Online Appendix for the paper "Audit Risk and Rent Extraction: Evidence from a Randomized Evaluation in Brazil"

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1 Theoretical framework

This section presents a simple model to analyze under what conditions an increase in audit risk reduces rent-taking. The model is tailored to our setting in which audit risk increased for all agents in treatment municipalities, including the mayor, members of the procurement commission, health service providers, as well as *Bolsa Família* beneficiaries and program managers. What varies is the nature of rent-taking across activities, as well as some of the parameters in the agents' optimization problems, such as the type of sanction they face if caught and the probabilities of sanction with and without an audit. The model is adapted from Allingham and Sandmo's (1972) classic analysis of tax evasion and delivers more realistic and nuanced predictions than the Becker (1968) model of crime, which assumes that the gain from committing an offense is fixed. Nonetheless, the results that higher audit risk does not unambiguously deter rent extraction and that the magnitude of the effect depends on the probability that sanctions are applied conditional on detection also obtain in the Becker model.

Let rent extraction Y be a continuous variable with support $[0, \overline{Y}]$, where $\overline{Y}$ denotes a natural upper bound. In procurement this would be some fraction of the total amount of federal transfers received in a given period that procurement officials could appropriate. In service delivery, $\overline{Y}$ denotes the nominal number of working hours of doctors and other medical personnel and Y is the hours spent shirking on the job. For cash transfer recipients, $\overline{Y}$ represents the maximum excess payment that could be achieved by over-reporting household size or under-reporting income. $\overline{Y}$ may vary across agents and is likely largest in procurement, followed by service delivery, followed by cash transfer or other welfare programs.

Utility is assumed continuously differentiable, increasing and concave in rent-taking, $U'(Y) > 0, U''(Y) < 0$. Expected utility depends on two key parameters: the magnitude of sanctions if caught, πY, which we assume are linearly increasing in Y, $\pi > 0$, and the probability that sanctions are applied p.[1] Sanctions could be administrative, judicial or electoral, or a combination of these, depending on the agent. For example, the mayor and his team likely care about all types of sanctions while procurement officials worry mostly about jail time, fines and loss of the job

[1] All results below go through if we assume instead that sanctions are convex in rent-taking. Derivations are available on request.

and perhaps care little if program funds are cut (as long as their salaries are not touched). Service providers can at worst lose their jobs, while for welfare programs the most severe sanction consists is loss of the benefit and perhaps some form of social sanction.

In each period the agent will choose Y so as to maximize expected utility:

$$E(U) = pU(Y - \pi Y) + (1 - p)U(Y). \tag{1}$$

Our model is static, which we believe is appropriate in our context as intertemporal linkages are limited. For example, stealing less today does not imply that more can be stolen tomorrow. This is because federal transfers for current spending cannot be saved for later periods. Federal transfers for budgeted capital projects can only be postponed in duly justified and authorized cases.[2] Empirically we find no evidence that the composition of purchases, the level of federal transfers or the amount audited were affected by the treatment. Likewise, the number of nominal working hours or the maximum cash transfer payment are fixed each period.

Stealing less today may admittedly increase the probability to be in office or in the job or in the program in future periods, which our model implicitly takes for granted. One could therefore imagine that agents in high audit risk municipalities reduce rent extraction during the period of extra scrutiny even more than they would if they knew that they will have the opportunity to extract rents for sure in the next period, a "golden goose" effect in the terminology of Niehaus and Sukhtankar (2013). Nonetheless, the decision problem remains essentially static: at the beginning of the post-monitoring period, the audit risk and other parameters are exactly the same as they were before the monitoring hike and therefore rent extraction should be back to the level that would have prevailed in the absence of the intervention. It is therefore theoretically unlikely that lower rents during the period of extra scrutiny are offset by higher rents in future periods. The static assumption is also in line with findings in Bobonis et al. (2016), showing that "timely" audits reduce corruption by about 67 percent in the short-run but leave future corruption levels unchanged.

The first-order condition for an interior maximum of (1) is

$$\frac{\partial E(U)}{\partial Y} = p(1 - \pi)U'(Y - \pi Y) + (1 - p)U'(Y) = 0. \tag{2}$$

[2]Public procurement law N^o 8,666, Art. 8 and Art. 26.

The second-order condition

$$p(1-\pi)^2U''(Y-\pi Y)+(1-p)U''(Y)<0, \tag{3}$$

is satisfied as long as utility is concave in rents.

In order to assess under what parameter values there is an interior solution, we evaluate expected marginal utility (2) at $Y=0$ and $Y=\overline{Y}$. In particular, we must have that

$$\frac{\partial E(U)}{\partial Y}|_{Y=0}=p(1-\pi)U'(0)+(1-p)U'(0)>0$$

and

$$\frac{\partial E(U)}{\partial Y}|_{Y=\overline{Y}}=p(1-\pi)U'((1-\pi)\overline{Y})+(1-p)U'(\overline{Y})<0.$$

We can rewrite these conditions as

$$1>(\pi-1)\frac{p}{(1-p)} \tag{4}$$

and

$$(\pi-1)\frac{p}{(1-p)}>\frac{U'(\overline{Y})}{U'\left((1-\pi)\overline{Y}\right)}. \tag{5}$$

From (4) we get that if the combination of π and p is too high then it is optimal not to shirk or steal at all. And from (5) we can see that if the combination of π and p is too low then it is optimal to extract as much rents as possible, i.e. $\overline{Y}$. Specifically, we need $\pi>1$, otherwise the level of p does not matter at all and it is optimal to extract maximum rents even as p approaches 1. Intuitively we need $\pi>1$ because the marginal sanction if caught has to be higher than the marginal gain from taking rents. Even when $\pi>1$, an increase in p might not be large enough to increase the left-hand side of (5) above the right-hand side and reduce Y below $\overline{Y}$. Because the right-hand side of (5) is smaller than 1 as long as there are some rents to be had ($\overline{Y}>0$), there are parameter combinations that satisfy both inequalities so that an interior solution may exist.

Our experiment did not vary p directly, but rather p_a, the probability of a central government audit. Let $p_{s|a}$ denote the probability of sanctions conditional on receiving an audit and $p_{s|na}$ the probability of sanctions in the absence of an audit, so that $p=(p_{s|a}-p_{s|na})\times p_a+p_{s|na}$. We

assume throughout that $(p_{s|a} - p_{s|na}) \geq 0$, i.e. sanctions are more likely with than without an audit. Differentiating (2) with respect to p_a and Y we get

$$\frac{\partial Y}{\partial p_a} = -\frac{(1-\pi)U'(Y-\pi Y) - U'(Y)}{\left[\frac{1-p_{s|na}}{p_{s|a}-p_{s|na}} - p_a\right]U''(Y) + \left[p_a + \frac{p_{s|na}}{p_{s|a}-p_{s|na}}\right](1-\pi)^2 U''(Y-\pi Y)} < 0. \qquad (6)$$

This derivative is negative; if there is an interior solution, rent extraction is decreasing in p_a.

The first prediction from this simple model is that an increase in p_a does not necessarily reduce rent-taking in environments where sanctions and the probability that they are applied are too low. The smaller is $p_{s|a}$ the smaller the increase in p when p_a goes up and the less likely it is that the left-hand side of (5) becomes larger than the right-hand side as long as the level of sanctions and the initial probability that they are applied are too low. In an environment of impunity, rent-taking may therefore stay at $\overline{Y}$ despite the increase in p_a. Moreover, even if there is an interior solution under normal monitoring conditions, inspection of (6) suggests that the magnitude of the derivative approaches zero when $p_{s|a}$ decreases. As a result, an increase in audit risk alone may not curb rent extraction much if the link between detection through an audit and eventual sanction is weak.

The model also suggests an intuitive interpretation of the differential impacts we find across procurement, health service delivery, and cash transfer targeting. The null result for the cash transfer program together with close to zero inclusion errors and few overpayments in the control group is consistent with a high probability of sanction even in the absence of an audit. In the model, a high $p_{s|na}$ means a high p even without increased p_a and hence $1 < (\pi - 1)\frac{p}{(1-p)}$ which yields a corner solution at zero. This makes intuitive sense because the number of children or the level of income are relatively easy to observe for program managers or the public at large even in the absence of an audit. In contrast, $p_{s|na}$ is likely lower in procurement or service delivery because public officials can hide their actions more easily, thus making corners at zero less likely.

Moreover, $p_{s|a}$ is likely lower in service delivery than in procurement because shirking in service provision cannot be identified with the same precision as irregularities in procurement. In the limiting case we have $p_{s|a} = p_{s|na} = 0$ in service delivery, in which case higher audit risk would not matter to service providers and they would continue to shirk to the extent possible. In terms of the model, p would not increase if $p_{s|a} = p_{s|na}$ and so despite the increase in p_a the corner at $\overline{Y}$ would remain unchanged. In procurement in contrast, $(p_{s|a} - p_{s|na}) > 0$ is likely because procure-

ment irregularities cannot be argued with (at least not to the same extent as reports of shirking on the job). As a result, increased audit risk might reduce rent-taking in procurement if the left-hand side of (5) gets pushed above the right-hand side.

The prediction that increased audit risk should reduce rent extraction more in procurement compared to service delivery also arises through two additional channels. First, π is likely higher for members of the procurement commission because in addition to losing their jobs, they may have to pay a fine or end up in jail for mismanaging public funds, while service delivery personnel only have their jobs on the line. From (5), a higher π makes it more likely that a given increase in p lifts the left-hand side above the right-hand side and breaks the corner at $\overline{Y}$. Similarly, a higher π makes it more likely that rent extraction is initially not at its upper bound and thus responsive to higher audit risk as shown in (6). Finally, increased audit risk should reduce rent extraction more in procurement compared to service delivery also because the upper bound of rent-taking is higher in procurement. Again from (5), a higher level of $\overline{Y}$ leads to a smaller fraction on the right-hand side of the inequality, making it more likely that a given increase in p breaks the corner at $\overline{Y}$.

2 Details on alternative corruption codings

This section describes alternative corruption codings of CGU auditors' classification of irregularities in procurement in more detail. We consider codings by Ferraz and Finan (FF, 2011), ourselves in prior work (Litschig and Zamboni, 2012), and Brollo, Nannicini, Perotti, and Tabellini (BNPT, 2013). Please refer to Table 2 in the paper for the discussion below.

The first procurement-related corruption category in Ferraz and Finan is their "irregular public procurement", which is when "there is an illegal call-for-bids where the contract was awarded to a "friendly firm" and the public good was not provided". This corresponds to a subset of the "simulated tender process" and "evidence of favoritism" categories in the CGU classification, where non-provision of the good or service was somehow confirmed, which we do not distinguish in our data. Another procurement-related type of corruption is what they call "over-invoicing", in which "auditors determined that the goods and services were purchased at a value above market price", or "there is no proof of purchase and community member confirm that goods were not delivered", which corresponds to a subset of the "unjustified or excessive payments for goods and services"

type of audit finding in the CGU classification. Another corruption case distinguished in Ferraz and Finan is not related to procurement, namely when resources "disappear" from municipal bank accounts. According to Ferraz and Finan (2011) a mismanagement episode in procurement occurs when "less than three firms bid for a public contract", corresponding approximately to the irregularity "invitation for bids to less than three firms" in the CGU classification.

Brollo et al. (BNPT, 2013) also use the CGU audit reports to construct a narrow and a broad corruption measure. Table 2 in our paper shows that their narrow corruption coding is broader than the corruption measure constructed by Ferraz and Finan. Specifically, Brollo et al.'s narrow corruption measure includes cases of "limited competition", corresponding roughly to the CGU "evidence of favoritism" category, "fraud", corresponding to the "simulated tender process" category, as well as "over-invoicing", which amounts to CGU's "unjustified or excessive payments for goods and services" category. The main difference with Ferraz and Finan's coding is the addition of "manipulation of the bid value", which CGU refers to as "fractionalizing of procurement amounts", that is, deliberate division of a purchase into smaller amounts in order to avoid unrestricted procurement modalities. Another difference with Ferraz and Finan is that corruption episodes are not restricted to those instances where non-provision of the good or service was somehow confirmed.

Brollo et al.'s broad corruption coding essentially corresponds to the management irregularities in Litschig and Zamboni (2012). Specifically, in their broad measure of corruption Brollo et al. also include "an irregular firm wins the bid process", corresponding roughly to "participating ineligible firm" in CGU terminology, "the minimum number of bids is not attained", which CGU labels "invitation for bids to less than three firms", as well as "the required procurement procedure is not executed", which roughly corresponds to CGU's "procurement modality too restricted". The final corruption case "diversion of funds" (e.g. earmarked transfers for supplies are used for salaries instead) distinguished in Brollo et al. is not directly related to procurement.

Table 1: Randomization lottery, May 12 2009

State	G	Draws	P(Treatment)
Acre (AC)	21		4.0
Amapá (AP)	15	2	4.0
Roraima (RR)	14		4.0
Alagoas (AL)	101	2	2.0
Amazonas (AM)	61	2	3.3
Bahia (BA)	415	10	2.4
Ceará (CE)	183	6	3.3
Espírito Santo (ES)	77	2	2.6
Goiás (GO)	245	6	2.4
Maranhão (MA)	216	6	2.8
Minas Gerais (MG)	849	14	1.6
Mato Grosso do Sul (MS)	77	2	2.6
Mato Grosso (MT)	140	2	1.4
Pará (PA)	142	4	2.8
Paraíba (PB)	222	6	2.7
Pernambuco (PE)	182	4	2.2
Piauí (PI)	223	6	2.7
Paraná (PR)	397	8	2.0
Rio de Janeiro (RJ)	88	2	2.3
Rio Grande do Norte (RN)	166	4	2.4
Rondônia (RO)	51	2	3.9
Rio Grande do Sul (RS)	495	10	2.0
Santa Catarina (SC)	292	6	2.1
Sergipe (SE)	74	2	2.7
São Paulo (SP)	636	10	1.6
Tocantins (TO)	138	2	1.4
Total	5,520	120	

Notes: Source: Portaria Nº 930, May 8 2009. G is the number of municipalities from a given state that are eligible for sampling in the lottery. Draws is the number of municipalities from a given state that are sampled in the lottery. P(Treatment) is the probability of assignment to the high audit risk group, given in percentage points.

Table 2: Sampling probabilities in the 29th lottery, August 17 2009

State	G	Draws	P(Draw)
Acre (AC)	18		2.3
Amapá (AP)	12	1	2.3
Roraima (RR)	13		2.3
Alagoas (AL)	82	2	2.4
Amazonas (AM)	53	1	1.9
Bahia (BA)	389	5	1.3
Ceará (CE)	166	3	1.8
Espírito Santo (ES)	71	1	1.4
Goiás (GO)	230	2	0.9
Maranhão (MA)	189	3	1.6
Minas Gerais (MG)	812	7	0.9
Mato Grosso do Sul (MS)	71	1	1.4
Mato Grosso (MT)	132	1	0.8
Pará (PA)	127	3	2.4
Paraíba (PB)	207	3	1.4
Pernambuco (PE)	159	3	1.9
Piauí (PI)	205	3	1.5
Paraná (PR)	378	3	0.8
Rio de Janeiro (RJ)	83	1	1.2
Rio Grande do Norte (RN)	153	3	2.0
Rondônia (RO)	46	1	2.2
Rio Grande do Sul (RS)	472	4	0.8
Santa Catarina (SC)	280	2	0.7
Sergipe (SE)	66	1	1.5
São Paulo (SP)	609	5	0.8
Tocantins (TO)	132	1	0.8
Total	5,155	60	

Notes: Source: Portaria Nº 1581, August 11 2009. G is the number of municipalities from a given state that are eligible for sampling in the lottery. Draws is the number of municipalities from a given state that are sampled in the lottery. P(Draw) is the sampling probability, given in percentage points.

Table 3: Corruption in procurement, BNPT (2013) broad measure

Dependent variable	32nd lottery			31st and 32nd lottery				
	Control mean	Simple difference	N [G]	Control mean	Simple difference	N [G]	Adjusted difference	N [G]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: CGU audit reports data, 2009 and 2010 transfers								
Share of audited amount involved in broad corruption in procurement	0.190	-0.107		0.199	-0.117		-0.113	
	(0.041)	(0.047)	[60]	(0.026)	(0.034)	[120]	(0.052)	[111]
Panel B: CGU procurement process-level data, 2009 and 2010 transfers								
Procurement process with evidence of broad corruption	0.407	-0.159	834	0.419	-0.172	1,304	-0.119	1,304
	(0.058)	(0.073)	[60]	(0.037)	(0.057)	[117]	(0.051)	[117]
Restricted procurement process with evidence of broad corruption	0.488	-0.194	539	0.477	-0.183	880	-0.113	880
	(0.057)	(0.076)	[60]	(0.033)	(0.070)	[113]	(0.073)	[113]
Unrestricted procurement process with evidence of broad corruption	0.234	-0.056	295	0.283	-0.105	424	-0.170	424
	(0.113)	(0.120)	[49]	(0.068)	(0.080)	[87]	(0.089)	[87]

Notes: Panel A: Municipality-level OLS estimations with robust standard errors. Panel B: OLS estimations at the procurement-process level with standard errors clustered at the municipality level. Broad corruption corresponds to cases of simulated tender processes, cases of favouritism, or when auditors determine that there were unjustified or excessive payments for goods or services, as well as cases of fractionalized procurement amounts. Broad corruption also includes instances where less than three firms were invited to submit bids or procurement modalities were too restricted or a participating firm was ineligible. The 'Control mean' columns (1) and (4) give the sample average in the low audit risk group. The 'Simple difference' columns (2) and (5) give the difference in means between high and low audit risk groups. In columns (3), (6) and (8) G is the number of municipalities and N is the number of procurement processes used to estimate columns (2), (5) and (7), respectively. The 'Adjusted difference' column (7) reports estimates on the high audit risk group dummy from a regression that also includes state intercepts, mayor's party dummies and mayor characteristics in 2008, and municipality characteristics from 2000 and 2007. In panel A the regression additionally includes the share of audited resources involved in broad corruption in procurement in 2008. Mayor characteristics: first-term mayor indicator, indicator for mayor win margin < 5%, mayor education level indicators, male dummy and age. Municipality characteristics: indicator for CGU audit at least once in lotteries 2 through 27, population, income per capita, average years of schooling, urbanization, poverty headcount ratio, poverty gap, gini coefficient and indicator for local radio station. Restricted procurement modalities refer to direct purchases by the local administration, bids only by invitation and the modality where only pre-registered bidders can compete for the contract. Unrestricted modalities are the sealed-bid (reverse) auction, on-site (reverse) auction, and electronic (reverse) auction.

Table 4: Corruption in procurement, FF (2011) measure

Dependent variable	32nd lottery			31st and 32nd lottery				
	Control mean	Simple difference	N [G]	Control mean	Simple difference	N [G]	Adjusted difference	N [G]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: CGU audit reports data, 2009 and 2010 transfers								
Share of audited amount involved in corruption in procurement	0.155	-0.077		0.154	-0.077		-0.096	
	(0.040)	(0.046)	[60]	(0.025)	(0.034)	[120]	(0.055)	[111]
Panel B: CGU procurement process-level data, 2009 and 2010 transfers								
Procurement process with evidence of corruption	0.172	-0.053	834	0.217	-0.098	1,304	-0.102	1,304
	(0.066)	(0.073)	[60]	(0.040)	(0.050)	[117]	(0.050)	[117]
Restricted procurement process with evidence of corruption	0.164	-0.051	539	0.227	-0.113	880	-0.130	880
	(0.064)	(0.072)	[60]	(0.043)	(0.054)	[113]	(0.066)	[113]
Unrestricted procurement process with evidence of corruption	0.188	-0.061	295	0.194	-0.067	424	-0.086	424
	(0.116)	(0.122)	[49]	(0.066)	(0.078)	[87]	(0.070)	[87]

Notes: Panel A: Municipality-level OLS estimations with robust standard errors. Panel B: OLS estimations at the procurement-process level with standard errors clustered at the municipality level. Corruption corresponds to cases of simulated tender processes, cases of favouritism, or when auditors determine that there were unjustified or excessive payments for goods or services. The 'Control mean' columns (1) and (4) give the sample average in the low audit risk group. The 'Simple difference' columns (2) and (5) give the difference in means between high and low audit risk groups. In columns (3) and (7) G is the number of municipalities and N is the number of procurement processes. The 'Adjusted difference' column (6) reports estimates on the high audit risk group dummy from a regression that also includes state intercepts, mayor's party dummies and mayor characteristics in 2008, and municipality characteristics from 2000 and 2007. In panel A the regression additionally includes the share of audited resources involved in corruption in procurement in 2008. Mayor characteristics: first-term mayor indicator, indicator for mayor win margin < 5%, mayor education level indicators, male dummy and age. Municipality characteristics: indicator for CGU audit at least once in lotteries 2 through 27, population, income per capita, average years of schooling, urbanization, poverty headcount ratio, poverty gap, gini coefficient and indicator for local radio station. Restricted procurement modalities refer to direct purchases by the local administration, bids only by invitation and the modality where only pre-registered bidders can compete for the contract. Unrestricted modalities are the sealed-bid (reverse) auction, on-site (reverse) auction, and electronic (reverse) auction.

Table 5: Need for medical attention at home or at the health post

	32nd lottery			31st and 32nd lottery		
Dependent variable	Control mean	Simple Difference	N [G]	Control mean	Simple Difference	N [G]
	(1)	(2)	(3)	(4)	(5)	(6)
Household should receive visits from community health worker	0.991	-0.025	1,123	0.994	-0.028	2,403
	(0.009)	(0.022)	[58]	(0.003)	(0.020)	[113]
Household required a visit from medical staff at home	0.227	-0.011	1,123	0.217	-0.003	2,403
	(0.063)	(0.081)	[58]	(0.032)	(0.060)	[113]
Household member required to see a doctor at the health post	0.531	0.019	1,123	0.578	-0.028	2,403
	(0.098)	(0.143)	[58]	(0.057)	(0.119)	[113]
Household member required to see a nurse at the health post	0.529	0.008	1,123	0.575	-0.037	2,403
	(0.099)	(0.142)	[58]	(0.057)	(0.116)	[113]
Household member required to see a dentist at the health post	0.430	-0.064	1,123	0.433	-0.067	2,403
	(0.088)	(0.119)	[58]	(0.050)	(0.094)	[113]
Household usually uses the health post for medical services	0.435	0.068	1,123	0.468	0.036	2,403
	(0.086)	(0.126)	[58]	(0.050)	(0.105)	[113]
Household required services from medical staff	0.977	-0.027	1,123	0.983	-0.033	2,403
	(0.011)	(0.024)	[58]	(0.005)	(0.022)	[113]
F-statistic		1.170			1.250	
(p-value)		(0.333)			(0.282)	

Notes: OLS estimations at the household level. Standard errors are clustered at the municipality level. The 'Control mean' column gives the sample average in the low audit risk group. The 'Difference' column gives the difference in means between high and low audit risk groups. N is the number of respondent households and G is the number of municipalities. F-statistics are for the joint hypotheses that all differences in outcomes are zero.

Table 6: Likelihood that cash transfer recipient household was inspected

	32nd lottery			31st and 32nd lottery				
Dependent variable	Control mean	Simple difference	N [G]	Control mean	Simple difference	N [G]	Adjusted difference	N [G]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Household head was interviewed	0.746	-0.012	1,762	0.758	-0.024	3,511	0.007	3,511
	(0.023)	(0.041)	[60]	(0.014)	(0.036)	[118]	(0.041)	[118]
Household composition was assessed	0.751	0.010	1,762	0.780	-0.018	3,511	0.016	3,511
	(0.035)	(0.046)	[60]	(0.016)	(0.033)	[118]	(0.053)	[118]
Household income per capita was assessed	0.770	-0.013	1,762	0.792	-0.035	3,511	0.003	3,511
	(0.022)	(0.037)	[60]	(0.013)	(0.032)	[118]	(0.042)	[118]
Household has children 0 to 6 years old and was interviewed	0.317	0.017	1,762	0.348	-0.014	3,511	-0.024	3,511
	(0.031)	(0.032)	[60]	(0.013)	(0.028)	[118]	(0.036)	[118]
F-statistic		0.270			0.670		0.360	
(p-value)		(0.895)			(0.613)		(0.840)	

Notes: WLS estimations at the municipality level with weights corresponding to the number of households investigated in each municipality. Robust standard errors in parentheses. The 'Control mean' columns (1) and (4) give the sample average in the low audit risk group. The 'Simple difference' columns (2) and (5) give the difference in means between high and low audit risk groups. In columns (3), (6) and (8) G is the number of municipalities and N is the number of respondent households or students to whom a given inspection applies that are used to estimate columns (2), (5) and (7), respectively. The 'Adjusted difference' column (7) reports estimates on the high audit risk group dummy from a regression that also includes state intercepts, mayor's party dummies and mayor characteristics in 2008, and municipality characteristics from 2000 and 2007. Mayor characteristics: first-term mayor indicator, indicator for mayor win margin < 5%, mayor education level indicators, male dummy and age. Municipality characteristics: indicator for CGU audit at least once in lotteries 2 through 27, population, income per capita, average years of schooling, urbanization, poverty headcount ratio, poverty gap, gini coefficient and indicator for local radio station. F-statistics are for the joint hypotheses that all coefficients in a given column are zero.

Table 7: Unduly discretionary modality

Dependent variable	32nd lottery			31st and 32nd lottery				
	Control mean	Simple difference	N [G]	Control mean	Simple difference	N [G]	Adjusted difference	N [G]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: CGU audit reports data, 2009 and 2010 transfers								
Share of audited amount involved in unduly discretionary modalities	0.063	-0.035		0.053	-0.025		0.004	
	(0.028)	(0.031)	[60]	(0.014)	(0.020)	[120]	(0.037)	[120]
Panel B: CGU procurement process-level data, 2009 and 2010 transfers								
Procurement process with unduly discretionary modality	0.224	-0.110	834	0.186	-0.070	1,304	-0.006	1,304
	(0.057)	(0.066)	[60]	(0.035)	(0.049)	[117]	(0.045)	[117]
Restricted procurement process with unduly discretionary modality	0.308	-0.147	539	0.227	-0.066	880	0.035	880
	(0.063)	(0.080)	[60]	(0.042)	(0.063)	[113]	(0.063)	[113]
Unrestricted procurement process with unduly discretionary modality	0.045	0.004	295	0.088	-0.039	424	-0.084	424
	(0.027)	(0.037)	[49]	(0.036)	(0.044)	[87]	(0.076)	[87]

Notes: Panel A: Municipality-level OLS estimations with robust standard errors. Panel B: OLS estimations at the procurement-process level with standard errors clustered at the municipality level. Unduly discretionary modalities are determined by auditors and include (without being limited to) cases of deliberate reductions of contract size by procurement officers (fractionalization). The 'Control mean' columns (1) and (4) give the sample average in the low audit risk group. The 'Simple difference' columns (2) and (5) give the difference in means between high and low audit risk groups. In columns (3) and (7) G is the number of municipalities and N is the number of procurement processes. The 'Adjusted difference' column (6) reports estimates on the high audit risk group dummy from a regression that also includes state intercepts, mayor's party dummies and mayor characteristics in 2008, and municipality characteristics from 2000 and 2007. Mayor characteristics: first-term mayor indicator, indicator for mayor win margin < 5%, mayor education level indicators, male dummy and age. Municipality characteristics: indicator for CGU audit at least once in lotteries 2 through 27, population, income per capita, average years of schooling, urbanization, poverty headcount ratio, poverty gap, gini coefficient and indicator for local radio station. Restricted procurement modalities refer to direct purchases by the local administration, bids only by invitation and the modality where only pre-registered bidders can compete for the contract. Unrestricted modalities are the sealed-bid (reverse) auction, on-site (reverse) auction, and electronic (reverse) auction.

Table 8: Federal transfers per capita before, during, and after increased audit risk, audited municipalities

	2008		2009		2010		2011	
Dependent variable	Control Mean	Simple difference	Control Mean	Simple difference	Control Mean	Simple difference	Control Mean	Simple difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Federal education transfers per capita	245.1	6.9	278.7	12.9	327.5	-1.7	396.1	-3.6
	(11.0)	(23.3)	(11.7)	(24.3)	(14.7)	(28.1)	(17.5)	(30.7)
Federal health transfers per capita	82.3	-5.8	94.1	0.0	109.3	-3.0	121.6	5.6
	(4.0)	(11.7)	(4.5)	(12.5)	(5.9)	(16.5)	(6.3)	(19.7)
Federal welfare transfers per capita	10.7	0.8	13.1	-1.5	17.3	-3.4	19.1	1.8
	(1.4)	(2.6)	(1.3)	(2.6)	(1.9)	(3.2)	(1.4)	(3.5)
Other federal transfers per capita	25.9	-7.8	42.0	-7.5	43.8	-8.6	34.7	-8.0
	(3.7)	(6.7)	(4.1)	(6.6)	(10.0)	(15.3)	(11.9)	(13.8)
Federal capital transfers per capita	49.2	-3.5	37.0	-1.3	91.1	-32.4	88.0	-4.8
	(8.0)	(16.3)	(6.4)	(12.4)	(1.1)	(31.3)	(20.7)	(28.7)
Number of municipalities	87	117	89	119	88	118	85	114
F-statistic		0.410		0.360		0.580		0.180
(p-value)		(0.838)		(0.874)		(0.717)		(0.971)

Notes: OLS estimations at the municipality level. Robust standard errors in parentheses. The sample consists of municipalities that were audited in the 31st or 32nd lottery with available data on federal transfers. The dependent variable is the per capita transfer of a given type and in a given year. Transfers are in current Reais. The 'Control mean' columns (1), (3), (5) and (7) give the sample average for a given type of revenue in a given year in the low audit risk group. The 'Simple difference' columns (2), (4), (6) and (8) give the difference in means between high and low audit risk groups for a given type of transfer in a given year. F-statistics are for the joint hypotheses that all differences in outcomes in a given year are zero.

Table 9: Municipal expenditure per capita before, during, and after increased audit risk, audited municipalities

	2008		2009		2010		2011	
Dependent variable	Control Mean	Simple difference	Control Mean	Simple difference	Control Mean	Simple difference	Control Mean	Simple difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Education expenditure per capita	446.8	-37.1	468.3	-26.6	555.4	-17.5	678.9	-41.6
	(20.7)	(36.5)	(18.1)	(29.9)	(24.6)	(51.8)	(33.1)	(51.2)
Health expenditure per capita	345.6	-26.5	359.2	-25.0	415.4	-19.4	517.8	-84.2
	(19.3)	(34.2)	(18.4)	(35.5)	(22.1)	(38.8)	(28.2)	(48.9)
Welfare expenditure per capita	85.7	-1.6	90.9	-11.3	110.5	-20.5	125.8	-10.5
	(9.5)	(14.8)	(8.4)	(12.8)	(10.4)	(15.6)	(10.6)	(18.1)
Transportation expenditure per capita	87.8	17.4	91.6	-8.2	130.3	-54.6	125.1	-19.3
	(14.3)	(28.6)	(18.7)	(26.6)	(26.5)	(34.8)	(24.0)	(40.7)
Housing expenditure per capita	180.9	-16.7	128.9	9.5	175.6	12.2	204.2	-27.1
	(16.5)	(31.9)	(11.1)	(22.0)	(22.1)	(41.3)	(19.8)	(35.8)
Number of municipalities	79	105	87	115	78	105	72	99
F-statistic		0.500		0.430		0.780		0.640
(p-value)		(0.774)		(0.828)		(0.568)		(0.668)

Notes: OLS estimations at the municipality level. Robust standard errors in parentheses. The sample consists of municipalities that were audited in the 31st or 32nd lotteries with available budget data. The dependent variable is the per capita municipal expenditure in a given budget category and year. The 'Control mean' columns (1), (3), (5) and (7) give the sample average for a given budget category in a given year in the low audit risk group. The 'Simple difference' columns (2), (4), (6) and (8) give the difference in means between high and low audit risk groups for a given budget category in a given year. F-statistics are for the joint hypotheses that all differences in outcomes in a given year are zero.

Table 10: Distribution of procurement modalities by level of audit risk and lottery

	32nd lottery				31st lottery	
	High audit risk		Low audit risk		Low audit risk	
Procurement modality	Freq.	Percent	Freq.	Percent	Freq.	Percent
Direct purchase	69	19.60	74	15.35	57	12.13
Bids only by invitation	98	27.85	188	39.00	198	42.13
Only pre-registered bidders	44	12.50	66	13.69	86	18.30
Restricted modalities	211	59.95	330	68.04	341	72.56
Sealed-bid auction	6	1.70	10	2.07	5	1.06
On-site auction	105	29.83	108	22.41	114	24.26
Electronic auction	30	8.52	36	7.48	10	2.12
Unrestricted modalities	142	40.05	155	31.96	210	27.44
Total	352	100.00	482	100.00	470	100.00

Notes: The unit of observation is an individual procurement process. For the 32nd lottery the data are from 2009 or 2010, while for the 31st lottery the procurement processes are almost entirely from 2009. The high vs low audit risk distributions from the 32nd lottery are statistically different from each other according to Pearson's chi-square test (p-value 0.012).