ECONOMIC INSTITUTIONS OF ELECTRICITY: AN APPLICATION TO THE BRAZILIAN CASE

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ABSTRACT

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Two branches of the New Institutional Economics (NIE) literature, Institutional Environment and Transaction Cost Economics (TCE), lack several causal explanations. Namely, the former has not fully explained why and how substantial institutional change occurs; and the latter fails to provide formal reasons for why firms may adopt "second-best" governance strategies to support exchange in a certain industry. In this thesis, the Brazilian electricity sector is used as a case study to analyze how institutions of electricity evolved from a state-dominated orientation to a competitive market-oriented organization. Sequentially, the adequacy of the classic TCE framework in explaining how economic agents adopt governance strategies is evaluated. Based on an extensive literature review and structured personal interviews with sector experts, results indicate that institutional changes were driven by 'high levels of uncertainty', 'economic recession', and the 'unreliability of utility services'. Moreover, results support the existence of gaps in the classic TCE framework and recognize necessary refinements in two additional concepts – complementarity and implementability). In light of those concepts, this thesis concludes that (i) some transactions conducted in the regulated market channel would be governed differently if parties were authorized by the institutional framework to choose their strategies; (ii) free market channel players choose governance strategies that are not always aligned with the TCE predicted governance mechanism because capital availability, existence of compatible partners, and reputation play crucial roles in determining strategic decisions.

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PREFACE

"O saber a gente aprende com os mestres e os livros.

A sabedoria, se aprende é com a vida e com os humildes."

"Knowledge we learn from mentors and books.

Wisdom must be learnt from life and through humbleness."

Ana Lins dos Guimarães Peixoto (1889 – 1985)

Pseudonym, Cora Coralina

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INTRODUCTION

The New Institutional Economics (NIE) literature has not yet provided causal explanations on how long institutions persist or why and how they suffer dramatic changes (Arrow, 1999; Ménard & Shirley, 2005). Empirical studies have confirmed that institutional change takes place at the margin of the institutional framework (North, 1990) and often suffices to explain economic growth and social progress. These results, however, provide little support to cases of substantial institutional change. According to Shirley (2005), evidence is still inconclusive to define a theoretical justification on how dramatic institutional change occurs.

Alongside, the classical notion of transaction cost economics (TCE) has shown some inability to explain why businesses in a certain industry adopt governance strategies that differ from the most efficient one to support exchange (Delmas & Tokat, 2005). Studies have yet questioned if TCE is the most indicated theory to predict optimal governance structures (Mahoney, 1992; Foss, 1996; Jongwook & Mahoney, 2005). In light of these claimed criticisms, this thesis uses Brazil's electricity sector as a case study with the aim to expand the body of empirical research in NIE and produce satisfactory explanations to motivate theory refinement.

The Brazilian electricity sector provides a particularly interesting case for three reasons: (i) in less than a century, the sector experienced two dramatic institutional changes – the first toward centralization and the second toward a market economy (Baer, 2008; Leite, 2009); (ii) the latter reformulation of institutions along with financial support has created incentives for production and consumption of renewable electricity (Almeida, 2005; Castro et al., 2008; Neves & Conejero, 2009), which can be analyzed as economic growth and progress in environmental protection; and (iii) in order to satisfy the new regulatory framework, wholesale market players

have adapted their strategies without being authorized to choose across the entire governance continuum.

Put differently, the sector characterizes a rich setting for reviewing *why* and *how* formal institutions of electricity were fundamentally redefined twice. Under the new set of institutions, Brazil's electricity sector makes a particularly appealing case study for analyzing *how* firms choose governance strategies to support exchange; and whether the classic TCE theory (Williamson, 1985; Peterson et al., 2001) suffices to predict those choices.

Plausible explanations for those *why* and *how* questions require details that go beyond the frontiers of economics and enter the space of political science and strategic management. According to Carroll et al. (1999), no other theory provides a better framework to address 'interdisciplinary questions' than the NIE. Furthermore, NIE not only recognizes the existence of path dependence (North, 1990; Aron, 2000; Jütting, 2003) between institutional evolution and definition of business strategies but also outlines a method for discussing complex questions (such as those related to institutional change and economic agent's strategic choices) based on qualitative analyses rather than a quantitative approach (Shirley, 2005). As Mary Shirley states, 'few empirical studies have attempted to grapple with the messy details of real institutional change' (Shirley, 2005 p. 631).

This thesis employs NIE theory and a case study research methodology (Yin, 2009) to analyze the following questions. (i) What historical facts led the government, in the first moment, to take control over power utilities; and in a second moment, to restructure the institutional environment with incentive-driven policies? The objectives here are to provide compelling empirical evidence for *why* dramatic institutional changes occur and *how* these changes influence development. (ii) Do current institutions guide wholesale market players to

adopt the most efficient governance strategy? (iii) Does the classical notion of TCE (Williamson, 1985; Peterson et al., 2001) suffice to predict the governance strategy chosen by trading parties? Our discussion suggests a set of refinements that might enlighten the path towards further understanding of exchange relationships.

This thesis is organized as follows: Chapter 1 introduces the analytical methodology and data used in this study. Chapter 2 reviews the NIE theory and relevant empirical literature related to electricity markets. Chapter 3 tackles the first research question posed above and analyzes the relationship between institutions and economic development in Brazil's electricity sector over time. Chapter 4 utilizes TCE theory to analyze the second research question and to discuss what reasons cause misalignments between predicted and observed governance strategies within Brazil's wholesale electricity market. Chapter 5 offers concluding remarks, identifies contributions, and proposes direction for future research.

1. ANALYTICAL METHODOLOGY AND DATA

This thesis uses case study (Yin, 2009) as research methodology to evaluate the institutions of electricity and their implications to wholesale market players. Results of this study are expected to enhance the body of empirical knowledge on institutional evolution (i.e. what causes institutional reform; why it is necessary; how it is implemented) and whether the classical notion of TCE suffices to explain adoption of governance strategies.

Case study corresponds to a research methodology that provides guidance for rigorous data collection, presentation and analysis. As Yin (2009) suggests, case study fits best for qualitative analysis if: (i) research focuses on open-ended questions, (ii) researcher is interested in contemporary context, and (iii) investigator has no control over the set of events analyzed. The author adds that case studies are appropriate for situations in which multiple sources of evidence and prior theoretical propositions are considered to guide data collection and analysis.

This thesis matches the conditions mentioned above. From an outside perspective, it reviews *why* and *how* Brazil implemented institutional reforms in its electricity sector. Sequentially, it relies on the classic TCE framework (Williamson, 1985; Peterson et al., 2001) to examine *how* economic agents playing in the Brazilian wholesale market of power select coordination arrangements. Following the inductive approach (Corbin & Strauss, 1990; Strauss & Corbin, 1994), the empirical analyses indicate that refinements of the TCE theory might enhance our ability to predict governance choices.

Case studies can be powerful when they are analytical narratives that follow methodological rigor and also describe all rich nuances of the institutional setting (Bates et al., 1998). A plausible counterargument against alternative analytical methodologies is that cases are

capable of providing causal explanations to entangled real-life occurrences; whereas experimental strategies (e.g. econometric methods) need to rely on the notion of *ceteris paribus* (Wooldridge, 2010 p.3). Put differently, case study is appropriate as this thesis aims to maintain the holistic and meaningful characteristics of real-life events without controlling related and interesting variables. Quantitative methods accept that several factors may be correlated with the variable of interest but in order to establish causal relationships, the investigator conversely imposes control to keep the effects of related variables constant.

Data collection was based on two sources: (i) extensive literature review; and (ii) key informant interviews. Two authoritative studies (Baer, 2008; Leite, 2009) provide the foundations of the historical background. For more recent years, additional sources were included in the literature review as they provide important descriptions to the sequence of facts analyzed (Feldman, 1997; 1998; Ferreira, 2000; Pinheiro & Giambiagi, 2000). The current regulation governing transactions between utilities of generation and utilities of distribution and between utilities and independent consumers was collected from publications and websites of related political bodies (i.e. Ministry of Mines and Energy, EPE, ANEEL, CCEE, and ONS).

Primary data was also collected from a series of structured interviews conducted between May 25th and July 16th of 2010 with sector experts who represent a range of interests: government, industry, and academia. In total, we interviewed fifteen people: seven decision makers at utilities; five members of consulting companies/market facilitators; one project manager from a design-building company; one member of CCEE (coordinating agency of the wholesale market of power, in Portuguese); and one member of ONS (National System Operator). The data collected in interviews are used as supporting arguments throughout the thesis.

Following the classic TCE framework (Williamson, 1985; Peterson et al., 2001), the underlying attributes of transaction (i.e. uncertainty, complexity, asset-specificity, and frequency) are quantitatively analyzed for representative transactions between power generating firms and wholesale market buyers. The attributes are then categorized discretely in order to permit comparative assessment of governance strategies. Sequentially, the analysis examines whether governance strategies predicted by TCE truly maps the strategy chosen by economic agents. Misalignments between predicted and adopted strategies suggest that TCE theory becomes more compelling when refining studies are taken under consideration. Three complementary studies are used as building blocks to connect predicted strategies and strategies observed in the marketplace.

Preliminary results of this thesis were presented and debated at the Graduate Research Symposium on March 23rd, 2012 in East Lansing, MI; and at the International Society for New Institutional Economics (ISNIE) Conference on June 21st, 2013 in Florence, Italy.

2. THEORETICAL FRAMEWORK

"Every student of (political) economy repeats in his own mind the historical evolution of the schools, and a study of the history of economic theory is not an academic curiosity – it is a recapitulation of the evolution of our own thinking."

- John Roger Commons (1934, p.260)

"The reader must do his own systematizing of the rich material put before him; but the result will amply reward the effort."

- Wesley Clair Mitchell (1935, p.643)

2.1. The Early Work on Institutions

The study of institutional environment, institutional change, and transaction cost economics integrate the theoretical framework used in the following chapters to assess the evolution of the Brazilian electricity sector and to analyze transactions in the wholesale market of power. No different than any other scientific field, these theories were gradually defined with chronological contributions. Human knowledge evolves as one thinker proposes a theory, or discusses a point of view, based on the knowledge put before him. Ostrom (1986 p.4) points that no scientific field can advance far if participants do not share a common understanding of key terms in their field: 'we cannot communicate effectively if signs used by one scholar in a field have different referents than the same sign used by another scholar in the same field'.

By 1945 institutionalism was fractured and diverse, and lacking consensus on its methodological and theoretical foundations (Hodgson, 2004). There have been three historic meanings to institutionalism. Firstly, it has been a protest movement against both (i) the market economy as it has been institutionalized in the twentieth century in the United States and (ii) the dominant school of neoclassic economics. The second historic meaning of institutionalism has been problem-solving. Institutionalists have typically followed the path of pragmatism seeking to accommodate parties with conflicting interests and therefore causing controversy. Thirdly, institutional economics, no less than other schools of economic thought has attempted to create its body of knowledge (Samuels, 1988).

Much emphasis has been given to Ronald Coase as the founder of the 'New Institutional Economics (NIE)'. Coase (1998) admits that the NIE started with his article "The Nature of the Firm" (1937). Although his contributions enlightened both research and public policy in the years to come, many theorists had worked on defining economic terminology largely employed in his work. The NIE was coined by Oliver Williamson to differentiate the subject from the "old institutional economics". For Williamson (1998), what distinguishes the NIE from the earlier work on institutions is that institutions are susceptible to analysis.

The study of institutions appeared in the 1890s with Thorstein Veblen whose work has been neglected partially because of 'the latterly acquired uneasiness among social scientists about importing ideas from biology' (Hodgson, 2004). As clearly stated in *The Evolution of Institutional Economics*, Hodgson attributes the foundation of institutional economics to Veblen. 'His (Veblen's) preliminary analysis on institutional evolution in the *Leisure Class* was a major achievement, standing significantly above his precursors' (Hodgson, 2004). 'What did mark off

Veblen's work from that of his predecessors was concentration upon the evolution of institutions' (Mitchell, 1935 p.650).

Veblen used principles of Charles Darwin to suggest explanations on institutions and institutional evolution. He was the first economist to present institutional evolution in terms of natural selection, and his conception of human nature derived from Charles Darwin and William James. 'Institutions are not only themselves the result of a selective and adaptive process which shapes the prevailing or dominant types of spiritual attitude and aptitudes; they are at the same time special methods of life and human relations, and are therefore in their turn efficient factors of selection. The changing institutions in their turn make for a further selection of individuals endowed with the fittest temperament, and a further adaptation of individual temperament and habits to the changing environment through the formation of new institutions' (Veblen, 1899 cited in Hodgson, 2004).

Diversely of Veblen, John Commons' work derived from Jeremy Bentham. Commons (1934) attempted to develop a theory of institutional economics as derived from the decisions of the Supreme Court of the United States. 'Institutional economics is the field of the public interest in private ownership, which shows itself behavioristically in buying and selling, borrowing and lending, hiring and firing, leasing and renting. (…) Transactions are the alienation and acquisition, between individuals, of the rights of future ownership of physical things, as determined by the collective working rules of society' (Commons, 1934). In the article *Institutional Economics*, Commons advanced that the 'transaction is properly regarded as the basic unit of economic analysis' (Williamson, 1985).

A vast discussion on related economical concepts was engaged by Frank Knight (1921) Herbert Simon (1978), Kenneth Arrow (1963), Elinor Ostrom (1986) and other theorists. Frank

Knight first discussed the concept of uncertainty as we employ in transaction cost economics. In his book *Risk, Uncertainty and Profit* (1921), Knight remarks the importance of the concept of uncertainty to economics: 'we live only by knowing something about the future; while the problems of life arise from the fact that we know so little. This is as true of business as of other spheres of activity. (…) If we are to understand the workings of the economic system we must examine the meaning and significance of uncertainty' (Knight, 1921).

Herbert Simon worked on defining bounded rationality. 'We must give an account not only of substantive rationality – the extent to which appropriate courses of action are chosen – but also procedural rationality – the effectiveness, in light of human cognitive powers and limitations, of the procedures used for choosing actions'. (…) The scarce resource is computational capacity – the mind. The ability of man to solve complex problems, and the magnitude of the resources that have to be allocated to solving them, depend on the efficiency with which this resource, mind, is deployed' (Simon, 1978).

Kenneth Arrow (1963) pioneering research on asymmetric information was crucial to the development of the NIE; more specifically, to the study of governance structure, enforcement mechanisms, monitoring methods, and incentives. Elinor Ostrom (1986) defined rules as the means by which we intervene to change the structure of incentives in situations. 'The term *rules* should not be equated with formal laws. Enforcement is necessary for a law to become a rule. In this rule-structured situation, individuals select actions from a set of allowable actions in light of the full set of incentives existing in the situation. Rules affect the structure of a situation in which actions are selected'.

Taking the past contributions on institutionalism and definitions of related economics concepts under consideration, North (1990) settled the lack of consensus about institutions:

'Institutions are the rules of the game in a society. Or more formally, institutions are the humanly devised constraints that shape human interaction. Institutions affect performance of the economy by their effect on the cost of exchange and production'. Other definitions of institutions were given throughout history[1].

2.2. The New Institutional Economics (NIE)

With the definition of institutions in place, the NIE as a theoretical framework can be examined in detail. Williamson (2000) considers four levels of social analysis: (i) social embeddedness, (ii) institutional environment, (iii) governance, and (iv) resource allocation and employment. In his point of view, the NIE is concerned principally with the second and third levels. Transaction cost economics (TCE) represents the branch of NIE that is predominantly concerned with governance arrangements. This branch has its origins in Ronald Coase's treatment of firms and markets in 1937 and received valuable contributions from Oliver Williamson, Benjamin Klein, Victor Goldberg, and others. The other branch holds studies of institutional environment, which has Douglass North as the prominent thinker and received insights from Thráinn Eggertsson, Mary Shirley, and others.

Williamson (1985) recognizes that the governance framework takes the institutional environment, at least in the first moment, as given. In concordance, Coase (1998) recognizes that the costs of exchange depend on the institutions of a country: its legal system, its political system, its social system, its educational system, its culture, and so on. The institutions of

[1] The intention here is to focus on the definition that has largely been accepted by scholars rather than to neglect researchers' efforts in developing theory.

governance operate at the level of individual transactions, whereas the institutional environment is more concerned with composite levels of activity.

The study of institutions maintains that there is a crucial distinction between institutions and organizations. Organizations include political bodies (political parties, the Senate, a city council, a regulatory agency), economic bodies (firms, trade unions, family farms, cooperatives), social bodies (schools, universities, vocational training centers). In other words, organizations are groups of individuals bound by some common purpose to achieve objectives. They are 'created with purposive intent in consequence of the opportunity set resulting from the existing set of constrains (formal or informal ones)' (North, 1990).

Coase (1937) mentions that firms and markets are substitute governance mechanisms to perform the very same functions. 'Whether transactions are organized within the firm (hierarchically) or between autonomous firms (across a market) is therefore a decision variable for managers and policy makers' (Williamson, 1985 p.4). Decades later Klein et al. (1978) argue that the distinction between transactions coordinated within a firm or through spot markets goes beyond a simple substitution of coordination arrangements as stated in Coase's work.

Nevertheless, institutional environment defines the sphere of study on formal constraints, informal constrains and third party enforcers. It creates a framework that leads us towards a better understanding of institutional evolution. In our case of interest, institutional environment provides theoretical background for assessing the 'rules of the game' in the wholesale market of power in Brazil over time. In a complementary fashion, TCE forms the theoretical core for analyzing the underlying attributes of transaction of electricity and how players strategically choose governance arrangements.

It is noteworthy to observe that these two spheres of knowledge are path-dependent branches of the NIE theory, and therefore must be addressed with equal weights when analyzing institutional reforms and modes of governance. While institutions of a society fundamentally influence both why organizations come into existence and how organizations strategically choose governances; organizations determine how the institutional framework evolves at its margin (North, 1990; Mahoney, 2005). Ultimately, these two spheres integrate the theoretical framework necessary for conducting the analysis of interest. The next sections review both institutional environment and transaction cost economics in more detail.

2.2.1. Institutional Environment

Three dimensions integrate the concept of institutional environment: informal constraints, formal constraints, and the effectiveness of enforcement (North, 1990). Institutional constraints include both what individuals are prohibited from doing and, sometimes, under what conditions individuals are permitted to undertake certain activities. They consist of formal written rules as well as typically unwritten codes of conduct that underlie and supplement formal rules. As rules and informal codes are sometimes violated, an essential part of the functioning of institutions is the costliness of ascertaining violations and the severity of punishment.

Informal constraints come from socially transmitted information and are a part of the heritage that we call culture. Culture can be defined as the "transmission from one generation to the next, via teaching and imitation, of knowledge, values, and other factors that influence behavior" (Boyd & Richerson, 1985). In other words, culture defines the way individuals process and utilize information and hence may affect the way informal constraints are specified.

Conventions and norms are culture specific. Honesty, integrity, trust, and living up to a reputation can be self-enforced in many societies via culturally informal constraints. Informal constraints embodied in customs, traditions, and codes of conduct are much more impervious than formal rules in any type of society.

Formal constraints include political and judicial law, economic regulations and contracts. The hierarchy of such restrictions, from constitutions, to statue and common laws, to specific bylaws, and finally to specific contracts defines constraints, from general to particular specifications. Political laws broadly define the hierarchical structure of the polity. Economic regulations define property rights. Contracts contain the provisions specific to a particular agreement in exchange. North (1990) adds that looking only at the formal type of constraints themselves gives us an inadequate and misleading notion about the relationship between formal constraints and performance of economies. Research on institutional environment also requires a great deal of knowledge on informal constraints such as norms of conduct and beliefs. With a sociological perspective, Granovetter (1985) agrees that a detailed analysis of social structure is essential to understanding how existing institutions arrived at their current state.

The legal system represents the usual enforcement of formal constraints. In specific markets, third party enforcers are sometimes established to solve contract breaches between business parties. As transactions become more complex, there are strong incentives to create private controlling systems (such as federal regulatory agencies) and minimize reliance on judicial bodies. The argument is that legal systems may face difficulties in distinguishing promised behavior from opportunistic behavior in complex and specific transactions (Joskow, 1985). As third party enforcers focus on a limited number of transactions, controlling measures and punishment on deviators tend to be more effective. The classic case studies of Ellickson

(1989) and Greif (1993) illustrate the latter argument. The authors show that enforcing bodies established by market participants may enforce norms of conduct more efficiently than centralized political bodies[2].

In other situations agreements between parties are self-enforcing and neither the legal system nor third parties are necessary. It often happens when the parties to exchange hold personal relationship and are involved in repeated transactions (North, 1990). Less likely, impersonal transactions may also be self-enforcing (even when information asymmetries are present) if contracts create incentives for both parties to live up to the terms of exchange.

Nevertheless, impersonal agreements in the modern society often require enforcement, which in turn is typically imperfect. The main reasons are due to potential uneconomical monitoring costs, bonding costs, and residual losses (Jensen & Meckling, 1976); and to the fact that enforcement is undertaken by agents whose own utility functions influence outcomes (North, 2005).

The literature on institutional environment has lately paid great attention to understanding how institutions change and how they cause economic growth. Successful institutional changes are interpreted by theorists as those able to foster sustained growth and social progress in countries or specific industries within economies. It is claimed that economic development requires: (i) institutions that support exchange by lowering transaction costs and encouraging trust, and (ii) institutions able to influence the state to protect private property and persons rather than expropriate and subjugate them (Shirley, 2005).

[2] Robert Ellickson looked at transactions and norms of the whaling industry (especially between 1750 and 1870). Greif evaluated the maghribi traders' coalition and its influence over transactions in the 11th century.

North (1990) explains that numerous but small changes constantly occur at the margin of institutions without affecting culture or the set of beliefs intrinsic to an economic sector or country as a whole. Despite the great acceptance on North's view about marginal adjustment, theorists have not yet explained how dramatic changes occur. North (2005) argues that radical institutional changes (resulting from revolution, invasion or crisis) take place only if norms of conduct and beliefs of the parties involved also change. For this reason, Shirley (2005) agrees with North when she affirms that successful institutional adaptations are likely led by insiders (i.e. those who have great deal of information about how institutions currently function) as they understand local norms of conduct and know how to navigate social relationships.

Numerous case studies have attempted to provide plausible explanations to what factors drive institutional reforms that in turn set the arena for economic progress: adoption of the common law rather than the civil law (La Porta et al. 1997, 1998, 1999), occurrence of political conflicts and wars (Herbst, 2000; Bates, 2001; Nugent & Robinson, 2002), cultural influence and radical change of beliefs (Greif, 1994; Jütting, 2003), and adoption of democracy over other political arrangements (Bardhan, 2000; Rodrik, 2000; Keefer, 2002). However, a general explanation about what drives successful institutional reforms and consequent economic growth is still missing. Shirley (2005) adds that more research on institutional evolution in developing countries is necessary.

2.2.2. Transaction Cost Economics

Transaction costs include the following: procurement costs, costs of negotiating and writing contracts; costs of safeguarding an agreement; costs of monitoring contractual

performance; costs of enforcing contractual promises; adaptations and haggling costs; bonding costs; and costs associated with maladaptation. Such costs are different from production costs and 'are equivalent of friction in physical systems' (Williamson, 1985 p.19).

Taking the institutional environment as fixed, at least in the first moment, firms decide among a wide array of governance arrangements to minimize the sum of production and transaction costs and safeguard relationship-specific investments against expropriation of quasi-rents (Klein et al., 1978; Williamson, 1996). At one extreme, spot market is the most efficient governance structure for minimizing production costs. At the other, vertical integration is superior for minimizing transaction costs. In between, there is a continuum of potential 'hybrid' strategies that firms can adopt (i.e. specification contract, relation-based alliance, and equity-based alliance) (Peterson et al. 2001). Carroll et al. (1999 p.73) comments that the study of governance is the largest contribution of Oliver Williamson to the field of strategic management.

Williamson (1991; 1996) argues that four attributes of transaction should drive adoption of governance arrangements: uncertainty, complexity, asset-specificity, and frequency. To mention, uncertainty arises naturally as trading parties cannot foresee all future contingencies and are limited in predicting what is going to happen as the transaction unfolds. In fact if uncertainty was considered absent, the existence of firms would be pointless (Knight, 1921; Coase, 1937). In real-world transactions, uncertainty associated with uneconomical levels of *ex ante* transaction costs (procuring, drafting, negotiating and safeguarding contracts) may force parties to move partnerships forward based on incomplete agreements. TCE recognizes that contracts are often incomplete (Grossman & Hart, 1986; Hart & Moore, 1990) due to the existence of uncertainty and bounded rationality.

Incomplete contracts in turn set the stage for holdup problems (Goldberg, 1976; Klein et al., 1978; Klein, 1996), especially when one or both trading partners have incentives to behave opportunistically if a particular outcome not *ex ante* specified in the contract is reached. When the lack of consensus emerges between parties due to misspecifications, the legal system must be contacted in order to solve the issue. But, as presented above, courts of justice are not always capable of solving partnership conflicts with efficiency. The latter argument is especially true when transactions are complex.

Along with uncertainty, the presence of information asymmetry (that is, when one or both parties are willing to retain strategic information) might lead players to complex transactions. As complexity increases, exchange partners tend to be more vulnerable to contract breaches and therefore, are likely to incur additional safeguards in order to protect specific assets. In other words, Masten (1984) suggests that the greater the complexity of a transaction, the greater the likelihood of a party being bound to an inappropriate action of the counterparty.

As complexity of a transaction increases, players have strong incentive to establish third party enforcers. These political bodies substitute the legal system when solving *ex post* problems that emerge due to the lack of *ex ante* contract specification. A private enforcer is often more efficient than the legal system to solve complex issues because the former focuses on a specific set of laws and is better equipped to interpret trading parties' actions. Higher efficiency, however, comes at a cost. As one would naturally expect, the establishment and managerial activities of an industry-specific organization generate additional costs to the involved parties. Nevertheless, the existence of uncertainty and information asymmetry prevents third parties from fully eliminating probabilities of opportunism.

If parties are interested in carrying on transactions even when contracts are incomplete and third party enforcers are not fully capable of solving disputes, *ex post* controlling measures must be launched to strengthen credibility and reduce threats of quasi-rents expropriation (Maskin, 1999; Klein et al., 1978). Controlling measures vary in nature and intensity conditional to the specificity of transactions. Peterson et al. (2001) suggests that *ex ante* control prevails when more market oriented governances are strategically chosen by parties and *ex post* control dominates when governance strategies are more vertically integrated.

The latter study also observes that the intensity of control increases as governance structures become more vertically integrated. More specifically, spot market requires mild intensity of control because parties do not engage in long-term relationships and the only control parties tend to exercise are over price discovery and the decision of whether to enter into a future transaction. When firms engage in more vertically integrated modes of governance, managers tend to exert control with more intensity because holdup problems or moral hazard problems are often more costly. Therefore, firms tend to adopt more vertically integrated coordination strategies and more intense controlling measures when idiosyncratic assets expose parties to higher expropriation of quasi-rents (Klein et al., 1978; Walker, 1988)

From a different perspective, the TCE literature suggests that transactions are likely to be coordinated under more vertically integrated modes of governance when specific assets are in place and inter-firms controlling activities are not solid enough to minimize threats of opportunism. Asset specificity is the degree to which an asset can be redeployed to alternative uses and by alternative users without sacrifice of productive value (Peterson et al., 2001). There are five types of asset specificity defined in the literature: site specificity (Joskow, 1985),

physical asset (Klein et al., 1978), human-capital assets (Becker, 1962), dedicated assets (Williamson, 1985 p.55), and intangible assets (Caves, 1982).

i. Site specificity: when the buyer and seller are located side-by-side reflecting *ex ante* decisions to minimize inventory and transportation expenses;
ii. Physical asset specificity: when one or both parties in the transaction make investments in equipment and machinery that involves design characteristics specific to the transaction and have lower values in alternative uses;
iii. Human-capital specificity: arises as a consequence of learning-by-doing, investment, and transfer of skills (specific human capital) specific to a particular relationship;
iv. Dedicated assets: general investments that would not be undertaken but for the prospect of selling a significant amount of product to a particular customer. If the contract is prematurely terminated, it would leave the supplier with significant excess capacity.
v. Intangible assets: intangible capital such as brand name loyalty can have relationship specific attributes. The value of these investments can be tied to the company's brand name.

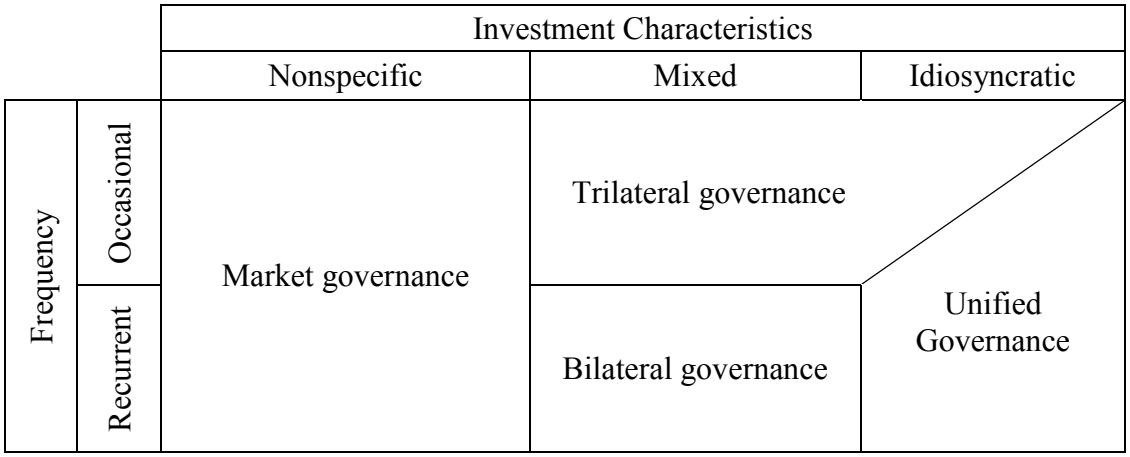
Finally, frequency is the last attribute of transaction that affects adoption of governance strategies. This attribute refers strictly to buyers activities in the market and specifies how often a given transaction happens. In some cases, recurrent transactions control opportunistic behavior as players are afraid of damaging reputation, and thereby affecting future transactions. Conversely, occasional transactions may force parties to exercise intense levels of control if they intend to engage in vertically integrated governance structures.

Nevertheless, all four attributes of transaction are equally important when parties to trade seek the optimal governance strategy to coordinate transactions. Examining each attribute individually may indicate whether more integration is necessary, but a serious decision only obtains when interactions among attributes are also taken into account. Based on these directions, Williamson (1985 p.72) proposed a methodology to predict the most efficient governance strategy. Although his model considered only asset-specificity and frequency as relevant attributes to guide the decision making process[3], it has not only shown that transactions are indeed susceptible to analysis but it has also taught us how to perform applied research using the TCE framework.

Accordingly to Williamson's model there is an efficient governance structure for each discrete combination of frequency and idiosyncratic assets. Namely, nonspecific investment (asset specificity dimension) and both occasional and recurrent contracting (frequency dimensions) lead to spot market governance. Occasional transactions with mixed and specific investments are efficiently conducted under trilateral governance. Bilateral governance is devised when recurring transactions are supported by mixed investments. Finally, vertical integration is the most efficient mode of governance when asset-specific investments are combined with recurring or occasional transactions. The efficient match of governance structures with transactions are shown in figure 1.

[3] Uncertainty is assumed to be present in sufficient degree to pose adaptation.

Figure 1: Efficient Governance According to Williamson (1985)



Source: Williamson (1985, p.79)

In another well-known study, Klein et al. (1978) present five empirical case studies that support Williamson's framework. The paper discusses, in light of the TCE, why less integrated governance structures may sometimes prevail over vertical integration. Years later Shelanski & Klein (1995) obtain similar conclusions based on an extensive review of case studies. Both surveys nevertheless conclude that each case study is unique and in-depth analyses are necessary to understand what governance structure tends to be more efficient (or perhaps less inefficient[4]).

Since the breakthrough studies of Klein et al. (1978) and Williamson (1985), the TCE literature has received important contributions. Milgrom & Roberts (1990) for instance have defined influence costs that arise when transactions are organized within firms. Although neglected in numerous empirical studies of governance strategy, influence costs are present in any firm and can be associated with bureaucratic inefficiencies that inevitably develop when

[4] TCE literature recognizes that Pareto efficiency is seldom obtainable. Hence, any governance strategy chosen by decision makers is likely to carry some degree of inefficiency in the traditional neoclassical sense of the word.

transactions are internalized (Masten, 1984). In sum, influence costs include not only direct costs of influence activities but also costs of bad decisions.

In another work, Milgrom & Roberts (1992) define the concept of complementarity, which along with asset specificity provides causal explanation to the costliness of holdup problems or breach of partnerships. Complementarity exists when the output of a vertically integrated firm is considerably larger than the sum of outputs generated by two or more firms engaged in a transaction. Such concept was borrowed from the classic paper of Alchian & Demsetz (1972) on agency cost theory. For them, complementarity is the synergy that emerges from team production.

Peterson et al. (2001) discuss that the existence of a more efficient governance strategy is not enough to guarantee its implementation. Although the study uses a business school oriented vocabulary, the authors propose a framework that provides insights to refine our understanding about coordination strategies. Specifically, the study points out that better governances need to satisfy four conditions in order to be implementable (i.e. capital availability, existence of compatible partners, control competence, and institutional acceptability).

Striking criticism to transaction costs theory has lately come from the emerging strategic management literature. Jongwook & Mahoney (2005) contend that TCE may not be well equipped to handle issues of shared ownership (e.g. cooperatives, joint ventures). They also claim that TCE assumes an initial equilibrium state that is not consistent if trading parties move a partnership forward based on incomplete contracts. The study suggests rather that the modern property rights theory (Grossman & Hart, 1986; Hart & Moore, 1990) provides a better framework for examining shared ownership cases.

Another study, also from the strategic management literature, indicates that two or more governance strategies may be similarly efficient to coordinate transactions within the same industry (Delmas & Tokat, 2005). The authors evaluate relative efficiency in the US electricity sector using Data Envelopment Analysis (DEA method). The paper concludes that vertical integration and spot markets are equally superior governance strategies to intermediate transactions.

In summary, both branches of the new institutional economics (i.e. institutional environment and transaction cost economics) have received numerous inputs throughout history. The institutional environment branch has provided consistent explanation to what institutions are and to how (marginal) institutional change happens. The branch has, however, failed to explain how and why dramatic changes to institutions occur. Shirley (2005) argues that 'the specifics of institutional change fall through a gap in the literature'.

The TCE branch defines an elegant framework for examining transaction relationships. Williamson (1991; 1996) and Peterson et al. (2001) have created an empirical research agenda in which uncertainty, complexity, asset-specificity, and frequency are the underlying attributes. Concerns have lately emerged from business scholars who argue that the classic TCE neglects measurement problems (Mahoney, 1992), and assume an equilibrium state for choosing governance strategies (Jongwook & Mahoney, 2005). Empirical evidence has also questioned whether the classical notion of TCE sufficiently explains why firms may adopt different governance strategies to coordinate transactions within an industry (Delmas & Tokat, 2005).

2.3. NIE Applied to Electricity Sectors

Electricity sectors have been extensively examined under the NIE lenses across the world (Joskow, 1985; 1996; Souza, 2000; Delmas & Tokat, 2005; Spiller & Tommasi, 2005; Jolink & Niesten, 2008; Fetz & Filippini, 2010). Regulatory reforms undertaken by countries over the last few decades stand as the main focus of those analyses. The objectives however are divided among implications, consistency as policies, and conformity with economic theory.

Joskow (1985) represents a landmark in the empirical application of TCE as a theoretical framework. The author offers an extensive literature review and examines organizational arrangements between power generating firms and coal suppliers in the United States. He concludes that empirical evidence is consistent with the predictions of TCE: vertical integration is superior for mine-mouth plants due to the high levels of asset-specificity (site specificity, physical asset specificity, and dedicated assets). Results also point out that when vertical integration is not observed, very long-term contracts are preferred alternatives to coordinate transactions. The author, nevertheless, recognizes that his research agenda is not complete as it provides little explanation for why coal-based generating firms 'optimize' the sum of production and transaction costs and safeguard idiosyncratic assets through two different governance strategies.

In another study, Joskow (1996) identifies some physical characteristics of electricity sectors that tend to complicate analyses of organizational arrangements and coordination strategies. To mention, network reliability requires supply and demand of power to be balanced subject to complex constraints in real time rather than relying exclusively on tradable property rights and spot market transactions to allocate resources efficiently (p. 342). Taking that into

consideration, the author suggests a few approaches to resolve coordination problems. The author also reviews how countries have implemented structural and regulatory reforms in order to promote competition among generating firms and to eliminate costly government-owned arrangements.

Souza (2000) covers the first case study about institutions of electricity in Brazil after the institutional reform (National Privatization Program and Electricity Sector Reform). The author explores marketing mechanisms for renewable electricity in Brazil in a period marked with high levels of uncertainty. Based on a qualitative analysis, the study concludes that uncertainty and asset-specificity of power generation stations led trading partners to settle long-term specification contracts. The study also suggests the definition of a minimum price policy for renewable electricity in order to enhance market competitiveness.

Delmas & Tokat (2005) analyze the efficiency of governance structures played by electric utilities during the process of retail deregulation (1998-2001) in the United States. The authors analyzed quantitatively which organizational arrangement seems more efficient to govern transactions between power generators and distribution utilities. Empirical evidences show that either vertically integrated or market oriented firms are more efficient than firms with intermediate governances. The study also concludes that the deregulation process has a negative impact on efficiency in the short term due to high levels of uncertainty. In addition, the authors discuss that transaction cost economics may not sufficiently explain why firms with different governance structures reach similar levels of efficiency.

Spiller & Tommasi (2005) discuss about the implications of new regulations on public electricity utilities. The authors argue that three main characteristics of utilities (large and specific investments, technologies with important economies of scale, and widespread

consumption) cause major impacts on the way formal institutions are drafted. Namely, large idiosyncratic investments in distribution grids may cause under-maintenance or under-investment by its operator. Economies of scale imply few suppliers in each locality, which in turn may facilitate exercise of market power. Finally, the massive consumption of electricity along with its inelastic demand may bias government's decisions and set the stage for corruption.

Jolink & Niesten (2008) uses the TCE framework to evaluate whether the liberalization and re-regulation of European electricity industries direct firms to improve performance in the Netherlands. Based on a qualitative analysis, results point out that the imposed spot market governance is not the most efficient structure as large degrees of asset-specificity characterize transactions. The paper concludes that generating firms would be better off under specification contracts since the adoption of vertical integration is banned.

Fetz & Filippini (2010) employ an econometric model to quantitatively test whether vertical integration is present in the Swiss electricity sector and whether it brings advantages to companies. For motivation, the authors observe that most regulatory reforms introduced to electricity sectors in Europe require legal and functional unbundling of vertically integrated firms. Empirical results show that the majority of power generating firms and small-sized distribution utilities are vertically integrated and enjoy some advantages of such governance. These results support the European Union policy directive that exempts companies with 100,000 customers or less from any barrier in the organizational arrangement chosen.

Although several studies have applied the NIE framework to electricity sectors, research gaps remain open. Namely, Joskow (1996) and Spiller & Tommasi (2005) address the question of how regulatory reforms have taken place and how critical re-regulation of electricity

industries is. Neither study however takes a country as case study and scrutinizes the reasons underlying its reform. Delmas & Tokat (2005) and Joskow (1985) have indicated that power firms may deliberately choose different governance strategies in order to reach similar levels of transaction efficiency. Delmas & Tokat (2005) however uses a quantitative approach and does not analyze the underlying attributes of transaction as proposed in the TCE literature. In our view this missing analysis could have provided causal explanation to firms' adoption of distinct governance strategies. Paul Joskow in turn recognizes that his paper lacks fundamental explanation for why businesses (in his case, coal-burning generation utilities) choose different coordination arrangements when the classic TCE theory suggests that they should adopt a unique efficient strategy.

Aiming to overcome these limitations, the next chapters tackle the case study of Brazil's electricity sector. Chapter 3 analyzes the evolution of institutions and its effects on economic growth from the 1930's - when Brazil's government started taking over operations of generation, transmission, and distribution – to the 2000's – when the sector reform and privatization program reduced governmental participation in all three operating spheres. Such analysis lets us examine the leading factors that motivated institutional reform, job not performed in Joskow (1996) or Spiller & Tommasi (2005). In chapter 4 the classic underlying attributes of transaction (i.e. uncertainty, complexity, asset-specificity, and frequency) are evaluated in-depth to guide consistent discussion on whether the classic TCE framework (Williamson, 1985; Peterson et al., 2001) suffices to explain adoption of coordination strategies.

3. INSTITUTIONS AND INSTITUTIONAL EVOLUTION OF THE ELECTRICITY SECTOR IN BRAZIL

"[The new institutional economics] suggests a whole agenda for microeconomics empirical work that must be performed (...). Until that work has been carried out, the new institutional economics and related approaches are acts of faith, or perhaps of piety."

- Herbert Simon (1991, p.27)

The evolution of Brazil's electricity sector is marked by a historical lack of consensus among governments about long-term economic policy. For over five decades (1934-1989), the government's involvement in the electricity sector prevailed and then started decreasing as the Constitution of 1988 was promulgated. With the new Constitution, a range of neoliberal polices were adopted including privatization of state-owned enterprises and reform of economic sectors.

In the face of severe international debts and high inflation rates, Brazil fell into recession between 1982 and 1984 (Baer, 2008). The plan of privatizing state-owned companies was seen as crucial for the raise of a long-term sustainable economy (Pinheiro & Giambiagi, 2000). Privatization alone, however, would not fulfill the major goal of recovering the Brazilian economy. In parallel to the privatization program, several economic sectors in which the government was present as player (e.g. electricity, telecommunications, railroads, highways, petrochemicals, steel, fertilizer) had institutions restructured in order to effectively meet the directives of the new Constitution.

The reformulation of institutions of electricity in specific was not an easy task for the reasons highlighted by Spiller & Tommasi (2005)[5]. Not to mention, decision makers had the additional challenge of designing incentives for new enterprises of power generation to enter the field given that the major player (Brazil's government) was in process of privatizing its assets. In a parsimonious fashion, rule markers defined categories of generation firms and power consumers, organized the marketplace as a dual-channel market, established regulatory agencies, and provided autonomy for those agencies to formulate enforcement rules. Almeida (2005) suggests that the ultimate intentions of the Electricity Sector Reform (ESR) were to create a competitive wholesale market of power and to regulate transmission and distribution services[6]. Almeida's suggestion in fact fits almost perfectly to the analysis carried out by Joskow (1996).

The following sections of this chapter review in-depth how the government became a player after the 1929 Great Depression, how it retired from the role of player more than six decades after, and how the institutional environment evolved to its current structure. The specific objectives here are to provide compelling empirical evidence for why dramatic institutional changes occur and how these changes influence development.

[5] Three features define utilities (electricity included): (i) technologies are characterized by large specific, sunk, investments; (ii) technologies are characterized by economies of scale; (iii) products are massively consumed. The authors argue that these features are always source of controversy when institutions are to be implemented or modified (Spiller & Tommasi, 2005 p.518).

[6] Joskow (1996) refers to transmission and distribution services as 'wire' services. The same terminology is adopted from here on.

3.1. Background

The negative effects of the 1929 Great Depression led occidental countries to adopt initiatives of market protection and domestic industrial support. Brazil was not an exception. State intervention in the electricity sector began with the Water Code (1934) which empowered Brazil's government to set electricity rates (Pompeu, 2006). The reason for this control was the fact that electricity rates had been partly indexed to international gold prices and partly to the domestic currency (Baer, 2008). As the Great Depression caused high volatility of gold prices and undervaluation of the Brazilian currency, power rates could easily go up and consequently bring electricity consumption down. Low electricity consumption in turn could adversely affect domestic production, which was one of the government priorities at that time to overcome the global depression.

Controlled rates of electricity were considered to be of national interest until the 1950s. For over three decades the government set relatively low rates as a mechanism of subsidy to industrial development. From one side, the rates policy (along with other policies defined in the 50s) indeed stimulated industrial development and economic growth (Baer, 2008 p.66). From the other however, it repelled private enterprises of power generation and distribution that were operating in the country. In other words, the government's control over electricity prices limited private power generating firms and distribution utilities (mainly foreign[7]) from reaching adequate rates of return on investments (ROI) which in turn led them to leave the country. In face with a growing electricity demand (associated with the supported industrial development)

[7] Brazilian Traction Light & Power Co. and American & Foreign Power Co. (Canadian and American companies, respectively) owned 70% of the capacity of generation in the country at that time (Leite, 2009).

the state had no other alternative but to gradually enter the fields of power generation and distribution.

Only two decades later, the state dominated the sector. In 1962, private companies accounted for 64% of the power generating capacity; in 1977 this proportion was reduced to less than 20%; and in 1982 almost all generation was run by state-dominated enterprises (Leite, 2009). Ferreira (2000) contends that the centralized model was justified not only to be consistent with government programs of economic growth but also to permit high levels of technical efficiency in a hydropower-dominated system. It is noteworthy to mention that the three largest operating dams in the country (Itaipu, Tucuruí, and Ilha Solteira, respectively) were built between 1967 and 1975 with government's financial resources.

During the 70s and 80s a sequence of economy shocks associated with poor financial strategies[8] pushed Brazil into recession times with serious inflationary problems. Government leaders believed that a large scale import substitution program (financed with international loans) was the best alternative to fight the first oil shock of 1973. The substitution program was set under the assumption that loans would be paid back as soon as the stimulated production was in place, declining imports and increasing exports. The reality, however, was not so: the second oil shock of 1979 and the interest rate shock of 1982 turned down international demand for Brazilian products and aggravated debts contracted few years earlier.

Storming debts and high inflation rates forced Brazil's government to venture its last attempt to overcome the inevitable crisis. Public enterprises, the last stable segment of the Brazilian economy, were used as tools of macroeconomic policies. Specifically, production of

[8] Brazil contracted numerous international loans in the 70s to finance constructions and to overcome the crisis imposed by the first oil shock of 1973. Loans, however, were contracted based on flexible interest rates which were sharply increased in 1982 (triggered by the Volcker's policy in the US).

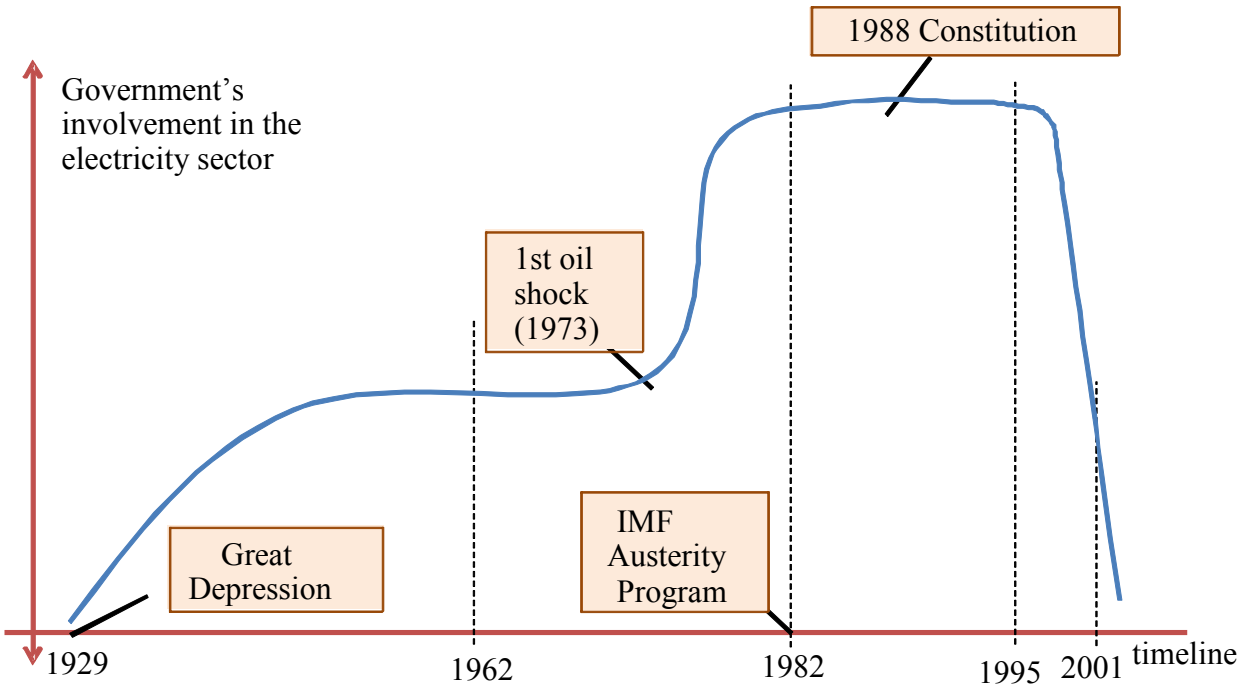
public enterprises (electricity, telephone services, iron, and steel) was used as instrument to control inflation. Companies were forced to borrow more on international markets than they needed in order to provide the government a continuous inflow of foreign exchange needed to cope with a deteriorating balance of payments (Werneck, 1987). Baer (2008) points out that as result of those policies the average electricity rate decreased by 40% between 1979 and 1984.

Economy shocks along with bad financial strategies left Brazil in a bankrupt state[9]. Regarding the electricity sector, the forced debt accumulation placed generating firms and distribution utilities in unsustainable financial situations. Moreover, increasing demand of power and frozen supply caused severe power outages in the 1990s.

With the liberal directives of the new Constitution, privatization of state-owned enterprises and reform of several economic segments were given high priority to overcome the debt crisis and better match supply and demand of power. The positive effects of such initiatives were, however, only seen after 2001 once the two major programs for institutional change were complete. Figure 2 attempts to represent government's participation in the electricity sector over time and highlights some of the related historical events.

[9] Brazil required IMF (International Monetary Fund) assistance in December 1982. The austerity program continued between 1983 and 1984.

Figure 2: Government's Participation in the Electricity Sector



Source: Designed by the author, 2011. For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this thesis.

3.2. National Privatization Program (1995-2001)

The National Privatization Program (NPP) was one of the government initiatives launched to modernize the Brazilian economy through a general liberalization process. 'Privatization was seen as a safety net or bridge to stability, affording the country some leeway for resolving its two main disequilibria, the current account and fiscal deficits' (Pinheiro & Giambiagi, 2000). Public enterprises of electricity, telecommunication, railroads, highways, petrochemicals, steel, fertilizer, as well as an aircraft manufacturing firm and a computer firm were all in the government's privatization list. The privatization process generated $93.4 billion

in revenues and the electricity sector alone accounted for 31.8% ($29.7 billion) of the total (Coelho, 2000).

Privatization was conducted differently depending upon the economic sector. Law 8,031 of 1990[10] established formal procedures for the privatization process of every sector where public enterprises existed. This law introduced legal structures not only for private acquisition of existing enterprises but also for the establishment of a variety of new private firms (Feldman, 1997), including investments in power distribution grids and transmission network.

Five years later, law 8,987 provided general rules for the process of contracting private companies to operate public assets. In the electricity sector, privatization of generation facilities, transmission grids, and distribution utilities occurred through the settlement of long-term concession contracts between the government and private firms. This law also specified the rights and obligations of concessionaries.

Concession contracts of electricity enterprises were publicly auctioned between 1995 and 2000. The NPP privatized a total of 23 state-owned firms. There was however a clear improvement on specifying contracts over time (Ferreira, 2000). As contracts were individually drafted for every public enterprise being conceded, clauses were better specified as the regulatory reform proceeded (Pinheiro & Giambiagi, 2000). In other words, because concession of state-owned electricity facilities and the restructure of formal institutions were happening simultaneously, contracts drafted at the end of the five-year period were better specified than those written at the beginning of the privatization program.

Concurrent policymaking decisions caused reluctance among potential auction buyers. Leite (2009) suggests that there was a lack of interest in public auctions because during early

[10] Feldman (1997) refers to this law as the 'Concession Law'.

stages of the electricity sector reform, high levels of market uncertainty intimidated buyers: 'auctions began before the complete definition of market regulations' (p.54). For Feldman (1997) Brazil was experiencing a paradox of simultaneous growth, represented by the necessary privatization; and inertia, associated with the lack of interest and market uncertainty.

The close relation between the National Privatization Program and the Electricity Sector Reform seems to cause confusion even among energy economists and policy makers. While Ferreira (2000) associates the three formal laws (8,031; 8,937; 9,074) with the Privatization Program, Feldman (1997) relates the first two laws with the same program and the third with the Electricity Sector Reform. Either way, it is noteworthy to observe the close relation between these programs. Regulations of the electricity sector were written taking into consideration definitions made through the laws associated with the NPP. Likewise, concession contracts were drafted based on the specific regulations as they were defined through the Electricity Sector Reform.

3.3. Electricity Sector Reform (1995-1998)

The Electricity Sector Reform (ESR) and post amendments established a market that was, until then, missing. Until 1995 market competition was not observed and all categories of electricity users could only accept products and services offered by local distribution utilities, all government-dominated. Rights and obligations of players, market regulations and mechanisms of enforcement were crafted from scratch. Incentives not only to generators but also to consumers of renewable electricity were created to diversify the electricity supply mix and to motivate entry of new power generating firms.

The Public Service law (law 9,074 of 1995) introduced the guidelines for free market competition in the electricity sector (Feldman, 1997). It formally defined electricity buyers and sellers, and their rights and obligations. Specifically, this law formalized the entity of Independent Power Producers (IPPs) just as the *Public Utility Regulatory Policies Act* did in 1978 in the United States. In addition, that law validated the entity of Independent Consumers (ICs) who can obtain 'wire' service from their local distributor and purchase power supplies directly from IPPs.

A questionable measure formalized through law 9,074 was that companies of generation, transmission, and distribution should be functionally separated or completely restructured through vertical divestiture. The measure partly meets the approach mentioned by Joskow (1996 p.361) to resolve coordination problems associated with abusive pricing strategies that could otherwise arise. Feldman (1997) suggests that a good reason for this action came from past experiences of other Latin American countries: 'a combination of reform and unbundling has resulted in a third more closing and twice as much megawatt production, as opposed to cases where the reform has not been accompanied by unbundling' (p. 5).

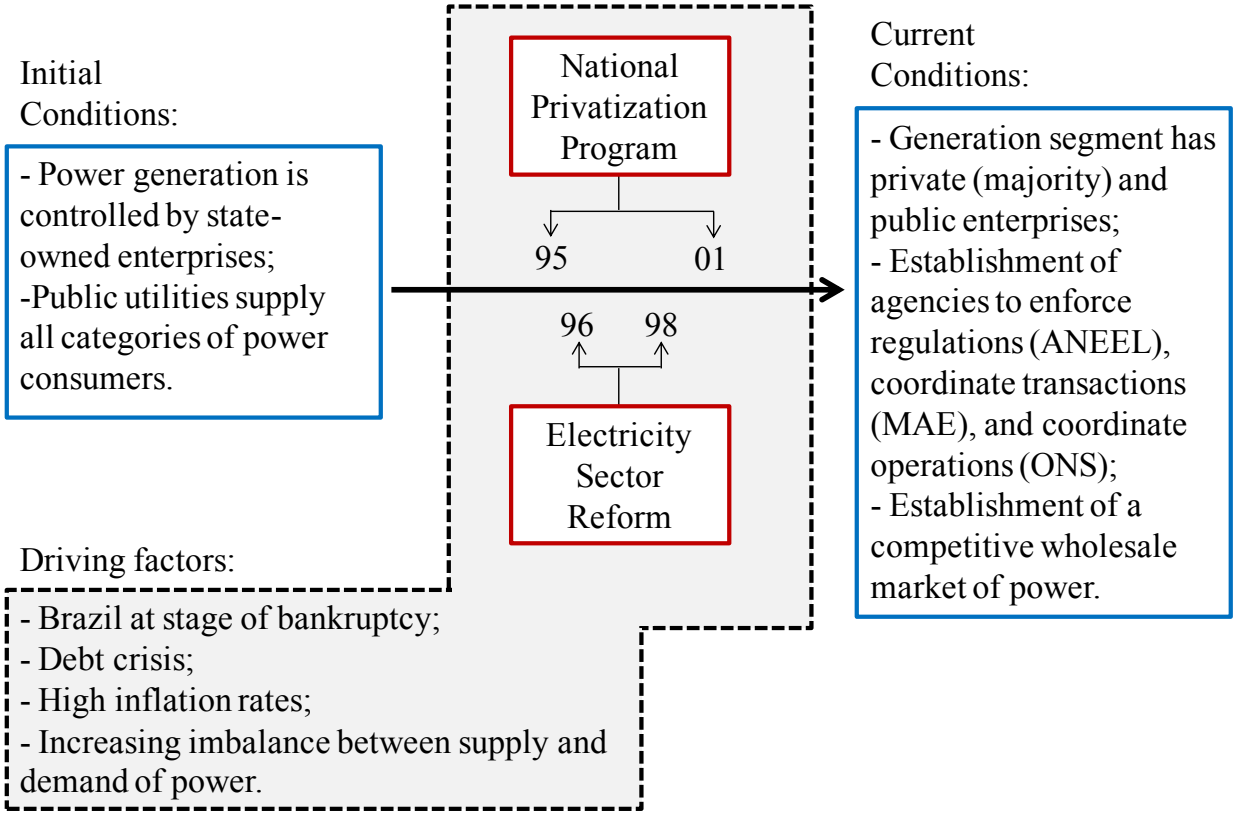
Ferreira (2000) in turn relates the measure to the situation of four state-owned companies: 'CESP, CEMIG, COPEL, and CEEE were not only responsible for 34.7% of the generation capacity in 1995 but also owned the largest assets of distribution across the country' (p.207). As the country did not intend to concede operation rights along with monopoly power to concessionaries, these four state-owned companies had their assets divided among 15 smaller companies. Some of them are still controlled by a single holding but organized under different subsidiaries (Key informant interviews, 2010).

Regulations and enforcement mechanisms were indirectly introduced with the promulgation of law 9,427 in 1996 which formalized the creation of the Electricity Regulatory Agency (ANEEL, in Portuguese). ANEEL is an autonomous regulatory agency responsible for overseeing the electricity sector and for enforcing quality protocols over generation firms, transmission utilities and distribution utilities.

Law 9,427 also defined the entity of special consumers (SCs), a sub-category of ICs who are authorized to trade renewable electricity (e.g. small hydro, biomass, solar, and wind-based) directly with IPPs and to obtain 'wire' services from the local distribution utilities. This definition marks the beginning of the renewable electricity segment, the fastest-growing segment within Brazil's electricity sector (Castro et al., 2008; Neves & Conejero, 2009). Captive consumers are also defined under this law as those consumers of power who must accept prices and conditions offered by local distributors.

The law 9,648 promulgated in 1998 established two other political bodies and introduced the first incentive to SCs. First, it formally established the Wholesale Electricity Market (MAE, in Portuguese), an agency responsible for assisting transactions among players (i.e. generating firms, distribution utilities, ICs, and SCs). Second, the law assigned the task of coordinating network operations to the National System Operator (ONS, in Portuguese). Finally, it introduced the first incentive for SCs: a 50% discount in 'wire' service rates. Figure 3 summarizes the conditions before and after the NPP and ESR; and what factors led Brazil to adopt these tools of institutional change.

Figure 3: Summary of Conditions and Driving Factors of Institutional Change



Source: Designed by the author, 2011

3.4. Later Institutional Changes

Out of the ESR scope, a set of major changes were still promulgated to formalize the specification of players and the new market design. Minor adjustments also took place after the conclusion of the ESR in order to stimulate new entry, especially in the segment of renewable electricity.

In 2000, an amendment of law 9,074 decreased the minimum load (capacity installed) required for independent consumers to trade directly with IPPs. Since then, ICs that have load of 3MW or higher have been authorized to negotiate and buy electricity from IPPs regardless of the

input used for generation. Medium-sized firms and hospitals, for instance, are compatible with these requirements and trade directly with IPPs.

Under the same amendment, the entity of SCs had specifications formalized: SCs are final consumers with load of 500 kW or more that are allowed to trade directly with IPPs as long as the input used to generate power is renewable. Shopping malls, galleries, and museums for instance can easily meet these technical requirements and be categorized as special consumers. Final consumers with load equal or less than 500kW (e.g. households, small-sized firms) are considered captive and must be supplied by local utilities. The law also re-states ANEEL regulation 264 and protects ICs and SCs rights by allowing them to accept prices and conditions offered by utilities of distribution rather than trading power themselves if they wish. Table 1 summarizes the definition of the economic agents in Brazil's electricity sector.

Table 1: Categories of Economic Agents in Brazil's Electricity Sector

Economic Agents	Description
- Utilities of generation	Concessionaries, private-owned, or government-owned firms responsible for generating power as determined by ONS.
- IPPs	Independent Power Producers. Private or public enterprises.
- Utilities of distribution	Concessionaires or government-owned firms responsible for providing services of distribution to captive consumers within a specific geographical region.
- Independent consumers (ICs)	Final-users with load of 3MW or more authorized by law to trade directly with IPPs.
- Special consumers (SCs)	Final-users with load of 500kW or more authorized to trade with IPPs based on renewable sources.
- Transmission utilities	Concessionaries and private companies responsible for transporting high voltage power from generating plants to utility-managed substations.
- Captive consumers	Final-users of electricity with load less than 500kW; Final-users with higher load who deliberately want to be provided by distribution utilities.

With the definition of economic agents in place, an additional rule was still necessary to complete the reformulation of institutions governing the electricity sector. The regulation 5,163 of 2004 played this role and formalized the marketplace as it currently is. The regulation has designed a dual-channel market in which utilities of distribution are enforced to purchase power through auctions, and the resulting mode of governance must be specification contract[11]. The same regulation has allowed ICs and SCs to coordinate transactions under a free channel using any governance strategy except spot markets. Also in 2004, CCEE (Chamber of Electrical Energy Commercialization) replaced MAE[12] with the mission of coordinating the dual-channel market defined through regulation 5,163.

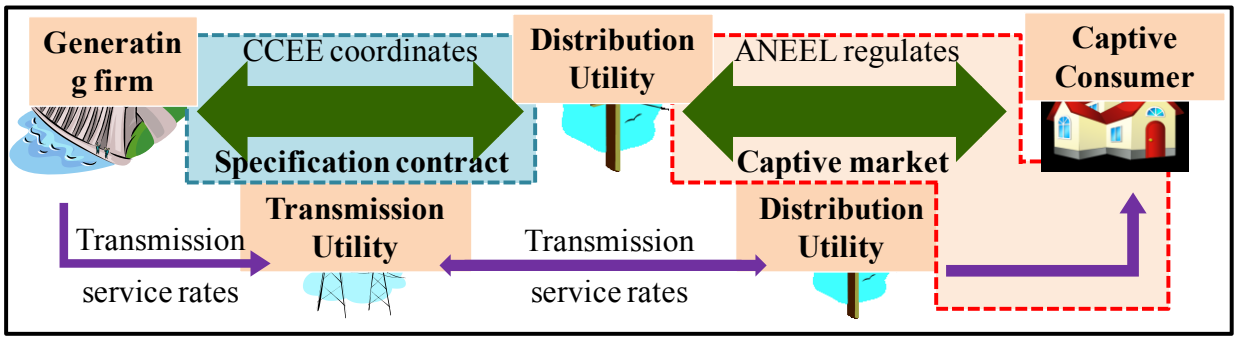
Figure 4 below summarizes the organization of both regulated channel and free channel. It highlights transactions (green arrows) between generating firms, utilities of distribution, and consumers of electricity. Blue-shaded boxes represent wholesale markets whereas the red-shaded box corresponds to captive markets. Purple arrows represent the flow of electricity.

[11] Other governance strategies are allowed but limited to small shares of their load.

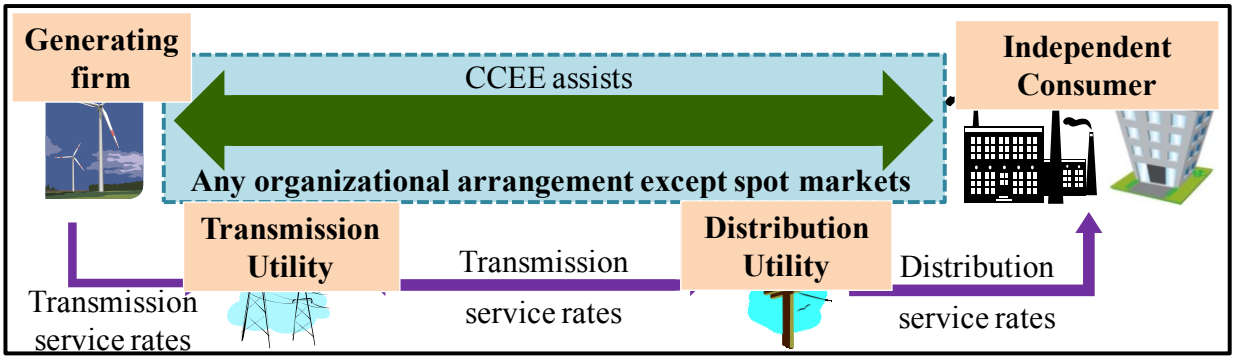
[12] Promulgated through law 10,848 of 2004.

Figure 4: The Dual-Channel Market of Power

▪ Regulated Market Channel:



▪ Free Market Channel:



Source: Designed by the author, 2011

The long history of blackouts and power outages led Brazil's government to establish Energy Research Corporation (EPE, in Portuguese), an auxiliary organization whose main role is to monitor the country's energy supply and demand from a strategic standpoint and to develop long-term planning[13]. Except for the latter, all agencies are subordinated to the Ministry of Mines and Energy (MME).

Minor institutional adjustments were also implemented in order to stimulate production and consumption of renewable electricity. The ANEEL regulation 281 expanded the discount in 'wire' service rates to IPPs: utilities of generation based on renewable sources that were

[13] Promulgated through law 10,847 of 2004.

established before 2004 receive a full exception in the service rate. The law 10,438 of 2002 expanded the stimulus even further and partially released renewables-based IPPs established after 2004 from paying the whole 'wire' service rate. Still, the law 9,991 of 2000 eliminated the R&D tax that biomass-, wind-, and small scale hydro-based generating firms had to pay.

Between 2002 and 2003 a national scale program took place to promote production of renewable electricity and solve the historical imbalance of supply and demand of power (that date from 1990s). The National Program of Incentives for Alternative Electricity Sources (*Proinfa*, in Portuguese) supported the construction of 63 small hydropower mills, 52 windmills, and 27 biomass-based generators with a total of 3,299MW (2.7% of the current capacity of generation). Financial and marketing advantages were given to Proinfa investors: (i) financial support of up to 70% of the total investment cost; (ii) reduced interest rates; (iii) acquisition of production guaranteed; and (iv) minimum price guarantee for the following 20 years. With the end of Proinfa in 2003, the Brazilian Development Bank (BNDES, in Portuguese) created a new line of credit that has provided similar benefits, except for the acquisition and minimum prices guarantee. Table 2 summarizes the laws and amendments related to the redefinition of formal institutions governing the electricity sector in Brazil.

Table 2: Laws and Amendments Related to the Formal Institutions of Electricity in Brazil

Law/Rule	**Year**	**Details**
8,031	1990	- National Privatization Plan (NPP).
8,987	1995	- Rights and Obligations of conceded companies.
9,074	1995	- Definition of independent power producer (IPP); - Definition of independent consumers (ICs); - Unbundling of generation, transmission and distribution segments.
9,427	1996	- Establishment of ANEEL; - Definition of special consumers (SCs).
9,648	1998	- Establishment of Wholesale Electricity Market (MAE); - Definition of ONS functions; - Creation of 50% discount in 'wire' rates for special consumers.
ANEEL 264	1998	- Independent consumers and special consumers may deliberately accept conditions imposed by distribution utilities and stay under captive markets.
ANEEL 281	1999	- Removal of 'wire' rates charged from IPPs based on alternative sources that become operational before 2004.
Amendment of law 9,074	2000	- Redefinition of independent consumers.
9,991	2000	- Elimination of R&D tax from biomass, wind, and small hydropower based firms.
10,438	2002	- Launch of *Proinfa*; - Extension of the 50% discount on 'wire' rates to IPPs based on alternative sources that become operational after 2004.
10,847	2004	- Establishment of Electricity Research Company (EPE).
10,848	2004	- Establishment of CCEE.
Reg. 5,163	2004	- Definition of the current market design: creation of the regulated contracting channel, free contracting channel, and imbalance market.

Multiple sources: CCEE website (2011), ANEEL website (2011), National Constitution.

3.5. Organization of the Dual-Channel Wholesale Market of Power

With the historical review of institutions and institutional change in place, the current organization of the wholesale market of power can be presented further. Figure 4 above summarizes the regulated channel and the free channel of power. As mentioned, blue-shaded boxes represent wholesale markets whereas the red-shaded box corresponds to captive markets. Regardless of the channel used for trading, all wholesale market players must liquidate positions in the imbalance market at the end of every month. Transactions conducted through the (i) regulated market channel, (ii) free market channel, and (iii) imbalance market are described separately below.

3.5.1. Regulated Market Channel

In the regulated channel, transactions between generating firms and distribution utilities are conducted through least-price auctions and are formalized as specification contracts. CCEE is the regulatory agency responsible for coordinating these auctions where contracts are pre-defined and parties to trade are left to bid prices under a competitive environment. Market experts name these auctions as ‘auctions of ordinary supply’ because they supply the largest share of power demanded by utilities of distribution.

Least-price auctions of ordinary supply are subdivided into two groups depending on whether the generating plant (seller) is an operating facility or new enterprises. Auctions with operating facilities are held one year before the actual supply. Auctions with new enterprises are held three or five years in advance with the objective of ‘allowing investors to better plan

financial flows and return on investments' (Key informant interviews, 2010). Nevertheless, contracts resulting from this category of auction often last three years or more.

There are two other categories of auction: adjustment and backup. Auctions of adjustment allow utilities that overestimated captive demand to transfer rights of future consumption to other distribution utilities that underestimated it. Transactions are conducted via best-price auctions and distribution utilities are both buyers and sellers. These auctions take place a few months before the transference rights but can happen multiple times while contracts of ordinary supply are valid. Contracts resulting from auctions of adjustment last less than one year.

Auctions of backup are exclusively used for contracting backup facilities. These facilities are left at ONS's disposition, which in turn activates them in the case of imbalance between immediate supply and demand. No different from the auctions of ordinary supply, specification contracts are *ex ante* determined and parties bid prices through least-price auctions. Table 3 summarizes auction types in the regulated market channel.

Table 3: Summary of Auctions in the Regulated Market Channel

Auctions		**Time before supply**	**Duration of contracts**
Ordinary supply	- Operating facilities	one year ahead	3 to 8 years
	- New facilities	3 or 5 years ahead	15 to 30 years
Adjustment		few months	one year or less
Backup		one year ahead	usually 15 years

Regulated transactions unfold as follows: distribution utilities forecast captive power demand in their designated area and communicate with CCEE; CCEE combines the demand of multiple distributors and following the merit-of-order approach, solicits generating firms to subscribe to the auction of ordinary supply; CCEE moves forward with the auction organization

when the number of subscriptions is large enough so the aggregate demand falls below the potential aggregate supply; CCEE drafts specification contracts and makes them available to auction participants; generators are provided with some time to review the contract and to modify their bid size (complete withdrawal is possible at this stage); when the given time expires, the remaining generating firms can only bid at the auction (withdrawal is no longer possible); the least-price auction occurs; winning bidders are those generators that offer the least price per megawatt hour (MWh) to partly supply the aggregate demand; specification contracts are formalized among all winners and utilities; supply starts.

Merit-of-order is the approach used for soliciting participation of generating firms to subscribe to auctions. The method guides CCEE to invite generating firms based on the average production costs, from the lowest to the highest, until the potential aggregate supply covers distributors demand. Following this approach, CCEE ends up soliciting participation to large scale hydropower plants more often than any other source or technology of generation. Estimations suggest that large scale hydropower plants supply approximately 56% of the power distributed to captive consumers. For the same reason, IPPs are more frequently left to trade power in the free channel. That, however, does not rule out the ability of IPPs to trade through the regulated market channel but to do so CCEE must solicit their participation.

As specification contracts evolve, distribution utilities are required to periodically report to ANEEL the actual amount of power delivered to captive consumers. In cases of mismatch between power acquired and power delivered, the regulatory framework authorizes utilities of distribution to engage in auctions of adjustment, also organized by CCEE. Although utilities can trade up to 1% of their captive market loads, auctions of adjustment are interpreted as tool for minimizing price risk at monthly imbalance market (Key informant interviews, 2011).

As contracts evolve ANEEL also compares gross profit margins across utilities. Specifically, ANEEL estimates margins based on wholesale prices of power at which utilities of distribution acquire power and the retail prices at which distributors resell to captive consumers. This study is periodically conducted for all concessionaries and government-owned distributors whose gross profit margins are cross-compared to control for unilateral market power.

3.5.2. Free Market Channel

The current institutions set ICs, SCs and IPPs partly free to adopt governance strategies in the free channel, except spot markets. CCEE only requires parties to report the amount of power transacted in order to guarantee network reliability and to enforce liquidation of positions at the end of every month through the imbalance market. Price need not be reported and can be used as strategic information for future transactions.

Other than ruling out spot markets as alternative governance, CCEE does not impose any additional restriction to wholesale transactions in the free channel. Higher autonomy, however, comes with the costs of procuring counterparties, negotiating and drafting contracts, establishing controlling measures, and monitoring performance as transactions unfold. Some free channel players, nevertheless, receive incentives (i.e. tax exemptions) that partly offset those transaction costs. The current regulatory framework states that SCs and generating firms based on renewable inputs are entitled to receive incentives whereas ICs and generating firms based on non-renewables are not and must incur those costs themselves.

Transactions coordinated through the free channel account for 26% of the annual electricity consumed in Brazil (EPE, 2011). Very often ICs and SCs hire assistance from

consulting companies to intermediate negotiations with IPPs due to their little understanding of the 'rules of the game'. These consulting companies often represent free consumers at CCEE.

3.5.3. Imbalance Market

Regardless of the market channel used to trade, both buyers and sellers must liquidate positions at the end of every month[14]. Consumers must match electricity acquired to electricity consumed. Likewise, sellers must meet electricity sold with electricity generated in the imbalance market. CCEE coordinates these transactions and imposes penalties in case of non-liquidation. Joskow (1996 p.360) mentions that the liquidation of imbalances is an essential part of any credible competition model.

Market players liquidate positions by accepting market-clearing prices defined by CCEE. Holders of short positions are requested to purchase additional shares of electricity at market-clearing prices. Holders of long position are credited with the difference (electricity acquired minus electricity consumed or, electricity generated minus electricity sold) at the same clearing prices.

Market-clearing prices are based on the marginal cost of generation (or average generation cost of backup power) per subsystem. These prices result from two sequential stochastic models: *Newave*[15] and *Decomp*. Specifically, ONS runs a stochastic dual dynamic programming model (*Newave*) to optimize reservoir storage and to schedule dispatches of backup generators taking into consideration uncertainties of water inflow and demand of power

[14] In the US electricity market, the imbalance liquidation follows the same rule but with different temporal granularity: if a seller generates less than its day-ahead schedule, then it must purchase the difference between this day-ahead schedule and its actual generation from the real-time market at the real-time price. The same rule applies for consumers.

[15] For more details, please refer to Pereira & Pinto (1991).

(reported by distribution utilities). Sequentially, using the estimates of *Newave* and a set of technical variables as inputs, the ONS runs another dynamic optimization model (*Decomp*) to match generation and demand and to determine the marginal costs of generation per subsystem. The marginal costs are then released to wholesale players as market-clearing prices.

3.6. Implications of the Institutional Changes

The NPP, ESR and later adjustments have intensively modified the industry structure as well as the opportunity set for economic agents. For instance, incentives (i.e. discounts in 'wire' service and R&D rates, and *Proinfa*) have stimulated the entry of numerous generating plants. As of 2012, there are 387 small hydropower plants, 459 biomass-based plants, and 96 windmills in operation that were not generating power before the institutional change. These power plants are mostly classified as IPPs and participate with approximately 13% of the total capacity of generation in the country.

As result of the second institutional reform – toward market economy; the entry of renewable electricity generators has not only diversified the electricity mix but also decreased oil dependence for electricity production in the country (Castro et al., 2008). Previously, large scale hydropower plants dominated the segment with more than 80% of the generation capacity. As of 2012, there are 178 large scale hydropower plants in operation that account for approximately 67% of the total capacity installed (ANEEL, 2012). Besides, numbers indicate that diesel fuel-fired plants represent no more than 3% of the country's power supply.

Incentives along with the dual-market design also motivated the entry of free channel players. There are approximately 587 ICs and 967 SCs trading electricity through the free

channel with demand of 982 TWh and 134 TWh per year, respectively (CCEE, 2012). It is noteworthy to remember that this segment of consumers was absent before 1995, and the only alternative available for final consumers of electricity was to accept prices and services offered by local utilities of distribution.

Commentators argue, however, that free consumers (ICs and SCs) might be exposed to additional procurement costs in the free channel as they need to identify counterparties, draft agreements and safeguards, monitor agreement performance, and so on. On the other hand, industry experts reply that 'incentives not only offset procurement cost but also create marginal benefits for consuming renewable electricity' (Key informant interviews, 2010).

In this sense the second institutional reform has created opportunities for some consumers to acquire more affordable electricity. By trading directly with power suppliers, free consumers are able to alleviate unnecessary expenses that would be intrinsic to retail prices otherwise (i.e. margin of the utility and related transaction costs). This interpretation seems to be aligned with the existing NIE theory: economic development happens as institutional reforms lessen transaction costs.

To a lesser extent, the same is true for captive consumers (i.e. those with capacity of consumption of 500 kW or less) who can only accept prices and conditions imposed by local utilities of distribution. Households, a likely type of captive consumer, would be harmed if utilities exercised unilateral market power in their conceded geographical area. To minimize the probability of such harm, the institutional reform has established enforcement organizations that play pivotal roles in regulating retail prices and services. Specifically, CCEE organizes competitive-oriented auctions through which utilities must acquire the largest share of their aggregate demand; ANEEL estimates profit margins based on retail prices and auction prices;

ANEEL compares those margins across all operating utilities in order to ensure that profits fall within a feasible range; also, ANEEL imposes operation standards so the service offered to captive consumers has a certain level of quality and reliability.

Those regulatory activities certainly generate transaction costs to captive consumers that were absent before the NPP and ESR, tools of the second institutional reform. However, one might plausibly argue that such costs are consistently inferior to the costs associated with power outages and blackouts frequently experienced across the country in 1990s. Besides, one would also argue that these transaction costs are lower than unilateral market prices that would have been charged to captive consumers if the institutional reform had not established regulatory agencies. Therefore, the institutional reform has positively affected performance of Brazil's electricity sector by lessening transaction cost to final consumers.

Interestingly enough, this latter implication appears to be aligned with structural reforms implemented in several other countries worldwide (Joskow, 1996). It also corroborates with Shirley (2005 p.611) when she suggests that economic development occurs only if the institutional framework protects firms and citizens against expropriation of rents, and fosters exchange by lowering transaction costs.

Discussions follow an opposite path as one attempts to analyze the results of the first institutional change – toward market protection. Due to high levels of uncertainty and worldwide instability after the Great Depression of 1929, government's decision forced private utilities to exit Brazil's electricity sector. Sequentially, a sequence of economic shocks and poor financial strategies not only threw the country into recession but also resulted in frequent power outages in the 1990s. The first institutional reform therefore failed to protect firms and citizens against

expropriation of rents and also failed to reduce transaction costs; the two necessary conditions for economic growth (Shirley, 2005).

3.7. Conclusions

The overall purpose of this chapter was to expand the empirical literature of institutional evolution. Specific objectives were: (i) to review the causes and implications of institutional reforms in a developing country; and (ii) to provide empirical evidence on how dramatic, rather than marginal, institutional change occurs.

Different from earlier studies, which have adeptly analyzed cases of marginal institutional increment, this chapter focused on a case of dramatic institutional change. Brazil's electricity sector provided an interesting case to review because it experienced two dramatic institutional changes in less than a century – the first toward government centralization and the second toward market economy. A comprehensive review of historical facts indicates causes and means for institutional change that had not been observed in earlier work. Specifically, the first dramatic institutional change was motivated by 'high levels of worldwide uncertainty'; whereas the second institutional reform was influenced by 'economic recession' (Brazil at stage of bankruptcy, debt crisis, and high inflation rates) and 'reliability of utility services'. These factors may be combined and classified as 'economic performance' in order to maintain the same degree of generality that scholars have used elsewhere.

Results also indicate that the first institutional change failed to satisfy two conditions for economic growth, as mentioned by Shirley (2005). The first dramatic reform not only forced private companies to exit Brazil – due to their inability to reach expected returns in a government

controlled environment – but also exposed citizens to frequent power outages – forcing business to incur additional transaction costs. Conversely, the second institutional reform re-established balance between supply and demand of power, created a favorable environment for medium and large firms to acquire power at low costs, and permitted diversification of the supply mix through the entry of generating firms based on renewable sources. Thus, the second institutional reform appears to have met the necessary conditions (Shirley, 2005) for economic development.

There were a few limitations that we could not overcome. Ideally, one would like to estimate and compare social, economic, and environmental conditions before the institutional change to conditions thereafter. In that way the effects of the institutional change could be estimated, or at least, correlated to the social-economic growth and progress in environmental protection. As this chapter covered a reasonably long time horizon, data has proven to be absent or of hard access. Specific employment data and GHG emissions data for Brazil's electricity sector, for instance, appear not to be available.

4. ATTRIBUTES OF TRANSACTION, GOVERNANCE STRATEGIES, AND MARKET PERFORMANCE

The institutional change conducted through the NPP and ESR has set the stage for a rich analysis. Activities of defining players, structuring market channels, establishing regulatory agencies, and creating incentives for renewable power were undertaken with the ultimate goal of substituting the former state-dominated structure and creating a competitive-oriented wholesale environment. Under the new circumstances discussed in chapter 3, a reasonable question arises: do current institutions direct wholesale market players to adopt the most efficient governance strategy in the sense of minimizing the sum of production and transaction costs?

This chapter attempts to answer the question by examining wholesale transactions – those represented as green arrows within blue shaded boxes in figure 4 – using the classic TCE framework. For every representative transaction, the underlying attributes (i.e. uncertainty, complexity, asset-specificity, and frequency) are analyzed and discretely categorized to allow comparative assessment across alternative strategies. Results indicate that not only institutions but other factors (e.g. existence of compatible partners, capital availability (Peterson et al., 2001), and reputation (Masten, 1996)) also prevent certain transactions from utilizing what seems to be the most efficient governance strategy. In sections three and four of this chapter we discuss about the reasons that have caused frequent misalignments between the TCE predicted strategies – or the most efficient governance strategies – and the strategies observed in Brazil's wholesale power market.

The next two sections of this chapter analyze in-depth seven representative transactions distributed between the regulated market channel and the free market channel.

4.1. Wholesale Transactions in the Regulated Market Channel

Wholesale transactions in the regulated market channel require utilities of distribution as purchasers of power. Sellers can be large scale hydropower plants, biomass-based generating plants, windmills, small scale hydropower stations, natural gas burning plants, and diesel fuel burning plants. The underlying attributes of transaction between large scale hydropower plants and utilities are analyzed below followed by transactions between biomass-based generating plants and utilities, windmills and utilities, and diesel fuel burning plants and utilities. Transactions between small scale hydropower plants and utilities and transactions between natural gas burning plants and utilities are deliberately left out of our analysis as they carry similar characteristics; and consequently, lead to insights similar to those obtained through analyzing transactions between windmills and utilities and transactions between diesel fuel burning plants and utilities, respectively.

a) Transactions between large scale hydropower plants and utilities of distribution

The first and most important set of wholesale transactions in the regulated channel has large scale hydropower plants and utilities of distribution as protagonists. Transactions between these parties represent approximately 56% of the electricity flow in the regulated channel (CCEE, 2012). From one side of the transaction, utilities must ensure stable supply of power to captive consumers located in their conceded region. From the other, hydropower plants seek to optimize generating operations without exposing idiosyncratic assets to expropriation of quasi-rents.

Uncertainty is the first attribute that affects decisions made at those firms. Weather conditions are, for instance, a source of uncertainty affecting operational decisions at large scale hydropower plants. Weather not only affects water flows but also decisions regarding reservoir management. On the other end, utilities of distribution have little certainty regarding electricity consumption in captive markets; mainly because those markets are composed of numerous end consumers with distinct characteristics (i.e. preferred voltage, seasonality of consumption, mobility from and to the free channel).

Despite the sources of uncertainty, decision makers at large scale hydropower plants and utilities of distribution face low exposure to uncertainty. As defined in the institutional framework, the National System Operator (ONS) coordinates water flow at large scale hydropower plants and activates backup facilities when there are expected shortages in supply or sudden rises in demand. As a result, ONS centralizes operations of water flow and exempts managers at large scale hydropower plants from responsibilities on power outages that poor reservoir management might cause.

Decision makers at utilities of distribution also face reduced exposure to uncertainty as a result of activities undertaken by regulatory agencies. Institutions of electricity dictate that distributors must periodically forecast power demand in their captive markets. Because such activity may produce outcomes with different time granularity, time horizon, units of measurement and so forth; ANEEL provides directives so utilities perform standardized forecasting analysis. The directives help utilities develop sophisticated models (in order to provide ANEEL and ONS with a certain set of outputs), which lead to accurate estimates. In addition, situations in which utilities of distribution receive direct assistance from ANEEL to

predict future power consumption of captive markets are not unusual (Key informant interviews, 2010).

To decrease uncertainty of demand even further CCEE authorizes utilities to trade future rights of consumption through 'auctions of adjustment'. Utilities that overestimated captive demand and acquired more rights of power consumption than captive consumers truly demand may trade up to 1% of those rights with utilities that underestimated demand in their service areas. In that sense, 'auctions of adjustment' can be interpreted as another tool for decreasing uncertainty of demand and price risk at the imbalance market.

Complexity is also reduced as regulatory agencies decrease the level of vulnerability to which large scale hydropower plants and utilities of distribution are exposed. Specifically, trading parties accept contract specification pre-determined by CCEE as well as its monitoring and enforcing activities. Monitoring activities can easily detect opportunism of either party since CCEE is fully informed about contract specifications, and rights & obligations of traders. Enforcement takes shape of severe fines if any party deviates from meeting *ex ante* specifications. Market participants suggest that even if market conditions change and contracts fall out of the self-enforcing range (Klein, 1996), CCEE is in a good position – in terms of information access – to adjust regulated contracts and decrease probability of opportunistic behavior (Key informant interviews, 2010). Hence, complexity of transactions between large scale hydropower plants and utilities is low.

The next attribute to be considered is idiosyncrasy of productive assets. Large scale hydropower plants have high degrees of asset specificity for three reasons. First, a switch from the first to the second best use[16] is likely to cause costly expropriation of quasi-rents. In other

[16] Footnote 4 (page22) applies here.

words, the fact of discontinuing generation of electricity for a few days, until a new transaction is formalized, may represent onerous costs to the generating firm. Not to mention the cost of turning water turbines back on after a sudden shut down may reach prohibitive levels (Key informant interviews, 2010).

Second, evidence of dedicated assets can be extracted from the news. Belo Monte for instance, a large scale dam under construction in the margins of Xingu River had future rights of supply auctioned on April of 2010 (five years prior to expected operation). Translating that to applied TCE, Belo Monte has been built to fulfill a specification contract previously settled through a regulated auction, which allows us to categorize such investment as transaction-specific investment. This observation seems to agree with Carroll et al. (1999 p.79) where the authors suggest that regulated power generators are unlikely to invest in highly specific assets without either very high up-front rents or assurances that once invested rents will not be expropriated. Besides, market participants argue that 'Belo Monte dam would not have been built if the sale contract had not been signed beforehand or if the contract had not been enforced by CCEE (Key informant interviews, 2010).

Third, maturity of financing projects is also a factor influencing specificity of generation assets. Two plausible assumptions are made here in support of our argument: (i) investments in large scale hydropower plants tend to require financial support due to the magnitude of the projects; (ii) a financed generating power plant has no further obligation with the lending organization after the end of its first commercial agreement.

The former assumption can be justified since investments are expensive and firms are not likely to undertake them without contracting loans from either BNDES or other private lending organization. Moreover, evidence in Brazil's electricity market supports this assumption. Belo

Monte plant, the same example used above, has relied on multiple funding sources including BNDES and private lending banks (BNDES, 2012).

The latter assumption is plausible because lending organizations may lend at reasonable rates only if the borrower guarantees its engagement in productive activities that will generate enough returns to repay loans and interests for the duration of the project. Consequently, when the first commercial agreement ends and a given power generating firm seeks a new partnership, it is likely that the firm has fully paid loans and interests back to the initial lender.

The argument here is that lending organizations often require investors to ensure repayment of loan shares plus interests at every agreed period of time. The guarantee in turn takes the shape of unrelated durable goods or partial appropriation of the investment made. If the commercial agreement is breached and the investor is forced to redeploy his or her assets, the next best use will sacrifice a large productive value as the lending organization may claim partial possession over the investment or over the durable goods previously put as guarantee. It is the same as saying that financed investments face appropriable quasi-rents that represent not only the potential costs of redeploying assets to the next best alternative but also the latent loss of capital put as guarantee to the lending organization.

Hence, large scale hydropower plants have high degrees of asset specificity that are supported by the fact that (i) reallocation of assets from the first to the second best use is costly; (ii) some large scale hydropower plants are categorized as dedicated assets; and (iii) financed investments are likely to incur additional expropriation of quasi-rents in case of *ex post* breach.

Finally, frequency of transaction is the last attribute of Williamson's framework. It is plausible to argue that electricity is a good of continuous generation and continuous consumption, which imply very high frequency of transaction. That is likely to be true regardless

of the technology or market channel used in its generation or transaction. Thus, frequency provides little insight about potential differences of governance strategies across transactions. For this reason we will give little attention to frequency as we analyze other transactions.

Based on low exposure to uncertainty, low level of complexity, high degrees of asset-specificity, and very high frequency of transactions, the classic TCE theory plausibly predicts specification contract as the most efficient governance strategy. Although some commentators may find this result controversial due to the high degree of idiosyncrasy, specification contract suffices because uncertainty and complexity are issues of little concern to decision makers. Alternatively, higher levels of involvement (i.e. alliance structures or vertical integration) in which parties share risks and benefits in order to strengthen controlling activities may not be necessary as ANEEL and CCEE provide intensive monitoring actions and punishments schemes.

However, it is noteworthy to mention that specification contract is imposed over transactions between large scale hydropower plants and utilities rather than a choice made by the parties. In that sense an intriguing question arises: If predicted and observed governance strategies are aligned, why does the institutional framework bind strategic decisions of firms? In other words, why do institutions prevent trading parties from freely making strategic decisions if the most efficient strategy – and most likely to be chosen – is the same as the one desired by policymakers? We shall return to these questions below.

b) Transactions between biomass-based generating plants and utilities of distribution

Transactions between biomass-based generators and utilities represent approximately 1% of wholesale electricity sales in the regulated channel (CCEE, 2012). Not different from the transactions analyzed above, utilities are responsible for ensuring stable power supply to captive

consumers and are closely monitored by regulatory agencies. Biomass-based plants, on the other hand, minimize the sum of production and transaction costs and safeguard specific assets against opportunistic behavior in order to optimize profits.

While utilities of distribution continue to receive assistance from ANEEL and CCEE, managers at biomass-based power generators have to cope with uncertainty exposure without counting on ONS operations. Quantity and quality of sugarcane biomass, for instance, are likely to vary across growing seasons which may in turn affect electricity generation (Key informant interviews, 2010). The variation in input quantity and quality is nevertheless less significant here than it is at windmills or small scale hydropower plants. Therefore uncertainty can be categorized as moderate for this transaction.

Market experts suggest that ONS centralizes operations at large scale hydropower plants but let other generating firms, such as biomass-based generators, cope with uncertainty of supply for two reasons: (i) unexpected defects at large scale hydropower plants might put the entire national grid at risk if ONS did not centralize operations in order to improve managerial efficiency; (ii) the network is conversely more resilient to technical flaws at independent biomass-based generators whose contracts represent smaller shares of supply (Key informant interviews, 2010). For these reasons, managers at biomass-based generating plants – as well as windmills and diesel fuel burning plants – are fully responsible for meeting obligations settled through regulated partnerships.

Complexity levels can be categorized as low because of the same reasons suggested above. CCEE defines *ex ante* detailed contracts for transactions between biomass-based generators and utilities, which increases task programmability and decreases vulnerability to opportunism. Besides, ANEEL's monitoring actions and CCEE's enforcing schemes also

decrease probability of opportunistic behavior of counterparties, leading to low levels of complexity.

Following with asset-specificity, the third attribute of transaction in Williamson's framework, biomass-based generators are often categorized as having moderate to high degrees of idiosyncrasy. The large variety of biomass-based residuals used for power generation imposes meticulous specification of equipments, which in turn imply physical specificity. Material density, granularity, moisture content, and temporal availability of inputs are some of the technical factors affecting specificity (Key informant interviews, 2010).

Investments in biomass-based generators are also site-specific due to the real purpose of the investments. Sugar & ethanol manufacturing plants, for instance, generate power based on bagasse – a residue of the sugarcane plant – in order to meet facilities' electricity demand. The same reason leads orange juice producers and rice processors to use orange peel and rice shells, respectively. These generating plants are often located next to the facility where the core business takes place in order to minimize transportation and inventory costs of residues. Using Williamson's terminology, these biomass-based generating plants are in a "cheek-by-jowl" relation with the core business plants, which implies site specificity.

Redeployment to alternative uses, however, is likely to sacrifice lower productive value when compared to large scale hydropower plants for two plausible reasons. First, electricity generation is a complementary activity to the core business; and second, there is a thick market for biomass-based generating equipment. Although power generating equipments tend to be designed for a specific plant, experts mention that adjustments might make redeployment possible (Key informant interviews, 2010). The same is not true for large scale hydropower

plants because of the unique landscape and geological configuration of dams. Therefore, biomass-based generating plants have moderate to high degrees of asset specificity.

Transactions between biomass-based generating firms and utilities of distribution are thus characterized with moderate exposure to uncertainty, low level of complexity, moderate to high degree of asset-specificity, and high frequency. Based on these attributes, classic TCE framework would predict that a strategic alliance would suffice to minimize the sum of production and transaction costs as well as safeguard specific assets. Such prediction is plausible because decision makers might be willing to align moderate uncertainty exposure to their risk aversion profiles without having to intensify control. Besides, decision makers understand that assets with moderate to high degree of idiosyncrasy are already safeguarded against expropriation of quasi-rents through activities undertaken by regulatory agencies.

Reality, however, indicates a mismatch between predicted and adopted strategies. Biomass-based generators and utilities of distribution are bounded by the institutional framework and forced to adopt specification contracts to govern transactions rather than a more efficient alliance. A natural question therefore is why the institutional framework seems to block biomass-based plants and distributors from reaching higher levels of transaction efficiency. Further discussion follows the analyses of the remaining transactions.

c) Transactions between windmills/small scale hydropower plants and utilities of distribution

Windmills and small scale hydropower plants together represent 3.1% of the electricity flow in the regulated market channel (CCEE, 2012). Because of numerous similarities between these sources, our analysis examines transactions between windmills and utilities of distribution

only. The results and arguments used here fit well and also represent transactions between small scale hydropower plants and utilities of distribution.

As briefly mentioned above windmills and small scale hydropower plants are more exposed to uncertainty of supply than large scale hydropower plants or biomass-based generators. The reason is primarily associated with the inability of managers at windmills to predict availability of input for power generation. Besides, ONS does not extend its assistance on operations management to windmills as it does to large scale hydropower plants, making managers at those plants responsible for meeting contractual obligations. Utilities of distribution though, continue to face reduced exposure to uncertainty since ANEEL assists managers forecasting power demand and CCEE holds auctions of adjustment, which allows utilities to transfer rights of power consumption. Thus, windmills and utilities of distribution must cope with moderate to high levels of uncertainty.

Complexity follows the same pattern discussed above: it tends to increase with the level of vulnerability to opportunism. But windmills and utilities of distribution simply rely on third party enforcers (i.e. ANEEL and CCEE) to minimize the probability of opportunism to occur at the cost of having to agree on pre-determined contract terms. In that sense, transactions between windmills and utilities have low levels of complexity due to monitoring activities and punishments imposed over deviants.

In regard to asset-specificity, windmills are designed to optimize power generation as a function of wind-energy resources available in a given region. The aerodynamic design of blades, gearbox, generator, and tower height for instance must be precisely built to meet specific characteristics of a given area. Experts suggest that re-dimensioning existing windmills to meet characteristics of an alternative site is possible; however, real generation would fall far below the

installed capacity since certain features of the new location were not considered in the original technical project (Key informant interviews, 2010). Hence, windmills characterize a type of specific physical asset.

But the reason pushing windmills to a higher degree of idiosyncrasy when compared to biomass-based generating plants has yet to be mentioned. Differently from biomass-based generators, power generation is the primary business at windmills which would lead to higher production loss in case of redeployment. In other words, redeploying a wind-based plant from the most suitable to an alternative use would keep its assets idle for a reasonably long time (e.g. time necessary to draft a new contract, time needed for technical adjustments) which can be easily interpreted as a period of continuous productive loss. At biomass-based generating plants, however, the core business (e.g. sugar & ethanol production, orange juice manufacture) would stay in operation even if power contracts had to be renegotiated, leading to lower productive losses. For that reason, asset-specificity tends to be higher at windmills than at biomass-based generating plants.

With moderate to high level of uncertainty, low level of complexity, high degree of asset-specificity, and very high frequency of transactions the classic TCE framework would predict that a strategic alliance lead to superior efficiency. That can be plausibly argued because an alliance structure would give autonomy for firms to mutually share exposure to uncertainty based on risk aversion profiles. Alternatively, more integrated governance structures (i.e. vertical integration) might lead to inefficient outcomes because activities undertaken by ANEEL and CCEE are already safeguarding assets with high degree of specificity and reducing probability of opportunism through strict monitoring schemes and punishments. Toward the left side of the governance continuum, specification contract might not create enough involvement between

parties so they can indentify mutual objectives and consequently, share risks and benefits from the transaction.

Nevertheless, the institutional framework prevents decision makers from adopting what seems to be a superior governance strategy and dictates that specification contract must be adopted instead. Discussion on why the institutional framework prevents firms from adopting a strategy that optimizes efficiency follows below.

d) Transactions between diesel fuel/natural gas burning plants and utilities of distribution

Transactions between utilities of distribution and diesel fuel burning plants or natural gas powered plants represent together 40% of the electricity flow in the regulated channel (CCEE, 2012). This analysis focuses on transactions in which diesel fuel burning plants are the sellers. As mentioned above, the results obtained here can be extrapolated to transactions between natural gas burning plants and utilities.

Uncertainty, the first underlying attribute in the classic TCE framework, can be classified as of low importance for two reasons. First, utilities of distribution continue to receive assistance from ANEEL and CCEE in order to cope with uncertainties of demand. Specifically, ANEEL provides sophisticated models for power demand forecasting and CCEE organizes auctions for utilities to trade future rights of power consumption. Second, diesel fuel is widely and consistently available across the country, which reduces uncertainty of supply. Although managers at these generating plants are responsible for coping with uncertainty and cannot rely on ONS to coordinate operational activities – as it is the case for large scale hydropower plants – stable supply of diesel fuel reduces uncertainty to an issue of little concern.

In concordance to the analyses conducted above, transactions between diesel fuel power plants and utilities of distribution are also of low complexity. Monitoring activities and punishment mechanisms strictly enforced by ANEEL and CCEE decrease the probability of rent expropriation due to opportunism of counterparties. As result, trading parties face low levels of vulnerability, which implies low complexity of transactions.

Regarding asset-specificity, diesel fuel burning plants seem to have two opposite forces balancing off the degree of specificity. On one hand, redeployment is likely to drive a given plant out of its core business until a new contract is settled or until technical adjustments are performed, leading to high productive losses. On the other, diesel fuel powered plants tend to be inexpensive investments when compared to other technologies, which leads to little sacrifice of productive value in case of redeployment. In other words, the opportunity cost of these facilities is relatively low but keeping assets out of production causes expensive losses. Asset specificity therefore appears to find its equilibrium at a moderate degree.

Frequency of transaction is the final underlying attribute in the classic TCE framework. Not different from the analysis conducted above, the continuous generation and continuous consumption of electricity characterize this attribute as of very high frequency.

Based on low levels of uncertainty, low levels of complexity, moderate degrees of asset specificity, and high frequency of transactions the classic TCE framework would predict specification contract as the most efficient governance. Such prediction is plausible as firms must agree on certain technical standards without having to adopt more vertically integrated structures in order to protect moderately idiosyncratic assets; especially because activities undertaken by ANEEL and CCEE seem strict enough to minimize the probability of hold-up problems.

The perfect alignment between predicted and observed governance strategies brings us back to the question posed at the end of our analysis of transactions between large scale hydropower plants and utilities: why are firms imposed to use specification contract if the TCE theory indicates that such governance would be the natural choice of decision makers? Table 4 summarizes regulated market channel transactions based on the categorized attributes discussed here. The remainder of this chapter examines transactions conducted in the free market channel and discusses the questions left open at the end of each subsection.

Table 4: Summary of Regulated Market Channel Transactions

Wholesale sources	Buyer	Uncertainty	Complexity	Asset-Specificity	Frequency	Governance Structure	
						Predicted	Observed
LS Hydro	Utility of Distribution	Low	Low	High	Very high	SC	SC
Biomass	Utility of Distribution	Moderate	Low	Moderate to high	Very high	Alliance	SC
Windmill	Utility of Distribution	Moderate to high	Low	High	Very high	Alliance	SC
SS Hydro							
Diesel Fuel	Utility of Distribution	Low	Low	Moderate	Very high	SC	SC
Natural Gas							

4.2. Wholesale Transactions in the Free Market Channel

Sellers in the free market channel are biomass-based generators, windmills, small scale hydropower stations, natural gas burning plants, and diesel fuel burning plants. Buyers are categorized as special consumers (SCs) – if the input used for generating the electricity acquired is renewable; or independent consumers (ICs) – if the input used is natural gas or diesel fuel. Such distinction is important due to a set of incentives (i.e. tax exemptions) offered to SCs but not available to ICs.

Although the institutional framework does not forbid large scale hydropower plants from trading here, two reasons drive them away from the free channel. The first is the merit of order approach utilized by CCEE to solicit participation of sellers in auctions. As large scale hydropower plants have the least expensive generating cost in comparison to other inputs and technologies, they are quite often invited to trade through the regulated channel. The second reason seems to be the overall preference of managers for the regulated channel over the free channel. Market experts mention that under the current institutional framework, firms are in favor of trading via specification contracts rather than setting up strategies in an environment with higher levels of uncertainty and higher exposure to opportunism (Key informant interviews, 2010).

Other than the absence of large scale hydropower firms, the key difference between channels lies primarily in the underlying attributes that receive direct influence from the institutional framework (i.e. uncertainty and complexity). Asset-specificity and frequency are very consistent across channels given that they are mainly related to the technology used for generation and the general characteristic of electricity as a product. For these reasons the

following analysis places special attention on uncertainty and complexity and refers to the analysis conducted above for asset-specificity and frequency. Transactions between small scale hydropower plants and distributors and transactions between natural gas burning plants and distributors are left out for the same reason mentioned in section 4.1 above.

a) Transactions between biomass-based generators and special consumers

Despite the fact that little information is publicly available regarding participation of transactions in the free channel, two factors indicate the importance of biomass-based electricity. First, estimates suggest that biomass-based electricity has potential to cover 15% of the national demand by 2015 (Neves & Conejero, 2009). Second, biomass-based power represents less than 1% of transactions conducted in the regulated channel, leaving the reminder to be traded via free channel.

Uncertainty, the first attribute of interest in the TCE context, is differently categorized here when compared to the regulated channel. In the demand side, SCs often rely on consulting companies to assist them to forecast future demand of power. The uncertainty level to which SCs end up exposed to is conditional on the ability of consulting companies to perform forecasting studies. It is well accepted, nevertheless, that consultants are not as well equipped as ANEEL to predict future demand of power (Key informant interviews, 2010), leading to high levels of uncertainty of demand.

In the other end, uncertainty of supply remains similar to what was discussed above. Although managers at biomass-based generating facilities deal with weather uncertainty themselves and are fully responsible for meeting agreement specifications without further operational assistance; biomass characteristics and the nature of generators offset some exposure

to uncertainty. Thus, the overall level of uncertainty for transactions between biomass-based generators and SCs is moderate to high.

Complexity also tends to have higher levels of importance for trading parties in the free market channel than it does in the regulated channel. In this channel parties must not only identify counterparties but also write formal agreements, negotiate safeguards, monitor agreement performance, haggle in case of ex post misalignment of interests; rather than simply accepting pre-determined contracts drafted by CCEE prior to regulated auctions.

In a first glance, bilateral agreements could decrease the probability to expropriation of quasi-rents as much as CCEE's regulated contracts do, but market participants seem not to agree for two reasons. First, free market players believe that monitoring activities and punishment mechanisms enforced by CCEE and ANEEL are more effective than any mechanism created to moderate transactions in the free channel. Disputes would be solved in courts of justice, which in turn, might have lower capability of judging and penalizing the deviator when compared to CCEE.

Second, it is widely accepted that CCEE is better informed to adjust contract terms in case of changes in market conditions than free market players would be to haggle. Thus, free trading parties understand that the probability of hold-up problems to occur are higher than in the regulated channel, considering that the contracts are naturally incomplete and related assets are specific (Key informant interviews, 2010). For those reasons, transactions between biomass-based generators and SCs are relatively more vulnerable, and therefore of moderate complexity.

As pointed out above, asset specificity and frequency are consistent with the discussions conducted in section 4.1. Biomass-based generators have moderate to high degree of specificity for three reasons: (i) high degree of physical specificity, (ii) high degree of site specificity, and

(iii) low sacrifice of productive value in case of redeployment. Frequency is always high due to nature of electricity as a product.

Based on moderate to high level of uncertainty, moderate level of complexity, moderate to high degree of asset specificity, and high frequency, the classic TCE framework would easily predict that efficient transactions between biomass-based generators and SCs would require vertical integration as governance strategy. That is a plausible finding because firms must adopt a reasonably high degree of involvement and mutuality such that uncertainty is shared based on risk preferences and opportunistic behavior is considerably inhibited.

Market observation intriguingly indicates that transactions are either governed through vertical integration – thus meeting TCE predictions – or via specification contract. More interesting is the fact that the institutional framework does not constitute a barrier for adoption of what seems to be the most efficient governance. There must be, therefore, other reasons for such misalignment. We return to this point below.

b) Transactions between windmills/small scale hydropower stations and special consumers

Transactions between windmills or small scale hydropower plants and SCs represent the second most important set of transactions in the free market channel. These transactions obtain high levels of uncertainty because generators need to deal with unstable weather patterns, and consequently unstable supply of inputs; and SCs must cope with uncertain patterns of consumption using less sophisticated forecasting models (when compared to those used by ANEEL). Nevertheless, uncertainty of transactions between windmills and SCs tends to reach

high levels as opposed to moderate to high levels in transactions between windmills and utilities of distribution in the regulated channel.

Transactions are moderately complex since parties need to define contract terms (and incur associated transaction costs) in order to safeguard specific assets and minimize the probability of opportunism. More specifically, windmills and SCs exert great effort in *ex ante* drafting contractual specifications and *ex post* monitoring counterparties behavior, especially because enforcing activities of regulatory agencies do not cover free market channel transactions.

It is broadly understood however, that vulnerability to opportunism is low in the regulated channel and moderate in the free channel, even though firms attempt high efforts in decreasing exposure to opportunism. As examined above, such difference has to do with higher monitoring capacity and stricter punishment mechanisms undertaken by ANEEL and CCEE.

Following with asset-specificity, windmills are considered to be highly specialized assets for the reasons given above. First, windmills are specific physical assets that would reach lower production capacity in case of redeployment. Second, electricity generation is the main purpose of a windmill, and therefore high productive value might be lost in case of contract breach. Frequency, the fourth attribute of transactions, is invariability high for transactions of power between windmills and SCs.

The classic TCE theory would then plausibly predict that vertical integration is the most efficient strategy to govern transactions in which uncertainty reaches high level, complexity is moderate, assets are highly specific, and frequency is also high. Several cases, however, indicate that specification contract is widely used in the marketplace to moderate transactions between windmills and SCs. More interesting is the fact that institutions are not blocking windmills and SCs from adopting vertical integration, the most efficient governance strategy accordingly to the

classic TCE theory. Thus, other factors not considered in the TCE framework seem to be affecting decisions of SCs and managers at windmills. After analyzing the last set of free channel transactions we look at three additional factors that might explain why parties seem to choose a governance strategy that is different from the predicted (or efficient) one.

c) Transactions between diesel fuel/natural gas burning plants and independent consumers

Evidence suggests that agreements between diesel fuel burning plants and ICs or between natural gas burning stations and ICs represent the third most important set of transactions in the free channel for two reasons. First, most of the power generated in 1178 plants (11% of the installed capacity in the country, approximately) is traded through regulated auctions – ordinary supply and backup – representing over 40% of the power supplied to captive consumers (CCEE, 2012). That evidence alone implies that a reduced number of plants are left to trade in the free market channel. Second, demand for non-renewable power in the free channel is low due to tax exemptions given to consumers of renewable energy. Therefore, diesel fuel and natural gas burning stations tend to suffer substitution effects introduced via incentive for renewables.

For a matter of completeness it is also important to categorize the underlying attributes of the last representative transaction in Brazil's wholesale power market and examine its efficiency. Not different from what was discussed in the regulated channel, low level of uncertainty of supply categorize this transaction. That is the case because of the consolidated diesel supply chain, which facilitates input access at inexpensive costs. Uncertainty of demand, on the other hand, tends to be of moderate concern to ICs. Small business, shopping malls, and museums – all potential types of ICs – often hire consulting companies to forecast consumption patterns and

assist them at buying decisions. Consulting companies, nevertheless, recognize that ANEEL provides better assistance to utilities of distribution in the regulated channel than they can offer to ICs in the free channel. Therefore, diesel fuel burning stations and ICs face low to moderate levels of uncertainty while trading power.

Complexity, the second attribute of transaction, also tends to reach higher level when compared to that obtained in the regulated channel. Because trading parties cannot rely on either ANEEL's monitoring activities or CCEE's punishments, they must draft agreements in order to minimize the probability of opportunistic behavior of counterparties. Experts suggest that firms – often assisted by consultants – formalize moderately effective agreements in the sense creating long-lasting partnerships. Although those agreements are not as effective as enforcing actions taken in the regulated channel, market participants believe that their level of vulnerability is moderate, and therefore complexity reaches moderate levels (Key informant interviews, 2010).

Similarly to the analysis conducted above, a moderate degree of idiosyncrasy categorizes diesel fuel powered plants. That appears to be the result because redeployment of assets related to the core business of a given firm might cause irreparable productive losses. However, its relatively low investment cost, when compared to other technologies, pushes the degree of specificity down, equilibrating at a moderate degree. Finally, transactions between diesel fuel powered plants and ICs are very frequent.

With low to moderate level of uncertainty, moderate level of complexity, moderate degree of idiosyncrasy, and very frequent transactions, the classic TCE framework would predict that efficiency is likely to be obtained via specification contract. That seems plausible because parties need to find a well defined set of contract terms that decrease vulnerability and

safeguards assets with moderate degree of specificity. Besides, exposure to uncertain events is of little to moderate concern of firms and hence need not be mutually shared.

In that sense, diesel fuel powered plants and ICs seem to choose the most efficient strategy to govern transactions. Remarkably this is merely the third set of transactions – out of seven sets – in which observed and efficient governance strategies are fully aligned. Table 5 summarizes free channel transactions based on the underlying attributes discussed here; and highlights both predicted and observed governance strategies. Next two sections discuss about the remarks left unanswered at the end of each subsection above.

Table 5: Summary of Free Market Channel Transactions

Wholesale sources	Buyer	Uncertainty	Complexity	Asset-Specificity	Frequency	Governance Structure	
						Predicted	Observed
Biomass	Special consumer	Moderate to high	Moderate	Moderate to high	Very high	VI	VI / SC
Windmill	Special consumer	High	Moderate	High	Very high	VI	SC
SS Hydro							
Diesel Fuel	Independent Consumer	Low to moderate	Moderate	Moderate	Very high	SC	SC
Natural Gas							

4.3. Mismatch between predicted and observed governance strategies in the regulated market channel

The analysis above shows that institutions block firms trading through regulated channel from choosing what the classic TCE predicts as the most efficient governance in half of the transactions analyzed – two out of four. In this section we look at two reasons that seem appropriate to explain why the institutional framework prevents trading parties from freely choosing governance strategies in the regulated section. The first reason complements the study of Spiller & Tommasi (2005), which we intend to recap here. The second reason has to do with the source of capital used for developing Brazil's electricity sector over time, especially those resources employed to finance investments in idiosyncratic assets of power generation.

Spiller & Tommasi (2005) argue that the nature of the product – electricity – sets utilities of distribution in a strategic position for exercising unilateral market power. Utilities are naturally large and specific investments that rely on economies of scale in order to be profitable. These two characteristics together imply few supplying firms in each location; and as a matter of fact, there is not a region in Brazil where two or more utilities compete for customers. Adding that to the fact electricity demand is often inelastic and widely consumed across the country, utilities have strong incentive to charge higher-than-competitive retail prices to households.

The authors, however, recognize that authorities in modern countries are well informed about this potential threat; and therefore, regulatory efforts are put into action to protect households (Spiller & Tommasi, 2005). In Brazil's case, regulation translates into specification contracts *ex ante* defined by a third party enforcer (i.e. CCEE) and into coordinated competitive auctions through which generators and utilities of distribution settle wholesale prices. Such

regulatory structure is ingenious and convenient because it forces utilities to disclose wholesale prices almost effortlessly, regardless of the source or technology utilized for generation.

What is remarkable, nevertheless, is that no other governance structure would allow CCEE to observe wholesale prices. If institutions allowed trading parties to adopt an strategic alliance – as it seems to be efficient for two representative transactions (table 4) – they would have strong incentives to hide wholesale price information. CCEE would then be incapable of estimating and comparing gross revenue margins across utilities of distribution; and consequently incapable of preventing unilateral market prices. In order to do so CCEE would need to use more intrusive mechanisms (e.g. fixed retail prices) to protect households. Fixing retail prices would, however, be harder to implement due to the heterogeneity of utilities and generators in operation in Brazil.

With that in mind commentators question why institutions do not set households free to purchase electricity directly from generating firms as ICs and SCs are allowed to do in the free market channel. If that was the case, key informants suggest that severe network problems could emerge because ONS would face difficulties managing the transmission system and maintaining reliability of the system as a whole. Utilities would no longer be responsible for predicting future consumption and consumption patterns in their conceded area, two crucial pieces of information for ONS and ANEEL. The system operator would consequently be incapable of running stochastic optimization models (i.e. *Newave* and *Decomp*) as it is currently done (Key informant interviews, 2010).

In that sense specification contract along with regulated wholesale auctions appears to be a convenient and unobtrusive regulatory mechanism, without which households would certainly suffer expropriation of rents as discussed by Spiller & Tommasi (2005). Besides, specification

contract creates just enough control so ONS can conduct network operations and minimize the probability of power outage.

The second reason for the lack of leeway in the regulated channel is the source of capital employed for investing in specific assets of power generation. A close look at the underlying features of generating firms trading power through the regulated channel reveals that most of them used financial resources from public accounts. The vast majority was either built in the 1960s and 1970s using direct resources from the country or built with financial support from BNDES (Brazilian Development Bank) after the NPP. The same is not true for generating firms trading in the free channel where investments are mainly undertaken using loans from private lending organizations or using private resources.

There are, therefore, strong evidences that policymakers designed the dual-channel market and established a third party (i.e. CCEE) to take better enforcing actions over transactions in which government's financial resources are at stake, or to guarantee a stable rate of return on investment (ROI) to concessionaries. CCEE enforcement is reduced to minimal levels in the free channel because potential holdup problems do not endanger repayment of loans to the government (through BNDES). Consequently, free channel players need to draft safeguards without relying on CCEE in order to protect specific assets against opportunistic behavior of counterparties.

4.4. Mismatch between predicted and observed governance strategies in the free market channel

Although trading parties can freely choose their governance strategy without being bounded by institutions, the analyses conducted in section 4.2 above indicate that predicted – or efficient – and observed governance strategies are sometimes misaligned. In agreement with the classic TCE framework biomass-based generating firms and SCs, for instance, would reach efficient outcomes if vertical integration was always the chosen strategy; but it turns out that specification contract is frequently chosen instead. Likewise, TCE predicts that vertical integration is superior for transactions between windmills and SCs but parties seem to prefer specification contract at all times. Thus, there must be other factors influencing strategic decisions that go beyond the scope of the classic TCE literature.

Implementability and reputation, two complementary concepts, seem appropriate to explain the distinction between adopted and predicted governance strategies for these transactions. Peterson et al. (2001) argue that the existence of an efficient governance strategy does not ensure its implementability. In the authors' view an efficient strategy can only be implemented if a set of four conditions are jointly met: (i) decision makers have the capital required to implement the strategy; (ii) decision makers have trading partners with desirable characteristics to meet the needs of the strategy to be implemented; (iii) decision makers are capable of exercising the type of control required by the new strategy; and (iv) the strategy is legal and does not violate the current institutional framework. Reputation, the second concept, might curb opportunistic behavior in some circumstances and guide firms toward less integrated

governance strategies. As Masten (1996 p.15) puts it, 'reputation may deter opportunism if counterparties can observe its occurrence and have alternatives for future transactions'.

The concept of implementability becomes functional to explain why transactions between biomass-based generators and SCs are sometimes governed via specification contract. Market evidences suggest that vertical integration, the efficient strategy, is inevitably preferred for transactions between biomass-based generators and co-located manufacturing firms. This governance appears to hold until the power demanded by "cheek-by-jowl" firms is fully supplied. From that point on, biomass-based generators find alternative SCs and trade the remaining power generated. But because alternative SCs seldom present equal advantageous characteristics, decision makers deliberately incur additional transaction costs and adopt specification contract, which might plausibly be the second-best governance strategy. Translating into Peterson et al. (2001) terminology, trading parties do implement the most efficient governance when compatible partners exist; but implement an alternative strategy – specification contract – when the second condition binds.

Looking from the alternative SC perspective as opposed to the biomass-based generator perspective, the concept of implementability would indicate that the binding condition is rather capital availability. While sugar & ethanol manufacturing firms, for instance, have either invested in new power generators or renovated existing ones[17] because such a decision creates competitive advantage; alternative SCs (e.g. museums, shopping malls) have plausibly decided not to do so because that investment might not give them a competitive edge in their industry. Thus, alternative SCs might have chosen to draft specification contracts with biomass-based generators due to the unavailability of capital for investing in power generators. This very same

[17] Also called *green-field* and *brown-field* projects, respectively.

reason might also explain why SCs engaged in transactions with windmills or small scale hydropower plants also choose specification contract over backward integration.

Interestingly specification contract – the second best governance strategy – implies a much lower degree of involvement between parties than commentators might expect. Based on the underlying attributes of transaction analyzed above (summarized in table 5), one might have expected to observe equity-based alliance (Peterson et al., 2001) – the next strategy moving to the left along the governance continuum – as opposed to specification contract. The concept of reputation (Masten, 1996), nevertheless, adds a new set of arguments to explain why specification contract provides enough involvement between trading parties.

As mentioned above, institutional incentives (i.e. tax exemption) play an important role in attracting consumers of renewable electricity; and these consumers – referred to as special consumers (SCs) – tend to honor agreements with renewable power generators (often IPPs) for two important reasons. First, interviewees suggest that tax exemptions not only offset transaction costs but also create marginal benefits when compared to alternative purchasing schemes (Key informant interviews, 2010). Second, there is only a handful of consulting companies assisting SCs find counterparties, predict consumption patterns, draft and safeguard agreements, and so on. This latter reason facilitates information flow across trading parties and let renewable power generators assess credibility and reputation levels of SCs before signing new agreements.

With that in mind it is plausible to argue that SCs are induced to honor agreements in order to purchase electricity at low prices; especially because renewable power generators can costlessly observe deviation – or at least access its past occurrence – and because the alternatives left for a deceiving SC to purchase power would be more expensive. Knowing this self-enforcing institutional structure, renewable power generators might feel comfortable setting a governance

of little involvement – specification contract – rather than an strategic alliance that would ultimately lead to rent sharing.

In that sense the nonexistence of potential partners with desirable characteristics or the unavailability of capital drive transacting partners away from the TCE predicted strategy. Parties appear to find specification contract superior to alliances, as some scholars would have expected in the first place, because renewable power generators may costlessly observe deviation and SCs have strong incentives to live up to the agreement.

4.5. Conclusions

This chapter contributes with empirical evidence that partly corroborates with Delmas & Tokat (2005) and Joskow (1985). The classical notion of TCE seems appropriate to predict the most efficient governance in the sense of minimizing the sum of production and transaction costs and safeguarding idiosyncratic assets for a given transaction. Our findings, however, suggest that the TCE framework might gain consistency in explaining why trading parties sometimes adopt less efficient strategies if two concepts broadly discussed elsewhere were taken under consideration.

Implementability (Peterson et al., 2001) explains that four conditions must be jointly satisfied for an efficient strategy to be implemented. 'Institutional acceptability' appears to be the binding condition in the regulated channel of Brazil's wholesale power market, preventing parties from adopting the most efficient governance strategy in two transactions analyzed. In the free market channel – although institutions set parties free to choose governance strategies – 'existence of compatible partners' and 'capital availability' bind and induce parties to choose

less vertically integrated strategies. Reputation, the second complementing concept, is functional to explain why firms with specific assets and moderate vulnerability to opportunism prefer specification contract over governance strategies that may provide better safeguards. Institutional incentives given to consumers of renewable electricity and the relative easiness in observing deviations make special consumers better off preserving reputation for future transactions.

Finally, the classic TCE theory has proven itself as an elegant framework for predicting transaction efficiency; but has also shown some inability to explain how firms decide over governance strategies. Results indicate that including two complementary concepts to the classic TCE framework might also distinguish TCE for its completeness to explain how trading parties make decision over governance strategies.

5. CONCLUDING REMARKS

This thesis analyzes how Brazil's electricity sector evolved from a state-dominated to a market-oriented structure in less than a century. Results indicate that 'economic performance' – high levels of worldwide uncertainty, economic recession, and reliability of utility services – was the main factor driving dramatic institutional reforms. Only the second institutional reform, however, was successful in creating economic growth and promoting environmental sustainability through the introduction of renewable sources of power.

Recognizing the existence of path dependence between institutional evolution and definition of business strategies, this thesis analyzes further whether the resulting institutional framework permits economic agents to choose governance strategies. Results indicate that regulated wholesale market players are bounded because regulations are enforced to protect households against unilateral market power (as also observed by Spiller & Tommasi, 2005); and also because public capital was vastly used for financing investments in idiosyncratic assets of power generation. Results also indicate that free wholesale market players, although free to choose the desired governance strategy, are seldom capable of implementing the most efficient governance strategy because capital availability, existence of compatible partners, and future reputation are issues of concern to decision makers.

For future research the results of this thesis might be aligned with other empirical studies (such as Joskow, 1985; La Porta et al., 1997; 1998; 1999; Greif, 1994; Bardhan, 2000; Rodrik, 2000; Delmas & Tokat, 2001; Nugent & Robinson, 2002; Keefer & Vlaicu, 2004; and those covered in Shelanski & Klein, 1995) in order to define a common pattern of institutional development and strategy formulation. Once a pattern is determined, a tentative hypothesis might

guide us towards refining the current NIE theory. Grounded theory (Corbin & Strauss, 1990; Strauss & Corbin, 1994) might be used as analytical framework to help us identify complementing concepts not yet considered in theoretical models.

Finally, we would like to add that further advances can only be obtained if we investigators enhance the body of empirical knowledge and consistently systematize historical evidence in order to create grounds for refining well-accepted economic theories. We hope this thesis has succeeded in doing so.

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