

Random Audit Programs and Game-Theoretic Models: establishing *ex-ante* corruption control

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ABSTRACT: Corruption has been a major concern worldwide for decades. In response, Brazil and many other countries have set up agencies focused on corruption control, oversight and prevention. In this study, we seek to analyze the actions and responsibilities of the Brazilian Office of the Comptroller General (CGU), established in 2003, and to develop an extension of current policy to enhance *ex ante* corruption and mismanagement control. The idea presented herein includes increasing the probability of a municipality being selected for an audit during a mayor's term, thus assuring that every local executive authority will be investigated at least once during its mandate. We develop a theoretical model of strategic interaction between the mayor and the Office of the Comptroller General, highlighting the factors that condition the mayor's choices, and conducting a cost-benefit analysis concerning CGU's policy decisions. A novel database based on audit reports for health transfers is drawn upon for illustration of players' response to the current levels of parameters.

KEYWORDS: corruption; Office of the Comptroller General; Game Theory; dynamic optimization.

RESUMO: A corrupção tem sido uma preocupação mundial por décadas. Em resposta, o Brasil e vários outros países criaram agências focadas na prevenção e no combate à corrupção. Neste estudo, buscamos analisar as ações e as responsabilidades da Controladoria Geral da União, criada em 2003, e desenvolver uma extensão da atual política de controle e supervisão para aumentar o controle antecipado da corrupção. A idéia aqui apresentada contempla aumentar a probabilidade de um município ser selecionado para uma auditoria durante a gestão de um prefeito, assegurando que toda autoridade executiva local seja investigada ao menos uma vez durante um mandato. Desenvolvemos um modelo teórico de interação entre o prefeito e a Controladoria Geral da União, destacando os fatores que condicionam as escolhas do prefeito, e conduzindo uma análise de custo-benefício das decisões de políticas públicas da CGU. Uma base de dados inédita, construída a partir dos relatórios de fiscalização para as transferências oriundas do Ministério da Saúde, é utilizada para ilustrar a resposta dos jogadores aos níveis atuais dos parâmetros.

PALAVRAS-CHAVE: corrupção, Controladoria Geral da União; Teoria dos Jogos; otimização dinâmica.

Área ANPEC: 4 – Economia do Setor Público

JEL Classification: H70, H75, H83.

1. Introduction

As with a number of other developing nations, Brazil has recently¹ been struck by a slew of corruption scandals. The Brazilian episodes have involved civil servants, government officials, politicians, private-sector companies, employers and employees, and members of civil society. As is widely known, “corruption is a widespread phenomenon which undermines good governance, erodes the rule of law, hampers economic growth and efforts for poverty reduction and distorts competitive conditions in business transactions” (OCDE, 2000: 2). This certainly holds true in the case of Brazil.

Yet, what has been done so far? Not much. Brazil has created a few agencies meant to fight corruption, and developed control and oversight agencies that operate with relative efficiency. However, few initiatives have proven to be effective for actual deterrence.

Some agencies date back to the 19th Century, such as the *Tribunal de Contas da Uniao* (Federal Audit Court) and several sub-national equivalents have been established during the first half of the 20th century. Today, all states and two municipalities (which ones?) have audit courts. Others have been created more recently (such as the Office of the Comptroller General, the focus of this study).

As such, how can transparency improve and corruption be more effectively prevented, given that the existing agencies are, at least theoretically, independent and exhaustive in terms of jurisdiction?

This paper seeks both to analyze the random-audit programs established by the Office of the Comptroller General (*Controladoria Geral da Uniao* or CGU) in Brazil and to suggest an extension of the existing model, in order to enhance *ex ante* control and consequent prevention of corruption.

Shleifer and Vishny (1993) argue that corruption always goes hand-in-hand with wasting resources. Contrary to one branch of the literature (Leff, 1964; Huntington, 1968) that believes that the optimal level of corruption is positive due to the alleged similarity of its effects on production with respect to taxation, the authors link the bureaucracy’s need for secrecy concerning misappropriation of funds to the emergence of inefficient allocative results. In particular, funds are channeled to rent-seeking activities with a low likelihood of being uncovered by the principal, due to the typical agency problem² in question.

In light of this, efforts to deter misappropriation of funds have a direct relationship with an increase in efficiency when managing funds. In fact, the Office of the Comptroller General’s oversight program for states and municipalities, as we shall see below, is the first attempt to monitor funds whose transfer has been governed by legislation since 1988. A more thorough understanding of the incentives underlying the oversight’s enforcement mechanisms is fundamental for fine tuning policy and minimizing wasted federal revenue, with virtuous effects for the provision of public goods at all levels of government.

Given that Brazil is a highly decentralized country, with more than one-third of public expenditures made at the sub-national level, since promulgation of the 1988 Federal Constitution, municipalities have acquired greater responsibility in terms of providing public services locally. Thus, we decided to focus on municipal oversight. Another reason for this choice relates to a novel database with audit-reports data for health transfers at the municipality level, which shall present new grounds for empirical efforts in order to qualify corruption determinants and policy effectiveness, used in this paper as an illustration of players’ response to current parameter values, in terms of the theoretical model developed herein. In any event, results drawn in further sections should theoretically hold for state-level oversight as well.

In the next section, we present a review of how anticorruption strategies are implemented around the world, exploring similarities and dissimilarities with the Brazilian case. Section three details the structure of the Office of the Comptroller General in Brazil, and section four explores the random-audit program and a proposed extension thereof through an interaction model between mayors and the Office of the Comptroller General. Section five discusses the main results of the proposed extended model.

¹ Since the beginning of the 1990s.

² On the agent-principal approach to the corruption issue, see Becker and Stigler (1974).

Section six reviews the topics presented throughout the article in greater detail, focusing on evidence for health-related funds audited in Brazilian municipalities, based on reports produced by the CGU between 2001 and 2004. The main conclusions are reported in the final section.

2. Anticorruption strategies around the world

2.1.1. Anticorruption agencies

In recent years, multilateral organizations have demonstrated growing concern for corruption-related issues in the development of aid programs for low-income countries in order to establish anticorruption initiatives. Two such examples are the OECD and the UNDP, which fund numerous country-specific anticorruption programs.

Upon analyzing a number of programs adopted around the world, we identified a strong trend for creating anticorruption agencies associated with high-level audit institutions. However, it is important to keep in mind that since corruption patterns vary through space and time, each country must develop its own anticorruption strategies.

According to Pope (1999),

“to operate successfully, an anti-corruption agency must possess the following: [a.]) committed political backing at the highest levels of government; [b.]) political and operational independence to investigate.... [c.]) adequate powers of access to documentation and to question witnesses; and, leadership which is seen as being of the highest integrity” (Pope, 1999: 1).

2.1.2. Random audit programs

Implementation of random-audit programs by national revenue services is widespread, although they serve varying purposes.

The Internal Revenue Service in the United States established a random-audit program for taxpayers in the early 1990s. It currently has plans to revive the practice, randomly auditing taxpayers in order to improve the mechanisms against tax-dodging. Even though the purpose is not the same as ours (local governments versus taxpayers), it is still interesting to understand its aims.

The use of random audits in the U.S. has a specific goal: to calibrate the Discriminant Inventory Function System software used by the IRS to assign scores to individual returns based on the likelihood that an audit will lead to a tax change, and to improve audit-selection techniques. The IRS’ random audits aim at sampling 13,000 taxpayers out of 136 million, a selection probability of just 0.0096%.

While this selection probability may seem tiny, it should not be read this way – the purpose of the IRS is to ameliorate its audit techniques, rather to gain a good picture of taxpayers throughout the U.S. On the other hand, the idea of anti-corruption random audit programs is either to obtain a representative portion of the entire universe or to investigate the greatest number of entities possible.

2.1.3. The Office of the Comptroller General in Brazil

In Brazil, the Office of the Comptroller General (CGU) is responsible for assisting the President with issues related to the defense of public assets and transparency of public management, through internal control, public auditing, corrections, corruption prevention/fighting, and an ombudsman office. It is also responsible for technical supervision of the entities that comprise both the Internal Control System and Correction System, providing normative guidance when needed.

The CGU was created on April 2, 2001, with the mission to investigate and fight fraud and corruption, and to protect public assets. With the promulgation of Federal Decree 5683, on January 24, 2006, the CGU became not only a control and audit agency, but also a corruption-prevention entity,

developing expedients to deter corruption *ex ante*. Decree 5683 delegated greater powers to the CGU by creating the Bureau of Corruption Prevention and Strategic Information.

After promulgation of Federal Decree 5683 (complementing Federal Constitutional Amendment 2.143-21/2001, Federal Decree 4.177/2002 and Federal Law 10.683/2003), the CGU's main functions were consolidated under the same operational structure.

According to Federal Law 10.683, from May 28, 2003, the CGU assists the Executive Branch in defending public property, promoting internal control, performing public audits, assuring correction, preventing and combating corruption, providing ombudsman services, and increasing transparency in government actions at the federal level.

The CGU is an executive agency designed to perform audits and control initiatives to verify the uses of public funding. This power is exerted by the Federal Secretariat for Internal Control (SFCI), responsible for evaluating execution of the federal budget, supervising implementation of government programs, and auditing federal funds transferred to other public or private entities at other administrative levels. It is also in charge of oversight and fraud detection in every issue related to public funds. It is responsible for developing mechanisms to prevent corruption, anticipating its action in corruption-related episodes through the SFCI. Since the creation of the Secretariat, established as an intelligence unit, the development of prevention initiatives has become a recursive issue, and this study seeks to contribute to this discussion.

2.1.4. The random audit program in Brazil

Given that the random-audit program is ran by a *de facto* national anticorruption agency (i.e. the CGU), some may view it as a politicized tool, and thus ineffective for preventing corruption. However, a mechanism for selecting states and municipalities to be audited completely eliminates this possibility. The initiative of making random selections through a national lottery has eliminated political influence over eligible counties, giving the transparency needed for an anticorruption program to be credible.

The random-audit program was first established in 2003 for municipalities, and in 2004 for states. Analyzing the drawings done to date, it seems plausible to conclude that the CGU's focus is to oversee municipalities, given that 23 drawings, involving over 1,200 municipalities, have already taken place for local-level administrations.³ The program was started in 2003 with a sample of five municipalities in the first random selection. The second program included 25 municipalities. From the third to the twelfth, 50 municipalities were drawn, and from the thirteenth on, 60 municipalities are now drawn on a bimonthly basis.

The municipal audit program investigates all federal transfers to municipalities: transfers earmarked to execute national health and education policies (legal transfers); direct transfers to citizens; and politically negotiated (voluntary) transfers.

The selection process was properly designed so that the samples would be geographically representative⁴, and selection probabilities are currently around one percent for each of the 5,560 municipalities in the Federative Republic of Brazil⁵, while complying with a population threshold currently set at a maximum of 500,000 inhabitants for the city to be eligible.

3. Interaction model

In the section above, we explained the structure of the domestic oversight system in detail, starting with its agencies, coverage and powers. This overview is relevant as a foundation of the CGU's underlying role, the complementarities and substitutions among different agents in the system, defining the initial conditions for interaction between the CGU and municipalities, about which we are particularly concerned.

³ Five drawings have selected states in 2004, 2005 and 2006. However, control actions are focused on specific areas due to the territorial extension of these sub-national governments.

⁴ Please see the appendix for the number of municipalities selected from each state.

⁵ This makes the overall probability of selection converge to 1%, or more precisely, 1.079%.

Even though the CGU oversees both states and municipalities, we have focused more on the latter due to particular interest in the influence of institutions and enforcement mechanisms on local economic development, which is fundamentally conceived based on policies formulated at the municipal level. Despite the local scope of these policies, their sources of financing often include funding that does not originate from municipal tax collection. Instead, they are transferred by the federal government either as voluntary or constitutional transfers that may be earmarked or not.

As of the 1988 Constitution, the system of vertical transfers initiated by the reforms of 1962-67 became a legal reality, corroborating the federalist character of the Constitution in terms of transferring funds and responsibilities to states and municipalities.

If on the one hand funding was now being transferred to subnational levels, with allocation of respective responsibilities, then on the other hand, the lack of enforcement mechanisms to guarantee investment of earmarked money in accordance with the objectives specified for each program raised doubts over the relative efficiency of this institutional arrangement. The incentives for misappropriation of funds and allocation of social funding to rent-seeking activities were directly associated with the distortion of engaging in productive activities, as well as a contraction to the supply of public goods, with direct impacts on social well-being.

In response to this perverse dynamic, an oversight program was set up in 2002 using public lotteries, seeking to provide special oversight of federal public funds invested through federal-administrative agencies either directly or through transfers of any kind to state or municipal administrative agencies, and to any other legally qualified agencies or entities.⁶

Within a contract theory framework, if definition of transfer systems in the Constitution of 1988 occurred without creation of the respective enforcement mechanisms capable of limiting the moral hazard associated with the mayors' unobservable actions – whose interests are not necessarily aligned with those of the federal government – then room was created for the emergence of a conflict inherent to agent-principal interaction. Renegotiation was fostered.

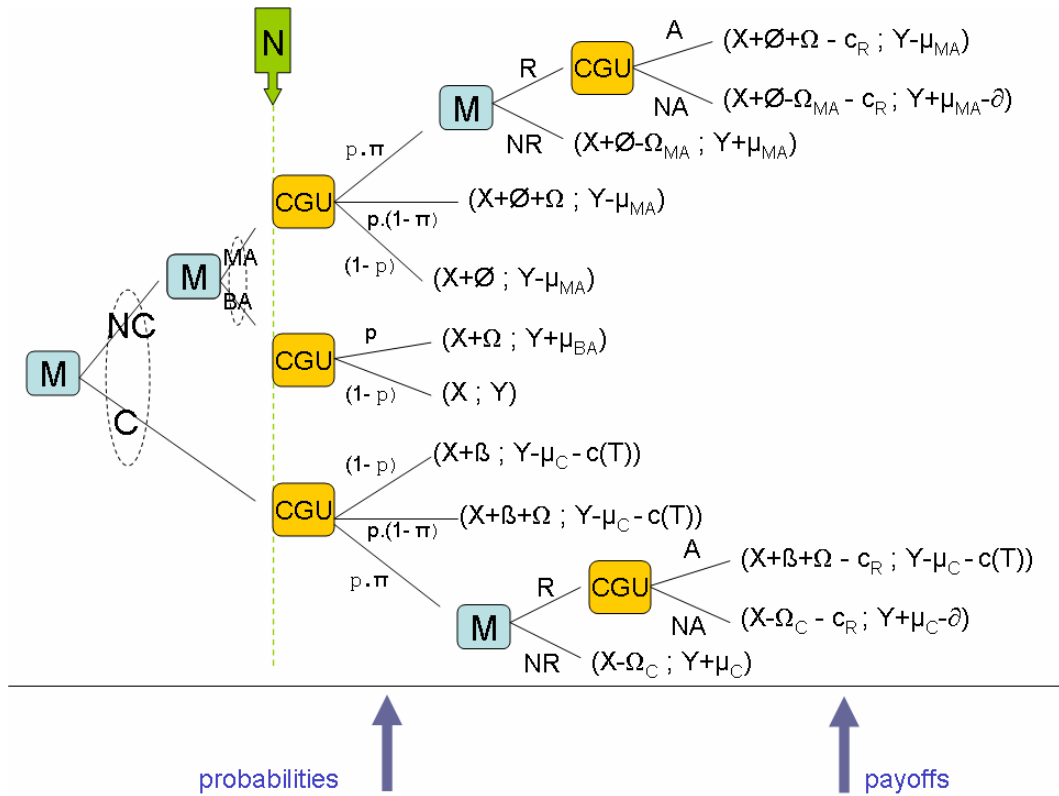
Contracts are intrinsically incomplete in a scenario of limited rationality, opportunism and transactions costs. In order to restrict the possibility of contingencies associated with events unforeseen by contractual terms, it is rational for the principal to introduce mechanisms to promote the alignment of incentives between the former and the agent. In the case in question, the establishment of an oversight program creates a monitoring mechanism that is able to limit the opportunistic behavior of municipal managers, to a greater or lesser extent, in the appropriation of funds transferred by the federal government and earmarked for specific objectives.

In this section, we present a model for strategic interaction between the CGU and mayors, specifying a full set of strategies and payoffs. From this characterization, we then discuss the optimal responses of each player based on his choices. We solve the game using certain simplifying assumptions to derive conclusions regarding the guidelines of public policies that might maximize the efficiency of the CGU's actions, limiting the opportunistic behavior of mayors while saving funds allocated to monitoring activities.

Inspiration for specification of the strategies available in this model comes from reading the complete inspection reports on federal transfers to municipalities reported to the Ministry of Health, as part of Biderman et al. (2007).

⁶ For the more recent, detailed information, please visit the CGU's website at: <http://www.cgu.gov.br/AreaAuditoriaFiscalizacao/ExecucaoProgramasGoverno/Sorteios/index.asp>

Figure 1 – Sequential game between the mayor and the CGU



Where the parameters are defined as follows:

- X = basic outcome for the mayor (M)
- Y = basic outcome for the Office of the Comptroller General (CGU)
- p = selection probability, parametric
- π = probability of being discovered, $f(\Delta$ - resource allocation parameter)
- β = appropriation function, f (electoral competition, local checks and balances, etc.)
- \emptyset = gain from less rigidity on resources management
- Ω = mayor's reputation function, f (local media, etc.)
(Mayor's measurable reputation in terms of votes or political capital, mean estimate)
- ∂ = additional cost of auditing, after mayor's appeal $f(\mu$, etc.)
- μ = accumulated credibility function (CGU)
- μ_1 = first derivative of the accumulated credibility function; signaling function
- $c(T,.)$ = cost of unfinished transactions

The game in Figure 1 schematically describes the sequence of interaction between the mayor **M** and the **CGU** during one term. At first, the mayor decides whether to engage in corrupt (**C**) or not corrupt (**NC**) behavior. If he chooses not corrupt, then he must also choose between good administration (**BA**, or **GA** in the dynamic optimization model) or mismanagement (**MA**), based on the CGU's criteria, which is more fully discussed below.

Even if one may argue that the decision for corrupt management occurs constantly throughout a term, or alternatively, that the decision between good and mismanagement does not belong in the mayor's realm of choices – given that a certain degree of uncertainty would remain – this model is still interesting,

because it focuses on the moral hazard of the mayor acting in breach of legal provisions regarding the appropriation of earmarked funds from the transfer program. If cases can actually be defined in which the mayor behaves this way due to ignorance or error, then it makes sense to imagine that through a process of natural selection, this type of behavior would disappear as the CGU produced arguments for its credibility function, as specified below.

Additionally, representing the decision to be corrupt in this way is interesting from a public-policy analysis standpoint that seeks to discover the alternative pursued by the public power, which cannot be a “lesser degree” of embezzlement, but its elimination. In terms of the choice between good and mismanagement, in addition to the argument regarding selective elimination of the action due to ignorance or error, one may also argue that these strategies belong to the mayor’s realm of choices due to a very specific definition of mismanagement used in the CGU’s oversight reports. Given that the analysis conducted by the auditors does not include any consideration of assessment of the policy’s performance, limiting itself to finding whether the appropriation of funds takes places for the purposes and in the way duly set out by legal prescriptions, it is possible to define mismanagement basically in terms of legal or administrative provisions directly chosen by the manager.

This is exemplified in Biderman *et alli* (2007), with the typology of irregularities encountered by the audits, prepared for the study on corruption at the Ministry of Health in Brazil, classified in general terms as mismanagement.

Except for one category⁷, which can only be indirectly attributed to a decision by the mayor, all of the other categories belong directly within the manager’s realm of choices. If the mayor is not personally involved in every decision, then at least selection of the managers in charge and the decision of whether to keep them in those positions based on their performance of the delegated choices are within the mayor’s power. Once eliminating the possibility of incurring these irregularities due to ignorance or error, we assume that the new agent-principal problem between mayor and secretaries, for instance, is equivalently settled by a monitoring mechanism (creating incentives for the mayor to develop his own instruments to limit the opportunism of secretaries, since the discovery of an irregularity by the CGU would directly affect him).

Thus, once a mayor has made his initial choices, the CGU gets involved in the interaction. The strategies available have to be dealt with carefully, given that they result from probabilities defined exogenously to the model. First, there is the likelihood of a municipality being selected throughout the term. Given that lotteries are done every two months; that the probability of a municipality being drawn in its state is around 1%; and that one percent of the state’s municipalities is selected, with a grace period of two months for replacement (Zamboni and Litschig, 2006), the likelihood of a municipality being chosen during a term is around 21.82%⁸.

It is clear that this likelihood is a choice variable of the CGU that is outside of the model. Another probability associated with the CGU’s actions is defined, though, as the chance of being discovered, such that the municipality need only be selected for any irregularities to be exposed. The next step depends on training the team of auditors, the amount of funds allocated to monitoring activities, among other factors that exogenously determine to a greater or lesser degree this likelihood as a function of parameters that belong to the CGU’s realm of choices.

Thus, three possible outcomes are presented for the municipality at each point in which the CGU is called into play, defined by their nature, since the likelihood of being drawn and discovered are defined as: (i) not being drawn; (ii) being drawn, having irregularities, but not being discovered; and; (iii) being drawn, having irregularities and being discovered. With respect to the first two cases, the interaction terminates there, and the payoffs are realized. In the last case, though, it is possible for the mayor to appeal the CGU’s report – which in auditing reports is referred to as presenting justifications – and if it opts to appeal, this justification may or may not be accepted by the CGU.

Even though this last stage of interaction after discovering irregularities is able to reflect reality more closely, if specified in stochastic terms, we are not especially interested in changing the incentives

⁷ The category is “poor customer service”. Details, not shown, are available upon request.

⁸ $P(\text{selection}) = 1 - (0,0102)^{24} = 1 - 0,7818 = 0,2182$

for the mayor to present a justification, since the right to a fair defense is a constitutional prerogative. Thus we limit the decision between appealing or not, and accepting or not, to a simple cost-benefit analysis in which the counterparts face the marginal costs of filing a formal suit or gathering additional evidence.

From this, in all cases in which the mayor is not selected, gains or losses of reputation are not determined; if the mayor opts for good administration, there is no change to the base payoff. If he opts for mismanagement, he appropriates the gains of more flexible management, and, in the event of corruption, he appropriates the amount embezzled. As a function of the gains and losses that we associate with **MA**, it is important to emphasize that we adopt an even more restrictive definition of this practice in order for it to have impacts solely on the credibility of the inspected agencies, on the one hand, and managerial savings for the mayor, on the other, without directly resulting in social losses (even indirectly, since less credibility of the CGU will have first-order impacts on the mayor's choice between being corrupt or not).

If the mayor is selected, but the CGU fails to find any irregularities, added to the payoffs discussed above is a gain of positive reputation – since this is the same as the CGU not having found any irregularity, as if every administration in this condition had chosen good management. If the CGU is successful in its discovery, though, then only those mayors who have chosen good administration immediately reap the gains of reputation, while those in the other branches of the tree may do so after appealing, if the CGU accepts their justification (but not without incurring costs c_R) or alternatively, suffering losses of reputation, as well as requiring misappropriated funds to be returned in the event of corruption, given that it does not appeal or has its justification denied.

For the CGU, on the other hand, being successful in the investigation of every type of management is related to variations of credibility. The cumulative credibility function will have a direct effect on the mayor's decision, since he does not observe the actual likelihood of being discovered (π). In the event of corruption, if he commits a type-I mistake (rejecting, when he should accept the assumption of corruption), losses are amplified, as a result of the implications of lack of enforcement from institutions that assure property rights, with impacts in the literature (Shirley, 2005) on economic results and social well being.

Since the CGU does not observe the choices that the mayor makes at the outset, the interaction is equivalent to a simultaneous game expressed strategically as:

Figure 2 – Strategic form of the simultaneous game

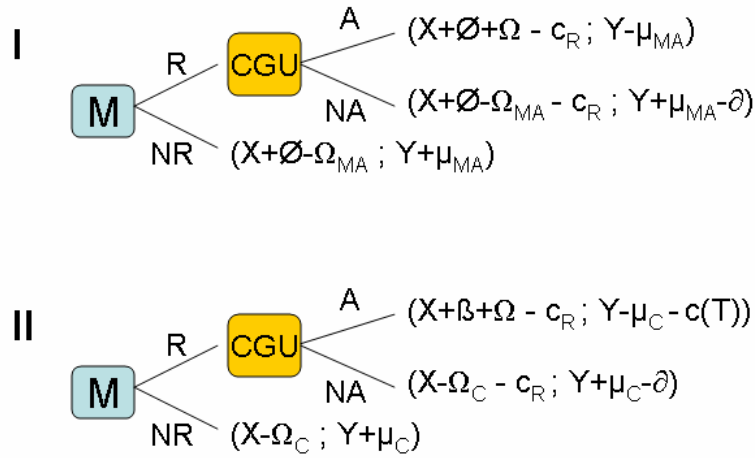
CGU

		$p \cdot \pi_{obs}$	$p \cdot (1 - \pi_{obs})$	$(1 - p)$
		Selected, Success	Selected, Failure	Not Selected
M	BA	$(X + \Omega ; Y + \mu_{BA})$	$(X + \Omega ; Y + \mu_{BA})$	$(X ; Y)$
	MA	I	$(X + \emptyset + \Omega ; Y - \mu_{MA})$	$(X + \emptyset ; Y - \mu_{MA})$
	C	II	$(X + \beta + \Omega ; Y - \mu_C - c(T))$	$(X + \beta ; Y - \mu_C - c(T))$

$\pi_{obs} = f(\mu)$

in which π_{obs} is the cumulative credibility function of the CGU as specified below.

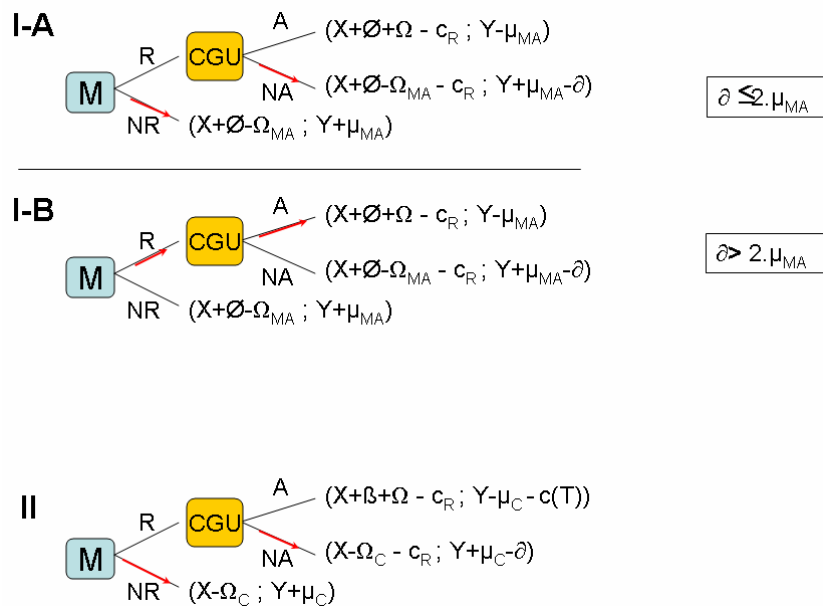
Figure 3 – Sub-interaction games between the mayor and the CGU



It is clear that in the case of mismanagement, it is possible that it may not be worth it for the CGU to pay the costs of additional investigation in order to reject a mayor’s justification, establishing a critical relationship between the parameters for determining choice. In each case, the mayor foresees the auditors’ behavior and behaves in a maximizing way. In the event of corruption, we shall admit that there is no relationship between the parameters that are capable of leading to type I error. Even if these assumptions are simplifying, once again we are not critically interested in this decision point, but, rather, in the initial choice between being corrupt or not.

Continuing in the interaction model, we have:

Figure 4 – Exploration of sub-games



From this, we get two possible game matrices associated with the CGU’s different responses to appeals in the case of mismanagement:

Figure 5 – Game matrix A

A

CGU

		$p \cdot \pi_{obs}$	$p \cdot (1 - \pi_{obs})$	$(1 - p)$
		Selected, Success	Selected, Failure	Not Selected
M	BA	$(X + \Omega; Y + \mu_{BA})$	$(X + \Omega; Y + \mu_{BA})$	$(X; Y)$
	MA	$(X + \emptyset - \Omega_{MA}; Y + \mu_{MA})$	$(X + \emptyset + \Omega; Y - \mu_{MA})$	$(X + \emptyset; Y - \mu_{MA})$
	C	$(X - \Omega_C; Y + \mu_C)$	$(X + \beta + \Omega; Y - \mu_C - c(T))$	$(X + \beta; Y - \mu_C - c(T))$

Figure 6 – Game matrix B

B

CGU

		$p \cdot \pi_{obs}$	$p \cdot (1 - \pi_{obs})$	$(1 - p)$
		Selected, Success	Selected, Failure	Not Selected
M	BA	$(X + \Omega; Y + \mu_{BA})$	$(X + \Omega; Y + \mu_{BA})$	$(X; Y)$
	MA	$(X + \emptyset + \Omega - c_R; Y - \mu_{MA})$	$(X + \emptyset + \Omega; Y - \mu_{MA})$	$(X + \emptyset; Y - \mu_{MA})$
	C	$(X - \Omega_C; Y + \mu_C)$	$(X + \beta + \Omega; Y - \mu_C - c(T))$	$(X + \beta; Y - \mu_C - c(T))$

In each structure, the payoffs are circled for the mayor’s action that is the best response for each possible event that results from the combination of drawing and discovery probabilities. For the sake of simplification and to maintain the emphasis on this paper’s central issue, we shall use the “A” interaction structure, supported by the strong hypothesis that the relationship between the parameters is such that the CGU never accepts the mayor’s justification in cases of mismanagement. As a result, we find that the decision to appeal is a strictly dominant strategy for the mayor; once an irregularity has been discovered, the payoffs are made.

Let’s return now to the issue of the likelihood of discovery and the problem of signaling and credibility. If in the game’s solution by retroactive induction, the mayor does in fact observe π , then the CGU’s credibility is irrelevant. Alternatively, if – as is much more reasonable to assume – the mayor does not observe the actual likelihood of being discovered once an irregularity occurs, then the

cumulative credibility of the monitoring mechanism plays a fundamental role, since we define an observed discovery probability as a function of cumulative density on the parameter μ , which is nothing more than the cumulative sum over time of the signs emitted each time that the CGU succeeds or fails to detect irregularities.

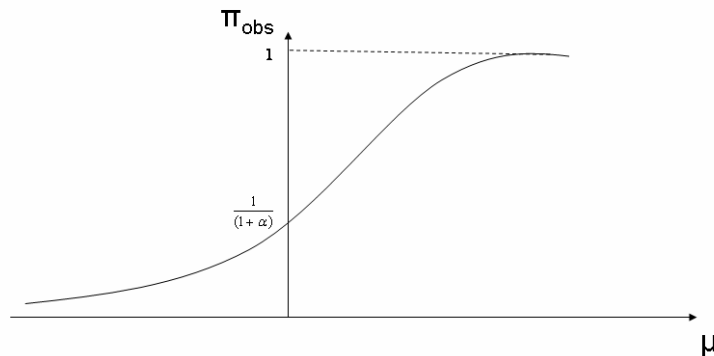
The cumulative density function shown below is specified in the most flexible way possible, and it is used only to provide further detail of the nature of the interaction between the signaling associated with discovering irregularities, the CGU's cumulative credibility, and the mayor's decision between corrupt or uncorrupt management.

Figure 7 – Cumulative discovery probability density function

$$\pi_{obs} = \frac{e^{\lambda\mu}}{\alpha + e^{\lambda\mu}}$$

Thus,

$$\begin{cases} \mu \in (-\infty; \infty) \\ \pi_{obs} \in (0; 1) \end{cases}$$



For the purposes of analyzing interaction results, though, we do not have to consider the functional form of π_{obs} , such that we may proceed with resolution of the game by reformulating the matrix in terms of the expected payoffs:

Figure 8 – Expected payoffs from the interaction between the mayor and CGU

A

		CGU	
		p, π	
M	BA	(X+pΩ ; Y+pμ _{BA})	
	MA	(X+Ω-pπΩ _{MA} +p(1-π)Ω ; Y+(p(2π+2)-1)μ _{MA})	
	C	(X-pπΩ _C +p(1-π)Ω+(1-π)β ; Y+(p(2π+2)-1)(μ _C -c(T))	

➡ CGU $payoff^E(BA) > payoff^E(MA) > payoff^E(C)$

An analysis of the CGU's expected payoff structure reveals the relationship regarding the hierarchy of outcomes for the CGU, such that good administration is always preferred to mismanagement, and mismanagement to corruption, regardless of the drawing and discovery probabilities. It is possible to represent the mayor's payoff relationship graphically as a function of these probabilities:

Figure 9 – Mayor's expected payoffs as a function of p

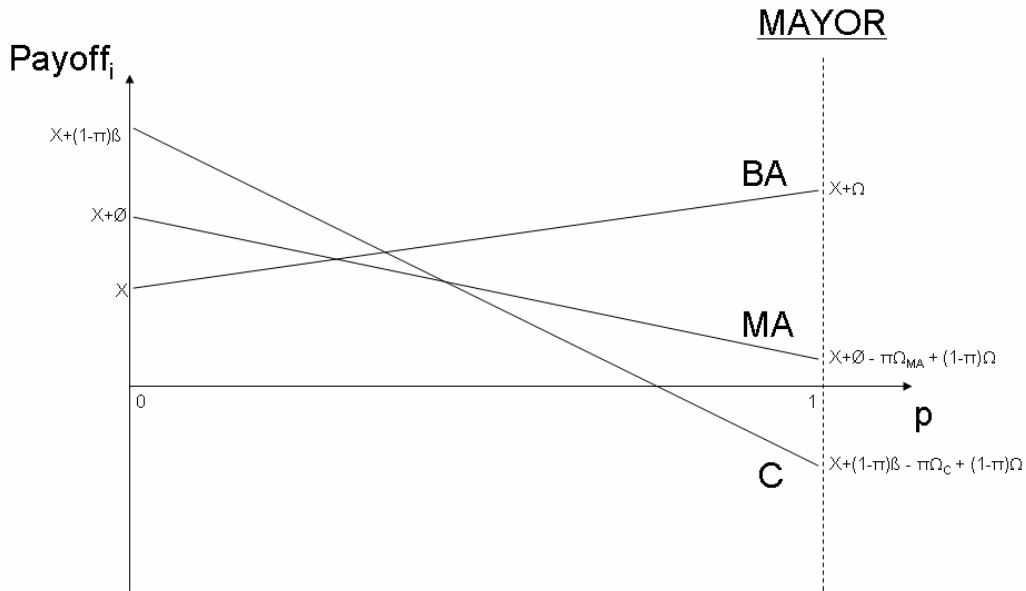
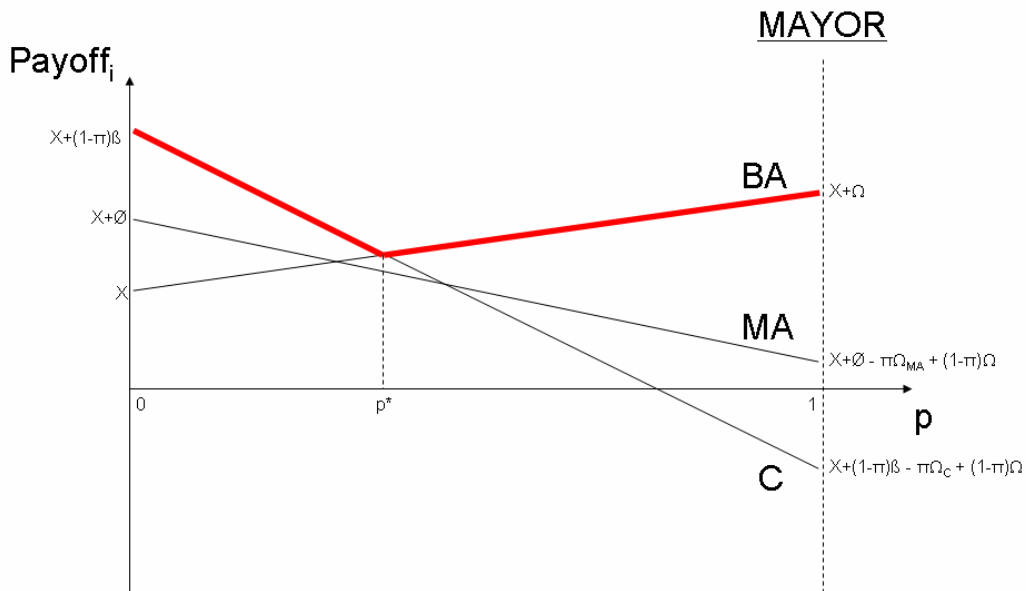


Figure 10 – Mayor's optimal response function



It is important to evaluate a bit more carefully how the intercepts and slopes are determined. The end points of payoffs associated with each strategy are determined when $p = 0$ and $p = 1$. Subsequently, the slopes of each expected payoff line can be determined. It is interesting to note that the intercepts and

slope of the expected payoff of good administration do not depend on π , for obvious reasons; that only the slope of the expected payoff from mismanagement depends on π ; and that both the slope and the intercepts of the expected payoff of corruption depend on the likelihood of discovery.

Figure 11 – Relationship between the model’s expected payoffs and parameters

→ C , $0 < p < p^*$
 → BA, $p^* < p < 1$

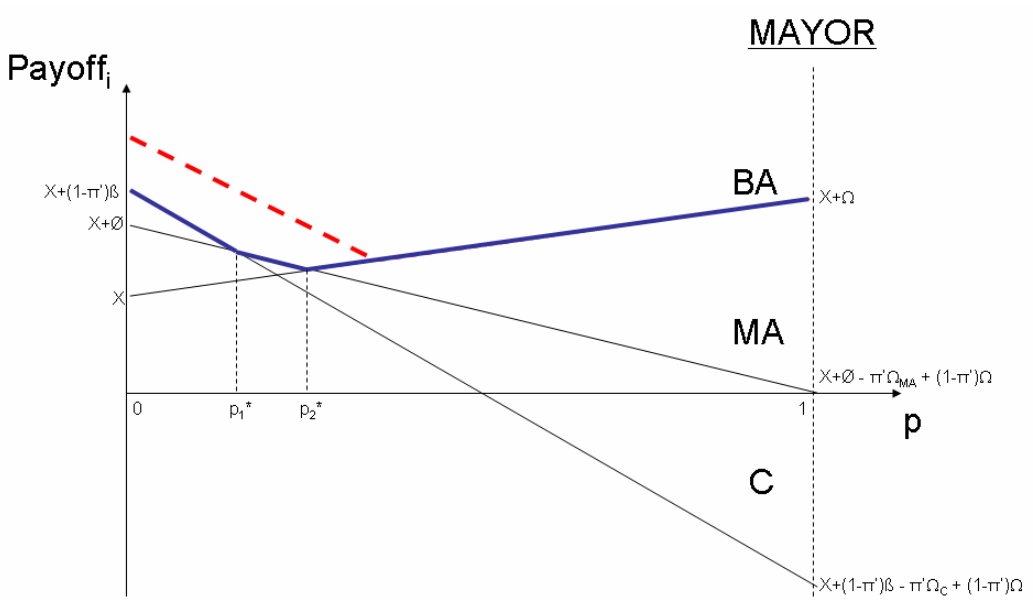
$$\begin{cases} BA' = \Omega \\ MA' = -\pi\Omega_{MA} + (1-\pi)\Omega \\ C' = -\pi\Omega_C + (1-\pi)\Omega \end{cases}$$

$$\begin{cases} \frac{\partial BA'}{\partial \pi} = 0 \\ \frac{\partial MA'}{\partial \pi} = -\Omega_{MA} - \Omega \\ \frac{\partial C'}{\partial \pi} = -\Omega_C - \Omega \end{cases}$$

Additionally, the way in which the slope of the expected payoff of playing each strategy reacts to marginal shifts in π is different, as Figure 11 illustrates. The important thing is to note that depending on the value of π , it is possible to have very distinct configurations with respect to the critical points of the mayor’s choice. For small values of π , a scenario is possible similar to the one presented in Figure 10, in which mismanagement is a strictly dominant strategy.

As π increases, though, the fact that the lines shift in very distinct ways, according to the relationships set out in Figure 11, may create room to define two critical points, in order to define intervals of p (under a certain level of π , given exogenously) for which it is optimal for the mayor to adopt each strategy.

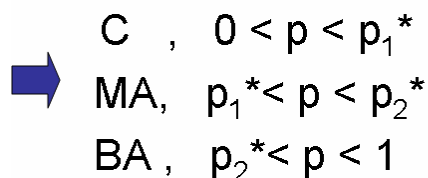
Figure 12 – Mayor’s optimal response function with 2 critical points



Thus, for drawing probability levels during a term between 0 and p_1^* , which is the same as saying a very low chance of receiving a team from the CGU, the best response for the mayor is to opt for corrupt administration. For intermediate probability levels, between p_1^* and p_2^* , the mayor's best response becomes mismanagement, since with greater chances of being audited, adopting corrupt management is very costly, but it is still worth exposing oneself to the risk of being caught and discovered in light of the gains that are earned from more flexible management. Finally, for probability levels over p_2^* , the chances of being drawn are sufficiently high for good administration to be the mayor's best response.

It is important to point out that the graph is not to scale, such that we cannot state precisely at what interval we ought to expect that the current level of p (given the current level of π), of around 21.82% is located. However, given that cases of mismanagement and corruption are observed, one can speculate whether this results from ongoing learning about π_{obs} (or likewise is the result of a natural selection process that is still incomplete, in the manner previously argued), or whether the choice of p , given π , is insufficient to surpass the mayor's critical decision levels.

Figure 13 – Mayor's optimal choice intervals



In order to induce **BA** behavior, p need only be greater than p_2^* , contrary to the common belief that selection probability must necessarily tend to 100%. But why wouldn't the CGU set $p = 1$ and $\pi = 1$? Because of the monitoring costs associated with the increase. What one may find is that the inclusion of this type of cost may make it rational to accommodate **MA** as an acceptable solution.

A relevant consideration is what result the CGU wishes to achieve. Since there are no costs to determine p and π (indirectly from training personnel, funds for monitoring activities, etc, condensed in the parameter Δ), the hierarchy of outcomes shown above follows, such that the best response for the CGU is to determine p over p_2^* . But if there are no costs associated with p and π , then the monitoring always chooses $p = 1$ and $\pi = 1$.

Since the analysis so far has been founded on this very strong hypothesis, we shall now introduce monitoring costs. This not only alters the CGU's rational calculation in the hierarchical determination of the optimality of different results, as Figure 13 explains, a possibility discussed later on, but also raises the question of substitutability between p and π .

4. Considerations about the model

In light of the foregoing, if π is hard to change in the short run, from an initial π that is not very high, then it may be very costly both to invest the necessary Δ to produce a higher π , which requires a smaller p^* , and to increase p^* in order to produce equilibrium at **BA**.

In this context, the optimal choice, from a cost perspective, for the monitoring body, is to produce a level of p^* sufficient only for the mayor not to choose to be corrupt, even if he chooses to manage outside the limits of certain legal provisions.

Finally, it is important to discuss the role of other parameters in the determination of the mayor's optimal choice. Since public policies may focus on these auxiliary parameters as a way of lessening the need for investment to increase both p and π , it is possible to have:

- a) local checks and balances: better instruments to monitor local public policies, such as municipal councils, or greater media penetration, with informational implications for the voter, that affect the magnitude of the mayor's appropriation parameter in the event of corrupt management, both

- b) instruments to publish auditing results: also essentially linked to the information issue, implying greater expectation of electoral punishment, and thus reducing the incentives for the mayor to behave in a way that involves risk. Additionally, it amplifies the effects on observed π , transmitting the effects more quickly of expanding investments on the oversight program for the mayors' behavior;
- c) imposition of additional costs: changing payoffs in order to make corrupt behavior more costly. Essentially, only having to return the amount embezzled might be insufficient punishment to limit this type of behavior; pecuniary penalties or incarceration would be ways of substantially modifying the mayor's optimal choice;
- d) the indirect effect of the judiciary's credibility on the mayor's decision: despite an efficient oversight program, if enforcement of punishment is weak, the effect on the mayor's behavior will be negligible. It is fundamental that punishment ordered by auditors be fully enforced, so that incentives for corrupt behavior are not limited solely by the expectation of election returns.

The final objective of this paper is to extend the current oversight program starting with public drawings coordinated by the CGU. The expansion explicitly focuses on political variables, since we assume that many if not all irregularities are term-specific, in the sense that they are related to the administrative team that accompanies the mayor during his term, more than any other specific characteristic of the municipalities in question.

In other words, analyzing the oversight program based on public drawings, one might reach a false conclusion that only by increasing a municipality's probability of being selected by the CGU to 100% would local governments be induced to govern properly. The idea of certain oversight during a term would lead mayors to adopt good municipal administrative practices – at least in theory. What we conclude after analyzing the interaction model proposed in Chapter 4 is that a selection probability higher than p_2^* is sufficient to induce good administration behavior **BA**.

5. Dynamic Programming

We now develop mathematically the results previously sketched, as a result of intertemporal maximization of the mayor's utility.

Let $U_t(\text{income}_t, \text{effort}_t, \text{status}_t)$ denote the mayor's instantaneous utility. Income may implicate utility through consumption; as the mayor's savings are irrelevant to the issue at hand, it is without loss of generality to include it directly in his utility function.

We define the following:

$$\text{income}_t = \overline{\text{wage}}_t + \text{corruption}_t \quad (1)$$

$$\text{effort}_t = \begin{cases} 1, & \text{if mayor chooses GA} \\ 0, & \text{otherwise} \end{cases} \quad (2)$$

$$status_{t,i} = \begin{cases} \Omega_i, & \text{if } \sum_{s=0}^t var_{s,i} = \bar{V}_i, \text{ with probability } \pi p + (1-\pi)p \\ -\Omega_i, & \text{if } \sum_{s=0}^t var_{s,i} \neq \bar{V}_i, \text{ with probability } \pi p \\ status_{t-1,i}, & \text{with probability } (1-p) \end{cases} \quad (3)$$

where $i = \{MA, C\}$, $var_{s,MA} = effort_s$, $var_{s,C} = corruption_s$, $\bar{V}_{MA} = t$, $\bar{V}_C = 0$.

Equation (1) states that the mayor faces a constant wage in each period, though his income may vary by his choice of corruption level. Equation (2) poses the effort level as a binary choice by the mayor, since all that matters is whether he is complying with regulation.

Equation (3) tells us that the mayor gains a reputation premium in either of the 2 dimensions whenever he is randomly chosen to be audited and (i) has acted according to legislation in each dimension, that is, has always made an effort and never chosen a corruption level different from zero, or (ii) has not, but the auditors have failed to detect it. Conversely, the mayor is penalized whenever he has not complied with legislation and the auditors effectively find out. Once more in accordance with the interaction model develop earlier, if the municipality is not randomly chosen to be audited, then the status of the mayor remains the same. Here, each period of time may correspond to two months, the time span between CGU draws.

Also, one important feature of equation (3) is that if the mayor has ever not complied with regulations, then he is penalized whenever his municipality is chosen and the auditors do not miss it. That means that even if a municipality has been investigated and no irregularities have been found, which would account for a reputation premium in the previous model, if a new audit takes place and irregularities are found, the new status of the mayor falls straight to $-\Omega_i$, instead of the accumulated payoff function. Moreover, in the present framework, if the mayor has been singled out for not complying with regulation in a particular dimension once, then it cannot be the case that a new random audit may alleviate his initial loss of reputation. This simplifies matters greatly, and also may be a more accurate account of how voters interpret audit results.

Thus, the dynamic problem becomes:

$$Max_{\{income_t, effort_t\}} \sum_t^{\infty} \beta^t U_t(income_t, effort_t, status_t) \quad (4)$$

s. t.

$$status_{t+1,i} = \begin{cases} \Omega_i, & \text{if } \sum_{s=0}^{t+1} var_{s,i} = \bar{V}_i, \text{ with probability } \pi p + (1-\pi)p \\ -\Omega_i, & \text{if } \sum_{s=0}^{t+1} var_{s,i} \neq \bar{V}_i, \text{ with probability } \pi p \\ status_{t,i}, & \text{with probability } (1-p) \end{cases}$$

defining income and effort as the control variables, and status as the state variable.

Let us now specialize the utility function of the mayor to be:

$$U_t(income_t, effort_t, status_t) = \log(income_t) - effort_t + status_t \quad (5)$$

This functional format is handy because it is concave in the control variables and still implies maximization with respect to income independent of the interest rate - as it is associated to a CRRA utility function with coefficient θ approaching 1 - a desirable feature since we are not interested in modeling its endogenous determination.

Finally, by the maximum principle, we can redefine the problem in (5) as:

$$\forall t, \quad \text{Max}_{\{income_t, effort_t\}} V_t = U_t + \beta E_t[V_{t+1}]$$

where E_t stands for the expectation operator, since V_{t+1} involves uncertainty associated to p , the probability of being audited, and π , the average effectiveness ratio of auditors.

So, inserting the specialized utility format and substituting for the restriction in the objective function:

$$\forall t, \quad \text{Max}_{\{income_t, effort_t\}} (\log(income_t) - effort_t + status_t) + \beta E[(\log(income_{t+1}) - effort_{t+1} + status_{t+1})] \tag{6}$$

As income and effort are not defined with uncertainty, all we have to do is specify the functional form of $E_t[status_{t+1}]$. We can rewrite it succinctly as:

$$E_t[status_{t+1}] = \pi p [(1 + (1 - \pi)p) \cdot \Omega_t \cdot E_t[\mathbb{1}\{\sum_{s=0}^{t+1} var_{s,t} = \bar{V}_t\}]] - \Omega_t \cdot (1 - E_t[\mathbb{1}\{\sum_{s=0}^{t+1} var_{s,t} = \bar{V}_t\}])) \tag{7}$$

where $\mathbb{1}\{ \}$ stands for the indicator function.

Thus, using (6) and (7), we can obtain the first order conditions of the problem:

First order conditions (FOC):

$$\begin{cases} \frac{1}{corrupt_t^*} + \sum_{s=1}^{\infty} \beta^s \cdot \frac{\partial(E_t[status_{t+s}])}{\partial corrupt_t} = 0 \\ -1 + \sum_{s=1}^{\infty} \beta^s \cdot \frac{\partial(E_t[status_{t+s}])}{\partial effort_t} = 0 \end{cases} \tag{8}$$

It follows from (8) that:

$$corrupt_t^* = \frac{1 - \beta}{\beta \pi p \Omega_t} \tag{9}$$

$$effort_t^* = \mathbb{1}\left\{\frac{\beta \pi p \Omega_t}{1 - \beta} > 1\right\} \tag{10}$$

Therefore, the mayor's optimal level of corruption is increasing in his discount rate and decreasing in the reputation loss associated with being caught, in the probability of being randomly selected and in the average effectiveness of the auditors. In terms of mismanagement decisions, the mayor makes an effort if the discounted expected cost of being caught exceeds his (certain) cost of complying with regulation.

In the bottom line, this model formally states the results previously shown that account for p and π as potential substitutes, and strengthens the point that, were the penalty of being uncovered more than the reputation loss, the mayor would internalize it as an additional source of deterrence. This should be

emphasized at this point, since the model states that once a mayor has suffered a loss of reputation, his best answer is to choose a corruption level at infinity, requiring additional punishment mechanisms that either enter the mayor's utility function or discharge him from the position of managing such decisions.

6. Application: Healthcare program audits

A relevant question in light of the foregoing analysis is the actual magnitude of the model's parameters, which is the same as saying: what type of optimal choice for the mayor does the current incentive system associated with the oversight program determine? To what extent are the current likelihood of being selected and the perceived likelihood of discovery – along with other elements that make the magnitude of other parameters, and thus, incentives, dependent upon the adoption of each behavior – sufficient to limit corrupt practices or mismanagement?

Shleifer and Vishny (1993), analyzing corruption theoretically in developing economies, state that “poor countries tend to spend their limited funds on infrastructure and defense projects, where opportunities for corruption are abundant, in comparison to education and healthcare projects, where they are much more limited” (Shleifer and Vishny, 1993, p. 615).

The results for Brazil from the CGU's municipal audits for the period from 2001-2004 challenge the view that in health care, at least, there are fewer opportunities for corruption. According to the analyses below, not only does a significant portion of municipalities show evidence of corruption, but indices of irregularities linked to mismanagement are also very high. The results dependent on the parameters of interest are alarmingly high, especially if we incorporate risk aversion to the interaction model, a highly plausible hypothesis foregone so far herein, which modifies the analysis since it amplifies the limitations of potential losses on the decisions of the incumbent mayor.

As such, despite a reasonably high value of p (over 21%, as we saw) and the reasonable hypothesis of risk aversion, the restrictions on the gains of undue appropriation do not appear so far to be sufficient to induce good administrative practices. Evidently, this may reflect extra-model elements, such as the legal system's enforcement capacity of auditor recommendations in the event of embezzlement.

An empirical analysis, summarized from Biderman et al. (2007), and Lopes, Lichand, Biderman and Avelino (2008a, 2008b), indicates that 63.4% of municipalities audited during the period in question had at least one case of evidence of corruption. Moreover, 74.1% of the municipalities are shown as presenting at least one case of performance issues of the programs financed by federal funds, an indicator that has a direct relationship with the concept of wasting funds.

Breaking down irregularities by programs, it is possible to discriminate the main types of misappropriations caught by the auditors. The findings for the Basic Pharmacy program, for instance, indicate that 9.4% of the actions audited correspond to non-investment of funds; 11.1% to lack of medication; and 34% to problems controlling drug inventories. Even though none of these categories is included as evidence of corruption for parsimonious purposes, they clearly indicate mismanagement and are directly tied to wasting funds, resulting in the under-provision of public goods, in the case of drug distribution subsidized to serve the underprivileged populations of the municipalities in question.

7. Conclusion and possible extensions for future research

Given that corruption is a widespread concern, affecting governments and societies worldwide, it is important to treat it very seriously. Furthermore, because corruption varies over space and time, local solutions seem to be the most appropriate.

Brazilian authorities have recently set up anticorruption agencies and developed prevention and control strategies aimed at ending corruption. Subsequent years have shown that control programs have been successful in identifying cases and causes, but prevention is certainly less than optimal.

Even though the CGU's powers include development of corruption-prevention mechanisms, this job has yet to be given priority. As such, we expect to contribute through optimization of the design of *ex ante* control mechanisms, using the public-drawing oversight program already in place.

The idea of developing a mechanism to prevent corruption is motivated by the proliferation of corruption scandals that have affected Brazil in recent years. However, we do not have the intention of discrediting the control initiatives that the CGU and other national agencies have already developed. Instead, this paper's proposal is to extend the model being used, so that it also becomes a means of preventing corruption and waste of funds, with direct and indirect effects on the capacity of all levels of government to provide public goods.

It is possible to conclude that the imposition of 100% selection probabilities during a local government's term is not only very costly, but unnecessary to establish certain *ex-ante* control: the establishment of theoretical selection probabilities over p_2^* is already sufficient to induce good municipal administrative behavior. A mathematical treatment of the interaction model allowed for a more rigorous assessment of the conditional response of the mayor's decision concerning mismanagement and corruption to the parameter values. The mayor's optimal level of corruption is increasing in his discount rate and decreasing in the reputation loss associated with being caught, in the probability of being randomly selected and in the average effectiveness of the auditors. In terms of mismanagement decisions, the mayor makes an effort if the discounted expected cost of being caught exceeds his (certain) cost of complying with regulation.

The idea of developing a theoretical model assumes empirical extension in future studies and expects new parameters to be reached in the practice of Brazilian municipal administration, assuring accountability and reducing chances for corrupt practices.

Once the model for municipal control and oversight has been derived, a future application of the model is expected at the state-administrative level, subjecting governors to the same type of restrictions that tend toward absolute conformity with the standards of conduct established by the CGU.

Empirical findings⁹ related to funding transferred for healthcare programs in Brazil from 2001-2004 reveal significant levels of mismanagement and corruption among municipalities, at sufficiently high levels to compromise the provision of public goods, with deleterious regressive effects; that is, greater impact on the poorest population. Furthermore, an analysis of the leading healthcare programs shows that the incidence of misappropriation is concentrated on its main components, such as medication, making consequences explicit in terms of wasting resources and the relevance of developing mechanisms to limit opportunistic behavior as a function of the lack of mechanisms to monitor and enforce the investment of vertical transfers.

We strongly believe in the possibility that once mayors and governors are under constant supervision and control, prevention of corruption will become a reality, and governmental officials will tend to have incentives to be more responsible and to follow administrative procedures more closely, thus reducing the number of cases and amounts involved in corruption-related scandals, allowing for scarce public resources to be more efficiently allocated.

References

Ahlenius, Inga-Britt. (2000). Performance audits, evaluations and supreme audit institutions. **International Journal of Government Auditing**, Vol. 27, Issue 1, p.1.

Azevedo, Paulo Furquim (1996) Integração vertical e barganha. **Doctoral Degree Thesis - Faculdade de Economia e Administração da Universidade de São Paulo**, 1996.

Becker, G. and Stigler, G. (1974). Law enforcement, malfeasance, and compensation of enforcers. **Journal of Legal Studies**, Vol. 3, pp. 1-18.

Biderman, Ciro and Avelino, George. (2007). Governance in Managing Public Health Resources Among Brazilian Municipalities. **Mimeo, Getulio Vargas Foundation, CEPESP**.

Di Tella, R. and Schargrofsky, E. (2003). "The Role of Wages and Auditing during a Crackdown on Corruption in the City of Buenos Aires." **Journal of Law and Economics**, vol. 46, pp. 269-92.

Dixit, Avinash and Skeath, Suzan (1999), **Games of Strategy**, Norton, New York.

⁹ Please refer to the original work, Biderman *et alli* (2007). Details are not shown, but available upon request.

- Eisenhardt, Kathleen M. (1989), Agency Theory: An Assessment and Review. **The Academy of Management Review**, Vol. 14, No. 1 (Jan., 1989), pp. 57-74
- Ferraz, C. and Finan, F. (2005a). Reelection Incentives and Political Corruption: Evidence from Brazil's municipal audit reports, **University of California, Berkeley manuscript**.
- Ferraz, C. and Finan, F. (2005b). Exposing Corrupt Politicians: The Effect of Brazil's Publicly Released Audits on Electoral Outcomes. **University of California, Berkeley manuscript**.
- Heilbrunn, J. R. (2004). Anti-Corruption Commissions: Panacea or Real Medicine to Fight Corruption? **World Bank Institute. Stock No. 37234**.
- Huntington, S.P. (1968). **Political Order in Changing Societies**. New Haven: Yale University Press.
- Klitgaard, R. (1998). International cooperation against corruption. **Finance & Development**, Vol. 35.
- Leff, N.H. (1964) Economic Development through Bureaucratic Corruption. **American Behavioral Scientist**, Vol. 8, No. 3, pp. 8-14.
- Lopes, M. F. M., Lichand, G. F., Biderman, C. and Avelino, G. (2008). Do random audits influence incumbent's management decisions? **Mimeo, Getulio Vargas Foundation, CEPESP – Center for Policy and Public Sector Economics**.
- Lopes, M. F. M., Lichand, G. F., Biderman, C. and Avelino, G. (2008). Performance of health indicators following random audits in Brazilian municipalities. **Mimeo, Getulio Vargas Foundation, CEPESP – Center for Policy and Public Sector Economics**.
- Mauro, Paolo. (1995). Corruption and Growth. **Quarterly Journal of Economics**, vol. 110, n. 3, pp. 681-712.
- Mauro, Paolo. (1997). The Effects of Corruption on Growth, Investment, and Government Expenditure: A Cross-Country Analysis. In: **Corruption and the Global Economy**, ed. Kimberly Ann Elliot. Washington, D.C.: Institute for International Economics.
- OECD. (1999). **ABD-OECD Anti-Corruption Initiative for Asia-Pacific: Combating corruption in the New Millennium**. Retrieved on August 19th, 2007, from <<http://www1.oecd.org/daf/ASIAcom>>
- Shirley, Mary (2005). "Institutions and Development". In: Claude MÉNARD e Mary M. SHIRLEY (eds). **Handbook of New Institutional Economics**. Springer: 611-638.
- Shleifer, Andrei and Vishny, Robert (1993). Corruption. **Quarterly Journal of Economics**, vol. 108, n. 3, pp. 599-617.
- Sparberg, Detlev. (2000). Fighting Corruption and Fraud. **International Journal of Government Auditing**, Vol. 27, Issue 3, p.10.
- Svensson, J. (2005). Eight Questions about Corruption. **Journal of Economic Perspectives**, Vol. 19, No. 3, pp. 19-42.
- Tanzi, V. (1998) Corruption Around the World: Causes, Consequences, Scope, and Cures. **Staff Papers, International Monetary Fund**, Vol. 45, 559–94.
- Treisman, Daniel. (2000). The Causes of Corruption: A Cross-National Study. **Journal of Public Economics**, vol. 76, pp. 399-457.
- Zamboni, Y. and Litschig, S. (2006) Law enforcement and local governance in Brazil: evidence from random audit reports. **Mimeo, Columbia University**, New York, NY, EUA.