Understanding Corruption:

Theory and Evidence from the Audits of Local Governments

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1 Introduction

The abuse of entrusted power by politicians through rent-seeking and corruption is a serious concern in much of the developing world. Developing countries have provided numerous examples of political elites diverting funds intended for basic public services such as health, schools, and roads.[1] As a result, corruption is often considered the single greatest obstacle for economic and social development, and several studies have documented a strong negative relationship between corruption and measures such as investment and growth (Mauro 1995). Yet despite its costs and the potentially large welfare losses associated with it, our understanding of what determines corruption and how we can reduce it remains rather limited.

The goal of this paper is to provide a framework for understanding the decision of politicians to engage in corrupt activities. We developed and estimate a structural model of a politician's decisions to provide public goods and engage in corruption over the span of his political career. By

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[1]For instance, the former President of Zaire, Mobutu Sese Skeo, is believed to have embezzled $5 billion before being ousted in 1997. Also, it has been suggested that the former president of the Philippines Ferdinand Marcos has stolen over $35 billion dollars. See also Di Tella and Schargrodsky (2003) and Olken (2007).

capturing the incentives and constraints that politicians face, our model allows us to distinguish between at least two key explanations for the large variation in corruption that we observe today: the utility that politicians derive for engaging in corruption and the punishment politicians receive if caught for corruption. Using this model, we evaluate the effectiveness of anti-corruption policies that increase politicians' wages, induce a higher probability of being audited by a central authority, or increases term limits.

While our model is general, we develop and estimate it in the context of municipal governments in Brazil. Local governments in Brazil provide an ideal institutional setting to understand how corruption is determined for at least two reasons. First, in many countries the most corrupt governments seem to be at the local level, where governments are under the control of narrow elites that use the apparatus for personal gain (Rose-Ackerman 1999). For instance, as reported in Table 1, municipalities in Brazil receive on average $ 2,526,877 per year in order to provide such public services as education, health, and sanitation. With the large influx of federal funds and the potential for local capture, it is not surprising that corruption at the municipal level is now an overarching concern (VEJA 2004). According to our data on Brazil, corruption was discovered in 78 percent of all municipalities, where on average almost 9 percent of these federal funds were diverted (see rows 2 and 3 of Table 1). This translates into losses of approximately $800 millions in local governments per year. Second, in 2003 the Brazilian government introduced an anti-corruption program that randomly audited municipal governments for their use of federal funds. Based on these detailed audit reports, we estimate our model using objective measures of corruption for local governments, thus overcoming an important obstacle that has plagued much the existing literature on corruption (Svensson 2005).[2]

Our main findings are as follows. While increasing salaries of politicians is frequently advocated as anti-corruption policy, we find that the effects of such a policy would be relatively small. Conversely, by increasing the probability of being audited from 5 percent, which was the probability before the Lula's program, to 17 percent, its current probability, our model predicts that corruption will reduce by almost 8 folds. While this effect may appear large, according to our

[2]Due to the inherent difficulties in measuring corruption, many previous studies have had to rely on subjective measures of corruption based on either perceptions or self-reported information. Unfortunately, these data rarely provide unbiased estimates and are often influenced by the characteristics of the survey respondents.

model it is comprised of two parts. First, the audit reveals the politician's type, thus reducing the probability of a bad type getting re-elected. Second, mayors that have been audited are forced to pay a significant fine. We also find that increasing term limits from 2, which is the current limit in Brazil, to 4 will also decrease corruption. As elected officials' political horizon increase, the incentive to engage in corruption decreases.

Overall, our paper makes two main contributions to the existing literature. First, the proposed framework captures many of the various mechanisms by which politicians choose to engage in corruption, which enables us to assess empirically the relative importance of these different mechanisms. This lies in contrast to the previous literature whose empirical evidence has been mostly based on simple correlations. These estimates are often confounded by other unobserved determinants of corruption and provide only limited insights into the mechanisms that produce these associations. But it is precisely the understanding of these mechanisms that is critical for the design of policy as a redress for corruption. As a second contribution, we use the estimated model to evaluate the impact of policies that have been recently proposed by policy makers and economists as potential instruments for curbing corruption. While Ferraz and Finan (2008b), in a related study, have estimated the effects Brazil's audit policy on the re-election rates of incumbent mayors, the study is unable to determine whether the policy actually reduced corruption - the program's principal objective. Using this framework, this paper overcomes this limitation.

There is a growing literature that has analyzed corruption and decisions by politicians.[3] Our paper is one of the first to use a structural approach to investigate these two issues. An important exception is the paper by Diermeier, Keane, and Merlo (2005), who estimate a structural model to quantify the returns to a career in the United States Congress.

2 Model

In this section, we develop a model of a politician's decision to engage in corruption. Although our model is quite general, given the empirical analysis that follows, we consider a particular type of politician: a mayor. Overall, our framework captures six important factors that we believe determines the level of corruption in a particular economy. First, politicians that care more about

[3]See for instance the surveys by Svensson (2005), Rose-Ackerman (1999), and Besley (2006).

public consumption are generally less corrupt. Second, the level of corruption depends on the return of one additional dollar of public funds invested in the production of public consumption. Corruption is generally lower if the marginal return is higher. Third, experience as a mayor generally has a positive effect on future wage offers unless the mayor was found to be corrupt. Fourth, wealthier mayors generally steal less. Fifth, fines and jail terms deter corruption. Lastly, mayors that plan to run for reelection steal less. In the next three subsections, we describe how we incorporate these insights into a model of mayors' decisions.

2.1 Preferences and Technology

The starting point for our model is that individuals care about the amount of public good available in a particular municipality. Some examples of public goods provided by municipalities include schools, police force, parks, and roads. The amount of public consumption produced in a municipality depends on the fraction of public funds invested in its production. This implies that, everything else equal, in municipalities with more corruption less public consumption is produced and therefore its residents experience lower levels of welfare.

Consider a municipality m populated by n individuals, all of whom live for T periods and are potential politicians. In each period t there is uncertainty in the municipality which is denoted by the state of nature ω. Each individual i is characterized by a common discount factor $\beta \in (0,1)$ and by preferences over a private good c and a public good Q. These preferences are allowed to vary across individuals and are described by the following utility function:

$$u^i\left(c_t^i, Q_t\right).$$

The heterogeneity in the utility functions is introduced to allow individuals to differ in their preferences for public consumption relative to private consumption. This feature of the model addresses the first determinant of corruption: municipalities governed by individuals that care more about public consumption relative to private consumption should enjoy higher levels of public good.

The public good is produced according to a municipal-specific production technology. It depends on inputs from the private sector z^{pr}, the amount of public funds invested in public consumption z^{pu}, the ability of the mayor governing the municipality a, as well as a vector X^m of

municipal characteristics. One example of municipal characteristics that affect the production of Q_t is the size of the municipality. We denote the production function for public consumption by

$$f_m\left(z^{pr}, z^{pu}, a, X_m\right)$$

The production function captures the second determinant of corruption described above. The level of corruption depends on the marginal product of the public inputs.

Each individual owns $\bar{h}$ units of labor which they supply inelastically in return for a wage w. If an individual becomes a mayor, he receives a deterministic wage $\bar{w}$ set by the central government. Otherwise, wages are drawn from the distributions $f_{pm}\left(w|Z\right)$ if the individual had been a mayor in the past or $f_{nm}\left(w|Z\right)$ if the individual had never been a mayor, where Z denotes a vector of individual and municipal characteristics that determine local wages. The different wage process for past mayors is meant to incorporate the possibility that individuals that have served as mayors generally receive better wage offers. To capture the additional insight that past mayors who were found to be corrupt receive potentially lower wage offers, we will allow the mean of the wage distribution for past mayors to depend on the amount stolen if the mayor was caught stealing.

Individuals possess non-labor income, Y, and can save or borrow an amount b at an interest rate R. Since wages, non-labor income, and savings determine the wealth of mayors, these aspects of the model capture the idea that wealthier mayors are less likely to steal.

2.2 Mayors' Decisions

Mayors make two types of decisions. They first decide the amount of public funds z^{pu} to invest in the production of public consumption Q and the amount they intend to steal s. They then decide how to allocate their private resources, which include the amount stolen, between consumption c and savings b.

Each municipality is audited with probability p. To indicate that a municipality was audited we set the variable δ equal to 1. If the municipality is audited and the mayor has engaged in corruption, the amount stolen becomes public knowledge. In addition, the mayor must pay a penalty which is given by the fine schedule $g(s)$, where $g(s)$ is increasing in the amount stolen. We do not explicitly model jail terms. They are transformed into monetary payments and added to the fine schedule. The fines are meant to capture an additional potential determinant of

corruption: lower fines increase corruption.

The mayor's decisions influence his probability of being re-elected in two ways. First, if a municipality was audited the voters know whether a mayor is corrupt and the amount stolen. As a result, voters are less likely to vote for the incumbent, where the probability of voting for the incumbent is decreasing in the amount stolen. Second, if the municipality was not audited, the voters only observe the level of public goods provision during the term that precedes the elections. The level of the public good is used to infer the ability of the incumbent and his preferences for public relative to private consumption. As is common in the political economy literature (e.g. Barro (1970), Ferejohn (1986)), we assume that voters adopt a retrospective voting strategy, whereby incumbents who provide public consumption above a particular threshold, Q^*, are rewarded with re-election. The threshold is determined endogenously and is a function of the following variables: the amount of public good produced by the municipality during the term; whether a mayor was audited and, conditional on being audited, the amount stolen; the campaign contribution received by the challengers relative to the one received by the incumbent r_c; an error term ϵ which captures the residual randomness. To model this election rule, we use a reduced-form formulation that incorporates these main features, i.e.

$$\text{the incumbent is reelected if} \qquad Q_t \geq Q_t^*,$$

where $Q^* = h(\delta, s, r_c, \epsilon)$. If individual i is elected we set the variable ρ_i to 1. This electoral rule captures the last determinant of corruption that we intend to model: mayors that plan to run for reelection steal less.

2.3 The Individual Decision Process

We are now ready to formally describe the decision process of individual i in municipality m. Individual i chooses the amount of private consumption and savings that maximizes his lifetime utility

$$E\left[\sum_{t=1}^{T} \beta_i^t u^i\left(c_t^i, Q_t\right)\right],$$

subject to the constraint that in each period and state of nature expenditure on consumption plus savings must equal the available resources,

$$c_t^i + b_t^i = w_t^i \bar{h}_t + 1_{\{\rho_t^i=1\}} s_t^i + R_t b_{t-1}^i + 1_{\{\rho_{t-1}^i=1, \delta_{t-1}^i=1\}} g\left(s_{t-1}^i\right) \qquad \text{for each } t \text{ and } \omega.$$

If individual i is the mayor, he also decides how much to steal, how much to invest in public consumption, and whether to run for mayor at the end of the current term. Moreover, his decision problem must satisfy two additional constraints. First, in each period and state of nature the resources stolen plus the resources invested in the production of public consumption must equal public funds[4], f_t^{pu},

$$z_t^{pu} + s_t^i = f_t^{pu} \qquad \text{for each } t \text{ and } \omega.$$

Second, the production function determines the amount of public consumption provided to the municipality,

$$Q_t = f\left(z_t^{pr}, z_t^{pu}, a, X_t^m\right) \qquad \text{for each } t \text{ and } \omega$$

Some remarks are in order. First, individual i can be fined in period t only if he was the mayor during the previous period and he was audited. Second, the sources of uncertainty faced by individual i depends on whether he is the current mayor. If he is, they correspond to the amount of funds the municipality will receive from the central government, whether he will be audited, and whether he will be reelected. If individual i is not the current mayor, the sources of uncertainty are his wage, the ability and the preferences of the current mayor.

3 Computation and Estimation

In this section we describe the approach used to estimate the model. In the estimation we use standard dynamic programming tools and indirect inference (Smith (1993), Gourieroux, Monfort, and Renault (1993), Gourieroux and Monfort (1996)). Specifically, the estimation is performed in two steps. For a given set of parameters that characterize the model, we first simulate the individual decisions. We then match some of the statistical moments that characterize the data with the corresponding moments obtained using the simulated data. The estimated parameters are obtained by minimizing the function of the distance between the simulated and data moments required by indirect inference.

The simulation of the model requires the derivation of its recursive formulation and of the corresponding value functions. To recover the recursive formulation it is important to describe

[4]We do not model local taxes because in Brazil 85 percent of a municipality's receipts are transfers from the central government.

the timing of events and decisions. At the beginning of term t, the current mayor decides whether to run for reelection. If he decides to run, he faces a challenger who is selected randomly from the population of the municipality. If not, two challengers face each other in the election. Elections take place in each municipality and their outcomes determine the mayor that will govern each municipality for term t. Wages, public funds, and private inputs are then realized. The central government collects fines from mayors that were caught stealing in the previous period. The mayors then choose the fraction of public funds to invest in public inputs, the fraction to steal, consumption, and savings. At the end of the period, a fraction of municipalities is audited where the fraction is exogenously determined.

We can now describe how the value function for each individual i can be computed. There are two different value functions that we have to calculate to determine the optimal decisions for each individual: the value function of current mayors and the value function of past mayors. To understand why both value functions are needed, observe that we are interested in the decisions of individual i only insofar as they provide information about the amount of corruption and the amount of public consumption that characterizes the corresponding municipality. We are therefore only interested in the decisions of individuals who are current mayors. When making decisions, mayors take into account the effects they have on their future welfare. As a consequence, to determine their optimal decisions for term t one needs to know their expected value function for term $t+1$. The expected value function at $t+1$ is a combination of two parts: the expected value conditional on still being the mayor, $E[V_M]$, and the expected value conditional on not being in power, $E[V_{PM}]$. The value function of past mayors is therefore part of the computation.

We are now in the position to describe the recursive formulation of the problem for mayors and past mayors. Let S_t^M and S_t^{PM} be the set of state variables at t for, respectively, a current and past mayor. Since only 3 percent of past mayors have run again for election after leaving office for at least one term, we assume that individuals can be mayor only once in their life. The decision problem of a past mayor for term t can then be written in the following form:

$$V_{PM}^i\left(S_t^{PM},t\right)=\max\ u^i\left(c_t^i,Q_t\right)+\beta E\left[V_{PM}^i\left(S_{t+1}^{PM},t+1\right)\right]$$

$$s.t.\ \ c_t^i+b_t^i=w_t^i\bar{h}+R_tb_{t-1}^i+1_{\{\rho_{t-1}^i=1,\delta_{t-1}^i=1\}}g\left(s_{t-1}^i\right).$$

where as mentioned above ρ_{t-1}^i equals 1 if individual i was a mayor in the previous period and

δ^i_{t-1} equals 1 if the municipality was audited in the previous period.

We can now describe the recursive formulation of the decision process for a current mayor. Let $p\left(S^M_t\right)$ be the probability that the incumbent is elected conditional on the state variables. One of the decisions of the current mayor is whether to run for reelection in the current term. If he decides to run, he wins the election with probability $p\left(S^M_t\right)$ and then solves the following problem:

$$V^i_M\left(S^M_t, t\right) = \max\ u^i\left(c^i_t, Q_t\right) + \beta E\left[V^i_M\left(S^M_{t+1}, t+1\right)\right]$$

$$s.t.\ \ c^i_t + b^i_t = w^i_t \bar{h}_t + 1_{\{\rho^i_t=1\}} s^i_t + R_t b^i_{t-1} + 1_{\{\rho^i_{t-1}=1, \delta^i_{t-1}=1\}} g\left(s^i_{t-1}\right)$$

$$z^{pu}_t + s^i_t = f^{pu}_t$$

$$Q_t = f\left(z^{pr}_t, z^{pu}_t, a, X^m_t\right).$$

With probability $1 - p\left(S^M_t\right)$ the election is won by the challenger, in which case the mayor's value function corresponds to the value function of a past mayor. The value function of an incumbent that chooses to run for reelection can therefore be computed as follows:

$$V^i_{RM}\left(S^M_t, t\right) = p\left(S^M_t\right) V^i_M\left(S^M_t, t\right) + \left(1 - p\left(S^M_t\right)\right) V^i_{PM}\left(S^{PM}_t, t\right).$$

If the mayor decides not to run for reelection, her value function corresponds to the one of a past mayor, i.e. $V^i_{NRM}\left(S^M_t, t\right) = V^i_{PM}\left(S^{PM}_t, t\right)$. Note that in our model it may be optimal for a mayor to not run for reelection if the incumbent receives an attractive wage offer as a past mayor. For instance he may receive an attractive offer from a law firm or he may receive the offer to run for governor. Finally, the value function of the current mayor can be computed as the maximum of V^i_{RM} and V^i_{NRM}:

$$V^i_M\left(S^M_t, t\right) = \max\ \left\{V^i_{RM}\left(S^M_t, t\right), V^i_{NRM}\left(S^M_t, t\right)\right\}.$$

The set of state variables depends on whether individual i is the current mayor. If he is, S^M_t includes the following variables: the number of terms individual i has been in power; the municipality in which the mayor is in power; individual i's education; his preferences for public consumption relative to private consumption; individual i's ability; the amount of public good produced by the mayor in the previous period; the amount stolen by the mayor in the previous

period; individual i's wealth; the probability the municipality will be audited. A past mayor has a larger set of state variables. It includes the state variables of a current mayor except ability and the current term. It also includes the following variables which characterize the mayor currently in power in her municipality for term t: the number of terms the current mayor has been in power; the amount of public good produced by the mayor in the previous period; the amount stolen by the mayor in the previous period; the mayor's wealth, preferences for public consumption and ability. The variables of the current mayor affect the past mayor decisions because they determine the amount of public good produced in the municipality.

The value function for each individual i is computed starting from the last period and moving backward in two steps following Keane and Wolpin (1994). In the first step, the state space is "discretized". Then using the corresponding grid, the value functions are computed for each period and each point of the state space in the grid. Finally, using the probability distribution for the discretized state space we can compute for each period the expected value functions conditional on the set of state variables $E[V|S]$. In the second step, the expected value functions are approximated using non-parametric methods. In practice, we regress the values of $E[V|S]$ obtained for each point in the grid on a polynomial of the discretized state variables. The corresponding coefficients are then used to construct the expected value functions for each period and value of the state space. Once the expected value functions are known, we can simulate the decisions of individuals in the municipalities observed in the data for different values of the parameters that characterize the model. The parameters of the model are then estimated using indirect inference.

4 Empirical Specification and Moment Selection

The model presented in Section 2 analyzes a mayor's decision to engage in corruption. In this section, we discuss the specifications used to estimate the structural parameters of the model using municipal-level data. To operationalize our model, functional form assumptions are needed for four key aspects of the model: 1) utility function; 2) public good production function; and 3) electoral rule; 4) wage process.

4.1 Functional form assumptions

Utility: In our model, a citizen i living in municipality m in period t has preferences over private consumption $c_t^{i,m}$ and public consumption Q_t^m that are described by the following utility function:

$$u^i\left(c_t^{i,m}, Q_t^m\right) = \frac{(c^{i,m})^{1-\gamma}}{1-\gamma} + \theta_i \frac{(Q^m)^{1-\delta}}{1-\delta}$$

The parameter θ_i captures a citizen's taste for public consumption relative to private consumption. Through θ_i we introduce an important source of heterogeneity into the model, as municipalities that are governed by mayors with a higher θ_i should experience less corruption, all else equal. In the estimation of the model, we assume that θ_i takes on two values $\{\theta_L, \theta_H\}$, where $\theta_L < \theta_H$. In each municipality there is a fraction π_θ of high types.

Public consumption: Local public goods are produced according to a municipal-specific Cobb-Douglas production function:

$$Q_t^m = (z_t^{pr})^{\alpha_1}(z_t^{pu})^{\alpha_2} exp^{\alpha_3+\alpha_4 a_i+\alpha_5 E^m+\alpha_6 P^m}$$

where z_t^{pr} and z_t^{pu} represent the amount of private and public sector funds, respectively, that are invested into public consumption. Mayors influence the local public goods provision both through the amount of public funds invested but also by their ability a_i, where $a_i \in \{0, 1\}$. Individuals with high ability are more able and can produce more public goods with the same level of inputs. The proportion of high ability-types in the population is denoted by π_A. We also allow for the mayor's education level, E^m, and the size of the municipality, P^m, to affect public goods production.

Electoral rule: As mentioned in the model section, individuals decide whether to vote for the incumbent by adopting a retrospective voting strategy, whereby incumbents who provide public consumption above a particular threshold, Q^*, are rewarded with re-election. We assume that the threshold is a function of the following variables: the amount of public good produced by the municipality during the term; whether a mayor was audited, *audit*, and, conditional on being audited, the amount stolen, *steal*; the campaign contribution received by the challengers relative to the one received by the incumbent r_c; an error term $\varepsilon \sim N(0, 1)$ which captures the residual randomness. This assumption implies the following reduced-form formulation for the electoral

rule:

$$\begin{aligned} Q_t - Q_t^* &= \lambda_1 + \lambda_2 \text{audit} + \lambda_3(\text{audit} \times \text{steal}) + \lambda_4(\text{audit} \times \text{steal})^2 \\ &+ \lambda_5 Q + \lambda_6 Q^2 + \lambda_7 r_c + \varepsilon \end{aligned}$$

Wage Process for Past Mayors: We assume that the wage offers for past mayors are drawn from the following process:

$$\ln w_t^i = \delta_1 + \delta_2 t + \delta_3 E + \delta_4 P^m + \eta_t$$

where t, E, and P^m are a time trend, the education of the past mayor, and the size of the municipality, and η_t is normally distributed with mean zero and variance σ_η^2.

4.2 Moment Selection

Given these functional form assumptions, we estimate the model using the method of indirect inference. Using this method, we estimate five sets of parameters. In this section, we discuss the moments used to estimate the model.

Production Function Parameters ($\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6$): Given the functional form assumption of the production function, the parameters on the observable inputs of production $(\alpha_1, \alpha_2, \alpha_3, \alpha_5, \alpha_6)$ are estimated by matching the parameters obtained from a regression of the log of public consumption on the log of private and public inputs, the mayor's eduction, and the size of the municipality. In the data, public consumption is measured as municipal-level GDP. The parameter on ability, α_4, the unobserved component of the production function, is estimated by matching the variance of the residuals obtained from the regression mentioned above.

Preference for public consumption parameters (θ_H, θ_L): To estimate the relative taste for public consumption for a good mayor, θ_H, and a bad mayor, θ_L, we use average stealing and average stealing conditional on mayors that are in their second term.

Probability parameters (π_θ, π_A): To estimate the probability of observing a mayor with a high taste for public consumption, π_θ, we use as a moment the variance of the residuals obtained

from regressing stealing on a polynomial of the exogenous variables in the model. To estimate the probability of observing a high ability mayor, π_A, we use the expected value of the residuals obtained by estimating the production function without ability conditional on the residuals being positive.

Labor market parameters: The parameters of the wage offer distribution for past mayors are estimated by matching the parameters obtained by regressing log wages of past mayors on the variables that characterize the wage function. We are currently in the field collecting the data on wages of past mayors.

Electoral Rule Parameters ($\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7$): The parameters of the electoral rule are estimated outside the model using a probit specification in which the dependent variable is a dummy equal to one if the incumbent was reelected. In Brazil, the fact that municipalities are audited randomly helps in the identification of the parameter on the audit dummy and of the parameter on the interaction between the audit dummy and the amount stolen.

5 Data

This section describes the data used in the analysis. We first describe the approach used to measure corruption. We finish by providing summary statistics of the main variables used to obtain the preliminary estimates for Brazil.

As with any illegal activity, obtaining data on corruption is a difficult task. Several empirical studies that focus on illegal behavior have used indirect evidence to analyze its determinants and consequences. However, a small, but growing body of literature has tried to assess corruption more directly by focusing on two forms: bribery of public officials and the theft of public resources (see for instance Svensson (2005) and Olken (2007)).

For our analysis, we exploit the data used by Ferraz and Finan (2008a). Their approach, although related to the studies cited above, uses a new methodology made possible by the availability of audit reports from Brazil's and Puerto Rico's anti-corruption programs. Contained in each report is the total amount of federal funds audited for the current administration, as well as, an itemized list describing each irregularity and in most cases the amount of funds involved. Each report classifies the irregularities found by auditors into corruption indicators and estimates the

amount of public resources misappropriated for each irregularity. Based on the coding of these reports, our principal measure of corruption is the total amount of resources related to corrupt activities, expressed as a share of the total amount of resources audited.[5] We complement these corruption measures with a rich data set that combines information on various socio-economic characteristics of the municipality with both local public finance data and election results.

We now describe in more detail the Brazilian data. The public finance data, which is collected from Brazil's National Treasury, are used to construct a measure of annual intergovernmental transfers received by municipalities from 1997-2005. From the electronic files of Brazil's electoral commission, we obtain results from the 1996, 2000, and 2004 mayor elections. These data contain vote totals for each candidate by municipality, along with various individual characteristics such as the candidate's gender, education, occupation, and campaign contributions. We use this information to account for various individual mayor characteristics that might affect corruption. The final piece of data come Brazil's statistical office, which provide municipal-level GDP, as well as, private GDP for 2001-2005. Finally, according to the Brazilian law, a mayor who is caught stealing must return the amount stolen and pay a fine that is equal to 1.5 the amount stolen. We choose the fine schedule used in the estimation accordingly.

Table 2 presents summary statistics for Brazil for some of the main variables used in the analysis. According the audit reports, municipalities diverted six percent of all funds that were transferred from the federal government. Corruption is also higher among second-term mayors compared to first-term mayors, which is consistent with re-election incentives. Based on the election data, we find that re-election rates are about 40 percent and that incumbent mayors receive over twice as much campaign contributions as the challenger.

[5]Political corruption is defined to be any irregularity associated with fraud in procurements, diversion of public funds, and over-invoicing. Specifically, we define a *procurement to be irregular* if: i) a required procurement was not executed; ii) the minimum number of bids was not attained; iii) there was evidence of fraud in the procurement process (e.g. use of bids from non-existing firms). *Diversion of public funds* is defined as any expenditure without proof of purchase or provision and/or direct evidence of diversion provided by Brazil's auditing agency. Finally, *over-invoicing* is defined as any evidence that public goods and services were bought for a value above the market price.

6 Preliminary Results

The estimated values for a subset of the model's parameters are report in Table 3. The parameters on the wage distribution have been fixed, since the wages of past mayors are still in the process of being collected. In this section, we use these initial parameter estimates to discuss three policy simulations. Even though these results are preliminary, they highlight the potential usefulness of this model for informing policy.

Figure 1 presents the relationship between corruption and the amount of federal funds received by the municipality based on simulated data from the model. In addition to the base case simulation (depicted by the solid line), the figure plots results of three policy simulations. The base case is computed using the estimated parameters and the probability of being audited before the Lula's anti-corruption program was introduced.

The first simulation considers the effects of a policy that would double a mayor's wage. By increasing the opportunity cost of stealing, corruption will presumably decrease. The second simulation considers the effects of a policy that increases term limits from 2, which is the current limit in Brazil, to 4. One would expect that mayors who face reelection incentives are significantly less corrupt than mayors who are unable to run for reelection. By increasing an elected official's political horizon, the incentive to engage in corruption decreases. The final simulation considers the anti-corruption policy implemented by Lula's government. In this simulation, we increase the probability of being audited from 5%, which was the probability before the Lula's program, to 17%, which is the current probability.

As expected, the figure depicts a positive relationship between the amount of funds received and the amount stolen, which explains why, as Brazil has becomes more decentralized, local corruption has become such a serious problem. Given our current set of parameter values, our model also suggests that while increasing the wages of politicians may encourage mayors to engage in less corruption, its effects are relatively small. Although these results are still preliminary, they question the effectiveness of a policy which is frequently endorsed by both academic and policy circles alike. The preliminary results suggests that the most effective manner of combating corruption is to simply increase the likelihood of getting audited. According to our model, the increase in the probability of getting audited uniformly reduces the amount of corruption by almost

8 folds.

These effects of the audit policy on corruption is comprised of two parts. First, the audit reveals the politician's type, thus reducing the probability of a bad type getting re-elected. Second, mayors that have been audited are forced to pay a significant fine. In Figure 2, we separate these two effects by considering, in addition to Lula's policy, an audit policy where mayors are not fined and are only required to return the amount stolen. As the plot depicts, although an audit policy without fines would reduce local corruption, much of the reduction can be attributed to the financial penalties associated with the policy. There is some informal evidence that the Brazilian mayors convicted of corruption are required to pay fines that are much smaller than what is established by the Brazilian law. The Lula's program is therefore likely to achieve less in terms of curbing corruption than its potential.

7 Conclusions

In this paper, we provide a framework for understanding the decisions of politicians to engage in corrupt activities. We develop a structural model of a politician's decisions to provide public goods and engage in corruption over the span of his political career. We then estimate the model using objective measures of local corruption based on the audit reports of an anti-corruption program conducted in Brazil in 2003. Using this framework, we explore three policies for reducing corruption: 1) increasing the probability of a municipality being audited, 2) increasing politicians' wages; and 3) increasing term limits from 2 terms to 4 terms. Our results suggest that increases the probability of being audited greatly reduced corruption in local governments. The reduction in corruption stems from the anticipated effects of not only losing re-election but also having to face prosecution and paying a fine. We also find that the effects of increasing politicians' wages on corruption are small, thus questioning the effectiveness of frequently advocated policy.

The framework proposed in the paper, while applied to local governments in Brazil, is quite general. Future research will explore the corruption decisions of mayors in Puerto Rico, and thus provide an interesting point of comparison.

Table 1: Description of the Audit Reports Data, Brazil

Amount of resources transferred from the federal government	2,526,877
Proportion of municipalities with at least one irregularity	0.780
Share of audited resources related to corruption	0.087

Source: Audit reports

Table 2: Summary Statistics

	Mean	Standard deviation
Share of resources found to be corrupt	0.060	0.097
Among first-term mayors	0.053	0.098
Among second-term mayors	0.070	0.096
Average GDP (2002-2005)	176,124.8	1,847,021
Average Private GDP (2001-2004)	56,219.4	400,484.1
Federal transfers	5,571,723.1	5,191,158
Population	34,855.3	205,689.3
Mayor's education level	12.76	4.17
Mayor's age	48	7.9
Proportion of municipalities audit	0.082	0.276
Relative campaign contributions	2.12	2.53
Re-election rates 2004	0.40	0.49

Table 3: Parameter Estimates

Parameter	Variable	Estimated value
	Probabilities of Type and Preference Parameters	
$1-\pi_A$	Probability of Low Ability	0.53
π_A	Probability of High Ability	0.47
$1-\pi_\theta$	Probability of Bad Type	0.32
π_θ	Probability of Good Type	0.68
θ_L	Relative Taste for Q Bad Type	11.40
θ_H	Relative Taste for Q Good Type	57.90
	Production Function Parameters	
α_1	Public Inputs	0.020
α_2	Private Inputs	0.710
α_3	Constant	2.102
α_4	Education	0.049
α_5	Small Municipality	-1.045
α_6	Medium Municipality	-0.585
α_7	Ability	0.194
	Electoral Rule	
λ_1	Constant	0.283
λ_2	Audit	0.065
λ_3	Audit*Stealing	-0.016
λ_4	Audit*Stealing^2	$0.105e^{-3}$
λ_5	Public Consumption	0.0654
λ_6	Public Consumption^2	$-0.833e^{-6}$
λ_7	Mayor's Age	-0.112
λ_8	Relative Contributions	0.183

Figure 1: Simulated Policies

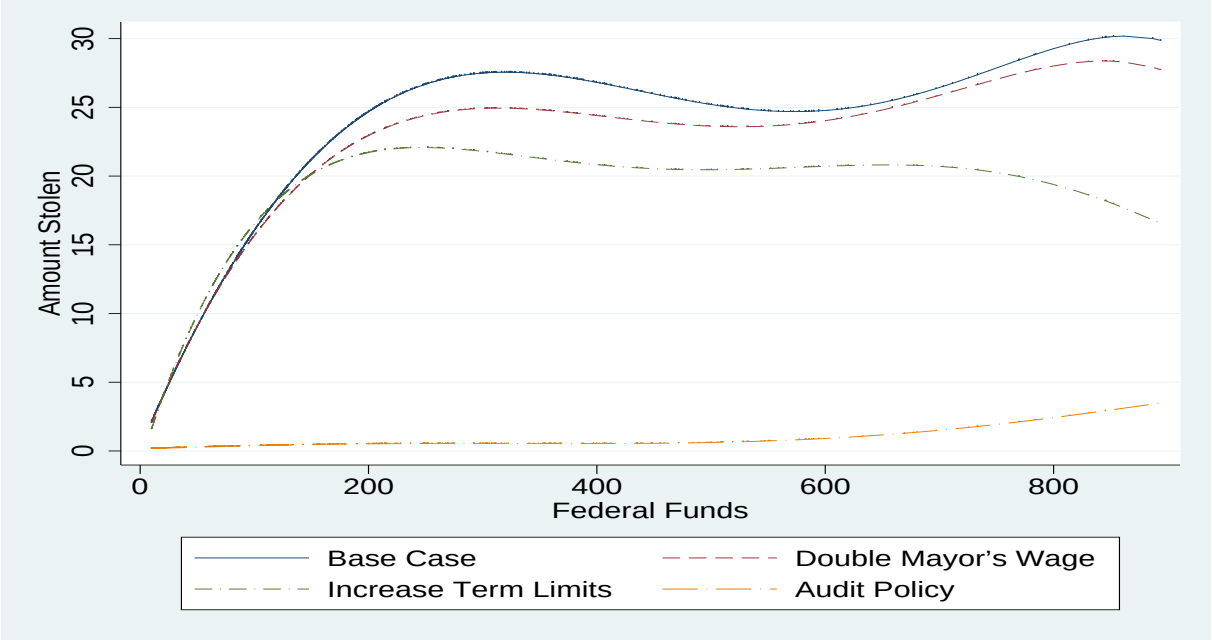
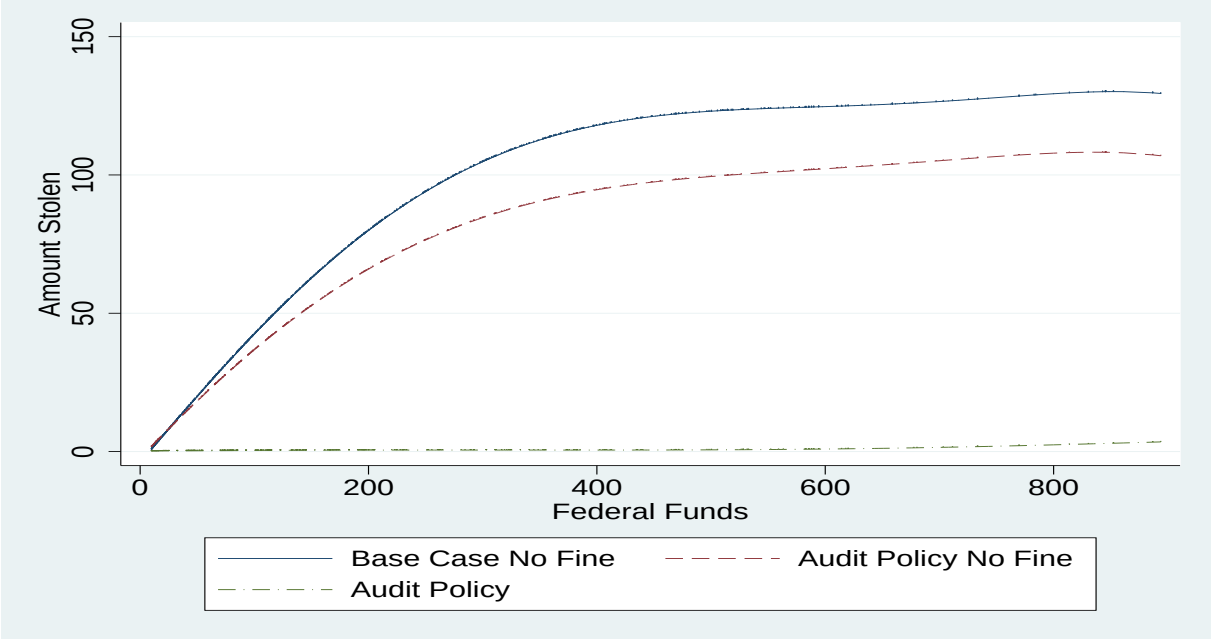


Figure 2: Simulated Policies



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