This work analyzes the consequences of allowing retail-level competitive commercialization and the conditions that must be satisfied to make that introduction to positively contribute to economic efficiency. The relevance of the issue is outstanding, because the figure of the marketer in the electric sector in the world is relatively new and recent experiences show ample benefits if they are adequately regulated. In particular, for the Chilean case, this is especially applicable, because while the regulation does not allow competition in the retailer stage, it considers energy savings incentives that allow the interaction between generators and regulated customers, generating spaces to introduce the marketer.

To estimate the effects of competitive commercialization, a model based on the Cournot game theory is developed. With acceptable assumptions, the model allows comparing short and long-term wholesale prices in the case of a monopolistic distribution regulated with low competitive commercialization prices. The role of the competitive marketers has effects on prices that depend on their particular risk aversion. The work concludes that competitive commercialization can generate lower wholesale prices than the traditional regulated monopolistic commercialization if the marketer is able to efficiently influence the demand (i.e., through contract options).

Keywords: electricity, marketer, commercialization, retail competition, game theory

1. Introduction

The strong change that has taken place on the structure of some world electric markets in part is due to the search for schemes that promote higher competition and less governmental intervention. In addition to the three traditional segments of Generation, Transmission and Distribution, today Commercialization has been added, which is traditionally associated to distribution and is visualized as related to services connected to demand management (i.e., commercial contracts for energy supply, metering and billing).

The recent international experience shows that it is possible to separate the activities of physical transportation of the energy from the commercial activity, maintaining the distribution activity as a monopoly and allowing the free entry of competitive agents in the commercial activity. Examples of this are the cases of Colombia (with commercialization only operating with large customers), England (with commercialization even with a large concentration of the market in the generation segment), Spain (full market liberalization), Brazil (huge reform with commercialization

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and bidding system) and Norway and the NoordPool (open to an international commercialization market).

The marketer is an intermediary agent (individual or firm) that participates in the exchange of goods between producers and consumers; generally that agent does not manufacture or consume the traded good. The wholesale electric marketers (Power Marketers) actively participate in the purchase and sale of energy, depending on the mechanisms allowed in the system in which they operate, with the most common being the Pool, Power Exchange or Bidding and Bilateral Contracts. The marketer at distribution level (IEA, 2001; Littlechild, 2004) (also called Retail Marketer or Electricity Service Provider) delivers the electric supply and services to end users; its activity includes energy services, metering and billing, with the right to have access to the local distribution networks (without being owner).

Traditionally, distribution companies have been local monopolies that supply electric power to consumers under conditions and tariffs established by a regulating governmental agency. However, in some countries the concept of competitive retail commercialization has been introduced (Retail Competition) or consumers’ freedom to choose (Customer Choice) defined by Joskow in the following manner: “Retail Competition or Customer Choice would allow consumers to choose the supplier offering the price/service quality combination that best met their needs, and competing retail suppliers would provide an enhanced array of retail service products, risk management, demand management, and new opportunities for service quality differentiation based on individual consumer preferences” (Joskow, 2003).

According to Littlechild (Littlechild, 2004), most of the countries that introduced competition in generation have also introduced a certain level of competition at the end users’ level. Currently, in most of those countries at least the large industrial consumers choose their supplier. There are cases in which all consumers can choose their supplier, known as Full Retail Competition.

The competitive commercialization presents multiple advantages among which the following are important (Littlechild, 2004): i) Possibility of the consumers to choose their supplier and menus of conditions and tariffs, ii) Business opportunities for energy marketers for an unlimited potential demand; iii) Possibility to promote clean technologies; iv) Efficiency stimulation in all the links of the supply chain (both competitive and regulated); and v) Higher liquidity for the wholesale market.

In a context of traditional regulation, commercialization allows offering the consumers several types of contracts (conditions and tariffs menus) that associate products and services to the single electricity supply, such as: reliability and quality differentiated supply (for example, to allow interruptions in exchange for lower tariffs), protection against the risk of energy price instabilities, advanced metering technologies, associating the electricity supply to the supply of other basic services (gas, water, telephone, Internet services), and differentiated sales of technologies (green energy supply) (Littlechild, 2004; Joskow, 2004; Livik, 2000).
On the other hand, the competitive energy commercialization has disadvantages because its implementation requires deep changes in the traditional regulatory schemes in the countries. (Greenwood, 1999; Black and Ilic, 2001; Littlechild, 2004; Joskow, 2004). Of course, it requires a clear tariff scheme for the power transportation systems, with vertical disintegration or at least with the ownership segregation between recognized monopolistic activities and the competitive activities. Consequently, the implementation processes are complex and there is the risk that small consumers remain static in face of the offers from Retail Competition, with the potential creation of problems in the market (Joskow, 2004).

The objective of this work is determining the effect on the economic efficiency of the introduction of the commercialization in the electric sector. The issue is relevant because theoretically, there are benefits and costs, but eventually the convenience depends on the specific electric system and its regulation. Thus, an exercise on the Chilean electric market is made, with a methodology that is general and applicable elsewhere. The empirical estimation of the effects of the introduction of commercialization on the economic efficiency should constitute assistance in the policy decision-making on the subject.

The article is structured in three sections. Section 2 introduces the reality of Chilean regulation, showing a market with commercialization possibilities. Section 3 develops an analytic model that delivers a methodology to evaluate how efficient it is to introduce competitive commercialization. Section 4 presents the conclusions and summarizes results.

2. The Chilean case and its possibilities in face of the competitive commercialization.

Despite Chile was well considered worldwide because it was the pioneer in changing the classical structure of electric markets, it has stayed behind in the introduction of marketers. Effectively, the Chilean regulatory framework establishes three segments: generation, transmission and distribution, and competition is only allowed at generation level through a system of centralized Pools. This scheme has worked during the last two decades, but considering the need to generate a scenario that ensures investments for the long term electric supply and the protection of consumers against potential energy crises, Law 20,108 was issued in 2005. This new law introduced a bidding system for long-term power sales and a savings incentive in residential consumption.

Bids create a long-term market that promotes higher investments on the system’s capacity and takes to the establishment of fixed prices, which expected benefit is to decrease the market’s volatility. The risk of possible contingencies (droughts, lack of fuels) is transferred to prices, causing a price increase. To prevent this effect, the new legislation allows the generators to offer monetary premiums to the regulated customers in exchange
for savings in electricity consumption in order to decrease the demand in case of contingencies without leaving the supply stipulated in the contracts unfulfilled.

The major problem in offering incentives is the way to implement them. Generators belong to a wholesale level segment; only with negotiating experience with large size customers (unregulated customers and distributors); therefore they do not have the tools to effectively reach the regulated customers that wish to save energy. The only channel to reach them are distribution companies, but it is not clear they would collaborate considering the value to them, that is based on consumed energy. In addition, the savings in consumption unilaterally depend on the consumers, so it is not possible to ensure the decrease in demanded energy. This generates a space for the entry of the marketer agent. Although a marketer does not prevent contingencies, he can effectively manage the demand, because as he has direct contact with consumers, he can find those that are ready to stop receiving energy in exchange for economic incentives.

Considering the elements of ideal competition structures in electricity markets mentioned by Joskow (Joskow, 2004) and the international experience, it is possible to notice that the Chilean regulation has multiple constraints for the entry of competitive commercialization, because it only allows energy purchases and sales negotiations between producers, large consumers and distributors and defends the vertical integration of the commercial function and energy distribution, preventing the entry of intermediary agents (marketers). In addition, the transparency of the wheeling systems and the free access to the distribution networks is debatable. This is a crucial issue for the effective introduction of the competitive commercialization agent.

For a real competition in the current Chilean electric market, its necessary to make modifications, specially in the distribution segment: i) **Transparent distribution tariffs**; ii) **Separation of distribution and supply activities**, that can be partial or total; iii) **Free access to distribution networks**; iv) **Elimination of the node price**; v) **Allowing the commercialization of new products and services associated to the electric supply**; vi) **Market liberalization**. In relation to the last element, Figure 1 depicts a scheme of the idea developed by Paredes *et al* (Paredes, 2001), that proposes a slow increase in the potential demand of marketer companies (as is the case in Spain).
3. Description of the proposed methodology

This section analyzes the effect of introducing the competitive commercialization in the Chilean electric market. Following Green (Green, 2002) and applying the risk concepts of the studies from Grinold (Grinold, 1996), our concern is focused on wholesale prices (comparing regulated monopolistic commercialization scenarios integrated to distribution and competitive commercialization). Figure 2 represents the interaction of the agents involved in the energy commercial transactions under the scheme of monopolistic distribution and competitive commercialization (CC).
As shown in Figure 3, energy is traded at a price $P$ generated by the interaction of competitive generators and Marketers/Distributors, to which the added value of distribution for physical operation (DAV\textsubscript{physical}) and the added value for commercial operation (DAV\textsubscript{commercial}) must be added to obtain the price ($P\textsubscript{final}$), that reaches the end consumer. It is possible to think that the only difference between a regulated monopolistic distribution scheme and a competitive commercialization scheme is the efficiency in the supply commercial costs. However, the agents in one or the other scheme have different risk factors (supply flexibility, customer attrition) that are transferred into prices. A hypothesis is that the interaction among the agents can influence the wholesale price at which power is traded.

![Figure 3: Stages influencing the final power price.](image)

### A. Assumptions

The agents involved interact in two types of markets: The Short Term Market or Spot Market (it considers the annual Spot prices variations summarized in its variance), where energy is traded to satisfy the short-term demand requirements and the Long Term or Forward Market (future power sales contracts) where the amounts are traded to satisfy all or part of the demand expected in the future without making any distinction between physical and financial contracts.

The model only considers the interaction between generators and distributors/marketers, so the price in the analysis does not include the charges for DAV\textsubscript{physical} and VAD\textsubscript{Commercial}. The non-inclusion of these charges is because the goal of the model is to only study the isolated effect of the interaction between the generators and distributors/marketers \textit{ceteris paribus} the other charges that are a burden on the final energy price. Transmission costs are not considered because they affect all the demanding parties equally, and there is no influence from them when comparing results.

The generation segment is an oligopoly that has three firms that are not necessarily equal and that compete for amounts of energy that are traded at a single price per unit, or with a Cournot type of game (the selection of the three firms applies to the Chilean case (Moreno et al, 2005). Generators can exchange energy between themselves depending on their marginal costs. It is assumed that the installed power is enough to face the demand, so no capacity restrictions are added. According to Newbery (Newbery, 1997), adding capacity restrictions only makes it more difficult to solve the problem but does not give more information about the behaviour of the agents in a Cournot style game, because if a firm exceeds its capacity in the equilibrium resulting from Cournot, such firm will produce at its maximum capacity, leaves the game and the remaining demand is shared.
among the remaining oligopolistic firms in a new *Cournot* game). It is not considered possible to have any agent with market power, and due to the interest from generators to assure energy sales, they are assumed to be risk-adverse.

Buyers (distributors and marketers) must decide how much energy to buy in each market (short and/or long term), facing the inherent uncertainty due to the energy’s price volatility. The model considers that the purchase of energy depends on the specific relationship with the risk of each agent.

The regulated distribution monopolistic case assumes a traditional monopolistic distribution scheme, namely, the distributors are not allowed to negotiate individual contracts (with different supply and price conditions) with end customers. Distributor companies are equal and do not compete among themselves, with concessions that integrate the distribution and commercialization activities, and with supply-regulated tariffs. Furthermore, end customers are linked without choice to the distributor firm in charge of the local concession. On the other hand, the competitive commercialization assumes equal firms that freely compete for the electric supply of end customers (without executing any distribution activity) that can choose the energy supply firm with the possibility of changing it at zero cost. The energy sales price to end consumers is established by each specific competitive marketer in function of its benefit, considering the possibility of customer attrition due to high prices. In both cases, the costs different to the energy price are considered as nil.

**B. Generators**

Generators participate in the short term (*Spot*) and long term (*Forward*) markets. In each market, each generator must solve a benefit-maximization problem, making energy offers based on the data they have available. The energy offers define the unit price and the single price to be traded in the short-term market. For this purpose the model considers the traditional representation of the inverse demand curve given by equation (1).

\[
p = A - b \cdot \sum q_i, \quad i = \{1, 2, 3\} \quad (1)
\]

a) In the short-term market

Each generator sells a total amount of energy \(q_i\) that is disaggregated in an amount \(x_i\) sold in the long-term market (at price \(f\)) and in an amount \((q_i - x_i)\) in the short-term market (at price \(p\)). The problem of each generator is defined by:

\[
\text{Max } \Pi_i = \left[A - b \cdot \sum q_i\right] \cdot (q_i - x_i) + f \cdot x_i - c_i \cdot q_i \quad (2)
\]

where \(A\) is known at the beginning of the operations in the short-term market (because in the short term there is certainty on the cap price for technologies). Assuming that each generator plays a *Cournot* style game (its offer depends on conjectures over the rest of the offers), it is solved:
\[ A - c_i + b \cdot x_i - \sum_{j \neq i} q_j \]
\[ q_i = \frac{2 \cdot b}{2 \cdot b} = \frac{2}{2} = 1, \quad i = \{1, 2, 3\} \quad (3) \]

From expression (3), a system of equations is obtained, which solution is:
\[ A - 3 \cdot c_i + \sum_{j \neq i} c_j + 3 \cdot b \cdot x_i - b \cdot \sum_{j \neq i} x_j \]
\[ q_i = \frac{4 \cdot b}{4 \cdot b} = 1, \quad i = \{1, 2, 3\} \quad (4) \]

Substituting the \( q_i \) in the demand, \( p \) is obtained in function of the amounts sold in the forward market, that is:
\[ p = \frac{A + (c_1 + c_2 + c_3) - b \cdot (x_1 + x_2 + x_3)}{4} \quad (5) \]

b) In the long-term market

Each generator faces in the long-term market the same market it faces in the short-term one, with the exception that now \( A \) is a random variable, because it is not possible to know with certainty which will be the cap price that will exist in the future. Therefore, the \( p \) price also becomes random. With that, it has sense to define \( p^e \) as the expected value of \( p \). The problem (6) each generator faces in the long-term market corresponds to the expected benefit maximization \( \Pi_i^e \) with \( i = \{1, 2, 3\} \). Note that if \( \sigma^2 \) is the variance of \( p \), the variance of \( A \) is \( 16 \sigma^2 \).
\[ \text{Max } \Pi_i^e = (E \{ p \cdot (q_i - x_i) + f \cdot x_i - c_i \cdot q_i \}) \quad (6) \]

Or, equivalently:
\[ x_i \cdot (f - p^e) + \frac{1}{16b} \left[ A^e - 3c_i + \sum_{j \neq i} c_j - b \cdot \sum_{i} x_i \right] \cdot \left[ A^e - 3c_i + \sum_{j \neq i} c_j + 3b \cdot x_i - b \cdot \sum_{j \neq i} x_j \right] + \frac{\sigma^2}{b} \quad (7) \]

Therefore, the amount each generator must contract forward to achieve the maximum expected benefit (by first order conditions, \( \frac{\partial \Pi_i^e}{\partial x_i} = 0 \)) is:
\[ x_i = \frac{A^e - 3c_i + \sum_{j \neq i} c_j - b \cdot \sum_{j \neq i} x_j + 8 \cdot (f - p^e)}{3b - 8 \cdot \frac{\partial (f - p^e)}{\partial x_i}} \quad (8) \]

C. Marketer Integrated to the Distribution, Regulated Monopolistic Agent.

To supply energy to end consumers, the regulated monopolistic agent must choose between buying energy in the short-term, in the long-term or in both markets. The energy is delivered to end customers at a regulated price \( s \), defined as the weighted average cost of the purchases in the short-term market (with importance \( a \)) and the purchases in the
long-term market (with importance 1 - a) made by an efficient distribution firm. Other costs are assumed to be nil.
\[ s = a \cdot p + (1 - a) \cdot f \]  
(9)

The agent must deliver a total amount \( V \) of contracted energy (\( y_i \) in the forward market and \( V - y_i \) to supply the demand in the present). The expected benefit for each regulated monopolistic marketer, \( rmc \), (for \( i = \{1 \ldots n_1\} \)) is:
\[ \Pi_{cmr \_i}^e = s \cdot V - (V - y_i) \cdot p - y_i \cdot f \]  
(10)

Its variance:
\[ Var(\Pi_{cmr \_i}^e) = \left[ y_i - V \cdot (1 - a) \right]^2 \cdot \sigma^2 \]  
(11)

The problem to be solved by the regulated distributor is the maximization of its utility, considering its specific relationship with risk. Grinold (Grinold, 1996) defines an expression to be used in utility maximization (happiness) in function of the benefit and the level of risk aversion \( \lambda \):
\[ \text{Max} \left\{ E(\Pi) - \frac{\lambda}{2} \cdot Var[E(\Pi)] \right\} \]  
(12)

Using the expression given by Grinold (Grinold, 1996), the regulated marketer/distributor’s problem is:
\[ \text{Max}_{y_i} \left( p^e - f \right) \cdot \left[ y_i - V \cdot (1 - a) \right] - \frac{\lambda}{2} \cdot \sigma^2 \cdot \left[ y_i - V \cdot (1 - a) \right]^2 \]  
(13)

Solving the expression, the optimal amount of forward contracts of the regulated agent is:
\[ y_i = \frac{p^e - f}{\lambda \cdot \sigma^2} + (1 - a) \cdot V \]  
(14)

The long-term contracts are signed between agents, the \( n_1 \) regulated distributors from the \( n_1 \) local monopolies and the \( i \) generators (\( i = \{1, 2, 3\} \)), therefore:
\[ n_1 \cdot \left( \frac{p^e - f}{\lambda \cdot \sigma^2} + (1 - a) \cdot V \right) = \sum x_i \]  
(15)

Given (15), it is possible to find the relationship between the expected short-term market price (\( p^e \)) and the long-term market (\( f \)):
\[ f - p^e = (1 - a) \cdot V \cdot \lambda \cdot \sigma^2 - (\sum x_i) \cdot \frac{\lambda \cdot \sigma^2}{n_1} \]  
(16)

And the expression for its derivative:
\[ \frac{\partial (f - p^e)}{\partial x_i} = - \frac{\lambda \cdot \sigma^2}{n_1} \]  
(17)

Parameter \( a \) can be determined endogenously; because in the forward market only distributors and generators participate and under the assumption of \( n_1 \) equal distribution
firms, then all what the generators sell in the long-term market is to cover the purchase needs in the distributors’ forward market, therefore it is:

\[ \sum x_i = n_1 \cdot (1 - a) \cdot V \]  

(18)

This shows that in a regulated monopolistic market in distribution there are no surprises between the expected price and the forward price, because it is established through equation (26) that \( p^e - f = 0 \), namely, \( p^e = f \). Replacing the former relations, in expression (8), the amounts of energy traded in forward contracts result in:

\[
x_i = \frac{A^e - 3c_i + \sum_{j \neq i} c_j - b \sum_{j \neq i} x_j}{3b + 8 \cdot \lambda \cdot \sigma^2 / n_t}, \quad i = \{1, 2, 3\} \quad (19)
\]

Taking \( \theta = 3b + 8 \cdot \lambda \cdot \sigma^2 / n_t \), and solving the system of equations, the following is obtained:

\[
x_i = \frac{A - 3c_i + \sum_{j \neq i} c_j - \theta \cdot b \cdot \left(A - 5c_i + 3 \cdot \sum_{j \neq i} c_j\right)}{(\theta - b) \cdot [\theta + 2b]} \quad (20)
\]

D. Competitive marketers

In this scenario, \( n_2 \) marketers compete for the energy supply to end customers. Each marketer faces a potential end consumers’ market that demand an energy amount \( V \). The energy is offered at a final price \( r \) and consumers can change from one marketer to another at a ratio \( h \), that represents the distance of price \( r \) (offered by a marketer) compared to the short-term market price \( p \). The demand curve faced by a specific marketer is defined as \( q = V - h(r - p) \) if \( r \geq p \), or \( q = V \) if the contrary is the case.

If \( y_2 \) is the future amount required, bought at price \( f \), it happens that the expected benefit of each competitive marketer, \( cc \), (for \( i = \{1 \ldots n_2\} \)) is:

\[
\text{Max } \Pi_{cc \_i} = [V - h \cdot (r_i - p)] \cdot (r_i - p) + y_2 \cdot (p - f) \quad (21)
\]

The value of \( r_i \) will be chosen in order to maximize the expected benefit, therefore:

\[
\Pi_{cc \_i}^e = \frac{V^2}{4 \cdot h} - y_2 \cdot (f - p^e) \quad (22)
\]

Its variance: \( \text{Var}(\Pi_{cc \_i}^e) = y_2^2 \cdot \sigma^2 \)  

(23)

Using the utility function defined by Grinold (Grinold, 1996) (12), the problem of the competitive marketer is:
Max \( x \left\{ \frac{V^2}{4 \cdot h} - y_2 \cdot (f - p^e) - \frac{\lambda}{2} \cdot y_2^2 \cdot \sigma^2 \right\} \) \quad (24)

Then, the amount of forward contracted energy by a competitive marketer is given by (25), that shows that for the competitive marketer it only has sense to buy in the forward market if \( p^e > f \).

\[
y_2 = \frac{p^e - f}{\lambda \cdot \sigma^2} \quad (25)
\]

If all long-term contracts are signed between the agents, the \( n_2 \) competitive marketers and the \( i \) generators, we have:

\[
n_2 \cdot \frac{p^e - f}{\lambda \cdot \sigma^2} = \sum x_i \quad (26)
\]

With that, the ratio between the short-term \( (p^e) \) and the long-term \( (f) \) market expected price is found.

\[
f - p^e = \frac{-\left( \sum x_i \right) \cdot \lambda \cdot \sigma^2}{n_2} \quad (27)
\]

And the expression for its derivative is:

\[
\frac{\partial(f - p^e)}{\partial x_i} = -\frac{\lambda \cdot \sigma^2}{n_2} \quad (28)
\]

Substituting the former terms in expression (8) and reordering, we have that the forward amounts offered by the generators are (for \( i = \{1, 2, 3\} \)):

\[
x_i = \frac{A^e - 3c_i + \sum_{j \neq i} c_j - \sum x_j \cdot \left( b + 8 \cdot \lambda \cdot \sigma^2 / n_2 \right)}{3 \cdot b + 16 \cdot \lambda \cdot \sigma^2 / n_2} \quad (29)
\]

To simplify the calculations, it is convenient to assume that \( \gamma = 3b + 16 \cdot \lambda \cdot \sigma^2 / n_2 \) and that \( \beta = b + 8 \cdot \lambda \cdot \sigma^2 / n_2 \). Solving the system of equations, we have that:

\[
x_i = \frac{\left( A^e - 3c_i + \sum_{j \neq i} c_j \right) \cdot \gamma - \beta \cdot \left( A^e + 5c_i - 3 \cdot \sum c_j \right)}{(\gamma - \beta) \cdot \left( \gamma + 2\beta \right)}, \quad i = \{1, 2, 3\} \quad (30)
\]

Finally, to see an estimated behaviour of the energy price, it is necessary to consider a weighted average price between the short-term and the long-term market.
4. Application for Chile

The model produces different results between the regulated monopolistic commercialization (RMC) and the competitive commercialization (CC). In the case of RMC, the monopolistic agents have their sales prices regulated, customers can not change their supplier and the long-term market prices are equal to the expected price. On the other hand, CC offers unregulated prices, customers can change their supplier and the long-term market prices are not necessarily equal to the expected prices. Considering these issues, it is possible to note that CC faces greater uncertainty than RMC, at that makes it to be expected (ceteris paribus) that CC will transfer the uncertainty to the prices, increasing them compared to RMC.

Equations (20) and (30) constitute the base of the model. Based on these equations, we can infer the effect of commercialization in prices and amounts. This requires concrete information about the group of related parameters, particularly, the values of those parameters for the specific Chilean case. It is assumed that at least the same distribution companies will be the ones that would participate under competition ($n_1=n_2=9$). Parameter $b$ (slope of the demand curve) is estimated based on its known mathematical relationship with the price elasticity. According to equation (1), each value of $b$ defines a specific value of parameter $A$, as shown in Table 1. Parameter $c_i$ ($i = \{1, 2, 3\}$) corresponds to the marginal cost of each firm $i$, that is considered constant, following the trend of multiple economic models that include the Cournot games theory; Table 2 gives the estimated values based on public information.

<table>
<thead>
<tr>
<th>Time</th>
<th>Elasticity ($E_d$)</th>
<th>$b$</th>
<th>$A$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Term</td>
<td>-0.70</td>
<td>59.4376</td>
<td>150.5185</td>
</tr>
<tr>
<td>Medium Term</td>
<td>-0.35</td>
<td>45.8518</td>
<td>123.4286</td>
</tr>
<tr>
<td>Long Term</td>
<td>-0.39</td>
<td>41.1491</td>
<td>114.0513</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model Company</th>
<th>Real Company</th>
<th>CMg [US$/MWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company 1</td>
<td>ENDESA</td>
<td>47.63</td>
</tr>
<tr>
<td>Company 2</td>
<td>Colbún</td>
<td>52.09</td>
</tr>
<tr>
<td>Company 3</td>
<td>AES Gener</td>
<td>63.97</td>
</tr>
</tbody>
</table>

The most interesting estimation corresponds to the risk aversion coefficient ($\lambda$) that allows making a sensitivity analysis on the model’s results. For that purpose, the financial investor problem is used. The investor decides to risk $aW$ ($a$ takes values between 0 and 1) in the stock market (with a rate of return $m$) and therefore $(W - aW)$ in risk-free instruments (with a risk-free rate of return $t$). Hence, the problem to be solved by the
investor is finding the portfolio that maximizes his utility on the investment. Using this utility function defined by Grinold (Grinold, 1996) (12), we have:

\[
\lambda = \frac{m - t}{\alpha \cdot W \cdot \text{var}(m)} \quad (31)
\]

For the Chilean case, \(m\) is 20.15% with a variance 0.3673, \(t\) is 6.35% and the equity of the electric distributor investor (utility of the sector) \(W\) is 2.65 in units of thousand US$. The rates are estimated based on the monthly IGPA\(^2\) values and risk-free bonds between years 1960 and 2000.

When adding the specific parameters of the Chilean system to the model, it happens that the weighted average price under competitive commercialization becomes higher (independent from the level of risk aversion) than the case of regulated monopolistic commercialization. This result is shown in Figure 4 and it agrees with the transfer of the higher uncertainty faced by the agents under CC to the prices. The Low, Medium and High elasticities correspond to the elasticities calculated for the specific Chilean case in the short (0.27%), medium (0.34%) and long (0.39%) terms, respectively (Galetovic et al., 2005).

![Figure 4: Comparison between the weighted average prices of wholesale markets under monopolistic and competitive commercialization for Low, Medium and High elasticity.](image)

The analysis shows that competitive commercialization at retail level is not socially appealing, as it would generate, as an average, higher wholesale prices than a

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\(^2\) The IGPA is an index that clusters almost all the stock exchange shares traded and its purpose is to measure share price variations in the long-term context.
commercialization scheme that is integrated to the regulated monopolistic distribution. Such conclusion agrees with the initial results obtained by Green (Green, 2002).

However, the previous analysis does not consider the own characteristics of the marketer. By definition, the marketer supplies energy to end customers negotiating the terms of the contract regarding prices and associated services. Then, the consumption flexibilization produced by the competitive commercialization will be added, and that will be reflected in the price elasticity of the demand.

A regulated monopolistic commercialization assumes that the industry faces a specific demand. In the short term, the residential demand is more inelastic (namely, it has less capacity to react to price variations) because the electric energy is a basic commodity and a price variation will not make the consumers to change their consumption immediately based on their own decision. In the Chilean case, despite the tariffs are differentiated by connected power, the monopolistic distributors currently do not have a way to convince their residential consumers to react quicker in the short run in face of a potential price increase. On the other hand, as competitive marketers offer to their users more flexible conditions and tariff assortments, they get hold of a tool that can influence the demand’s behaviour, making the market to face a demand that has a different elasticity than the case without competitive commercialization and even causing additional changes in case of contingencies. For example, this flexibility would mean that if the consumers’ prices are increased at a specific moment in exchange for reducing them in another moment, this would take to the purchase of technology that allows stopping their consumption at moments when energy is more expensive (for example, through self-generation or purchasing more efficient devices).

The former is consistent with Paredes (Paredes, 2004) in his study on peak hours. The study establishes that peak hours must be defined in function of how much it is possible to affect that amount demanded and of the available technology to supply – with a long-term criterion – a higher demand at specific moments. The consumers’ decisions are affected both by direct contracts they can sign among themselves or other generators and by the possibility of having the opportunity to choose from a whole menu of tariff structures. As a corollary derived from the economic theory, it is concluded that as higher the certainty on peak hours and tariff menus, more elastic the demand will be, as the consumers will choose the most adequate and efficient technological options to supply their energy needs during peak hours.

Competitive commercialization would allow the existence of actually adapted tariff menus to make consumption more flexible. The competitive marketer can negotiate the terms of supply with each consumer; namely, he can create a customer portfolio taking advantage of the different energy needs and readiness to pay. With that, consumers would have a range of firms and options from where to choose (a sample of this is the international experience with interruptible supply contracts, remote load management, saving premiums, etc.). Through contracts it is possible to achieve greater certainty about the consumption that allows to accurately estimate the demand behaviour. The marketers
give to their customers the tools (or, in other words, ties them up with contracts) to change the demand in an efficient manner.

Assuming that competitive marketers achieve a change in the demand curve, a short term elasticity of 0.39% (High level) in absolute terms is assumed, while the monopolistic distributors can only have a demand with 0.27% of elasticity (Low level). Figure 5 shows the same trend obtained by Green (Green, 2002) comparing the weighted average prices of wholesale markets with regulated monopolistic commercialization (RMC) versus competitive commercialization (CC).

![Figure 5: Comparison of the weighted average price in wholesale markets between the regulated monopoly commercialization (Low elasticity) and competitive commercialization (Low elasticity).](image)

For a level of risk aversion of 0.14, the prices under CC are 3.58% more expensive than RMC prices; on the other end, for the higher level of risk aversion (1.44), the difference increases to 4.11%. From Figure 5, it is concluded that the prices under CC are higher than under RMC, independent from the risk aversion of the agents. This conclusion is the same one as Green’s (Green, 2002) conclusion under the ceteris paribus assumption, which assumes that the demand curve faced by monopolistic marketers is the same one as the one for competitive marketers.

However, when comparing a possible short-term scenario where monopolistic marketers face an inelastic demand (Low elasticity) with the short-term scenario where competitive marketers would face the more elastic demand (High elasticity or long term elasticity for the monopolistic case), the trend in Figure 5 is reverted and CC has lower prices than RMC, independent from the risk aversion level; as shown in Figure 6. In this case, the prices under CC are lower than under RMC between 2.94% (for the risk aversion level of 0.14) and up to 6.26% (for the risk aversion level of 0.144).
Figure 6: Comparison of the weighted average price in wholesale markets between the regulated monopoly commercialization (Low elasticity) and competitive commercialization (High elasticity).

The recent analysis assumes that the existence of competitive commercialization produces a change in the demand curve (the demand is more elastic) compared to the demand curve faced by regulated monopolies.

But: Why a change in flexibility or in the contract options could be translated in a change in the demand curve? The answer is not unique or absolute. Competitive commercialization can generate different supply contract alternatives differentiated in various aspects. Energy metering can be different depending on the technology available, energy charges, security levels, etc. Depending on the efficacy of the tools used by competitive marketers, it is possible to achieve permanent changes in the behaviour of the consumers (for example, if self-generation is promoted, probably there will be a general decrease in consumption during historical peak hours).

For example, we will assume that marketers can offer supply security contracts. Under normal conditions, if there is rationing, the supply outage is equal for all customers; however, there are some customers that would be open to stop consuming in exchange for economic premiums while others are open to pay extra for not having supply outages.

Make $\overline{v}$ the cost of securing the supply. As shown in Figure 7, the consumers in segment AM are open to pay a higher price for energy because that generates surplus above the cost of securing the supply. On the other hand, consumers that are located exactly in point M, are indifferent to consume secure or unsecured energy, because their surplus is equal to the cost of securing the energy. Finally, for consumers in segment MN it is not attractive to secure the supply because the supply security has a cost that is higher than the surplus generated from their electricity consumption. Given the former, it has sense having the marketers selling secure supply contracts to those consumers that are in segment AM.
The economic theory states that the supply security contract price $\Omega(Q)$ is related to the consumer’s surplus when he receives energy (or when he stops receiving it). In this case, it is assumed that the higher value of $\Omega(Q)$ is equal to the value of the surplus with the probability of supply outage $\Theta$. Therefore, $\Omega(0) = (p - \bar{u}) \cdot \Theta$, that is consistent with Figure 7.

The security contract offered by a marketer applies when there is a risk of supply outage, allowing the consumers that receive energy to pay more for it, while the consumers that do not receive energy receive a bonus. The new curve determined by the energy price is given by $D_2$ (see Figure 8).
It is clear that curve $D_2$ has a point that cannot be differentiated, so it cannot be considered as an input for the model developed. Therefore, we must divide the curve into two straight lines ($D_3$ and $D_4$) as shown in Figure 9 and look for a Cournot equilibrium point given by the proposed model that results in a higher economic value. $D_3$ represents the demand curve if in case of contingency only the ones that the contract allows to be supplied receive the energy and there is no bonus (compensation) for the ones that do not receive the supply. On the other hand, $D_4$ represents the demand curve if in case of contingency the consumers that stop receiving energy receive a bonus in return.

To illustrate the former, we will present a numerical example. Let us assume that the cost to secure the supply is equivalent to the average marginal cost of coal generation (therefore, $\bar{u} = 50$ US$/MWh$). We will assume that the failure probability of the system is 30%, so $\Theta = 0.3$. Under these conditions, a contingency occurs and the contract-secured capacity is reduced to one half (namely, $Q_c/2$). Figure 9 shows the key points for the theoretical analysis of the situation and the surcharge value for secured energy $\Omega(p)$.

If the capacity is reduced to one half, when looking at the lower chart of Figure 9, it is possible to see that the maximum surcharge to be paid by the ones who receive energy is $\Omega(A)$, while the maximum bonus is $\Omega(A)/2$. Hence, curve $D_4$ is determined by points $(Q_c/2, p(Q_c/2))$ and $(p(Q_c), \bar{u} + \Omega(A)/2)$.

![Figure 9: Relevant points to estimate the equilibrium in a new demand curve](image)

When inserting curves $D_3$ and $D_4$ in the model developed in section 3, we have that the equilibrium that gives the highest economic efficiency (lower price and highest amount...
of energy) is found in curve $D_4$, domain that also belongs to curve $D_2$ (shown in Figure 8). Such results are shown in Table 3; and from them, it is possible to conclude that the competitive commercialization tools (such as the supply security contracts) can change the demand curve. If the marketers achieve to influence the demand curve, they can obtain prices that are economically more efficient compared to the traditional regulated monopolistic commercialization.

Table 3
Comparison of market equilibriums with and without supply security contracts.

<table>
<thead>
<tr>
<th>Curve</th>
<th>Equilibrium Type</th>
<th>$P$ [US$/MWh]</th>
<th>$Q$ [GW]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Demand</td>
<td>CC</td>
<td>71.712</td>
<td>1.326</td>
</tr>
<tr>
<td>$D_4$</td>
<td>CC</td>
<td>69.982</td>
<td>1.573</td>
</tr>
</tbody>
</table>

5. Conclusions

The methodology presented represents an electrical system with a generation park of three agents competing Cournot style and that allows analyzing the effect of introducing the competitive commercialization on wholesale prices in an electric market. In particular, an exercise is presented with parameters from the Chilean electric market that is used to compare the current case of the regulated monopolistic distribution segment with the potential case of a competitive supply commercialization.

When comparing the regulated energy supply and the ceteris paribus competitive supply, the wholesale prices for the case of regulated monopolistic commercialization are socially appealing (namely, they are lower prices) than the case of the competitive commercialization. However, when considering that the competitive commercialization can achieve changes in the demand curve that can be reflected in the curve’s elasticity, the results change radically. If the commercialization through conditions and tariffs menus can change the demand curve in the correct direction, it can obtain wholesale prices that are lower than the regulated monopolistic commercialization, and the latter one looses the economies of scale that justified it in the first place.

The electric energy marketer both at wholesale and retail level is a competitive agent that is feasible to be introduced in electric markets, contributing to higher flexibility and liquidity in electric systems. The electric energy demand is not necessarily inelastic in the short term, because it depends on the market structure and participating agents. The commercialization could introduce space for changes in favour of economic efficacy.

Risk is an important factor that influences prices. The marketer can manage the demand’s decreasing risks; for example if there is the possibility to ration supply due to lack of capacity, the marketers would be able to manage the consumers’ loads through contracts and technology; and that is translated into a decrease in risks, which is transferred to the prices.

The main conclusion for the Chilean electric system is that the Chilean market could rescue the benefits of the competitive commercialization at industrial/commercial level
and more slowly at residential level. The introduction of the marketer as a competition agent in the Chilean electric market could be the next step to face the demand growth, the increase in capacity requirements and the future supply crises in the Chilean electric sector.
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