastructure, lagged one or two years

Polynomial specification:	Linear	Linear	Linear	Linear	Third-order
Sample:	2%	2%	5%	5%	All
Covariates and municipality FE:	No	Yes	No	Yes	Yes
	1	2	3	4	5
Dependent variable: Quantity of municipal education infrastructure					
One year lag	0.087	0.060	-0.008	-0.012	0.057
	(0.081)	(0.055)	(0.037)	(0.067)	(0.057)
Two years lag	0.066	-0.159	0.048	0.042	-0.066
	(0.075)	(0.097)	(0.029)	(0.067)	(0.052)
Dependent variable: Quality of municipal education infrastructure					
One year lag	-0.050	0.055	-0.026	0.021	0.006
	(0.038)	(0.045)	(0.021)	(0.018)	(0.015)
Two years lag	-0.209	0.037	-0.118	0.039	0.016
	(0.180)	(0.032)	(0.141)	(0.029)	(0.014)

Notes: Dependent variables are top panel) number of classrooms in municipal schools per thousand school-age inhabitants, bottom apanel) index of quality of municipal school infrastructure. An indicator equal to one if lagged population is above a population cutoff is used as an instrument for non-tax revenue. Transfer revenues in the bottom two panels are per capita and in units of 10 Rs. All specifications include year fixed effects and control flexibly for population size, using local linear regressions in columns 1-4 and a spline third-order polynomial in the last column. Additional covariates are municipality fixed effects, GDP per capita, the share of agriculture and services in GDP, municipal population and political characteristics of the municipality. The sample includes all municipalities that are not state capitals and with a population of less than 142,633 inhabitants over the period 1999-2011 within a 2% bandwidth of a population cutoff in the first two columns, a 5% bandwidth in columns 3 and 4 and all municipalities within the bracket mid-points around a cutoff in the last column. The first line presents results obtained when pooling all thresholds. Standard errors in parentheses are clustered at the municipality level. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

Table 22: Impact of a 10 Rs revenue increase, with and without a local radio

	Education infrastructure (quantity)	Education infrastructure (quality)
Non-tax revenue	-0.195	-0.021
	(0.088)	(0.024)
Tax revenue	0.712*	0.331*
	(0.329)	(0.142)
Non-tax revenue*Radio	-0.090	0.019
	(0.251)	(0.074)
Tax revenue*Radio	-0.140	-0.027
	(0.283)	(0.081)
Observations	35426	35426
Clusters	2930	2930
T-test p-value (no radio)	0.05	0.02
T-test p-value (radio)	0.82	0.86

Notes: The dependent variables are the number of classrooms in municipal schools per thousand school-age inhabitants (column 1) and the index of quality of municipal schools (column 2). Program participation and the transfer allocation rule are used as instruments for tax and transfer revenues. All specifications include year and municipality fixed effect and time-varying controls and a spline cubic polynomial in population size which allows for different slopes on both sides of each cutoff. Standard errors in parentheses are clustered at the municipality level. Radio is the presence of a local radio station in the municipality in 1996, a time-invariant variable. The sample includes all municipalities for which information on presence of a local radio station in 1996 is available that are not state capitals and with a population of less than 142,633 inhabitants over the period 1999-2011. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***. The t-test (no radio) tests for equality of the coefficients in lines 1 and 2, the t-test (with radio) for equality of the sum of the coefficients in lines 1 and 3 and the sum of those in lines 2 and 4.

Table 23: Impact of the tax capacity program on the probability of re-election

	Whole sample: All	2004 and 2008	Common support: all	2004 and 2008
Program	0.061	0.005	0.079	0.023
	(0.045)	(0.084)	(0.042)	(0.087)
Mayor's education control	No	Yes	No	Yes
Observations	10059	5764	8200	4730

Notes: The dependent variable is an indicator equal to 1 if the incumbent mayor was re-elected in 2000, 2004 or 2008, 0 if the incumbent mayor not facing a term limit was not re-elected in those years and is missing otherwise. All specifications include year and municipality fixed effect and time-varying controls, specifications in columns 2 and 4 include a control for the mayor's years of schooling which is not available for the 2000 election. The sample in columns 3 and 4 is the common support sample and non-PMAT municipalities are weighted by a function of their estimated propensity score. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

Table 24: Impact of a 10 Rs increase in tax or non-tax revenues on health infrastructure

	(1) Whole sample	(2) Close to cutoffs only	(3) Common support
Non-tax revenue	0.387	-0.352	0.394
	(0.316)	(1.093)	(0.325)
Tax revenue	0.647	0.755	0.433
	(1.144)	(2.099)	(1.008)
Observations	9878	3039	9698
Clusters	2676	1153	2624

Notes: The dependent variable is the number of municipal health units per 100,000 inhabitants. Program participation and the transfer allocation rule are used as instruments for tax and transfer revenues. All specifications include year and municipality fixed effects and time-varying controls as well as an indicator equal to 1 if the municipality has applied to the program but not started yet. The sample in column 2 includes only municipalities within a 5% bandwidth of the population cutoffs, the sample in column 3 only municipalities in the common support. The specifications in column 2 controls linearly for population on either side of each cutoff, in columns 1 and 3 include a spline cubic polynomial around each cutoff. Standard errors in parentheses are clustered at the municipality level. Statistical significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

6 Theoretical Appendix

6.1 Set-Up

This model follows the political agency framework of Besley and Smart (2007) in which a representative citizen decides whether to re-elect a rent-seeking incumbent without observing part of his actions. Public resources R come from local taxes T, endogenously determined, and exogenous non-tax revenues F which are subject to some random variation (in the Brazilian setting of study these are intergovernmental transfers). Non-tax revenues can take two values : F is equal to $F_H = \bar{F}(1+u)$ in the high state H with probability q and $F_L = \bar{F}(1-u)$ in the low state L, where $u,\ q \in [0,1]$.

The incumbent politician faces a budget constraint $T + F = R = G + S$, with G the level of public good and S the rents he diverts for himself. He maximizes the sum of rents extracted from being in office $S+\sigma Z$, where Z is the exogenous value of re-election and σ the probability of re-election. He can choose to divert all public resources and forgoe re-election but institutional constraints limit maximal rent taking to $\bar{S} = \alpha R$ where $\alpha < 1$.[3] Challengers in the election would behave in the same way as the incumbent once elected; the election is a way for the citizen to discipline the incumbent, not to choose the best type of candidate.

The representative citizen derives utility from the provision of public good net of taxes. Her welfare is $W(G,T) = G - \phi C(T)$ where ϕ indexes the marginal utility cost to the citizen of paying taxes and $C(\cdot)$ is increasing and strictly convex. I define $h(\cdot) = C'^{-1}(\cdot)$.

6.2 Full information equilibrium

The citizen chooses for each state $i = H, L$ the reelection rule $\sigma(G_i, T_i) = \sigma_i$ that induces the politician to provide the policy menu (G_i, T_i) that maximizes her welfare. The maximum level of public good G_i she can obtain from the government when paying taxes T_i must be so that it leaves the government with enough rents today to make abiding by the re-election rule more attractive than running away with maximum rents and forgoing re-election. This *participation constraint* takes the form:

$$T_i + F_i - G_i + \sigma_i Z \geq \alpha(T_i + F_i), \forall i = H, L \tag{1}$$

Re-electing the incumbent leads to an increase in the public good at no cost to the citizen so in equilibrium she sets $\sigma_i^* = 1$ in each state i as long as the government provides the menu (G_i^*, T_i^*) such that:

$$G_i^* = (T_i^* + F_i)(1-\alpha) + Z. \tag{2}$$

T_i^* is set such that the marginal value of the public good is equal to the marginal cost of taxation: $T_i^* = h(\frac{1-\alpha}{\phi})$. Local taxes are decreasing in the marginal cost of paying taxes ϕ and in α, a proxy for the ease with which the politician can run away with public resources. When the

[3] I assume $Z < \alpha R$ to ensure that rents are never negative. This assumption simply says that the politician discounts the future and cannot expect to extract more rents in the future than the maximal level of rents it could extract today.

citizen fully observes all public revenues the way in which in the local government is financed does not matter. The marginal effect of an increase in tax or non-tax revenues is to increase the public good by $(1-\alpha)$ and rents by α.

6.3 Equilibrium with asymmetric information

Assume now that the citizen does not perfectly observe transfer revenues: the realized value of F is known only to the incumbent. Asymmetries of information increase the incumbent's capacity to extract rents from the public budget as he can now pretend to be in the low state when he receives high transfer revenues to capture the difference in revenues between the high and the low states.

To deter the incumbent in state H from implementing the L state menu the menus offered by the citizen must now also respect the incentive constraints:

$$S_H + \sigma_H Z = T_H + \bar{F}(1+u) - G_H + \sigma_H Z \geq T_L + \bar{F}(1+u) - G_L + \sigma_L Z, \tag{3}$$

and

$$T_L + \bar{F}(1-u) - G_L + \sigma_L Z \geq T_H + \bar{F}(1-u) - G_H + \sigma_H Z \tag{4}$$

Putting together (3) and(4) there is only one situation in which both constraints are satisfied simultaneously : $G_H = G_L + T_H - T_L + Z(\sigma_H - \sigma_L)$.

It is optimal for the citizen to ask the incumbent in the low state to provide the maximal amount of public good given the amount of taxes paid: state L's participation constraint – equation (1) – is binding. This implies the following equilibrium levels of public good provision:

$$G_L^* = (T_L^* + \bar{F}(1-u))(1-\alpha) + \sigma_L^* \, Z \tag{5}$$

and

$$G_H^* = (T_H^* + \bar{F}((1-u))(1-\alpha) + \sigma_H^* Z + \alpha(T_H^* - T_L^*) \tag{6}$$

Re-election leads to an increase in the public good at no cost to the citizen whatever the state, so $\sigma_H^* = \sigma_L^* = 1$. Maximizing $W(G_H, G_L, T_H, T_L; q)$ subject to (5) and (6) determines the level of taxation in both states :

$$T_H^* = h(1/\phi) \tag{7}$$

and

$$T_L^* = \max\{0; h((1-q-\alpha)/\phi(1-q))\} \tag{8}$$

Tax revenues are lower in the low state as any increase in the level of taxes offered in the low state menu makes mimicking the low state equilibrium more attractive to the incumbent in the high state. This comes at the cost of less public good in the low state. The less likely the low state (the higher q) the more the citizen is willing to incur this cost, and the lower T_L^*. The asymmetry of information leads to an equilibrium with lower public good provision (on average) than in the full information equilibrium due to the increase in rent-seeking obtained by the incumbent in state H.

The structure of public finance now affects the way in which the incumbent allocates the budget. Using equations (5) and (6) we can write the average level of the public good as:

$$E(G^*) = (1-\alpha)(E(T^*) + \bar{F})) - \bar{F}u(1-\alpha) + Z + (1-q)\alpha(T_H^* - T_L^*) \tag{9}$$

The term $u(1-\alpha)\bar{F}$ corresponds to the informational rents the incumbent can appropriate in state H by 'hiding away' the extra transfer revenues. The last term in equation (9) simply says that the more the citizen can provide the incumbent in the high state with high powered incentives relative to the low state (the bigger the difference between taxes in both states) the lower the informational rents. A marginal increase in taxes still increases public good provision by $(1-\alpha)$, assuming for simplicity that the increase does not affect the spread $T_H^* - T_L^*$. A marginal increase in average transfers has a smaller impact of $(1-\alpha)(1-u)$.[4]

The equilibrium share of rents in public revenues s^* is increasing in the share of transfers in the budget proxied by $\bar{f}^* = \bar{F}/E(R)$:

$$E(s^*) = \alpha + E(\bar{f}^*)2u(1-\alpha)(1-q) - Z/E(R) - (1-q)\alpha(T_H^* - T_L^*)/E(R) \tag{10}$$

Equations (9) and (10) show that as the share of taxes in revenue increases, so does the share of revenues that is spent towards public good provisions. Intuitively increasing the share of taxes increases the amount of information the citizen has on her government's budget and thus limits the extent to which a rent-seeking politician can capture public funds by 'hiding' them. This leads to an allocation of the budget that is more favorable to the citizen.

Finally, note that the lower the information asymmetry (the lower u) the lower the informational rents of the incumbent and the smaller the difference between how tax and transfer revenues are spent. The paper tests this implication of the model by considering whether the difference is lower in municipalities with better-informed citizens, proxied by the presence of a local radio station following Ferraz and Finan (2011).

[4] I assume that any increase in non-tax revenues comes from an increase in $\bar{F}$ and not a change in the probability q of the high state. This is consistent with the type of increase in transfers considered in the empirical strategy which are a consequence of a local government moving to a higher transfer bracket.

7 The PMAT program and investments in local tax capacity

I describe here the context of creation of the the *Programma de Modernizacao da Administracao Tributario* (PMAT) program and the types of investments in tax capacity Brazilian municipalities undertook thanks to it. Information comes from field interviews, a 2002 case study by the BNDES of a few municipalities enrolled in the program (BNDES, 2002) and a survey of 82 municipalities that started a PMAT program from 2005 onwards conducted in 2012 by the author.[5]

7.1 Context of creation

The program was designed in 1997-1998 as part of an effort among Brazilian policy makers to strengthen the public finances of all levels of governments. During the 1980s and early 1990s Brazil experienced hyperinflation - three to four digits annual inflation rates. The success of the Plano Real in 1993-1994 led to a rapid decrease in inflation, but in the absence of substantive fiscal adjustment pushed all levels of government into fiscal distress. The loss of fiscal control mechanisms that had previously relied on high inflation to erode the real value of budgeted expenditures[6] and the sharp increase in interest rates eventually led to serious cash flow problems in many states, municipalities, and regional banks. In 1997 the federal government organized a subsidized restructuring of most states' and many municipalities' debts and in 1998 the federal government itself obtained a $41.5 billion loan from the IMF. The fiscal crisis pointed out the costs of soft budget constraints in a fiscal federation and the necessity to re-think inter-governmental fiscal relations (Bevilaqua, 2002, Baer, 2001). The Fiscal Responsibility Law, designed in its aftermath and eventually passed in 2000, specifies hard-budget constraint rules at all levels of government and directs all municipal governments to levy the two main taxes - the urban property tax *IPTU* and service tax *ISS* - that are devolved to them. Federal authorities were aware that municipal tax administration were in many cases unfit for the task set to them by law yet very anxious that they 'share the burden' of collecting public revenues. The *PMAT* program was initially thought of as an answer to this problem.

The *PMAT* program consists in a subsidized loan from the Brazilian development bank (BNDES) to municipal governments to modernize their tax administration. Interested municipalities have to apply to the BNDES with a tax modernization program specifying how they expect to spend their loan. In practice all projects were accepted, sometimes after some revisions.[7] Municipalities have up to 6 years to reimburse the loan. The *FPM* transfer each municipality is entitled to from the federal government is used as a collateral (see the companion paper for more details on this transfer)- in practice no municipality has ever failed to pay back. BNDES officials regularly check that the program's funds are used on tax administration

[5] 90 municipalities started a program since 2005, 8 could not be reached via phone or email or were unwilling/unable to answer questions about PMAT. Finding someone able to discuss the PMAT program in municipalities that joined the program before 2005 proved extremely difficult, I exclude the few we were able to reach from the analysis.

[6] Seignorage was an implicit source of public spending at the local level as well, as tax revenue followed price movements but public payrolls lagged behind.

[7] Municipalities were not eligible to the program if they had outstanding debt with any branch of government, including public banks.

expenditures by going through receipts.

7.2 A typology of investments in tax capacity

Updating tax registers

No tax administration can function without a basic knowledge of who its potential taxpayers are and a method to assess their tax liability. Many Brazilian municipalities however are only equipped with a small list of service firms, rarely updated, and an old register of properties on their territory, often without any indication of their size and value. Nearly all participants in the *PMAT* program undertook an updating of their tax registers.Table 25 shows that all but two surveyed municipalities (98%) declared having updated their tax registers. Information on when tax registers were most recently updated was collected in a 2003 survey of local governments run by the statistical agency and is presented in Table 26. Roughly 60% of both non-PMAT municipalities and PMAT municipalities that start the program after 2003 had updated their property tax register between 1998 and 2003. This proportion jumps to 81% for municipalities that had already started a PMAT program in 2003.

The most simple method consists in hiring a small team to go around all the municipality and take notes on every single property. Larger municipalities hired firms to take pictures of each property in the municipality from above and extrapolate their value. The city of Nova Iguacu thus doubled in size after updating its registers: the number of registered properties went from 160,000 to 320,000 and the average property doubled in size (it took Nova Iguacu three years to update its registers). Equipped with better information on its tax base the municipality introduced a progressive property tax rate, and lowered the average rate by nearly 50%.

Many municipalities switched from paper registers to electronic versions (77% of surveyed municipalities). Storing tax information in secure, digitalized form enabled some municipalities to enter data-sharing agreements with banks and other branches of governments who have high data confidentiality standards by increasing the confidentiality of the local tax data. These agreements made cross-checks on the plausibility of self-declared tax liabilities feasible.

Table 25: Actions undertaken by PMAT municipalities

	% Municipalities	Number municipalities
Updating tax registers	98%	82
of which: digitalizing tax registers	77%	79
Increasing control of taxpayers	67%	82
of which: recovering tax arrears	84%	62
of which: changing audit methods	47%	60
Facilitating tax payments	71%	79
of which: higher frequency of payments	82%	63
Staff training	75%	62
Purchasing hardware/software	77%	64

Source: survey of Brazilian municipalities that started a PMAT program after 2005 undertaken by the author in 2012. The number in the second column is the number of municipalities that answer the question in the survey.

Table 26: Municipalities that updated their tax registers between 1998 and 2003

	% updated 1998-2003	Number municipalities
Never start a PMAT program	61%	4723
Start 2004-2009	58%	122
Start 1999-2003	81%	146

Source: *Perfil dos Municipios Brasileiros 2004*, IBGE (2004). The number in the second column is the number of municipalities that answer the question in the survey.

Several municipalities also started programs to provide local service firms with incentives to register with the local tax authorities. A study of informal small firms in the study of the Sao Jose area in Manaus reveals that the main reason small entrepreneurs do not register with the local authorities is because the paperwork would take them too much time (SEBRAE, 2008). Several municipalities designed programs that aimed to decrease the paperwork associated with registration, streamline the process and emphasize the advantages of registering (in Manaus this was the *Seja Legal* project).

Mayors were wary of the potential political cost of getting more citizens in the tax net. Many consequently emphasized the uses to which tax revenue are put and tried to involve citizens in the updating process. One option used was to follow up on the technical updating of registers by organizing local community meetings in which every citizen was told the estimated value of its property and given a chance to disagree with the finding of the register. This seems to have made the initiative quite popular with citizens, who appreciated having their municipal tax officers come to their local area *not* to collect taxes - this system was called *Fazenda Movil*, or 'mobile treasury'.

Facilitating tax payments

Facilitating tax payments was a declared intention of the *PMAT* program and most municipalities (71%) endeavored to do so. Municipal tax officials often claim that low tax compliance is not so much a consequence of deliberate tax evasion but of the fact that paying taxes is complicated, time-consuming, and even sometimes not seen as compulsory - '*a principal razao de falta de pagamento neao e sonegacao de impostos mas o esquecimento, a falta de informacao e as difculdades para realizar of pagamento.*' (BNDES, 2002). Prior to the program local governments typically had one separate office for each different part of the tax paying process (registering, finding out your tax liability, contesting your liability, paying your tax bill, paying your tax arrears), but all located at the municipality's townhall. Some municipalities sent out tax liabilities to taxpayers but many had no such system, and it was up to the law-abiding citizen to go to the townhall to find out about it. Many *PMAT* participants created several tax bureaus ('*centro fiscal de atendimento ao cidadao*') in different parts of the municipalities in which all steps of the tax paying process could be undertaken and several local benefits could be claimed. This has the double benefit of saving time to the taxpayer and making it easier to communicate each taxpayer's information between different municipal services.

The physical way in which taxes are declared and paid was also changed. Some municipalities installed a system for checking your tax liability and paying your taxes on the internet (for example the *Projet S-Fiscal* in Belo Horizonte). Others launched a system of tax declaration on a CD-rom, and some set up systems which made it possible to wire tax payments directly from a bank account.[8]

Once the physical method of finding out tax liabilities and making tax payments was streamlined and facilitated numerous smaller innovations were made to decrease collection costs borne by both taxpayers and the tax administration. One particularly popular change was allowing for quarterly or monthly tax payments. This benefits both potentially credit-constrained taxpayers and the tax administration as it increases cash on hand.

Increasing control of taxpayers

Several tax administrators acknowledged that pre-*PMAT* their municipalities were in a state of 'permanent tax amnesty'. One administrator who was involved in several *PMAT* programs estimates that more than 90% of municipalities are unable to check that the amount of ISS paid by a taxpayer is the correct one. Improving tax registers is only the first step in increasing control of taxpayers. Once the identify of taxpayers is known tax administrations have to 1) find out what their tax liabilities are (the registers may suffice to determine the property tax liability, but not that of the service tax) 2) ensure tax payments are indeed paid. Overall, nearly half of the surveyed municipalities reported reforming their audit method (47%) and putting extra effort in recovering tax arrears (84%), to put an end to the widespread idea that local tax amnesty is the norm.

The most straightforward way to ensure that firms declare their true tax liability is to make it difficult for them to hide a transaction. This is typically the case when all transactions are done by credit card and the information on the credit card terminal can be checked by the tax authorities. This systems is complicated, and was set up as part of *PMAT* in a few cases (see Boavista (2011) for a detailed explanation of the set-up of this system in Rio de Janeiro). Once the system is in place one needs to make sure firms actually use it. Several municipalities, including Rio de Janeiro and Sao Paulo, designed a scheme which gives consumers incentives to ask as third party enforcers. These schemes tell consumers of services to ask for a fiscal receipt when they make a purchase. To issue this receipt firms have to use a specific terminal that automatically stores the information in a format that can easily be checked by the tax authorities. These receipts in turn give customers a right to some financial compensation - tax rebates on their IPTU bill in the most high-profile schemes, or simply a ticket to a local annual lottery.

When tax administrations have to use self-declared tax liabilities the threat of audits provides firms with incentives to declare truthfully. Training staff in the tax administration to undertake these audits is an oft mentioned expenditure financed by the program. This typically involved setting up methods that automatically flag tax payments that seem irregular; the purchase of software and skills helped put such systems of data management in place.

Once tax liabilities have been checked the tax administration must make sure tax payments are effectively paid. Recovering tax arrears - *divida ativa* - is a preoccupation mentioned by all my interviewees. The law specifies that tax arrears are written off after 5 years if the municipality does not send a legally certified document claiming the payment. The development

[8]Municipalities had to meet banks high security and confidentiality requirements before they could enter such agreements, see above.

of systems of data management which automatically flag out missing tax payments as part of *PMAT* greatly improved municipalities' capacity to recover tax arrears. Similarly setting up a sophisticated partnership with a bank as enabled at least one municipality to ask Banco do Brasil for automatic transfer of tax arrears from uncooperative citizens. In the five year period since its implementation this system was never used - the threat and the simultaneous one-time scraping of penalties for late payments was enough to make citizens pay their tax arrears.

Economists are divided on the importance of social norms in determining tax compliance - see Andreoni, Erard and Feinstein (1998). Local governments in Brazil seem not to be: most of them have included in their *PMAT* program some elements which try to increase the social returns to paying taxes and shift the social equilibrium away from the widespread belief that tax amnesty is a norm. Advertising campaigns emphasized that tax revenues are used to pay for essential public services and stressed some version of the message 'good people pay their taxes'. Many municipalities entered citizens that paid their taxes on time in a lottery. Lottery prizes were delivered during very social occasions (generally the municipality's Christmas party). Winners received a small monetary prize and given the opportunity to shake hands with the mayor and get their picture and a small interview in the local newspapers. It is of course impossible to disentangle the impact of those social incentives from the purely financial ones but the widespread use of these (cheap) social nudges suggest there are reasons to think they play an important role in this context. Finally, note that these efforts also often increased the social status of tax administrators. Several of them told me that these public events shed a positive light on their job.

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