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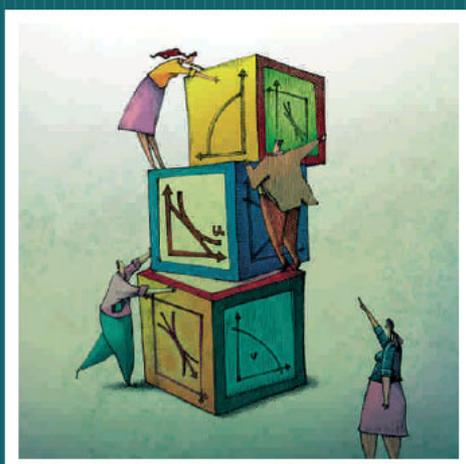
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Conflict Resolution in the Electricity Sector - The Experts Panel of Chile

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- The Experts Panel of Chile -

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Abstract—. **One of the main challenges facing the electricity sector worldwide is the design of efficient markets. In particular, the mechanisms used to solve regulatory conflicts are a crucial element of a regulatory regime and a major determinant of the risks borne by private investors. We use the Chilean experience to analyze the evolution of mechanisms for conflict resolution within the electricity sector. We propose a theoretical framework based on bargaining theory to explain the behavior of market agents. This methodological approach is used to explain the evolution of conflict resolution following the introduction of the Experts Panel in 2004, as well as to explain the reduction in the number of conflicts. The results can also be applied to other electricity markets, leading to future market design proposals and governance improvements.**

Keywords—Market design, conflict resolution, Experts Panel, bargaining, game theory.

I. INTRODUCTION

Competitive electricity markets need effective market design solutions. In this context several key aspects such as the definition of private/public information, the rights/duties of the market agents, the operation/planning criteria, and the remuneration of ancillary services, among others, should be taken into account by the sector legislation, by-laws, norms, and standards [1, 2]. These definitions should also include the mechanisms for conflict resolution in the case of different interpretations of the regulatory framework by the market agents or by the regulator. In this context, the experience of diverse market design solutions can help in the understanding of agents' behavior and of market robustness.

One of the puzzling features of the Chilean electricity sector is that the introduction in year 2004 of a new institution for the resolution of conflicts, the Experts Panel, led to a marked decline in the number of disputes among power generating firms[1] [3]. This decline in the number of disputes has taken place even under conditions of great stress in the system due to abnormally high marginal prices that led to large transfers between companies [4].

Consequently, important questions arise: Why did the change in the mechanism of conflict resolution reduce so drastically the number of disputes? Which specific features of the new scheme determine the observed evolution? The answer to these questions can provide a basis for the development of specific market design proposals.

This paper seeks to analyze the effects of different systems of conflict resolution, on the basis of the experience in Chile during the last 20 years. We hypothesize that different mechanisms of conflict resolution lead to different rates of bargaining breakdown among electric power firms. Moreover, we hypothesize that the conflict resolution mechanism known as the Experts Panel, established by the 2004 Electricity Law has been successful in containing bargaining breakdowns compared to previous mechanisms, and this explains the reduction in the number of cases bought to the Experts Panel.

This paper is organized into six sections. Section II presents an overview and theoretical analysis of conflict management in the electricity sector. Section III is devoted to the evolution of conflict resolution mechanisms in the Chilean electricity sector. Section IV presents a methodological approach to model behavior of conflicts in the electricity sector. In Section V the application of the proposed framework to the Chilean sector is presented. Finally Section VI presents the conclusions and proposals for future work.

II. RESOLUTION OF CONFLICTS IN THE ELECTRICITY SECTOR

Over the last 15 years, more than 200 infrastructure regulatory entities have been created in various countries in all continents. During the 1980s and early 1990s, in the OECD countries and Latin America, these entities were primarily responsible for the telecommunications sector. Over the last 5–10 years, the number of regulators has greatly increased, and there has been a spread of regulatory institutions to other infrastructure industries (particularly electricity, energy, and, to a lesser extent, water and transport) and to other countries, including a number of countries in Africa [5]. Moreover, much of the experience and discussion of regulation in other fields is applicable to the electricity sector.

A first important aspect of the new regulatory entities is their relationship to the government. In particular, many agencies established since 1990 have been ministry regulators. Some of these institutions were autonomous, but had narrow decision-making power; for instance, many have limited, if any, power to regulate retail prices to consumers. Moreover, many ministry regulators now operate subject to duties defined in regulatory law and this seems to affect both their behavior and the performance of the infrastructure industries that they regulate [6].

A. Conflicts in Regulated Sectors

Regulatory conflicts resulting from different interpretations of laws and by-laws by the market agents are common in the

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[1] Another source of disputes are those between the regulator and private firms (power generating, distribution and transmission firms), which have not declined. The difference is due, first, to the fact that many of the conflicts with the regulator are part of the regulatory process and second, because conflicts with the regulator are subject to political economy incentives.

electricity sector. Typically, they involve disputes between the government authorities or regulators and the companies, in topics such as tariff reviews, the awarding of concessions and permits, the enforcement of service obligations or of compensation for past investment. They may also entail conflicts among the regulated companies themselves or between these companies and users, for instance, in issues related to interconnection charges, transmission fees or service standards [7].

The mechanisms used to solve regulatory conflicts are a key element in a regulatory regime and a major determinant of the regulatory risks borne by private investors. A common assumption is that a government official or, ideally, an independent regulator, will make the right decisions, guided by the desire to promote social welfare or by provisions stated in the law or in the regulatory contracts. Improvements can be made on this model by allowing the affected party to request a review of regulatory decisions, by establishing rules of due process and by creating norms aiming at the independence and accountability of regulators. However, if the objectivity of the all-powerful regulator is not guaranteed, either by its past reputation or by the written codes, regulatory risks are likely to remain high and sector performance to be poor [7].

B. Theoretical Framework

Our hypothesis is that conflicts arise from a breakdown of a bargaining process between parties. Thus, we begin by analyzing the canonical bargaining model, with two participating agents.

i. Bargaining model

Nash [8] was the first to define a bargaining problem and a solution satisfying four reasonable properties: i) Pareto efficiency, ii) a symmetric bargaining problem has a symmetric solution, iii) the solution changes linearly with linear transformations of the feasible set, and iv) Independence of irrelevant alternatives, i.e., adding feasible points that are worse than the solution does not alter the solution. Formally, for the case of two bargaining agents, the problem is characterized by couple (X, d), where X is a convex subset of R^2 and d is a point in X representing the 'status quo' if the players disagree and cannot reach an agreement [13].

A bargaining solution S is defined as

$$F : (X, d) \rightarrow S,$$

where $X \subseteq R^2$ and $S, d \in R^2$. X represents the utilities of the players in the set of feasible bargaining agreements.

More generally, if we dispense with assumption ii) of symmetry, we may assume that the solution is influenced by the relative bargaining ability of each party, given by a parameter $0 < \alpha; 1-\alpha < 1$. One interpretation of bargaining ability is that it represents the time preference (higher time

preference implies a desire to settle quickly and weakens the negotiating ability of the firm), but it could also represent economic advantage or any other type of advantage in the negotiation. Note that the solution will depend on the relative bargaining powers of the two parties, which is usually unrelated to the legal merits of the case.

For the case of two agents dividing a sum which (for simplicity) we normalize to 1, Nash showed that the unique solution (outcome O) to the problem satisfying conditions i), iii) and iv) is [13]:

$$O = \underset{0<u_1+u_2<1}{\arg \max} \ (u_1 - d_1)^{\alpha}(u_2 - d_2)^{(1-\alpha)} \qquad (1)$$

where

α: ability or bargaining power of agent one,
d_i: utility for agent i representing the *utility* if the agents disagree, i.e., the utility under the judicial solution.
u_i: utility of agent i.

The solution is fairly simple, and by assumption, leads to an efficient division of the surplus (over the disagreement point). In this simple setting there is no breakdown of negotiation.

In certain bargaining games, one party has an outside option. Assume that the weaker party, (say $u_1 \ll \frac{1}{2}$ in (1)) has the possibility of abandoning the bargaining game and receiving a value of O. If the solution to the bargaining problem without the outside option is $u_1 < O$, the party chooses the outside option. The solution to this reformulated bargaining problem is for the other party to offer the maximum between the solution to the bargaining problem without an outside option (1) and O. In this case, again, there is no breakdown, and the bargaining solution is efficient: the only effect of the outside option is to improve the prospects of the first party in the negotiation [9].

In order to have a breakdown of the negotiation, there must be an essential failure due to the incompatibility of each party's information. As shown by Myerson and Satterthwaite in a very general bargaining setting [10], if there is uncertainty about what each firm expects to be able to receive (its 'value') in the bargaining game, and moreover, the ranges of these values overlap, there is scope for a breakdown of bargaining, i.e., there is no efficient solution to this problem.[2]

Once we have the possibility of breakdown in the bargaining process among firms, we have to consider how the electricity sector deals with the resulting conflicts or disputes.

A variety of procedures can be used to resolve disputes and avoid court litigation and renegotiation of contracts. They include, among others, arbitration, mediation, mini-trial, private judging, neutral expert fact finding, and final offer

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[2] More precisely, there is no efficient solution that satisfies incentive compatibility (telling the truth) and participation (receiving more than the disagreement point).

arbitration. Table I summarizes the most common dispute resolution processes [11]:

TABLE I
DISPUTE RESOLUTION PROCESSES

Mechanism	Description
Negotiation:	A discussion among two or more agents with the goal of reaching an agreement.
Mediation:	A voluntary and confidential process in which a neutral third-party facilitator helps agents discuss difficult issues and helps negotiate an agreement. Basic steps in the process include gathering information, framing the issues, developing options, negotiating, and formalizing agreements. Parties in mediation create their own solutions and the mediator does not have any decision-making power over the outcome.
Conciliation:	A process whereby the parties to a dispute agree to utilize the services of a conciliator, who then meets with the parties separately in an attempt to resolve their differences.
Arbitration:	A process in which a neutral third party, after reviewing the evidence and listening to arguments from both sides, issues a decision that settles the case.

Arbitration, the usual approach to solving differences in the industry, can be further subdivided in more specific types.

ii. Types of Arbitration

In this case a neutral third-party issues a decision to settle the dispute. For instance, it is possible to use the judiciary system, on the basis of the provisions of commercial, administrative or sectorial law.

Legal system

Although this is a widespread solution, it is seldom adequate when the regulatory conflicts are technically complex. This is the case of the electricity sector, where technical and economical decisions are strongly coupled. This is especially valid in emerging countries with no specialized judges, lack of independence of the courts or inefficient and extremely long and time consuming procedures [7].

Standard arbitration

In this type of arbitration, the mediator imposes a binding decision on the parties, and is free to choose any solution that is compatible with the norms and regulations of the sector and the general legislation. It tends to reach intermediate solutions between the positions of the parties in dispute. See for example, Montero [12].

Final offer arbitration

In this type of arbitration, the mediator imposes a binding decision on the parties and is only allowed to choose between the final offers made by each party during the mediation. The arbitrator does not have the authority to choose an intermediate position. The choice of the arbitrator under this arrangement is limited [12].

Final offer arbitration encourages the parties to make reasonable offers, because if party A makes an unreasonable offer, there is a risk that the arbitrator will find party B's last offer to be more reasonable, even though it is not an optimal choice, and therefore impose party B's proposal as the binding decision. See Montero [12] for a criticism in the case of disputes in more than one dimension.

III. EVOLUTION OF CONFLICT RESOLUTION MECHANISMS IN THE CHILEAN ELECTRICITY SECTOR

A. Historical Overview

Using the theoretical framework described previously, there have been three different conflict resolution mechanisms in the Chilean electricity sector in the more than 20 years since it began operating as a competitive market (see Table II).

TABLE II
EVOLUTION OF MECHANISM IN CHILEAN CASE

Name	Mechanism	Advantage	Disadvantage
Courts of justice 1990-1997	Arbitration	Binding, slow	Lack of independence.
Experts Committee/ CDEC Chile 1997-2004	Mediation	Independence	Decisions are only recommendations.
Experts Panel / Chile 2004-	Final offer	Independence Binding Quick	Higher costs.

The mechanisms are explained in further detail in the following subsections.

B. Courts of Justice: Arbitration

In this period there was no explicit procedure to resolve differences between firms, so they would bargain in the absence of an outside option within the electric sector. The firms in dispute had the possibility of going to the ordinary courts of justice, but given the complexity of the issues and the delays of the justice system, it was not a real option in most cases[3]. Otherwise, the firms would reach a bargaining solution [14].

C. Experts Committee: After the Reglamento Eléctrico and before the Experts Panel.

The *Reglamento Eléctrico* of 1987 was the first bylaw after the initial law setting up competition in the market in 1981. It

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[3] Possibly incorrect and slow outcomes were expected from the judicial system given the lack of specialized knowledge.

helped to clarify several issues subject to interpretation (concessions, system security, power quality, open access scheme to the main transmission system, price model). It also introduced a new procedure to resolve disputes. Once a conflict arose among market agents (working in coordination with the market/system operator) and if they could not reach an agreement, the issue was presented to an Experts Committee[4], independent of the firms. Their decisions were not binding, but were recommendations or advice for the market agents (it acted as a mediator). If a firm was dissatisfied with the proposal, it could appeal to the regulator (*Comisión Nacional de Energía, CNE*) which would issue a report and recommendation to the Ministry of Economic Affairs. The Ministry not only had final decision power, but could also alter the regulations that related to the specific issue, by reinterpretation of the electrical legislation.

Usually, this last stage might take several months or years for the regulator to reach a decision. Moreover, these decisions could be overturned by lobbying or by reintroducing the original issue in a slightly modified way, given the double role of the regulator as adjudicator and as the originator of regulation. In this way, issues could remain undecided for years, as the regulator changed its mind in accordance with new arguments. A final consideration is that since few human capital resources were devoted to solving conflicts, the decisions were not always correct within the legal framework or under the logic of the electrical system, in those cases in which the issue had not been regulated before.

From the point of view of a firm with a weak legal argument, appealing to the Committee of Experts could delay an unfavorable decision, considering the appeals process, or even change it in its favor[5]. The uncertainty about the outcome of the process led to breakdowns of the bargaining process and hence to an increasing number of disputes that had to be settled by the regulator.

D. Experts Panel

The Electricity Law of 2004, or "Ley Corta", introduced a new mechanism for conflict resolution, namely, the Experts Panel, given the unsatisfactory results of the previous approach. The Experts Panel has several important differences with the previous approach to disputes. First, it is an independent organism, both administratively and economically. It is composed of members with proven expertise in the field, and the Panel acts very quickly, with final adjudication within 30 working days. Second, it can only choose among the alternatives presented by the market agents, and cannot select intermediate positions[6]. The Panel decides on the basis of the stronger of the two arguments, because

usually there are reasonable arguments for both sides. The reasoning used to reach the decision must be included in the report. The Panel decisions are final and binding on the parties [15]. The following points describe additional features of the Experts Panel as a body for conflict resolution [16].

i. Independence of the members

Strict ineligibilities apply to ensure that members are not affiliated in any way with the government or electric sector companies. Members cannot own shares in electric sector companies. Panel members are subject to integrity rules defined in the administrative and penal law and cannot intervene in disputes related with topics in which they were directly involved before becoming members.

ii. Time constraints

The short deadlines for decisions of the Experts Panel are designed to avoid regulatory uncertainty in the sector, which can involve large financial commitments for firms. Moreover, it seeks to discourage strategic use of the conflict resolution mechanism in order to delay reporting an adverse result. However, a disadvantage inherent to short deadlines is the possible decline in the quality of decisions. This can be a problem if there are a large number of simultaneous disputes.

iii. Reasoned decisions

The verdict of the Experts Panel must include the arguments and reasoning used to reach the decision. The judgment is strictly limited to the matters under discussion. The final report as well as all the background information and the minutes of the sessions are made publicly available.

iv. Binding resolutions

The final decision of the Experts Panel is binding on all participants. They can be no appeals to the decision, either of a jurisdictionary, administrative o ordinary nature. This implies that companies are aware that a disagreement creates a precedent because the verdict of the Panel cannot be appealed and they will have to comply with the resolution of the Panel.

These features show that the Experts Panel does not replace the regulator, and that it is restricted to applying the current regulatory framework.

E. Flow Diagram

The bylaws of the Experts Panel regulate the submission process for conflicts among agents. The procedure incorporates several instances to help reach an agreement among the parties, before submitting a divergence to the Panel. In our interpretation, this is the bargaining stage, whereas an appeal to the Expert's Panel represents a breakdown. At this stage, the participants provide the Panel

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[4] Composed by one lawyer and two engineers or economists.
[5] From the point of view of the CEO of a company, this may also delay the recognition of a loss in the balance sheet.
[6] Except in exceptional cases, determined in the bylaw "Reglamento del Panel de Expertos".

with the documents that allow the Experts Panel to identify the specific matters involved in the conflict.

The flow diagram in Figure 1 shows the general mechanism for the treatment of a conflict in the market (market agents or companies C1, C2, .., Cn).

The companies can follow two options to resolve their conflicts. First, the companies can avoid the Experts Panel if they reach an agreement (possibly after a bargaining process). The final result of this bargaining procedure is formalized by the market operator (in Chile the Economic Load Dispatch Center or CDEC in the Figure 1) which requires unanimity in the vote for approval of the agreement.

In the case where no agreement can be reached, the conflict is submitted to the Experts Panel, i.e., the bargaining process among firms breaks down. The companies that are in conflict, as well as the CDEC, develop the arguments that sustain their positions. Fifteen days after the discrepancy has been formally declared in the CDEC, the Panel receives the arguments and the different stances of the participants as well as the background information showing the origin of the conflict (transcription of the voting session in the CDEC).
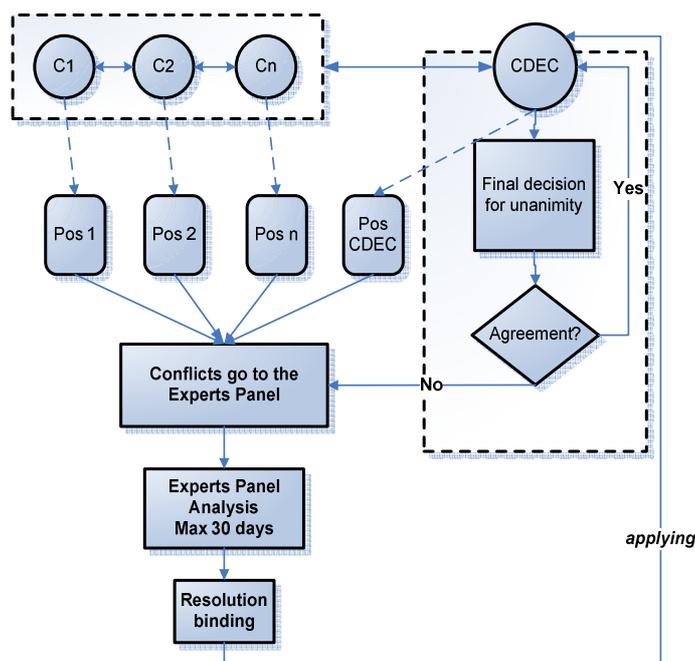
Fig. 1. Flow diagram for modeling the behavior of the agents.

The Panel uses this information as well as other relevant information to analyze and reach a decision within 30 working days. This stage involves a public hearing where all parties and interested institutions can voice their arguments and positions. Members of the Panel can question the representatives of the differing positions in order to understand specific points of the conflict. The final decision, binding on all the participants, becomes public after thirty working days have elapsed.

IV. PROPOSED METHODOLOGY

In what follows, we try to explain the behavior of the agents under these different approaches to conflict resolution.

A. Courts of Justice: *Arbitration before 1997*

In this period, the only option for firms in case of a disagreement that could not be resolved through bargaining was to appeal to the judicial system. Given the uncertainty about the outcome, the long delays before decisions as well as the cost of judicial procedures, firms preferred to solve their problems by negotiating agreements, i.e., by bargaining. As there were no breakdowns, the procedure was efficient but perhaps unfair.[7]

However, due to the differences in bargaining power between firms ($\alpha \gg \frac{1}{2}$), the outcomes were perceived to be unfair and sometimes even in violation of sector regulation. This led to calls for its replacement by a system which allowed appealing to the regulatory authority if a firm felt the outcome was unfair or that it violated the laws and bylaws of the sector.

B. Experts Committee: *After the Reglamento Eléctrico and before the Experts Panel.*

In this period, a firm that was dissatisfied with the results of the bargaining process within the CDEC could appeal to the CNE. After a fairly long period (and going through the mediation of the Experts Committee, see Section III.C), the CNE would send a recommendation to the Economics Secretary, who would issue a decree. The whole process was slow and could be overturned by appeals by rival firms presenting other divergences with slightly changed conditions. Moreover, there was a tendency to look for intermediate solutions.

In our analysis, to a first approximation, we assume that a divergence, which implies going first to the Experts Committee, and then to the CNE, provides an outside option to the weaker party (i.e. with $u_1 \ll 1/2$) with a value of O. Thus if the solution to the bargaining problem without the outside option is $u_1 < O$, firm 1 can appeal to the CNE, obtaining a payoff of O. The solution to this bargaining problem is for firm 2 to offer the maximum between the solution of the bargaining problem without an outside option, i.e. the maximum between the solution to (1) to firm 1 and O.[8] The advantage is that this solution avoids the cost and delay of going to the CNE, i.e. it is efficient. If this were the applicable

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[7] One of the firms represented more than 55% of the generating capacity, and it owned the main transmission system.

[8] Note that the value of the outside option should include the cost of using the option. In particular, the slowness of the process meant that the firm with the weaker legal position could delay including the results of the bargaining process in its balance sheet. This implies that from the point of view of the firm's management, the delay reduced the cost of the outside option, making it relatively more attractive.

model, there would never be an appeal to the CNE, contrary to the observation of many cases of breakdown.

In order to get a breakdown of the bargaining game, it is necessary that the positions of the two firms are incompatible. Assume now that firm 2 believes its outside option is worth $O + \varepsilon_2$, while firm 1 believes that it is only worth $O - \varepsilon_1$. Assume now that the solution without an outside option lies between the estimates of the outside option by the firms, i.e., $u_1 \in [O - \varepsilon_1, O + \varepsilon_2]$. Then firm 1 will make the offer u_1, which she believes firm 2 should accept, but this is below firm 1's belief of the value of its outside option, so it prefers to go to the CNE (if the difference between firm 2's estimate of the outside option and u_1 is larger than the cost of appealing to the CNE). Note that firm 2 cannot believe in announcements of firm 1 that its true outside option is $O - \varepsilon_1$ (an announcement of this value by firm 1 is considered cheap talk and not credible by firm 2), since firm 1's only credible action is to appeal to the CNE, and thus to have a breakdown of the negotiation process. Hence we have a model of breakdown that seems to explain the numerous appeals to the CNE, reflecting a failure of the bargaining process due to uncertainty about the value of the outside option, i.e., the result in case of disagreement.

C. Experts Panel

The most recent stage of conflict resolution in Chile corresponds to the Experts Panel. It has led to a marked reduction in the number of disputes (see Figure 3) that are not solved by bargaining between firms, but lead to the intervention of the Panel, i.e., breakdowns. We propose that the explanation lies in the fact that the Panel increases the cost, or alternatively, reduces the benefits of the outside option to the firm with the weaker legal position, while simultaneously lowering the uncertainty about the outcome. Hence the likelihood of breakdowns (disputes that arrive at the Experts Panel) in the bargaining process is reduced. To see this, it is important to consider that most of the disputes among power generating firms concern the division of the capacity payment[9]. The capacity payment rewards firms for being able to provide active power to serve maximum demand (as well as to provide some ancillary services), and is a fixed global amount (paid by users) that must be divided among firms. Any increase in the payment to one firm implies a loss to another firm, so the interests of the firms are totally opposed. Other disputes taken to the Panel also represent division of costs, and correspond to situations in which firms have totally opposed interests, in the sense that one firm's gain implies a loss to the other firm.

Consider the case of two firms that have a conflict regarding

the division of the capacity payment.[10] We can model this as a bargaining problem, where two firms must split the capacity payment, and the threat-point is to receive no payment. As described in section II.B.1, the solution to the bargaining problem depends on the relative power of the firms, which in turn is related to the ability to wait out – the ability to resist a delay in the capacity payment– [16].

Under the conditions of the Expert Panel, the outside option for the firm with the weaker legal argument is lower than previously. First, because the process is short, so there is no benefit for management of the firm with the weaker position to attempt to delay recognizing a loss in the balance sheet. Second, because an application to the Panel amplifies the effect of a loss, by increasing the probability of getting nothing, due to the use of final offer arbitration. Second, the probability of breakdown is reduced, because there is less uncertainty about the final outcome when taking the dispute to the Experts Panel. The combination of increased costs and reduced uncertainty lowers the attraction of a breakdown in negotiation.

Initially, when the Experts Panel was introduced, there were many breakdowns, i.e., cases before the Panel, but the number of cases fell rapidly in succeeding years (see Figure 3). We model this evolution by assuming that there exists a function $g(z)$ that describes the known probability of the Panel giving support to firm 1 as a function of the strength of its legal arguments, relative to those of firm 2, parameterized by $z \in [0, 1]$. We assume that:

$$g(z) = \begin{cases} 0 & \text{if } z \leq \mu_1 \\ \in [0,1], g' > 0 & \text{if } z \in [\mu_1, \mu_2] \\ 1 & \text{if } z \geq \mu_2 \end{cases}$$

That is, if the evidence is weak ($z < \mu_1$), firm 1 is sure to lose the case ($O = 0$) in the Panel. If the evidence is strong ($z > \mu_2$), it is sure to win, $O = 1$ in the Panel. Finally, in intermediate cases, there is a probability, increasing in z, that it receives value $O = 1$ if it appeals to the Panel. Assume that firms have continuously updated expectations of μ_i, given by past experience, and that μ_1 is increasing and μ_2 is decreasing over time.[11] Assume also that there is a cost $0 < c_B < 1$ to both firms from appealing to the Panel, given by lawyers cost, preparation time, etc.

In this setting, the value of the outside option in the range [0, μ_1] is known to both firms to be $O_1 = 1 - c_B$, $O_2 = - c_B$. Hence firm 2 will accept any offer greater than zero, and not go to the Panel when its legal arguments lie in that range. An analogous argument applies in the range [μ_2, 1] for firm 1. Hence, only in the cases in which the strength of the legal arguments of both

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[9] There have been a few conflicts regarding the appropriate marginal cost to use in valuing transaction under very unusual circumstances, but these are due to the exceptional circumstances of 2008, which combined an initial dry season, the failure of a major generating plant and the low initial state of reservoirs and high demand.

[10] We will assume two firms, though in general the conflict involved more firms. However, this assumption simplifies matters and also is consistent with the fact that in most (but not all) cases there were basically two opposed positions.

[11] This means that, over time, the firms observe that the decisions of the Experts Panel become more precise.

firms lie in the range [μ_1, μ_2] is there scope for appeals to the Experts Panel, if the beliefs of the firms about the relative strength of their arguments are such that they lead to a breakdown, as in section IV.B. Assuming that the Experts Panel provides good decisions (i.e., favoring the firm with the stronger legal argument), over time firms will update their perceptions of the thresholds, with $\mu_1 \uparrow$, $\mu_2 \downarrow$, and therefore there is a smaller interval of uncertainty, implying that fewer cases will be brought to the Panel. Within the interval, cases would still be brought to the Panel, but these will become cases in which it is more difficult to make a decision, since both positions will have strong arguments. Note that with an erratic Panel, the interval [μ1, μ2] would not decrease over time and the number of cases would not change.

V. APPLICATION TO THE CHILEAN SECTOR

This section presents an application of this framework to the Chilean sector, during the periods of the Experts Committee and the Experts Panel. Unfortunately, the small number of observation (years) does not allow the use of conventional statistical analysis.

Before the Experts Panel, the methodology analyzed in Section IV.B predicts a large number of discrepancies presented to the CNE, because the uncertainty about the ultimate resolution of the regulator led to breakdowns. Figure 2 shows the number of conflicts presented and resolved before the Experts Panel. During this period, an average of 16 conflicts per year were presented to the regulator. It can be also be observed that the number of conflicts that were decided was significantly smaller than the number of conflicts. This confirms that for the regulator the procedure took a long time to reach a decision and that there was a stock of undecided cases by the time the law was changed and the Experts Panel was instituted.
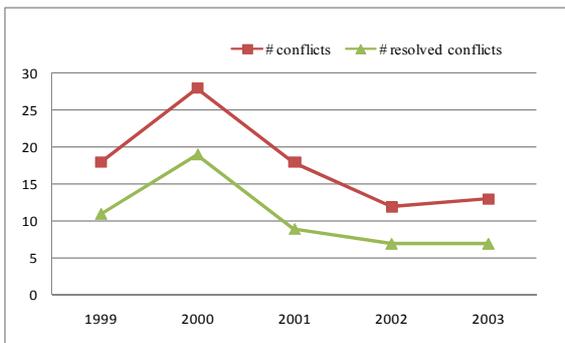
Fig 2. Number of conflicts per year before the Experts Panel.

On the other hand, since the creation of the Experts Panel it has decided 30 disputes involving generation companies within the CDECs, an average of 6 conflicts per year. This number corresponds to a decline in 66 % in relation to the previous period. Moreover, after the first two years in which the stock of disputes corresponding to the previous period was resolved, the number of these conflicts has never been above 6.

Table III describes the number of conflicts per year among generation companies and the number of issues involved in the conflicts. Figure 3 shows the decrease in the number of disputes presented to the Experts Panel [16]. Note also that because there are no more than 30 days between the presentation of the issue and the decision of the Panel, the number of solved dispute equals the number of disputes.
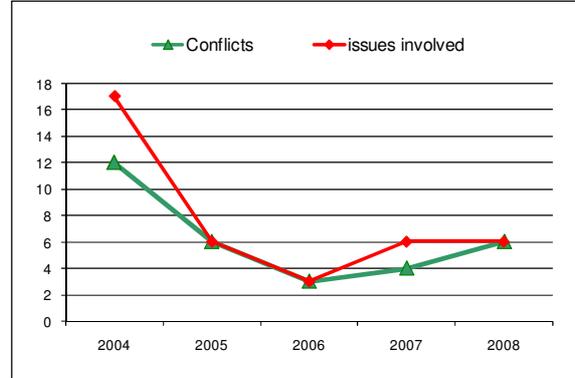

Fig. 3 Number of conflicts and issues in the Experts Panel.

TABLE III
EVOLUTION OF CONFLICTS

Year	Number of conflicts in the CDEC	Number of Issues involved
2004	12	17
2005	6	6
2006	3	3
2007	4	6
2008	6	6

The observed evolution was anticipated by the methodology presented in Section IV.C. It is noteworthy that during this period there were serious supply problems (interruption of gas supplies from Argentina, large increase in fuel prices, low levels in hydro reservoirs) which led to exceptionally high marginal costs, but which were accommodated without an increase in the number of disputes.

In order to explore in more detail the evolution of this process during the Experts Panel period, we present a descriptive analysis in the following paragraphs.

In the first place, the *conflicts* are classified in figure 4 on the basis of whether the key issue was of a technical or legal nature. According to this analysis, disputes of a technical character were prominent in the first period, from 2004 to 2005. Since 2006, legal issues have been key, due to incorporation of new bylaws required by the Electricity Law of 2004. The increase in bylaws may be the reason for the increase in the number of legal conflicts, due to the uncertainty about the interpretation of the new bylaws by Regulator and Companies.
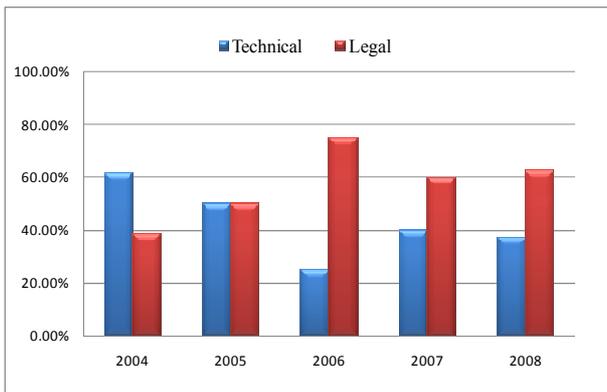
Fig 4. Key issues in conflicts/year indicator.

Figure 5, *Who presents the discrepancy?*, shows the frequency of use by different companies of the dispute settlement system, while Figure 6 shows, for the same agents, the percentage of positive results (winning position) achieved in the conflict.

It is important to note that the origin of the discrepancies that arrive at the Experts Panel are concentrated: three firms which originate 50% of the conflicts. However the distribution of market agents whose positions were supported by the Experts Panel decisions is very different, as shown in Figure 6.
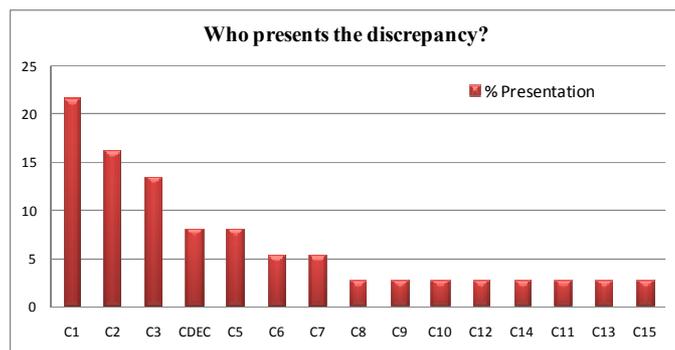
Fig. 5. Percentage of discrepancies presented by each company
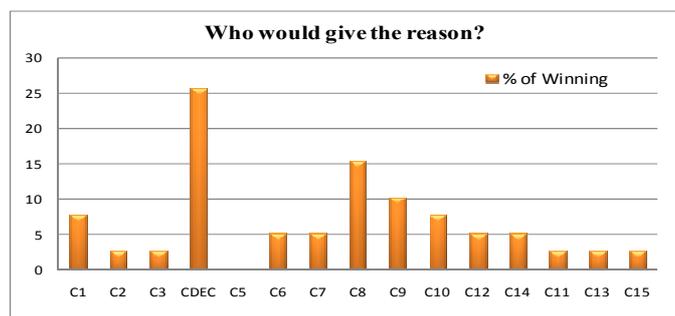
Fig.6. Percentage of positive outcomes of each agent.

It is noteworthy that many disputes that arrive at the Experts Panel are presented by hydro power companies. Possible explanations are that there is substantial uncertainty about the capacity in the case of reservoir-based generation than can be depleted in a dry year, which would lead to breakdowns of the

bargaining process of dividing the capacity payment. Moreover, hydro power companies are major users of the main transmission system, a common source of conflicts.

It is important to note that the positions of the CDEC (market/system operator) were supported by the Experts Panel in close to 25% of the cases, and that the positions of company C8 won in 15% of the cases. The remaining cases are widely distributed. It can be concluded that the most convincing arguments are not necessarily associated to the agents who present the discrepancies.

Figure 7, Type of decision of the Experts Panel, classifies decisions of the Panel according to the votes of Panel members. They are divided among those that are unanimous, those that are decided by a majority of members, and also those that contain additional observations (preventions) by at least one member.
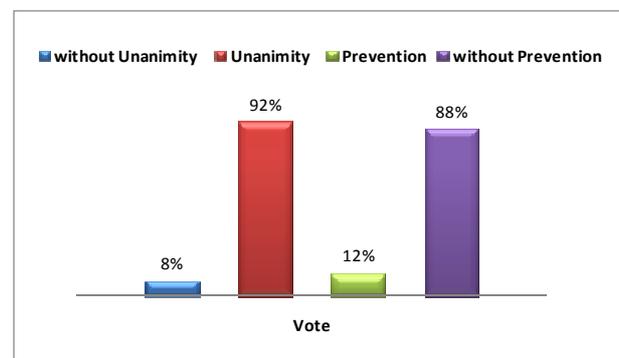
Fig. 7. Type of decision of the Experts Panel.

It can be observed that in nearly all conflicts the final decision was approved by consensus and without any observations by individual members. The reason for the consensus appears to be due to the process by which the Experts Panel arrives at decisions, with many rounds of discussions of the issues at stake, until a consensus usually appears.

VI. CONCLUSIONS AND FUTURE WORK

This paper proposes a model for the analysis of conflict resolution mechanisms in the electric sector, based on the Chilean experience in the last 20 years of market operation. The different periods are described and analyzed, focusing in the last period, which follows the introduction of the Experts Panel institution since year 2004.

The proposed models, based on Nash bargaining theory, are consistent with the historical experience of the Chilean electricity sector. During the 4 years of operation of the Experts Panel, the number of conflicts presented to the Panel has decreased, as well as in comparison to the number of conflicts under the previous procedure.

The work constitutes a first step in the formal study of conflict resolution mechanisms in power markets. Further research is

proposed for a more detailed modeling of agents behavior and their relationship with the market design performance.

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