University of California
Los Angeles

Essays on Political Economy

A dissertation submitted in partial satisfaction
of the requirements for the degree
Doctor of Philosophy in Economics

by

Paulo Guilherme Melo Filho

2007

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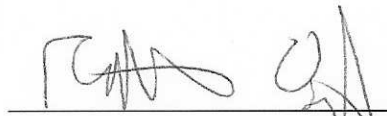

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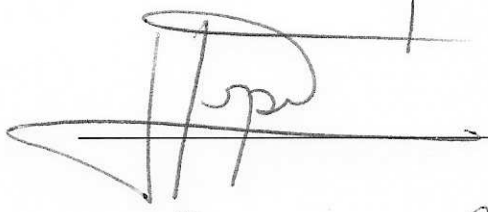

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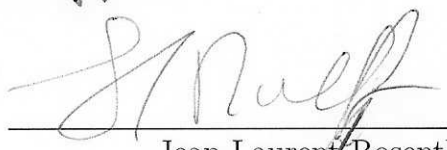

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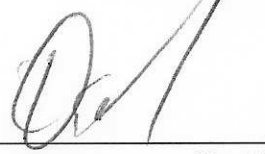

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University of California, Los Angeles

2007

To Rosa

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Acknowledgments

I gratefully thank David Levine, my main advisor, for his guidance and dedication through all these years, always being available to discuss my work and help me in my academic life. He is a great inspiration and I am very honored of working with him.

I am very tankful to Jean-Laurent Rosenthal, co-chair of my dissertation committee, for all his great comments and incentives to my work.

I am thankful to all the members of my dissertation committee —Hugo Hopenhayn, Matthias Doepke and Michael Chwe—, as well as Hongbin Cai, a former member of this committee, for their support and valuable suggestions.

I was pleasured with the company of many colleges from the program, that along these years become big friends. Gonzalo, Nelson, Flavinha, Rolf, Ili, Facu, Juan, Hector, Miguel, Sebastian, Burcu. Without these guys this whole journey would have been much harder.

Chapter 1 is a version of "Shopping for Support: Controlling Congress in Multiparty Presidential Systems", a working paper co-authored with Cesar Zucco Jr. That work counted with valuable comments from Barbara Geddes, Kathy Bawn, Jeff Lewis, David Samuels, Patricio Navia, as well as participants in seminars at the Economics and Political Science Departments at UCLA.

I am very grateful for the support from all my family. Even from a long distance, they always helped and motivated me to get here.

I gratefully acknowledge the financial support from the Brazilian Ministry of Science and Technology through the CNPq, and from the 2006-2007 Department of Economics Dissertation Year Fellowship.

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Melo Filho, Paulo and Cesar Zucco (2006): "Shopping for Support: Controlling Congress in Multiparty Presidential Systems" paper presented at the Latin American Meetings of The Econometric Society (LAMES), Mexico City.

Abstract of the Dissertation

Essays on Political Economy

by

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Doctor of Philosophy in Economics

University of California, Los Angeles, 2007

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My dissertation, "Essays in Political Economy", is composed by three different essays were I analyze the functioning of different political institutions.

In Chapter 1, I propose a cost minimization approach to the problem of obtaining legislative support in a presidential multiparty setting. Presidents control different types of politically useful resources, part of which, in such settings, has to be spent to obtain support in the legislature. I present a formal model of the president's resource allocation decision problem. The most general result is that even if there are economies of scale for dealing with parties rather than with individual legislators, presidents will always do some of both. In the empirical section, I use data from Brazil to simulate the model, and show that for some set of parameters, the model's predictions fit very closely the observed data.

In Chapter 2, I give a look at the Brazilian electrical sector. Until the middle of the 1990s, all the Brazilian electric utilities were public companies. In 1995, with the beginning of the privatization of those utilities, the government started to implement a regulatory model for the sector. After almost one decade, the regulatory model has failed in many ways. In particular, the investments in

thermal generation capacity to back-up the hydroelectric system did not happen, resulting in a huge electrical crisis. I want to formulate a model that allows us to understand the cause of the inefficacy of the regulation and helps to answer how to improve the efficiency in this regulatory model.

Finally, in Chapter 3, I present a brief literature review on multiple equilibria in the determination of the incidence of corruption, trying to emphasizes the implications of corruption on economic growth.

CHAPTER 1

Shopping for Support: Controlling Congress in Multiparty Presidential Systems

1.1 Introduction

Presidents in multiparty presidential systems are frequently confronted with the arduous task of post-electoral coalition building. An important part of this task consists on deciding how to allocate various kinds of resources, such as cabinet appointments, pork and jobs (henceforth spoils) to distribute to those who support the government in Congress. In this paper, we propose a cost minimization approach to this problem, where the president controls different types of politically useful resources, part of which, he has to be spent to obtain support in the legislature. We assume the president seeks to obtain the necessary support to govern (pass legislation) using up the least possible amount of his political resources. We present a formal model of the president's resource allocation decision problem. Our stylized president faces a legislature composed of parties, which are depicted as distributions of individuals with some exogenously defined level of *affinity* towards the government. Given the distribution of affinities, the president decides how his political resources should be invested.

Although our model can be applied to any situation where an elected president may negotiate with different political groups to build his coalition, this reality

is particularly common among Latin America countries. And there are many evidences in the literature that in those countries, the allocation of spoils is often more important than consensus building on issues. We observe president's coalition partners not demanding policy concessions even when the president's policies differ radically from their expressed ideology, apparently because they value spoils more than concessions. It is also very common parties that should be aligned with the president's policies attempting to extract a high toll in exchange for legislative support.

In our model, legislators have preferences on voting with or against the president, which depend on their affinities, and are willing to trade their votes in exchange for political favors. The parties are composed by legislators with different preferences, and the president choose to allocate political benefits for the parties, or directly to individual legislators. The benefits allocated to parties are common goods, that favors all the members from the party. Those are typically cabinet positions.

But the president allocates also individual pork to legislators, to complement the support obtained in exchange for the benefits given to parties. Dealing with parties, the president generates more benefits than he does using only individual pork, because the legislators from the same party share the "consumption" of the common good. However, the heterogeneity of preferences across legislators from the same party implies they have different "prices". Therefore, the president will always use also targeted expenditures to buy legislators at the margin, instead of raising the allocation to the party wasting resources with "free-riders".

In the empirical section of the paper, we use data on legislative votes, cabinet composition and federal budget execution from Brazil for 2003 and 2004 to simulate the model. We use the distribution of cabinet posts among parties and the

allocation of resources to projects included in the budget law by individual legislator's amendments as proxies for the common and private goods respectively. Then, we parameterize the model, to compare the allocations predicted by the model with the ones observed in our data set. Our results show that for some set of parameters, the model's predictions fit very well the observed membership of parties in the cabinet and the proportions of individual pork allocated for legislators from each party.

The next section brings a literature review, mostly focused on executive-legislative relations in Latin America, and try to situate our paper in that literature. In Section 1.3, we present our model, with the formalization of the president's decision problem, its general solution, and a brief discussion of some of the model's predictions. Section 1.4 has the empirical exercise with data from Brazil, and Section 1.5 concludes.

1.2 Literature Review

The study of political institutions in Latin America has advanced markedly over the past twenty years, and within this general area of interest, the study of executive-legislative relations has enjoyed considerable attention. Since many Latin American countries combine presidential regimes with multiparty systems, Latin Americanists have drawn not only from the American Politics tradition of legislative studies (Weingast and Marshall, 1988; Kiewiet and McCubbins, 1991; Cox and McCubbins, 1993; Krehbiel, 1991, 1998) and its interest in the effects of legislative rules, the power of the party vis-a-vis its members, and incentives faced by legislators, but also from the European literature of coalition formation in multiparty systems (Laver and Shepsle, 1990; Laver and Schofield, 1990; Tsebelis, 2002).

What is now considered the canonical body of work in the discipline focused initially on the capacity of the president to shape policy through the use of constitutional and partisan powers (Shugart and Carey, 1992; Mainwaring and Shugart, 1997). Special attention was given to prerogatives such as exclusive introduction of legislation, veto and decree power, on one hand, and to conditions such as legislative fragmentation and indiscipline, on the other. While agreeing that formally assigned powers matter in determining the holders of agenda and veto power, Aleman and Tsebelis (2002) argued that positional dimensions such as centrality of the agenda setter and dispersion of the veto players are fundamental in predicting policy outcomes. Along the line that "policy position matters", a parallel literature has developed and to further understand the ideological structure of parties in Latin America (Alcántara, 1994-2000; Rosas, 2005; Zechmeister and Luna, 2005).

Subsequently, scholars turned to yet another presidential prerogative – appointment power – and to the coalitional dynamics entailed by it. Perhaps the first to call attention to the coalitional dynamics of multiparty presidential systems was Abranches (1988), and since Geddes (1994) noted the different political uses of bureaucracies, several works have addressed the determinants of nominations to cabinet positions (Deheza, 1997; Amorim Neto, 1998, 2006; Altman, 2000) and have also directly or indirectly began tackling the issue of whether providing cabinet position does in fact affect the levels of support presidents obtain in the legislature (Morgentstern, 2004; Desposato, 2004).

More recently a variant of this literature has emerged, mostly focused on Brazil, that calls attention to the coalition management techniques adopted by different presidents. These authors, have noted the role of pork in the electoral prospects of legislators (Ames, 2001; Samuels, 2003) and from there turned to

the study of the president's provision of pork to legislators as a mechanism to obtain legislative support (Pereira and Mueller, 2004; Alston and Mueller, 2005).

What makes this topic especially interesting is that in Brazil, the executive has a very high discretionary power to define budget appropriations.[1] That presidents use the decision power and their control over state resources in their bargaining with legislatures has been noted and documented by scholars and casual observers alike, but there is controversy as to the form by which this bargaining takes place. In what is probably the majority position among Brazilian scholars, Figueiredo and Limongi (2002) claim that parties play much greater role than commonly assumed. Based on a positive research agenda that spans more than 15 years,[2] they confidently claim that the concentration of power in the executive and the centralization of power inside the legislature "make any individual action by legislators innocuous". In this context, "the rational course of action for legislators is to act through parties" (Figueiredo and Limongi, 2002, p.306), and not bargain directly with the executive. They also add that to reduce transaction costs it is in the president's best interest to negotiate with party rather than individuals.

Though this is a relatively well developed literature, there are two main weaknesses. First though this body of work has identified an analyzed many different tools the president has at his disposal to govern and build coalitions, most works have focused on only one of these at a time, with the noteworthy exception of recent work by Pereira et al. (2006).[3] Second, this literature is almost exclusively

[1] As in other Latin American countries, the budget law merely "authorizes" expenditures. The executive has the power to cap or cancel expenditures and to determine the schedule of disbursements. Even in US the president has some power over the execution of the budget, but in most of the Latin American countries this is more clearly one of the president's attributions.

[2] A considerable portion of their earlier research can be found in Figueiredo and Limongi (1999).

[3] In this paper, the authors call attention to the existence of a presidential "tool box," as well as to different styles of coalition management.

empirical, and very little formal theorization has been carried out though theoretic approaches exist in closely related topics, that could be adapted and applied to this issue.

Our paper addresses both of these weaknesses, as we present a formal theoretical model in which presidents control different types of resources that are allocated simultaneously to both parties and individual legislators. In this sense, we attempt to go beyond a purely empirical treatment of the issue and take an important step to unify the two variants of the literature in executive-legislative relations in Brazil.

Our model builds on wide body of previous work. As the incipient but promising literature (Schady, 2000; Dias-Cayeros et al., 2003; Dias-Cayeros and Magaloni, 2003; Calvo and Murillo, 2004) that has analyzed the strategy behind Latin American presidents spending decisions, we also focus on trying to explain when, where and on whom the president will spend his resources. This literature follows works such as Cox and McCubbins (1986) and Dixit and Londgregan (1996), from whom we borrow part of the technical setup of the problem.[4] However, while these works address electorally guided spending, we adapt and apply it to a legislative setup.

Within the specific context of legislatures, Groseclose and Snyder Jr (1996) represent perhaps the culmination of a research tradition in legislative coalition formation in an American setup. They claim that cost-effectiveness rather than than ideology (Axelrod, 1970) or universalism (Weingast, 1979) explains why supermajorities form so often, even when the canon of the discipline predicts minimal winning coalitions should be prevalent (Riker, 1962; Shepsle, 1974; Baron and Ferejohn, 1989). Like in Groseclose and Snyder Jr, we assume votes can be

[4]A very comprehensive literature review of this tradition can be found in Dias-Cayeros and Magaloni (2003).

bought and we share the interest on the costs of coalition building. However, the disproportional amount of resources presidents control in Latin American polities renders their setup with two competing vote-buyers inadequate. Hence, in our model the president is the sole vote buyer.

More directly related to our specific case, Alston and Mueller (2005) and Pereira and Mueller (2004) are, to the best of our knowledge, the only attempts in the comparative politics literature to address this issue theoretically. Their model treats legislators as points on an ideological continuum and patronage functions as a second dimension. Their main result is that legislators on the ideological fringe of the president's coalition should receive more transfers than those closer to the president. Though intuitive, their result implies that opposition legislators and those too close to the president receive nothing. Additionally, their model ignores the fact that parties do play a role in the bargaining between executive and legislative patronage and that the president had other tools beside patronage at his disposal. Our model, in comparison, treats legislators as constituent elements of parties, but assumes that what parties receive is in some sense a public good for the parties' members. So, parties may generate economies of scale to the president.

1.3 The Model

1.3.1 Environment

Legislators: Legislators have preferences based on *political favors* they can receive from the president, and on whether they vote with or against the president. Each legislator has an exogenous *affinity* toward the president, which determines

the difference on legislator's utility depending on the way he votes.[5] Let C be the level of political benefits received by a legislator and X be the negative of his affinity (i.e., how distant he is from the president), and the legislator's utility is defined as

$$U = \begin{cases} v(C) + X & \text{if voting against the president} \\ v(C) & \text{if voting with the president,} \end{cases} \tag{1.1}$$

with $v(0) = 0$, $v'(C) > 0$ and $v''(C) < 0$.

For any given level of political benefits received by a legislator, if $X > 0$, he would always prefer to vote against the president. However, a legislator with $X > 0$ who receives no political benefits ($C = 0$) would be willing to vote with the president in exchange for receiving some $C > 0$, as long as $v(C) - X \geq 0$.[6]

Parties: Legislators are divided into J identifiable parties, with each legislator belonging to only one party.[7] Each party j is composed by a continuum of legislators with mass $N_j > 1$, heterogeneous in their preferences toward the president. Legislators from party j have their parameter X distributed according to the density function $\phi_j(X)$, with cdf $\Phi_j(X)$. The composition of the parties

[5]Note that the legislator's affinity may aggregate his personal and ideological preferences with respect to the president and his political program. Although the legislator's preferences are determined *exclusively* by the benefits received and how he votes, not being directly affected by policy, the affinities may reflect the whole set of policies the president wants to pass in the Congress. The main assumption we are making is that legislators do not care about the outcome of the vote. This assumption contemplates the parsimony in our model, which helps for the empirical exercise. Moreover, legislators are generally evaluated by their constituencies, and are usually held accountable for the way they vote, no matter if their positions prevail or fail.

[6]For simplicity, we assume that whenever a legislator is indifferent, he votes with the president. It just helps us to have an uniform exposition of the problem, and our results do not depend on that.

[7]Though we will refer to parties, these could be thought of as any kind of political groups, such as parties, regional groups or factions.

and, therefore, the diferent distributions ϕ_j are exogenous. And for simplicity, we assume that the support of $\phi_j(X)$ is an interval $[\underline{X}_j, \overline{X}_j]$.[8]

Political Favors: The president controls the allocations of two types of "goods" he can use to obtain political support in the Congress: a *common good* M ("Ministries"), that he allocates to parties and benefits all party members; and a *private good* P ("Pork"), allocated individually to legislators. Neither of these are straight out cash transfers, but both have monetary equivalents. The common goods are typically cabinet positions that are given to parties and that politically benefit all of its members in proportion to the amount of resources controlled by each Ministry. The private goods can be thought of as any kind of Pork, that benefit legislators individually. The provision of both types of political favors depends on discretionary decisions by the president. In the case of Brazil, which we deal with in the empirical section, one very important source of legislator specific pork are budget amendments presented by individual legislators.

Transfer Technology: For the legislators, political benefits are additive. The total amount that enters their utility function is simply $C = m + p$, where m and p denote the monetary equivalent of the benefit received from each type of benefit provided by the president. From the president's perspective, the main difference between those goods is their respective "transfer technology". For the private goods P, the amount received by the legislator is exactly equal to the amount transferred by the president. For the common goods M, we assume that when the president provides M_j to party j, each legislator in that party receives an equal amount $m_j = \mu_j(M_j)$, where $\mu_j(0) = 0$ and $\frac{1}{N_j} < \mu_j'(M_j) < 1$.

The first inequality, $\frac{1}{N_j} < \mu_j'(M_j)$, means that each individual legislator in

[8]It can be the case that $\underline{X}_j = -\infty$ and/or $\overline{X}_j = \infty$.

party j gets a marginal benefit from the common good M allocated to the party greater than when the same amount of resource is divided and allocated individually. If the president wants to benefit all the members from a party with some amount, it is cheaper to use M instead of P. The second inequality, $\mu_j'(M_j) < 1$, just guarantees that there is some degree of rivalry in the consumption of the common goods. The marginal benefit that a legislator gets from the resources that goes to the party still lower than the marginal benefit from having the same resources allocated directly to him. Thus, if the president wants to target a specific legislator, it is cheaper to use P instead of M.

1.3.2 The Decision Problem

For any given distributions $\phi_j(X)$, the president can induce more legislators to vote with him by providing political favors either to parties, or directly to legislators. The president allocates an amount M_j of the common good to party j and distributes individual pork among its legislators according to the a function $p_j(X)$[9] in exchange for the votes of all legislators in that party with $v(m_j + p_j(X)) \geq X$. In this way, every legislator whose utility when voting with the president and receiving the transfers is at least as high as when voting against him without transfers, will choose to take part in the deal and vote with the president. Legislators' choice is effectively between getting X and not voting with the president, or voting with the president and receiving $v(m_j + p_j(X))$. Hence, an increase in transfers causes some votes to switch over to the president's side. Exactly how the votes change depends on party's and legislator's specific parameters, and this will drive the president's decision on how to best spend his

[9]Actually, legislators in the same party j and with the same X could, in principle, receive different amounts of P. However, because we assume a continuum of legislators, the president's optimal allocation will always give the same amount $p_j(X)$ for those legislators, as we show later.

resources.

The president does not seek to maximize the number of votes in congress, but rather to minimize the costs of passing legislation provided he obtains a necessary level of support $Q > \sum_{j=1}^{J} N_j \Phi_j(0)$. If $Q \leq \sum_{j=1}^{J} N_j \Phi_j(0)$, the problem becomes trivial. Since legislators with $X \leq 0$ are always better off voting with the president, he does not need to expend any resources in order to have the votes he needs. Thus, for the non-trivial case we are interested in, the president needs to choose an allocation of resources that satisfies the "quorum constrain" given by

$$\sum_{j=1}^{J} \left[N_j \int_{-\infty}^{\infty} 1\{v(m_j + p_j(X)) \geq X\} d\Phi_j \right] \geq Q \tag{1.2}$$

where $1\{\cdot\}$ denotes the indicator function, which is equal to 1 if the argument is true, and 0 otherwise.

1.3.3 Optimal Decision

Proposition 1.1 *The president's optimal decision will be such that for each party j there will be a cutpoint X_j^* such that a legislators from that party with "anti-affinity" X will vote with the president* if and only if *$X \leq X_j^*$. There will be also another cutpoint $\widetilde{X}_j \leq X_j^*$ such that only the legislators with $\widetilde{X}_j < X \leq X_j^*$ will receive $p_j(X) > 0$.*

Proof 1.1 *Suppose that in the president's optimal decision, party j receives $M_j^* \geq 0$ of the common good. Then, each legislator in the party gets $m_j^* = \mu_j(M_j^*)$. Define $\widetilde{X}_j = v(m_j^*)$ and all legislators with $X \leq \widetilde{X}_j$ will vote with the president without receiving any P.*

To use individual pork in order to get the vote from a legislator with $X > \widetilde{X}_j$*, the president needs to give him* $p_j(X) > 0$ *such that* $v(m_j^* + p_j(X)) = X$*. Therefore, the marginal cost of those extra votes is increasing in* X*, and the president either does not "buy" any extra vote (*$\widetilde{X}_j = X_j^*$ *and* $p_j(X) = 0 \ \forall X$*) or buys extra legislators up to a cutpoint* X_j^**, and* $p_j(X) > 0$ *if and only if* $\widetilde{X}_j < X \leq X_j^*$*.*

Proposition 1.2 *Let* M_j^* *be the optimal provision of* M *to party* j *(with* $m_j^* = \mu_j(M_j^*)$*), and* $p_j^*(X)$ *the optimal provision of* P*. Then,*

- $\widetilde{X}_j = v(m_j^*)$*, and*
- $v(m_j^* + p_j^*(X)) = X \quad \forall X \in [\widetilde{X}_j, X_j^*]$.

Proof 1.2 *These follow directly from the proof of Proposition 1.1.*

By Proposition 1.1, equation 1.2 becomes

$$\sum_{j=1}^{J} N_j \Phi_j(X_j^*) \geq Q, \tag{1.3}$$

and from the Proposition 1.2, we can write

$$p_j^*(X) = \begin{cases} v^{-1}(X) - v^{-1}(\widetilde{X}_j), & \text{if } X \in [\widetilde{X}_j, X_j^*]; \\ 0, & \text{otherwise.} \end{cases}$$

Let P_j denote the president's total expenditure in private goods (i.e. $P_j = \int_{-\infty}^{\infty} N_j p_j(X) d\Phi_j$), and the president's decision problem can be stated as:

$$\min_{\widetilde{X}_j, X_j^*} \sum_{j=1}^{J} (M_j + P_j)$$

$$s.t$$

$$\sum_{j=1}^{J} N_j \Phi_j(X_j^*) \geq Q$$

$$\widetilde{X}_j = v(\mu_j(M_j))$$

$$P_j = \int_{\widetilde{X}_j}^{X_j^*} N_j \left[v^{-1}(X) - v^{-1}(\widetilde{X}_j) \right] d\Phi_j.$$

Proposition 1.3 allows us to derive the remaining two optimality conditions for the allocation of resources. Equation 1.4 represents the *Marginal Rate of Substitution* between P_j and M_j, keeping the votes from party j constant, and thus refers to the optimal provision of favors within the same party. Equation 1.5 deals with the optimal allocation of resources across parties, and reflects the notion that the *Marginal Cost* of support from each party should be the same.

Proposition 1.3 *If the president's decision problem has an interior solution, it is such that* within parties*, we have*

$$N_j \left[\Phi_j(X_j^*) - \Phi_j(\widetilde{X}_j) \right] \mu_j'(M_j^*) = 1, \tag{1.4}$$

where $\widetilde{X}_j = v(\mu_j(M_j^*))$*. And* across parties*, the optimality condition is*

$$v^{-1}(X_j^*) - v^{-1}(\widetilde{X}_j) = v^{-1}(X_k^*) - v^{-1}(\widetilde{X}_k) \quad j, k = 1, ..., J. \tag{1.5}$$

Proof 1.3 *Direct from the first order conditions of president's problem (see Ap-*

pendix A).

Within Parties: Given the number of votes the president will need from some party j, X_j^* is defined. The question becomes which balance between M_j and P_j the president will provide to obtain the necessary votes. The left hand side (LHS) of equation 1.4 shows how the president's expenditure with individual pork P_j changes in response to a change in M_j, keeping the number of votes constant. The legislators between $\widetilde{X}_j$ and X_j^* are the ones who receive $p_j(X) > 0$. Therefore, when the president increases M_j, the individual benefit m_j increases by $\mu_j'(M_j)$, and that is how much he can reduce the amount of pork given to each of those legislators. Equation 1.4 tell us that the total reduction in P_j must be equal to the increase in M_j. For example, if the LHS of equation 1.4 is less than one, the president should decrease M_j, because the cost with pork to keep the same votes would be lower than the economy with the common goods M. It implies that whenever $M_j > 0$, we cannot have $\widetilde{X}_j = X_j^*$, which means $P_j > 0$. Or, in other words, if party j has legislators been bought, some of them must be receiving individual pork.

Across Parties: To determine how to allocate resources among parties in order to meet the minimum support threshold, the president must compare the marginal cost of buying votes from different parties. Equation 1.5 states that the marginal cost of a vote must be equal across parties. The marginal cost associated with party j is measured as how much of P the president needs to give to the marginal legislator he buys from that party: $p_j^*(X_j^*) = v^{-1}(X_j^*) - v^{-1}(\widetilde{X}_j)$. Although M_j changes when X_j^* increases, the *within parties* optimality condition guarantees that the marginal effect of the change in M_j is compensated by the

change in P_j.[10]

The Appendix B analyzes in details the cases when corner solution occur.

1.3.4 Implications and Intuitions

Here, we discuss some implications from our model. One of the main results from the optimality conditions presented in the previous section is that, in any party that receive benefits from the president, there are legislators that are "bought" with individual pork. Although the president can delivery more benefits for the legislators allocating the common good to the party, since the parties are heterogeneous, he can always buy legislators at the margin, using very few targeted resources.

Another implication is that if the proportion of legislators receiving pork in some party in not large, it will be better for the president to reduce the allocation of the common goods (if the party is getting some) and increase the use of pork. That happens because when he allocates the common good, there are many legislators that get more than they need to vote with the president (the ones with $X < \widetilde{X}_j$). Therefore, it is better for the president to reduce the amount of common good, and use individual pork to buy the legislators he would lose, allocating the exactly amount to bring those legislators to his side. Only when the president is buying a number sufficiently large of legislators from the party, the widespread expenditure of the common good will compensate the economy in terms of individual pork. As a consequence, parties with ministries will tend to have a larger proportion of legislators getting individual pork than the parties out of the cabinet.

[10]This result comes directly from the Envelope Theorem, and is discussed in details in the Appendix A.

We can see also that parties in average not so close to the president, but with very heterogeneous affinities, may have legislators supporting the president in exchange for pork. But those parties will hardly have a ministry. On the other hand, more homogeneous parties that give support to the president are be very likely to take part in the cabinet.

1.4 Model Meets Data

As a first attempt to gauge how well the model performs against real world data, we present a exercise using data from Brazil for 2003 and 2004. We simulate the president's decision environment by feeding the model empirical stylized parties that approximate real world conditions, and then compare the outputs of the model with the observed patterns of votes and distributions of pork and cabinet positions. Note that the essence of this exercise is an attempt to establish if the model can match qualitatively the data on cabinet composition and distribution of individual pork among the members of different parties for some parameterization.

Before showing the results of the actual simulations, which we do in Subsection 1.4.2, we spend Subsection 1.4.1 discussing the numeric assumptions that were necessary to run the simulations and explaining the algorithm that was used. Appendix C has a more detailed description of the data.

1.4.1 Numeric Assumptions

The algorithm used to obtain the predictions is mostly a straightforward implementation of the optimality conditions described in the previous section, adapted to deal the possible corner solutions that arise whenever a party receives no M.

Details are given in the Appendix D. We now describe some basic assumptions we do, in order to proceed with the simulations that follow.

The distribution of X: We assume $\phi_j \sim logistic\,(\lambda_j, \sigma_j)$. The assumption of a bell shaped distribution seems reasonable empirically, and the use of a logistic distribution brings the advantage of a convenient analytical form.

The technology function: For the transfer technology of the common good, we use the function $\mu(M_j, N_j) = \frac{kM_j}{N_j}$. In this form, k is a parameter that captures the degree of non-rivalry of the common good. Greater is k, more the members of the same party can share the political benefits of what is allocated to the party. If k were 1, each member of the party would get $\frac{1}{N_j}$ of the total amount allocated to the party, meaning that the good would be completely rival. In that case, there would be no advantage on using M instead of P. On the other hand, if we had $k = N_j$, the common good would be perfectly non-rival, and there would be no reason for the president to deal with individuals. According to our general assumptions for the transfer technology, we must have $1 < k < \min(N_j)$ (see Subsection 1.3.1).

The utility function: For the utility function, we assume the general form $U(C) = C^\alpha$, with $0 < \alpha < 1$, that meets all the theoretical assumptions made in Section 1.3.

1.4.2 Making Predictions

Given the numeric assumptions explained above, from the point of view of the model, parties are distributions of X defined by their sizes, means and standard deviations. In order to obtain real world approximations of these values, it is

necessary to locate legislators in the continuum we call "affinity".[11] For the current version of the model, we employed an "of the shelf" method of retrieving ideal points as the basis of our procedure.

Ideal point estimation within legislatures has been a prolific literature in political science, as many theories require measures of legislators' preferences in order to be tested. The most popular approach to this problem has been NOMINATE and its variants, developed by Poole and Rosenthal (Poole and Rosenthal, 1985, 1991; Lewis and Poole, 2004; Poole, 2005). Nonetheless, the Bayesian approach (Jackman, 2000; Clinton et al., 2000; Jackman, 2001), which includes a specific software called IDEAL (Jackman, 2003), have been gaining popularity with recent computation advances.[12]

Both of these approaches use roll calls as the data from which to retrieve underlying ideal points through the use of a quadratic-normal random utility model. While NOMINATE relies on maximum likelihood techniques, the Bayesian approach is a direct implementation of item response models. The latter has the advantage of not needing a priori constrains on the estimates, and allows for easy incorporation of covariates, which for the purposes of this paper, however, are irrelevant. Therefore, we chose NOMINATE as our estimation technique.

We approximated affinities simply by estimating each legislator's one dimensional ideal point in the previous year, and computing the absolute distance between their and the president's ideal points.[13] The spread and position of each

[11]Remember, X is the negative of the legislator's affinity, which can also be interpreted as the distance between the legislator and the president.

[12]Another variant in ideal point estimation not directly generalizable to non US scenarios is the use of ADA scores, rather than roll calls, to estimate ideal points (Groseclose et al., 1999). Krehbiel and Rivers (1988) and Londregan (2000) are examples of yet another approach to the subject, where small data sets are compensated for by the inclusion of information on the nature of the proposal being voted on.

[13]Though ideal points can be estimated in multiple dimensions, work on American politics (Poole and Rosenthal, 1997) and on Latin American politics (Rosas, 2005) suggests that usually

party was computed from the position of its members on this transformed scale. These estimates, along with the size of the party in the actual year, were used as inputs to the model.

Obviously, this is not a truly "exogenous" measure of affinity. After all, the previous' year roll call votes are a product of the previous year's provision of political favors. The upside is that, at least, this is not as redundant as using the current year's roll call patterns, especially if we consider that between 2002 and 2003 (one of the year's used in our model) there was a presidential change.[14] Between 2003 and 2004 changes were less acute, but there was still some variation on the composition of government's coalition.

We concur with many objections to this procedure, as an estimation of the affinities. However, for our objective of having a set of parameters to simulate our model, it allow us to calculate means and standard deviations to input for the distributions ϕ_j, and see how the model performs with that parameters.

Inputting the model with these distributions, we try a wide range of values for the parameters for the transfer technology and the utility function (k and α respectively). Here, we present the results for the simulations with $k = 3.2$ and $\alpha = 2/3$, the values that give the model's best fit with the observed cabinet composition and pork allocation for both years.

With those inputs, the model generate predictions about what the optimal allocation of pork and cabinet positions should be, as well as what the expected number of votes each party contributes to the president given this allocation of resources. In this section, we discuss how well these aggregate party level

one dimension, and never more than two dimensions provide an accurate depiction of real world preferences.

[14] As a test of the robustness of our exercise, we tried also the simulations using same year's roll call patterns. The results were very similar to the one we report here.

predictions fare against real world data. In is important to note that the model also yields individual level predictions as to how much pork each legislator should receive and how he should vote, but for lack of time and space we leave the task of analyzing these predictions for future work.

We start by looking at the model's pork allocation predictions, which are the the percentage of the total pork predicted to be given to each party. Using data from the Brazil, we compare these predictions with the actual execution of legislator amendments to the budget. In Brazil, the executive sends a draft budget to congress, and legislators are allowed to present amendments.[15] The amendments usually benefit legislator's constituencies, but as is true with the rest of the bill, the budget only "authorizes" expenditures. The executive has the final say on appropriations, and given that revenues are usually overestimated and there is a perennial need to shore up primary surpluses to meet debt servicing need, most amendments are not executed or executed only partially. As has been said in the literature, bargaining over the actual execution of these amendments is a central part of executive–legislative relations in Brazil.[16]

Unfortunately, 2002 was an election year, which compromise our data on pork distribution for 2003. Retention, measured as the share of legislators present in the first vote in 2002 who were also present in the first vote in 2003, was only around 52%, meaning that about half of the legislators in Congress in 2003 did not present amendments to the budget for that year.[17] Therefore, the president had to use some other kind of pork to negotiate with those congressmen, and we cannot account for that with the data at hand.

For 2004, we do not have that problem, and Figure 1.1 compares the model's

[15]For the years used, legislators had a quota of 20 amendments for a total of up to 2 million reais.

[16]Note that Figueiredo and Limongi (2002) question the importance of these amendments.

[17]Between 2003 and 2004 retention was around 95%.

predictions and actual values of pork execution. Perfect predictions would fall along the diagonal line. The figure shows that for most of the parties, the model's prediction were very close to the observed data.

Compared to the model in Alston and Mueller (2005), the only other formal analysis of this problem we are aware off, our model's predictions are more realistic. While they predict that the further away coalition members are, the more pork they will receive, their model takes membership in the coalition as exogenously given, and is mute regarding how much pork non coalition members should receive. Additionally, in their model, the president's party should receive no pork at all, which is far from being true. For example, looking at the proportion of individual pork received by the president's party (PT), our model predicts that the party should get 21%, a figure very close to the actual 23% they got. Additionally, our model has implications that extend beyond simply distribution of pork, and we now turn to them.

The model also makes predictions about cabinet membership, as shown in Figure 1.2. In reality, since M is continuous, the model makes more fine grained predictions than simply predict membership or not. We hope to eventually use budgetary data, such as the size of the budget commanded by each ministry, to better analyze the fit of the model.[18] However, since this involves dealing with intricacies of the budget, it is yet another task that we leave for future work.

Note that now, we can look at both 2003 and 2004, since the data on cabinet composition do not share the same problem we have with pork. And here our model performs extremely well. Looking at both years, the only mistakenly classified party is the PTB in 2004. Note that our model is sensitive enough to

[18]Following Figueiredo and Limongi (2002), the best fit is probably to use the investment budget of each ministry, since that is the most politically useful and more flexible component of the budget.

predict that the PDT would be in the cabinet in 2003 but not in 2004, and that the PMDB would not be in the cabinet in 2003, but would join the government in the following year.

Finally, Figure 1.3 compares the predicted votes with the president by parties with the actual average. Here, we do not have a fit as good as the ones for pork or cabinet. However, we still get predictions relatively close to the actual averages for many parties.

1.5 Conclusion

This paper proposed a generic framework in which the provision of political favors (pork and cabinet positions) by presidents to a multiparty legislature is treated as a problem of cost minimization. It also stated, analyzed, and solved the specific decision problem such a president faces, and presented some preliminary empirical support for the model's predictions. The general framework was inspired by the approach on the provision of goods to the electorate in Dias-Cayeros and Magaloni (2003), and the model's mechanic by the model on political redistribution in Dixit and Londgregan (1996).

We believe our model improves upon the best preceding attempt to approach this issue formally, namely Alston and Mueller (2005), in that it attempts to unify two parallel and variants of the literature on coalition formation in presidential systems — one on cabinet formation and another on pork distribution — as well as open the way to incorporate this literature with the one about the provision of goods by presidents directly to the electorate.

We also believe to have incorporated at least some of the powerful criticism that Figueiredo and Limongi (2002) present to the whole conception of executives

buying support from locally minded individual legislators. In our model, parties play an important role, bargaining with legislators is done on the margin and the executive is the main actor. In principle, this is compatible both with a story where legislator's amendments are crucial and one where this dynamic is marginal.

In the empirical part of the paper, we are still working to improve the analysis in many ways, as we describe in Section 1.4. However, for the exercise we proposed, of trying to establish if, for some set of parameters, the model can match qualitatively the data on cabinet composition and distribution of individual pork, the results were very satisfying. These results give us a great incentive to keep working on that agenda, pursuing to advance on the estimations of the model, and exploring the many possible extensions and applications of our model.

Appendix

A Optimality Conditions: Proof of Proposition 1.3

For the within parties optimality condition, we can look at the parties individually. For any given Q_j, the number of votes needed from party j, we want to find the optimal choice between M_j and P_j to get that. If $N_j\Phi_j(0) < Q_j \leq N_j$, define X_j^* such that $N_j\Phi_j(X_j^*) = Q_j$,[19] write P_j as a function of M_j, and the problem becomes

$$\min_{M_j \geqslant 0} \left\{ M_j + \int_{v(\mu_j(M_j))}^{X_j^*} N_j \left[v^{-1}(X) - \mu_j(M_j) \right] d\Phi_j \right\}. \tag{1.6}$$

The first order condition gives us

$$1 - N_j \mu_j'(M_j) \int_{v(\mu_j(M_j))}^{X_j^*} d\Phi_j = 0,$$

and substituting $v(\mu_j(M_j)) = \widetilde{X}_j$, we have

$$N_j \left[\Phi_j(X_j^*) - \Phi_j(\widetilde{X}_j) \right] \mu_j'(M_j) = 1.$$

Second order condition is given by

$$N_j v'(\mu_j(M_j))[\mu_j'(M_j)]^2 \phi_j(\widetilde{X}_j) - N_j \mu_j''(M_j) \left[\Phi_j(X_j^*) - \Phi_j(\widetilde{X}_j) \right] \geq 0.$$

The first term is always positive, while the second will be whenever $\mu_j''(M_j) \leq 0$.

The case where $Q_j \leq N_j\Phi_j(0)$ is trivial. Since the legislators with $X \leq 0$ are

[19] For $Q_j = N_j$, define $X_j^* = \infty$ if the distribution ϕ_j has infinity support.

willing to vote with the president without receiving any political favors, we will have $M_j = P_j = 0$. And finally, note that we cannot have $Q_j > N_j$.

For the across parties, we will use the case with only two parties, for simplicity, but the results can be extended for the general case with $J \geq 2$. Define $TC_j(Q_j)$ as the minimum cost to "buy" Q_j votes from party j.[20] From the quorum constraint we can write $Q_2 = Q - Q_1$, and the president's problem can be stated as

$$\min_{Q_1 \in [0, N_1]} \{TC_1(Q_1) + TC_2(Q - Q_1)\}. \tag{1.7}$$

Now, note that $\frac{dTC_j}{dQ_j} = \frac{dTC_j}{dX_j^*} \times \frac{dX_j^*}{dQ_j}$. Applying the Envelope Theorem on (1.6), and using $N_j \Phi_j(X_j^*) = Q_j$, we get

$$\begin{aligned} \frac{dTC_j}{dQ_j} &= N_j \phi_j(X_j^*) \left[v^{-1}(X_j^*) - \mu_j(M_j)\right] \left(\frac{1}{N_j \phi_j(X_j^*)}\right) \\ &= \left[v^{-1}(X_j^*) - \mu_j(M_j)\right] = p_j^*(X_j^*). \end{aligned}$$

Thus, the first order condition for (1.7) is

$$\left[v^{-1}(X_1^*) - \mu_1(M_1)\right] - \left[v^{-1}(X_2^*) - \mu_j(M_2)\right] = 0,$$

or just

$$p_1^*(X_1^*) = p_2^*(X_2^*),$$

[20] Let $TC_j(Q_j) = \infty$ if $Q_j > N_j$.

and the second order condition is

$$\frac{dp_1^*(X_1^*)}{dQ_1} + \frac{dp_2^*(X_2^*)}{dQ_2} \geq 0.$$

For the general case, where $J \geq 2$, the first order conditions are

$$\left[v^{-1}(X_j^*) - v^{-1}(\widetilde{X}_j)\right] = \left[v^{-1}(X_k^*) - v^{-1}(\widetilde{X}_k)\right] \quad j,k = 1,...,J,$$

and the second order conditions

$$\frac{dp_j^*(X_j^*)}{dQ_j} + \frac{dp_k^*(X_k^*)}{dQ_k} \geq 0 \quad \forall j \neq k.$$

B Corner Solutions

Proposition 1.3 characterizes the presidents optimal decision when his problem has an interior solution. By that, we mean that every party will have some legislators who vote with the president in exchange of benefits received only thought the party, others who get also individual benefits (P) to support the president, and the free-rides, who vote against him but enjoy the political benefits the party receives (M).[21] Formally, we have $0 < \widetilde{X}_j < X_j^* < \overline{X}_j$. Equations 1.4 and 1.5 defines, for each party, who are the legislators in each of these three groups.

The corner solutions occur if for at least one party j:

1. $\widetilde{X}_j = 0$ and $X_j^* > \max\{0, \underline{X}_j\}$ (i.e., $M_j = 0$, $P_j > 0$, and legislators are bought only with private goods);

[21] These legislators are willing to give up these benefits to keep voting against the president. They benefits only by free-riding on the support from the other legislators in their party.

2. $\widetilde{X}_j = 0$ and $X_j^* = \underline{X}_j > 0$ ($M_j = P_j = 0$, and no legislators are bought); or

3. $X_j^* = \overline{X}_j$ (the whole party is bought).[22]

In the first case, we have a corner solutions associated with the within party allocation, and Equation 1.4 becomes

$$N_j \Phi_j(X_j^*) \mu_j'(0) \leq 1.$$

When the LHS is less than 1, the president would like to reduce M_j, but it is already zero.

The other two cases involve corner solutions related with the across parties allocation, and inequalities will take the place of Equation 1.5.[23] The equation will hold only among the parties partially bought, where $\max\{0, \underline{X}_j\} < X_j^* < \overline{X}_j$. Each side of the equation gives the marginal cost of an additional vote for the president, which we will denote that as MC. For the corner solutions, parties in the second case may have marginal cost greater than MC, while for the ones in the third case, the marginal cost may be less than MC. Note that we cannot have a party j with no legislators bought and $\underline{X}_j \leq 0$, since at $X = 0$, the marginal cost of a vote is zero. Thus, for the second case, the cost to buy the legislator at the lower bound of the distribution must be at least as big as MC, and Equation 1.5 becomes

$$v^{-1}(\underline{X}_j) \geq MC.$$

In the third case, since the parties were completely bought, it could be the case that the marginal cost still lower than MC, but these parties "sold out". There-

[22] We showed before that we cannot have $P_j = 0$ while $M_j > 0$.

[23] Actually, the second case will also have Equation 1.4 violated, since its LHS becomes zero.

fore, for this case, Equation 1.5 is replaced by

$$v^{-1}(\overline{X}_j) - v^{-1}(\widetilde{X}_j) \leq MC.$$

C Data

All data management, computations, simulations and graphs were done in R. Code and raw data are available from the authors upon request.

Roll Call votes, party sizes, and legislative retention figures were all computed from Limongi & Figueiredo's database, which spans the last 15 years of Brazil's legislative activities. To obtain the rough measure of affinity we computed legislator NOMINATE[24] scores for the year prior to our year of interest and then computed the absolute distances between all legislators and the executive. This yielded an affinity score measured on a scale between 0 and 2. Note that in 2002 the PT was not yet in government, so we used the position of the PT whip as the reference point instead. For 2003 we used the position of the government's leader in congress as the reference point.

Cabinet membership is coded as of March of each year since January and February are usually "dead" months, and March is when the legislative period begins. Data was obtained from Octavio Amorim Neto and complemented by the authors.

Budgetary data was obtained from databases provided by the Brazilian's Lower House *Consultoria de Orçamento e Fiscalização Financeira*, created from queries to the SIAFI, the official budgetary management system used by the Brazilian government.[25] From these databases we obtained both the share of

[24] See Section 1.4.2 for a discussion on NOMINATE.

[25] These yearly databases are available at `http://www.camara.gov.br/internet/orcament/`

the budget controlled by each ministry as well as the amendments presented by legislators. Legislators can present amendments to pre-existing projects (projects included in the budget draft by the executive) or create new projects for which no amount was reserved. In the former case, it is impossible to distinguish if the amount executed was from the legislator's amendment or not. Therefore, all pork figures used in this paper take into consideration only "pure amendments," or the execution of amendments that created new projects. The computation of "pure amendments" are only implemented for 2003 onwards, but we have made arrangements to have them extended backwards until 1995, and will probably be included in future versions of this paper.

D Algorithm

The only caveat is that instead of choosing the $\widetilde{X}_j$ and X_j^* that minimize the president's costs we opted to solve analytically for $\widetilde{X}_j$, and to optimize the resulting system of J equations only for X_j^*. This decision was made to allow for faster computation, and also to facilitate dealing with the issue of corner solutions for $\tilde{X}$.

Since previous to the allocation of any political favors, all the legislators with $X \leq 0$ vote with the president, all $\widetilde{X}_j$s and X_j^*s have to be non-negative numbers. This is not much of a problem with X_j^*s, since the use of a distribution such as the logistic, with infinite support, ensures an interior solution for the across party optimization problem. All parties have positive mass along the entire real line so Equation 1.5 holds without alterations and all parties will have a positive X^*.

However, in some cases we might have a corner solution for $\widetilde{X}$, in which case

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the marginal rate of substitution between P and M will not be equated to 1, as is required in the general within party condition (Equation 1.4). To deal with the possibility of corner solutions for $\widetilde{X}$, we start by defining a threshold $\widehat{X}$ for which $\widetilde{X}$ will only be greater than zero if $X^* > \widehat{X}$:

$$\widehat{X}_j = \begin{cases} \overline{\overline{X}}_j - \sigma \log\left(\dfrac{1 - \frac{1}{k} - \Phi_j(0)}{\frac{1}{k} + \Phi_j(0)}\right) & \text{, if } \Phi_j(0) < 1 - \frac{1}{k} \\ \infty & \text{, otherwise,} \end{cases} \tag{1.8}$$

where $\overline{\overline{X}}_j$ is the mean of the distribution ϕ_j.

We then define $\widetilde{X}$ as either zero, whenever the optimal solution is a corner, or as the $\widetilde{X}$ that meets the within parties optimality condition, if the solution is interior:[26]

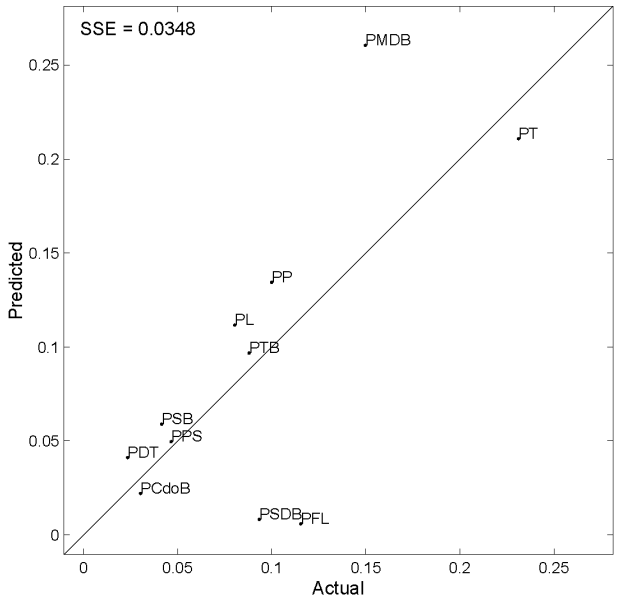
$$\widetilde{X}_j = \begin{cases} 0 & \text{, if } X_j^* \leq \widehat{X}_j \\ \overline{\overline{X}}_j - \sigma \log\left(\dfrac{1 - \Phi_j(X_j^*) + \frac{1}{k}}{\Phi_j(X_j^*) - \frac{1}{k}}\right) & \text{, otherwise.} \end{cases} \tag{1.9}$$

Equations 1.8 and 1.9 "replace" Equation 1.4 as our new within parties conditions. Along with the across party condition (Equation 1.5) and the quorum constrain (Equation 1.3), these define the system of equations we solve for. Once $\widetilde{X}_j$ and X_j^* are obtained, it is straightforward to obtain predictions for M_j and P_j.

[26]The second case in Equation 1.9 is simply the analytical solution to Equation 1.4.

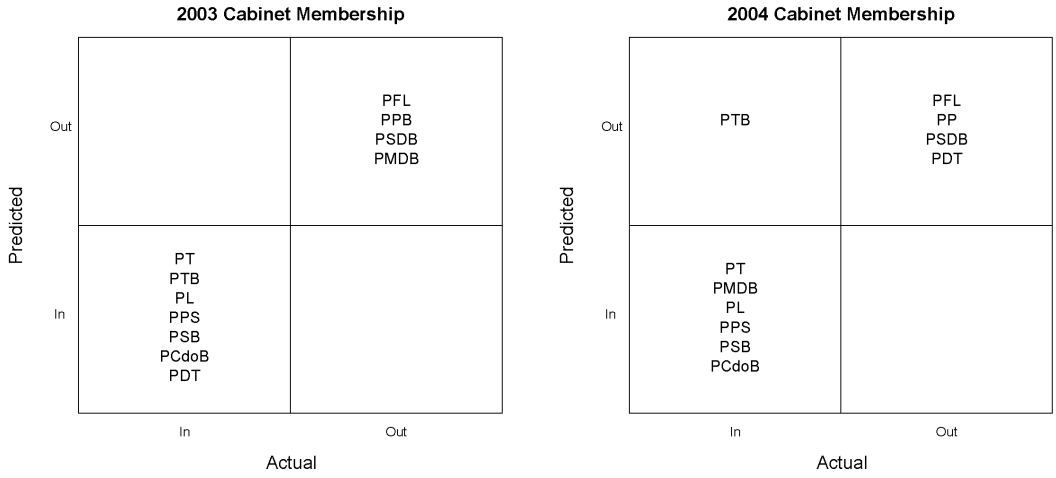
Figures

Figure 1.1: 2004 Model's Predicted Pork Distribution



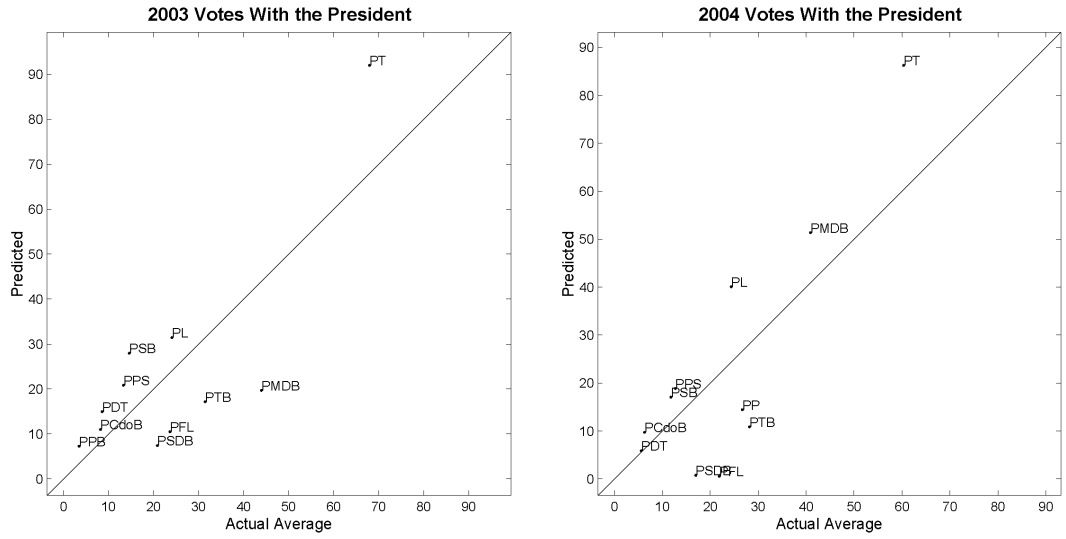
Notes: The horizontal axis is the observed values of pork, computed as the shares of executed "pure amendments" proposed by party members relative to the total of pure amendments executed the given year (See Appendix C for more details). The vertical axis are the values predicted by our model, also measured as the shares of total pork that corresponds to each party. SSE: sum of squared errors.

Figure 1.2: Model's Predicted Cabinet Membership



Notes: Actual cabinet membership is coded as of March of each year. Parties were considered as predicted in the cabinet if the model assigned it $M > 0$.

Figure 1.3: Votes With President



Notes: The horizontal axis is the average number of party members voting with the president across all votes in the given year. The vertical axis is the number of votes our model predicts the president will receive in each party.

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CHAPTER 2

The Back-up Investment Incentives in the Brazilian Electrical Sector Regulatory Model

2.1 Introduction

Until the middle of the 1990s, all the Brazilian electric utilities were public companies, and the federal government centralized the planning and execution of all the investments in generation. In 1995, with the beginning of the privatization of those utilities, the government started to implement a regulatory model for the sector. One of the most important targets of that regulation was how to guarantee the necessary investments in generation. After almost one decade, the regulatory model has failed in many fronts. In particular, the investments in thermal generation capacity to back-up the hydroelectric system did not happen, resulting in a huge electrical crisis.

In this paper, I analyze some aspects of the regulatory model implemented after the start of the privatization, and present a model that helps to understand how that regulation should work and why it did not. That model must helps to understand how different features of the regulatory model affect the behavior of the firms.

In the next Section, I present a big picture of the Brazilian electrical sector. There I go from since its origin until the crisis in 2001, describing some important

characteristics about its regulatory model, especially about the generation, that needs to be considered for in my analysis. In the Section 2.3, I present a model that try, in a simplified way, to represent the environment described in the Section 2.2. This model is a starting point for the analysis, and need to be improved to approach the many faces of the problem. Finally, in Section 2.4, I presented futures improvements for the analysis presented here, and discuss some conclusion that can be taken already.

2.2 The Brazilian Electrical Sector

2.2.1 Origins and Development of the Sector

The Brazilian electrical sector had its origin in the end of the nineteenth century. In 1883, it was constructed the first hydroelectric plant of the country. From that time until 1930, the sector developed basically by the private initiative, with a massive participation of foreign companies. After the Revolution of 1930, the growth of the nationalist ideas resulted in resistances against the control of the electrical sector by foreign companies. In 1934, the Brazilian government implemented the *Código de Águas* that established the concession regime for the utilization of hydric resources. Before, the rights over the waterfalls were associated with the property of the ground, and with the *Código*, the Federal government became the conceding power. The *Código* also established that the prices should be based on the service costs and on the capital value, which should be calculated from the historical costs of good and installations used. The *Código de Águas* represented a big reverse for the private companies in the sector, and probably was directly related with the occurrence of crises that demanded saving plans in 1939.

Although the *Código de Águas* gave to the Federal government the control over the concessions, until the beginning of the 1950's the direct participation of the state as investor still discrete. The strong increase in the demand, propelled by the increasing urbanization and industrialization resulted in constants crises of electricity supply. After that, along the 1950's and the first half of the 1960's, we can observe the intense participation of the state in the electrical generation sector. Data from Lima (1995) show that between 1952 and 1965 the installed capacity increased more than 10% per year, going from 1,985 MW to 7,411 MW. Most of the increase was due the public investment, as the participation of the public generators in the total capacity went from 6.8% to 54.6% in the same period.

In 1965, the government created the DNAEE (National Department of Water and Energy), with the normative and regulatory functions, while the ELETROBRÁS was the Federal company that deal with planning and execution of the electrical federal policy. According to Lima, that reform allowed the sector to auto-finance the needed investments from 1967 and 1973. After that, the Federal government opted to finance the electrical sector with foreign resources. However, the government may have taken that strategy more because of its necessity to finance the balance account than because of the sector's needs.

With the second oil shock in 1979, and the international financial crisis that follows, that centralized model started to face difficulties to keep the investments. As we can see in Figure 2.1, the total investments in the electrical sector fell from US$ 15 billions in 1982 to US$ 5 billions in 1997. We should note that at this point, almost all the utilities companies were public.

2.2.2 The Change of Regimes

In that context, the government decided to initiate the process of privatization of the electrical sector. In 1995, the first distribution utility was privatized, and in 1997 the privatization arrived in the generation sector, with the selling of the first hydroelectric plant.

Just before the implementation of the new regulatory model, most of the regulatory tasks were performed by the DNAEE. It included the planning, coordination and development of the hydrological studies. The DNAEE was responsible also for the evaluation of the price of the electricity and the supervision of the concession in the electrical sector.

The planning of the system (generation and transmission) was responsibility of the GCPS (Group of System Planning Coordination). The GCPS is coordinated by the ELETROBRÁS, the holding company of all Federal generation subsidiaries, and was composed by these subsidiaries and the main distribution companies (in general, state's public companies). The GCPS used to prepare the system expansion plan for 10, 15 and 25 years. However, it is important to note that, in the centralized regime, the investments proposed by the GCPS depended on the government's final decision, and the data presented in the previous section suggest that in the last years of that regime, most of them were not realized.

Finally, the GCOI (Interlinked Operation Coordinator Group) was responsible for the coordination of the physical operation of the system, establishing the criteria of the determination of who should generate, according to the hydrological risks, transmission possibilities, and the costs of thermal generation available. The GCOI had a composition similar to that of the GCPS, and counted also with the DNAEE, as observer.

With the beginning of the privatization in the electrical sector, it was adopted a new regulatory model, designed to regulate a sector based on private agents. In that model, a new institution controlled by the generators took the task of the coordination of the physical operation system. The planning of expansion of generation became only indicative, and the new regulatory agency - the ANEEL - took the responsibility over the process of concession for the new investments in the expansion plan. It is important to note that there are no guarantees that the proposed investments will be realized, and the potential investor may ask for the ANEEL to open the concession process of some investment not included in the indicative planning.

In this new environment, it was fundamental that to create the right incentives for the private sector to take its part in the execution of what were planned, specially taking in account the absence of investments in the last years of the old regime.

As we saw in the Figure 2.1, the amount of investments in the electrical sector fell continuously in the last years of the centralized system. From 1987 to 1997, the investments decreased in almost two thirds, going from US$ 15.4 billions to US$ 5.3 billions. This fall in the investments, together with the consistent increase in the consumption until the crises after 2000 (see Figure 2.2), suggests that the planning had became just indicative years before the new model. Those different trends of investments and consumption resulted in a increasing utilization of capacity. In Figure 2.3 we see that the capacity utilization in the generation sector fluctuated around 45% in the 1970s, grew to almost 50% in the 1980s, and increased eight percent points along the 1990s.

It is also important to notice that in a mainly hydroelectrical system like the Brazilian one —in 2000 about 95% of a total of 356 GWh was produced from

hydroelectric plants, while the conventional thermal generation and the nuclear generation produced the complement—, large reservoirs play and important role, storing water from the rainy season to the dry season, and eventually from an year to another. Therefore, the system needs to operate with a lower capacity utilization than a system where the generation in mainly thermal/nuclear. In that system, the non-hydroelectrical generation works as a backup, securing the system against long periods of dryness, preventing the level of water in the reservoirs of getting too low, which may drive the system in collapse. The need of backup will be greater, higher is the average capacity utilization of the hydroelectrical plants.

As part of the incentives for the new investments in generation, distributors were obliged to buy through long-run contracts at least 85% of their captive demand. In that way, generators could have a guaranteed future demand for the new investments. And to induce the investment in thermal plants that would work as back-up in case of a long drought, the generators were exposed to a "spot price" if their own generation were not enough to cover their contracts. It was created a wholesale market (MAE), where the differences between contracts, productions and demands would be compensated among generators and distributors. However, the MAE wholesale price did not come from the match between supply and demand. Instead, it was set by the optimization model that determines the dispatch of the generation. The model calculates the cost of the water in the reservoirs, chooses the best to way to generate energy to meet the demand, and sets the MAE price at the marginal cost of the generation.[1] In that way, if the thermal plants are dispatched because of a shortage in the hydroelectric generation due the low level of water in the reservoirs, the hydroelectric generator without back-up plants would buy energy in the MAE to honor its contracts. In

[1]It is important to note that the Brazilian hydroelectric system is highly interlinked with many generation plants and reservoirs in the same drainage basin. Because of that, the dispatch control must be centralized, in order to optimize the use of the water.

the extreme case, if the thermal plants in the system are not enough to cover a contracted demand, the MAE price would be extremely high,[2] penalizing the hydroelectric generator for not doing the back-up investment.

2.2.3 The Crisis

In 2001, a hard shortage in rainfalls, combined with the absence of investments in generation, drove the Brazilian electrical sector to a big crisis, with a large reduction in the hydroelectric generating capacity due the critically low level of the reservoirs. The risk of blackouts resulted in the implementation of an energy saving plan, with the establishment of quotas of consumption, in order to reduce the whole demand for electricity in 20%, with a huge impact in the economic activity. Of course, the crisis was even worse for the firms of the electrical sector. Not only they were facing a mandatory reduction of 20% in their markets, but also, according to the rules, the generators should be paying large amounts in the MAE. The shortage drove the MAE price to a very high level, and the generators should pay that to the distributor for the amount of contracted energy they were not delivering. That situation resulted in a big pressure, from the agents in the electrical sector and from the whole society, asking for a governmental intervention, in order to mitigate the crisis.

The government answered the society creating a committee to due with the crisis. This committee, composed with members of the government and the regulatory agency, had the purpose of make feasible a short term expansion of the electricity supply, and rearrange the regulatory model. As part of the regulatory remodeling, they should find a solution for the current crisis in the sector.

[2]In that case, the cost of the water, that reflects in the marginal cost of generating more from the hydroelectrical plants, would take in account the social cost the deficit in power generation.

In order to help the electrical sector firms to overcome the crisis, many rules were changed and, among them, the exposure of generators to the MAE price during the saving plan period was drastically reduced, avoiding the insolvency problem of the firms. At the end, the large penalty the generators should pay, that was supposed to induce them to invest in back-up plants, was not paid.

For the short term expansion of the supply, the committee contracted many emergency thermal plants, to increase the generation capacity, with the cost of this expansion being passed through to the consumers. In general, these plants were oil-fueled, which means their operational cost was extremely high, if compared with the natural gas plants. We must note also that, since it was contracted when the reservoirs were below the critical level, the amount of emergency generation capacity was higher than the regular back-up needed by the system. Therefore, for the period that these emergency plants will be connected in the system (about three years) the society will be paying for a "insurance" much more expensive than that one the hydroelectric generators where expected to do.

It is true that the regulatory model had many problems on its implementation, for example, the agents never completely agreed with the rules for the MAE. However, the size of the help given to the agents suggests the presence of a moral hazard problem. The agents were supposed to make investments in thermal plants for back-up, to guarantee the generation capacity in the bad state (absence of rain); otherwise, they should be punished in the bad state. But if they do not invest and the bad state occurs, the effects of the electrical sector crisis spillover all the economy. It results in a pressure from the society on the government to fix the problems in the electrical sector. As part of the government actions to help the sector, the regulator waives the agents from the punishment, avoiding the crisis to be aggravated. The result is that the agents take the risk of not

investing in back-up because they know that in the bad state they will be helped, and the risk of crisis in the electrical sector become bigger than should be.

2.3 The Model

To start with a model relatively simple, I will not include the distributor in the model. Instead of that, I will assume a unique consumer with demand function $D(p)$ (and inverse demand $P(\cdot)$) and no bargaining power. This consumer will buy directly from the generator, through a noncontingent contract that specifies price and quantity.

The model is a modification from the Bertrand competition with capacity constraint in Kreps and Scheinkman (1983). In a first stage, two firms that already own identical hydroelectric plants, with stochastic generation capacity h_i (identically distributed and positively correlated across the firms), decide simultaneously to build additional thermal generation capacity. The cost for the firm i of installing a thermal with generation capacity of t_i is $b(t_i)$, and the marginal cost of producing through the hydroelectric or the thermal plant, up to each capacity constraint, is c_h and c_t respectively, where $c_h < c_t$.

In the second stage, before knowing h_i's, but knowing their distribution and the thermal capacity of its opponent, each firms simultaneously set a price p_i, from the interval $[0, P(0)]$, and the maximum quantity x_i that it is willing to contract. Then, like in Kreps and Scheinkman (1983), if $p_1 < p_2$, the consumer will contract

$$q_1 = \min\{x_1, D(p_1)\}$$

from the firm 1, at the price p_1, and

$$q_1 = \min\{x_2, \max\{0, D(p_2) - x_1\}\}$$

from the firm 2, at the price p_2. The case where $p_1 > p_2$ is symmetric, and if $p_1 = p_2 = p$, the consumer will contract

$$q_i = \min\left\{x_i, \max\left\{\frac{D(p)}{2}, D(p) - x_j\right\}\right\}$$

from the each firm i.

After the second stage, with prices and quantities $\{p_1, p_2, q_1, q_2\}$ set, the hydroelectric generation capacity will be determined by the nature. Let $g_i = h_i + t_i$, the total generating capacity of the firm i, and let the system total generating capacities $G = g_1 + g_2$, $H = h_1 + h_2$ and $T = t_1 + t_2$ (total generating capacity, hydro and thermal totals respectively). Then, the total quantity $Q = q_1 + q_2$ will be generated through the most efficient way, i.e., by the source with the lower marginal cost. The marginal cost of the most expensive source used will determine the wholesale price p_{MAE} by which the firms can buy energy from the other. Thus, if the hydroelectric generation is enough to cover the demand (i.e., if $Q \leq H$), we have $p_{MAE} = c_h$. If instead of that, the thermal generation needs to be used ($H < Q \leq G$), we have $p_{MAE} = c_t$. In the extreme case, where the total contracted quantity is higher than the total generating capacity ($Q > G$), the wholesale price must be set on some arbitrary level. An alternative is put this price as a function of the size of the deficit $Q - G$. By now, I will keep it constant, but higher than the thermal marginal cost ($p_{MAE} = d > c_t$).

When the deficit occurs, if some firms have excess to sell for the others in the wholesale market, they will do at that price d. After the wholesale trades,

the firms that still with deficit with respect to their contracts will pay for the consumers this price, over the amount contracted but not delivered. It is straightforward that higher is this value d, greater is the incentive for the generator to invest in back-up plants, to prevent against the bad state.

So, according to the realization of the hydroelectric generating capacity we can have different situations:

Case 1: $H \geq Q$

If the total hydro generating capacity is greater than the total contracted quantity, only the hydro plants will be used. Even if for one of the firms, $h_i < q_i$, the other will generate the additional and that will be traded between the firms by the marginal cost of production ($p_{MAE} = c_h$). Then each firm will get

$$\pi_i = q_i \left(p_i - c_h\right) - b\left(t_i\right).$$

Case 2: $H < Q \leq G$

In that case, the system will need to use the back-up plants, and if the firms need to trade energy, they will at the price $p_{MAE} = c_t$. Therefore, if the hydro capacity is less than the contracted quantity for both firms ($h_i < q_i$ for $i = 1, 2$), each firm gets

$$\pi_i = h_i \left(p_i - c_h\right) + \left(q_i - h_i\right)\left(p_i - c_t\right) - b\left(t_i\right). \tag{2.1}$$

If one of the firms, say firm 1, does not need all the hydro capacity to cover its contract (i.e., $h_1 > q_1$), the firm will sell its excess $(h_1 - q_1)$ for the other at

$p_{MAE} = c_t$.[3] Then, firm 1 would get

$$\pi_1 = q_1 (p_1 - c_h) + (h_1 - q_1)(c_t - c_h) - b(t_1),$$

while the payoff for firm 2 still given by Equation 2.1.

Case 3: $Q > G$

That is the case where the system is in deficit, without generating capacity to meet the demand. If it occurs with both firms in deficit ($q_i > g_i$ for $i = 1, 2$), each one will produce using all the capacity and they will need to pay for the consumers the difference between the MAE price and the contracted price ($d - p_i$) times the deficit in its contract (the energy contracted but not delivered). Thus, each one will get

$$\begin{aligned} \pi_i &= h_i (p_i - c_h) + t_i (p_i - c_t) - (q_i - g_i)(d - p_i) - b(t_i) \\ &= p_i q_i - h_i c_h - t_i c_t - (q_i - g_i) d - b(t_i). \end{aligned} \tag{2.2}$$

If for one of the firms (say firm 1) has total capacity greater than its contracted quantity, the firm will sell this excess to the other, and its profit will be

$$\pi_1 = p_1 q_1 + (g_1 - q_1) d - h_1 c_h - t_1 c_t - b(t_1),$$

while the other firm's profit still the same given by Equation 2.2.

[3] Eventually, this firm will also generate from its thermal plant, to sell for the other. However, as long as we still have $Q \leq G$, the price for the trade between the firms will be $p_{MAE} = c_t$, and it will not affect the profit of that firm.

2.4 Future Improvements and Conclusion

The model presented here should allow analyzing some of the characteristics of the regulation of the Brazilian electrical sector. For example, we may have some insights about how the way the MAE wholesale price is determined affects the equilibrium. One natural modification in the model is to introduce the moral hazard problem described in the Section 2.2. It is important to compare the efficiency in the different equilibria (with and without "bailout"), to understand possible trade-offs between different mechanisms.

Other extension of the model is to introduce more than one period. In a multiperiod model, it must be possible to transfer capacity from one period to the other. That is one more risk factor that can be controlled by the agents in different degrees according to the regulatory model. The level of that control should have direct impact on the level of the back-up investment.

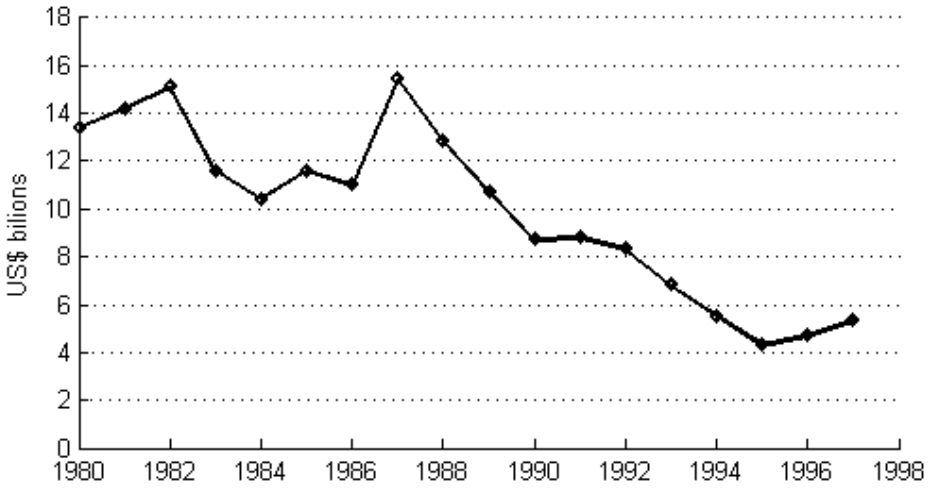
It is necessary also to examine how the presence of the distributor between the consumer and the generator changes the problem. That will be a big step from that model presented here to a model that may be useful to analyze many other features of the regulation in the Brazilian electrical sector.

But even with those improvements to be done, the data presented here shows that in 1996, when the privatization begun and the new regulatory model started to be implemented, the centralized system had already lost its capacity to perform the needed investments. However, even with part of the problem coming from the absence of investments in the "old regime", the evidences are that the regulation did not worked as it was supposed to. Although the new model cannot be entirely responsible for the crisis, it was designed to correct the path of the sector. However, it seems that under the new regime, the investor did not find

the incentives to resume the investments in the sector. It still necessary to look deeply in the data and go further with the theoretical model to understand in which extension inefficiencies of the regulatory model contributed for the crisis, and how to improve that regulation.

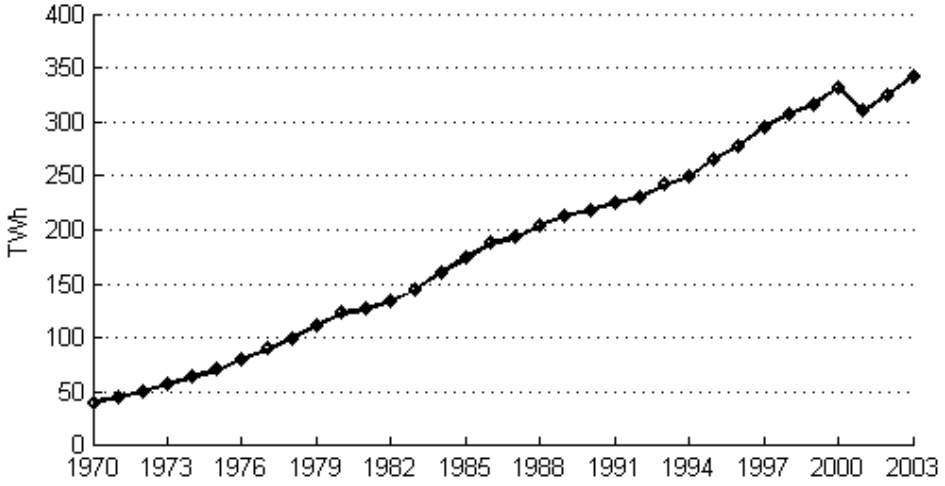
Figures

Figure 2.1: Total Investments in the Electrical Sector



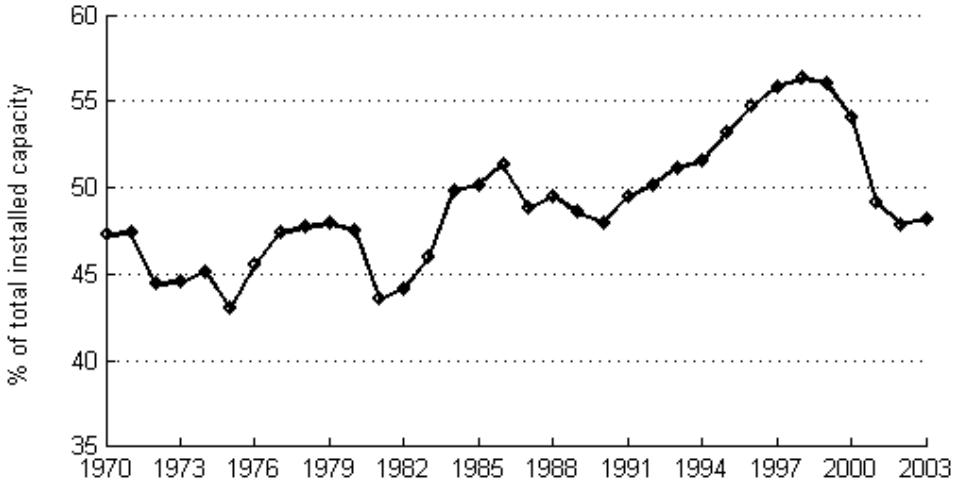
Source: ELETROBRÁS

Figure 2.2: Total Consumption of Electricity



Source: ELETROBRÁS (2004)

Figure 2.3: Generating Capacity Utilization



Source: ELETROBRÁS (2004)

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CHAPTER 3

Multiple Equilibria on Determination of Corruption and Implications to Economic Growth: A Review

3.1 Introduction

The level of corruption varies widely across countries in the world. Although most people agree that corruption is something bad, and that societies should create mechanisms to avoid or reduce the incidence of corruption, many countries presents consistently very high level of corruption, despite the harm it cause to their societies. On the other hand, many countries succeeds on keeping corruption at a low level of incidence.

This work is the first step of a project where I plan to have a deep look on determinants and implications of corruption, trying to understand the different profiles of corruption across countries. Here, as a starting point, I present a brief literature review on multiple equilibria on determination of the incidence of corruption, trying to emphasizes the implications of corruption on economic growth.

3.2 Literature Review

One of the most widespread ideas on why corruption is bad is related with its implications to economic growth. Mauro (1995) presents an empirical analysis on the effects of bureaucratic honesty and efficiency on economic growth. With cross-section data, he finds that corruption reduces growth by lowering private investments. Even looking at subsamples of countries where bureaucracies are very cumbersome, his main result still holds, which challenges the idea that in some extreme situations, corruption could be beneficial, by helping investors to go through bureaucracies faster than usual.

Because of the effects of corruption on economic growth, we should expected societies to make a huge effort in the attempt to reduce corruption. One of the seminal papers on the economics of corruption, Rose-Ackerman (1975) analyzes the relationship between the structure of the market and the incidence of corruption in the process of governmental contracts, and points out that the establishment of precise rules to direct the actions of government officials is one way to reduce corruption. A clear definition of the government preferences helps to reduce the occurrence of corruption on the contracting processes. So why do some countries succeed on keeping the the incidence of corruption at a low level, while others fail?

The general answer to that question in the theoretical literature is related with the occurrence of multiple equilibria. Cadot (1987) models a situation where a corrupt government official asks for a bribe, in order to let a candidate pass in a test. The model is applied for three different assumptions on the information available for each player —perfect, asymmetric and imperfect information—, with the official asking for a bribe in the amount that maximizes his expected payoff, given the information he has. When it is open the possibility of the superiors

of the corrupt official also being corrupt, the multiplicity of equilibria occurs. With superiors being able to ask for a bribe to cover up when the subordinated is denounced, it happens that higher is the corruption in one level, greater is the incentive for corruption in the other. Typically, we have an equilibrium with low corruption at the low level administration but no corruption from high-ranked officials, and another with higher corruption from the low-ranked and corruption occurring also at the high level administration.

In Andvig and Moene (1990), we have a model where the profitability of the corruption depends on the established frequency of it. There, the incidence of corruption is analyzed in a context of demand and supply, with bribers and bribees behaving as "price takers". On the supply side, higher is the proportion of corrupt bureaucrats, lower is the expected cost of being caught, and then, higher is the profitability of corruption. For the demand, when the overall corruption is greater, the search for a corrupt bureaucrat to bribe becomes shorter, and then more people engage in that search. This model also delivers many possible situations where multiple equilibria occur.

Exploring the implications of corruption to economic growth, Murphy et al. (1991) points out the importance of talented people working as entrepreneurs. They argue that talented people will self-allocate to sectors that exhibits the highest returns. With the development of the rent-seeking sector, some talented people would be attracted to that sector, reducing the talents in the entrepreneurship sector. There would be yet a second effect, where more talent in the rent-seeking sector will increase the expropriation of the gains from the productive and entrepreneurship sectors, reducing even more the returns in these sector, and driving more talents to rent-seeking. In Murphy et al. (1993), the authors go deep in their arguments, asserting that rent-seeking activities exhibit increasing

returns. That would occur due the existence of fixed costs to establish the rules that favors the rent-seeking, the character of self-generating of those activities, and finally, the lower probability of being caught stealing when more people steal. They also emphasizes that the public rent-seeking by government officials is specially harmful to the entrepreneurship sector, in opposition to the productive sector, since entrepreneurs are in greater need of the government services, such as permits, licences and import quotas. Therefore, that kind of rent-seeking is more adverse for the economic growth.

Back to the question of persistence of corruption, Dawid and Feichtinger (1996) presents a dynamic model that focus on economically motivated corruption, between a bureaucrat and an agent outside. The bureaucrats like bribes, but also care about their reputation. Higher is the expected level of corruption, lower is the cost in reputation for being corrupt. In that model, there are two stable equilibrium: one where all the bureaucrats are corrupt, and everybody accepts corruption; and another where no one is corrupt and corruption is condemned by all individuals.

Addressing the issue of persistence, together with the implications of corruption on economic growth, Mauro (2004) develops two distinct models for different kind of corruption. The first model focus on corruption where individuals steal from the government. In an environment similar to the one in Murphy et al. (1993), the individuals allocate time between productive work and stealing from the government expenditures. If many steals, probability of being caught is low. We have strategic complementarity that results in multiple equilibria. In the bad equilibrium, corruption is high, and growth is low due to the labor wasted in unproductive activities and the low marginal product of capital, since a low share of the government resources is allocated in production processes, where it was

supposed to be an input. In the second model, the corruption occurs with the government that steals from the public. That model relates corruption with political instability and low economics growth, and also delivers multiple equilibria through strategic complementarity. High corruption, with large brides, reduces growth. The low growth rate brings the pressure from the society to change the government. Thus, with a shorter horizon of the permanence in the power, the members of the government want to charge larger bribes. Alternatively, with small bribes, growth is bigger, we have a greater stability, and with a long horizon, meaning a longer flow of bribes, the members of government charge lower bribes.

3.3 Future Work

The next step in this project will be to extend the literature review presented here, putting more emphasis on the empirical literature, to identify stylized facts that the theoretical models do not explain satisfactorily. I have a particular interest on the possible explanations for the developments of different types of corruption in different societies.

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