PRICE AND ACCESS CHARGE DISCRIMINATION IN ELECTRIC DISTRIBUTION: AN APPLICATION TO THE CHILEAN CASE[†]

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Abstract: Under the assumption that the firm has better information than the regulator we analyze a model for electricity distribution pricing where distribution basic cost are independently calculated, but the monopolist is allowed to set discriminatory prices in terms of consumers demand functions being subject to some constraints to induce the convergence of the firm solution to the social optimum. Two classes of constraints are analyzed, a price cap as proposed by Laffont and Tirole (1996), and a physical cap with prices restricted to be between the marginal cost and the stand-alone cost. The physical cap is a specific application for electricity distribution, using biases of the power coincidence factors used as a criteria for cost assignation, restricting the firm to balance the power distributed and the peak power sold. The model is calibrated with Chilean data, being demonstrated that through the proposed model an increment in the benefit of the firm, the consumers, and consequently, in social welfare, can be achieved. Among other factors, the magnitude of the achieved benefit depends on the price elasticity of the involved demands.

I INTRODUCTION

Worldwide the electric sector is experiencing deep structural changes, evolving from integrated state companies, toward disintegrated and private companies where many segments of the industry are treated as potentially competitive. Within this process, regulation have evolved to incentive economic efficiency and increase social welfare promoting competition wherever is possible.

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In this paper we propose a model to regulate electricity distribution allowing de distribution company (DISCO) to price discriminate in tariffs and access charges. The efficiency of the model is analyzed in terms of social welfare, consumer surplus and DISCO profits. In terms of a quantitative assessment, the model is applied to the case of electricity distribution in Chile.

The socially optimal price setting for multi-product firm was determined by Ramsey (1927). Lately many others have proposed the use of Ramsey solution to set prices on regulated industries. For example, Laffont and Tirole (1996) use Ramsey prices to set access charges in network infrastructure industries, where they also suggest the use of a price cap constraint on the firm if it is going to be allowed to set prices; Baumol and Willig[1] proposed to restrict de company price discrimination having the incremental cost as a floor and the stand-alone cost as a ceiling, expecting by this way to prevent a predatory behaviour by the monopolist.

In Chile regulated distribution tariffs are set by the regulator assigning a basic cost to the different tariffs, the basic cost called Distribution Value Added (DVA) is calculated through a yardstick competition mechanism for an efficient DISCO. The DVA correspond to the efficient cost of distribution for one unit of peak power coincident with the maximum load of the distribution system. The proposed model is also based in a distribution basic cost, but to allow price discrimination when the tariff formulas are set, the demand functions of the different kinds of consumers are included.

Under this scheme and with the assumption that the firm has better information than the regulator, the monopolist set its price policy incorporating some constraints to induce the DISCO solution to approach the social optimum. In this way, two classes of constraints are analysed, a price cap and a physical cap where prices are restricted to lay between the marginal or incremental cost and the stand-alone cost. The physical cap is specifically designed for electricity distribution, and uses a deviation from the coincidence factors of the power to set prices, restricting the company to balance the power distributed and the peak power sold.

[1] See Laffont – Tirole (1996)

II MODEL OF TARIFFS AND ACCESS CHARGES OF ELECTRICITY DISTRIBUTION

The final objective in the regulation of a monopoly is social welfare. For it, the regulator should settle down mechanisms to stimulate the efficient allocation of resources and to promote competition whenever is possible under the assumption that it enlarges social welfare, where the main difficulty is to design a model with a set of rules and contracts that balance objectives and incentives, and to get the necessary information to feed these models.

For example, the *Rate of Return* tarification model has the advantage of being able to determine in an easy and objective form the tariff level, assuring the cost recovery to the firm, where it uses accounting cost information; however, it provides not efficient investment incentives (Averch and Johnson, 1962). On the other hand, models as the *Price Cap* incentive the efficiency in the assignment of resources, but they require great quantity and quality of costs information, it is needed to speculate about future efficiency improvements and demand projections to determine the weights of the index price cap. And to apply *Ramsey* prices it is required to know the demand functions or their elasticities.

In a network with an open access scheme, to incentive competition in the sell of electricity through the electricity distribution network is fundamental to set appropriate access charges, where their determination should be transparent to all the agents in a way that access charges cannot be used as a barrier against potential competitors.

2.1 Model assumptions

It will be studied a homogeneous good model of a natural monopoly in electricity distribution. In general, in electricity distribution are broken some of the conditions needed for a competitive industry, having one DISCO that provides the electricity distribution service, the existence of scale and scope economies and sunk cost that mean entry barriers for new competitors.

In our experiments with alternative tariff structures, their efficiency will be measured against the solution of a benevolent Social Planner Ramsey problem. However, since our experiments allow for price discrimination, they will benefit some consumers and detriment others so Pareto optimality conditions are not satisfied.

Without loss of generality, it will be studied the case of a company with just one voltage level and present in one electricity distribution typical area, where the good traded is peak load power. We will assume that in the purchase and sale of energy distribution there is no margin. The maximum demand of the distribution system coincides with the maximum power bought by the distributor.

The costs of the network owner are peak power purchase costs and peak load power distribution costs. Let C_{PM} be the purchase cost of peak power incurred by the firm. In general these costs have constant returns to scale without a significant fixed cost, so it will be represented as:

$$C_{PM} = c_{PM} \cdot Q \tag{2.1}$$

where c_{PM} is the marginal cost (and the average cost) of buying one unit of peak load power, where Q corresponds to the peak load power in physical units (KW). This value is obtained carrying out a physical balance of peak load power of the firm subject to regulation.[2] It will be assume a technological coefficient of power production equal to one, by which to sell one unit of peak load power is required to buy one unit of power (null losses). Let C_D be peak load power distribution cost of the firm that depends on the distributed peak load power Q.

[2] It will be understood that the peak load power correspond to the coincident power, the power measured at the date and hour of the annual maximum demand of the distribution system that also, by the supposition previously indicated, coincides with the hour of maximum purchase of power.

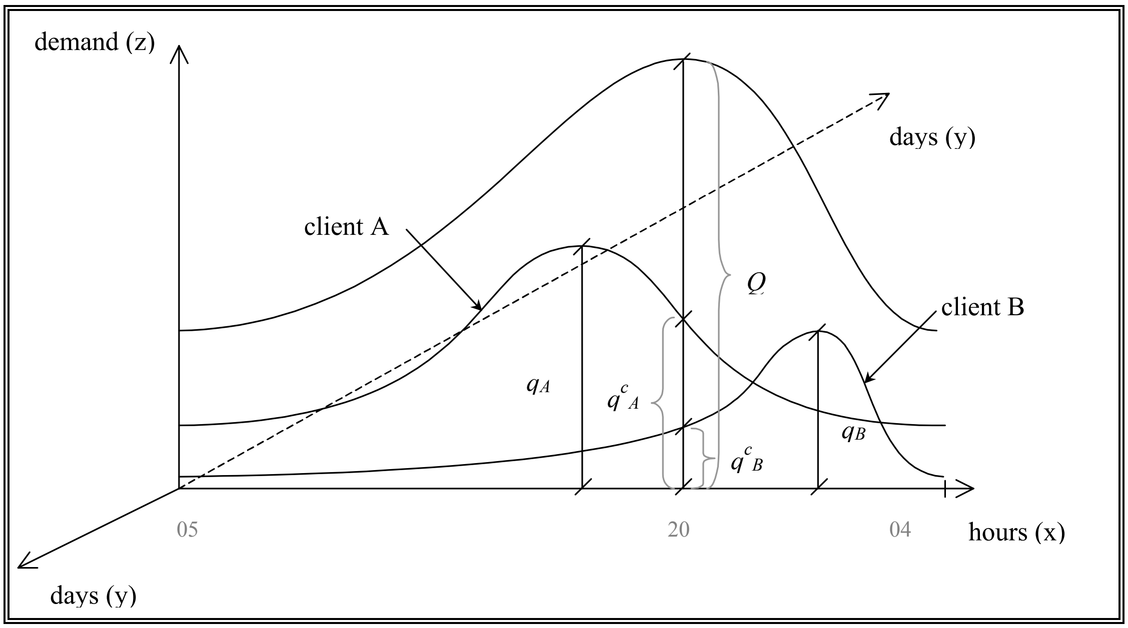

Figure 2.1: Load Profiles

Figure 2.1 is a load graph, at an individual and aggregate level, where the x axis indicates time of day, the y axis indicate the day of the year (365 days in a year), and the z axis indicates electricity consumption or load. On the graph the day of maximum load of the system is shown, with two hypothetically clients *A* and *B* whose billed powers, q_A and q_B, correspond to each client's respective maximum demands.[3] At the distribution system peak load, *Q*, the powers $q^c{}_A$ and $q^c{}_B$ correspond to the contribution that each of the clients makes to the peak of the distribution system, and we are going to denote them as coincident power. We define the coincidence factor, *f*, for each of the consumption as:

$$f_A = \frac{q_A^c}{q_A} \tag{2.2}$$

[3] For bigger clarity of the illustration, it has been supposed the individual maximum demands the same day of the maximum demand of the system, but it can be in any day.

$$f_B = \frac{q_B^c}{q_B}$$

The supply of energy is assumed to be potentially competitive, open to third parties sellers that contract the access services or network use with the DISCO. The model is one where DISCO produces three goods, power at a tariff 1, power at a tariff 2, and the access services, in quantities q_1, q_2 and q_3, respectively. For simplicity we will assume that each client consume only one of the three goods. This is consistent with the reality, since the clients choose the tariff option more appropriate to their consumption characteristics, what also makes very difficult that they could change to tariff.[4]

Because individual loads have peaks at different instant of time, the distribution system is affected by cost subaditivity, since the distribution system peak load is smaller than the sum of the individual maximum loads. Thus, the capacity distribution cost function is related with the quantities of coincident power. The cost function of the DISCO is:

$$C(q_1^c, q_2^c, q_3^c) = C_D(q_1^c + q_2^c + q_3^c) + C_{PM}(q_1^c + q_2^c) \tag{2.3}$$

where

$$q_i^c = f_i q_i \quad i = 1,2,3. \tag{2.4}$$

$$Q = q_1^c + q_2^c + q_3^c = f_1 q_1 + f_2 q_2 + f_3 q_3 \tag{2.5}$$

$$Q_M = q_1^c + q_2^c = f_1 q_1 + f_2 q_2 \tag{2.6}$$

Q represents the peak load of the distribution system, and Q_M the power sold by the DISCO. The DISCO prices of the three goods (power tariff 1, power tariff 2 and access) are p_1, p_2 and a, respectively. These prices will be expressed as:

$$p_1 = \alpha_1 f_1 p_D + f_1 p_P$$

[4] For example the typically residential BT-1 tariff is for a maximum capacity of 10 kW, the typically industrial BT-4.3 tariff is not cost effective for residential customers given the cost of the meters needed.

$$p_2 = \alpha_2 f_2 p_D + f_2 p_P \tag{2.7}$$

$$a = \alpha_3 f_3 p_D$$

where

$$p = p_D + p_P \tag{2.8}$$

p_D and p_P are predetermined distribution and peak power prices, and α_1, α_2, and α_3 are free variables that at the end allow us to change final prices. Our interest is to analyze price discrimination in distribution, it is for that reason that we apply the factors α_i to the corresponding price component p_D.[5]

In this way DISCO profits are:

$$\begin{aligned}\Pi_1 = {} & p_1 q_1(p_1) + p_2 q_2(p_2) + a q_3(p_3) \\ & - C_D(f_1 q_1(p_1) + f_2 q_2(p_2) + f_3 q_3(p_3)) \\ & - C_{PM}(f_1 q_1(p_1) + f_2 q_2(p_2))\end{aligned} \tag{2.9}$$

The behavior of the competitive fringe will be summarized in a peak load seller company that produces peak load q_3 at a tariff 3, where for each unit sold the company should pay an access charge a to the DISCO. The peak load seller company has a peak load purchase cost C_{PE}:

$$C_{PE}(f_3 q_3) = c_{PE} f_3 q_3 \tag{2.10}$$

Since this good is offered in a competitive way, its price is equal to the marginal cost:

$$p_3 = a + c_{PE} f_3 \tag{2.11}$$

In this way peak load seller company profits are:

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[5] Also is feasible to apply discriminatory factors to P_P, but in our particular case it can be demonstrated that it is of no value, and that in the case of the physical cap it implies a different set of factors (see Physical Cap).

$$\Pi_2 = p_3 q_3(p_3) - a q_3(p_3) - c_{PE} f_3 q_3(p_3) \tag{2.12}$$

It is supposed that the demand of each good only depends on it's own price, thus cross elasticities don't exist.

Let $V(q_1, q_2, q_3)$ be the aggregated gross consumer benefits, then consumer's surplus is:

$$\Pi_C = V(q_1(p_1), q_2(p_2), q_3(p_3)) - p_1 q_1(p_1) - p_2 q_2(p_2) - p_3 q_3(p_3) \tag{2.13}$$

For a Utilitarian Social Planner the social benefit is given by the sum of consumers' plus producers' surplus:

$$\begin{aligned} \Pi_S = {} & V(q_1(p_1), q_2(p_2), q_3(p_3)) \\ & - C_D(f_1 q_1(p_1) + f_2 q_2(p_2) + f_3 q_3(p_3)) \\ & - C_{PM}(f_1 q_1(p_1) + f_2 q_2(p_2)) - C_{PE}(f_3 q_3(p_3)) \end{aligned} \tag{2.14}$$

Maximization of Utilitarian Social Planner objective function is subject to companies nonnegative profits constrain, where choice variables are power tariff 1, power tariff 2, and access charge, where distribution price p_D and peak load power price p_P have been previously determined by some other mechanism.[6]

The regulator, in possession of the efficient global prices, looks to maximize the social benefit through the differentiation of the prices for the diverse segments.

With these objectives, the prices and charges can be deviated from the assignment by costs made when determining p_D and their effective coincidence factors (f_i) through the application of factors $\alpha_i \neq 1$.

2.2 Self-financing of the Firm: Social Optimum

In network services exist a fixed cost to be recovered, then the social planner chooses $\alpha_i \geq 0 \quad i = 1,2,3$ to determine power tariff 1, power tariff 2, and

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[6] In the case of Chile, p_D is calculated through Yardstick Competition, while p_P is based on projected marginal costs.

access charge that maximize social welfare (2.14) subject to the constraint that the DISCO profits are (2.9) bigger or equal to zero.

In the Lagrangean function of the optimization problem λ is the shadow price of the DISCO budget constraint.

$$\begin{aligned} L = {} & V(q_1(p_1), q_2(p_2), q_3(p_3)) \\ & - C_D(f_1 q_1(p_1) + f_2 q_2(p_2) + f_3 q_3(p_3)) \\ & - C_{PM}(f_1 q_1(p_1) + f_2 q_2(p_2)) - C_{PE}(f_3 q_3(p_3)) \\ & + \lambda(p_1 q_1(p_1) + p_2 q_2(p_2) + a q_3(p_3) \\ & \quad - C_D(f_1 q_1(p_1) + f_2 q_2(p_2) + f_3 q_3(p_3)) \\ & \quad - C_{PM}(f_1 q_1(p_1) + f_2 q_2(p_2))) \end{aligned} \tag{2.15}$$

Solving first order conditions for α_1, α_2 and α_3 that in turn define $p_1(\alpha_1)$, $p_2(\alpha_2)$ and $p_3(\alpha_3)$, according to the equations (2.7) and (2.11), it is obtained:

$$p_1 - (C_D^Q + c_{PM}) f_1 = \frac{\lambda}{1+\lambda} \frac{p_1}{\eta_1} \tag{2.16}$$

$$p_2 - (C_D^Q + c_{PM}) f_2 = \frac{\lambda}{1+\lambda} \frac{p_2}{\eta_2} \tag{2.17}$$

$$p_3 - (C_D^Q + c_{PE}) f_3 = \frac{\lambda}{1+\lambda} \frac{p_3}{\eta_3} \tag{2.18}$$

where $C_D^Q = \dfrac{\partial C_D}{\partial Q}$ and $c_{PM} = \dfrac{\partial C_{PM}}{\partial Q_M}$. From (2.18) and (2.11) we obtain the optimal access charge:

$$a = C_D^Q f_3 + \frac{\lambda}{1+\lambda} \frac{p_3}{\eta_3} \tag{2.19}$$

As in Laffont and Tirole (1996), the obtained prices are Ramsey prices that exceed the marginal cost since there exists fixed costs to recover, where the additional margin that is charge over the marginal cost of each good is inversely related to the price elasticity of each good as it is shown next:

$$\frac{\left[p_1-(C_D^Q+c_{PM})f_1\right]/\,p_1}{\left[p_2-(C_D^Q+c_{PM})f_2\right]/\,p_2}=\frac{\eta_2}{\eta_1} \tag{2.20}$$

$$\frac{\left[p_2-(C_D^Q+c_{PM})f_2\right]/\,p_2}{\left[p_3-(C_D^Q+c_{PE})f_3\right]/\,p_3}=\frac{\eta_3}{\eta_2} \tag{2.21}$$

$$\frac{\left[p_3-(C_D^Q+c_{PE})f_3\right]/\,p_3}{\left[p_1-(C_D^Q+c_{PM})f_1\right]/\,p_1}=\frac{\eta_1}{\eta_3} \tag{2.22}$$

2.3 Physical Cap: Firm Optimum

As was defined in (2.7), prices p_i and access charges can be biased from distribution price p_D and the effective coincidence factors (f_i) through the application of factors $\alpha_i \neq 1$. DISCO revenues are $p_1q_1 + p_2q_2 + aq_3$, using (2.7) we obtain ($\alpha_1 f_1 q_1 + \alpha_2 f_2 q_2 + \alpha_3 f_3 q_3) p_D + (f_1 q_1 + f_2 q_2) p_P$, where $\alpha_1 f_1 q_1 + \alpha_2 f_2 q_2 + \alpha_3 f_3 q_3 = Q$. This last constraint is what we are going to denominate the DISCO physical cap:

$$\alpha_1 f_1 q_1 + \alpha_2 f_2 q_2 + \alpha_3 f_3 q_3 = f_1 q_1 + f_2 q_2 + f_3 q_3 = Q \tag{2.23}$$

$$\alpha_i \geq 0 \quad i = 1,2,3$$

Subject to the physical cap (2.23), the DISCO will maximize its utility (2.9), where he is left free to choose α_1, α_2, and α_3, and with them p_1, p_2, and a, according to equations (2.7) and (2.11).

The Lagrangean of the DISCO optimization problem is:

$$\begin{aligned} L = {} & p_1 q_1(p_1) + p_2 q_2(p_2) + a q_3(p_3) \\ & - C_D(f_1 q_1(p_1) + f_2 q_2(p_2) + f_3 q_3(p_3)) \\ & - C_{PM}(f_1 q_1(p_1) + f_2 q_2(p_2)) \\ & + \lambda(\alpha_1 f_1 q_1(p_1) + \alpha_2 f_2 q_2(p_2) + \alpha_3 f_3 q_3(p_3) \\ & \quad - f_1 q_1(p_1) - f_2 q_2(p_2) - f_3 q_3(p_3)) \end{aligned} \tag{2.24}$$

where λ is the DISCO shadow price of the physical cap constraint. Solving the first order conditions for α_1, α_2 and α_3 that in turn define $p_1(\alpha_1)$, $p_2(\alpha_2)$ and $p_3(\alpha_3)$, is obtained:

$$p_1 - (C_D^Q + c_{PM})f_1 = \frac{p_1}{\eta_1} + \frac{\lambda}{1+\lambda}(p - C_D^Q - c_{PM})f_1 \tag{2.25}$$

$$p_2 - (C_D^Q + c_{PM})f_2 = \frac{p_2}{\eta_2} + \frac{\lambda}{1+\lambda}(p - C_D^Q - c_{PM})f_2 \tag{2.26}$$

$$p_3 - (C_D^Q + c_{PE})f_3 = \frac{p_3}{\eta_3} + \frac{\lambda}{1+\lambda}(p_D - C_D^Q)f_3 \tag{2.27}$$

With equation (2.11) we obtain the optimal access charge:

$$a = C_D^Q f_3 + \frac{p_3}{\eta_3} + \frac{\lambda}{1+\lambda}(p_D - C_D^Q)f_3 \tag{2.28}$$

Then to obtain the prices in absolute values, is enough to solve the previous equations with the demand equations and restriction (2.23).

2.4 Price Cap: Firm Optimum

The regulator in the determination of the tariffs wants to incentive cost efficiency and to maximize social welfare. Thus, the regulator should maximize (2.14) to determine the DISCO price cap that will restrict his price decision. Laffont and Tirole (1996) proposed this mechanism, demonstrating that if the weights of the basket of prices considered to set the price cap are in proportion with the exactly carried out quantities, then Ramsey prices are induced.

The price cap can be expressed in a similar way to the physical cap (2.23) multiplying each term by the preset price p_D and balancing it with the evaluation of peak power distribution. Contrary to the physical cap, under a price cap the quantities q_i are predetermined as $\overline{q}_i$ for the DISCO. In this way, the price cap restriction can be expressed as a particular case of the physical cap, thus DISCO optimum under a price cap should be lower than under the physical cap.

$$\alpha_1 p_D f_1 \overline{q}_1 + \alpha_2 p_D f_2 \overline{q}_2 + \alpha_3 p_D f_3 \overline{q}_3 = \overline{Q} p_D \tag{2.29}$$

It is possible to express this constraint in terms of final prices, adding to both sides of the equation the constant terms (independent of α_i) and then the valuation of peak power, $\overline{Q}_M p_P$:

$$\alpha_1 p_D f_1 \overline{q}_1 + p_P f_1 \overline{q}_1 + \alpha_2 p_D f_2 \overline{q}_2 + p_P f_2 \overline{q}_2 + \alpha_3 p_D f_3 \overline{q}_3$$
$$= \overline{Q} p_D + p_P f_1 \overline{q}_1 + p_P f_2 \overline{q}_2$$

$$p_1 \overline{q}_1 + p_2 \overline{q}_2 + a_3 \overline{q}_3 = \overline{Q} p_D + \overline{Q}_M p_P = \overline{PC} \tag{2.30}$$

Subject to the price cap(2.30), the DISCO maximize its utility (2.9) choosing final prices through the parameters $\alpha_i \geq 0, \quad i = 1,2,3$.

The Lagrangean of the DISCO optimization problem is:

$$\begin{aligned} L = {} & p_1 q_1(p_1) + p_2 q_2(p_2) + a q_3(p_3) \\ & - C_D(f_1 q_1(p_1) + f_2 q_2(p_2) + f_3 q_3(p_3)) \\ & - C_{PM}(f_1 q_1(p_1) + f_2 q_2(p_2)) \\ & + \lambda(p_1 \overline{q}_1 + p_2 \overline{q}_2 + a \overline{q}_3 - \overline{PC}) \end{aligned} \tag{2.31}$$

where λ is the shadow price of the price cap constrain. Solving first order conditions for α_1, α_2 and α_3, that in turn define $p_1(\alpha_1)$, $p_2(\alpha_2)$ and $p_3(\alpha_3)$, according to equations (2.7) and (2.11), we obtain:

$$p_1 - (C_D^Q + c_{PM}) f_1 = (1+\lambda) \frac{p_1}{\eta_1} \tag{2.32}$$

$$p_2 - (C_D^Q + c_{PM}) f_2 = (1+\lambda) \frac{p_2}{\eta_2} \tag{2.33}$$

$$p_3 - (C_D^Q + c_{PE}) f_3 = (1+\lambda) \frac{p_3}{\eta_3} \tag{2.34}$$

With (2.34) and equation (2.11) the optimal access charge is:

$$a = C_D^Q f_3 + (1+\lambda) \frac{p_3}{\eta_3} \tag{2.35}$$

The solution has the same structure as the one obtained in the social optimum with Ramsey prices, what gives the same inverse relationship of margins and elasticities settled down in the equations (2.20), (2.21) and (2.22). To obtain final prices in absolute values is enough to solve the previous equations with the demand equations and the constraint (2.30). In this way, social optimum with Ramsey prices and firm optimum with a price cap set under the right weights give the same solution.

2.5 Calibration of the Model

The model is calibrated base on a Chilean distribution company cost and demand data implicit in the tariff decree in force[7]. Basic data is an estimate of the costs structure, a point of peak load demand and an estimate of the price elasticity of the respective demand.

For each of the three goods sold by the DISCO use a linear demand function

$$q_i(p_i) = a_i - b_i p_i \quad i = 1,2,3 \tag{2.36}$$

for which we need to pick a_i and b_i parameters, i = 1, 2, 3, from the point of the demand curve and using the following equation

$$\eta_{i,j,T} = -\frac{\partial q_i}{\partial p_i}\frac{p_{i,j,T}}{q_{i,j,T}} = -b_i \frac{p_{i,j,T}}{q_{i,j,T}} \tag{2.37}$$

2.5.1 Data analysis to pick demand function parameters

For power at tariff 1 we are going to consider BT-1 tariff, for power at tariff 2 we are going to consider BT-3 tariff, and since representative data for access demand do not exist, we will assimilate tariff BT-3 PP as if it is supplied by a third party.

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[7] Decree Nº300 of 1997 of the Ministry of Economy

The DISCO inform that in the year 1999 2.500 GWh were billed in BT-1 tariff, typically residential, that considered 420 hours of use, they imply 862 MW of power (not peak), at an average price of $ 11.25 per kW-month; in BT-3 tariff were billed 100 MW of power at an average price of $ 9.78 per kW-month; and in tariff BT-3 PP were billed 300 MW of power (not peak), at an average price of $ 14.68 per kW-month.

To obtain demand elasticities for the three goods we use the following econometric model of demand:

$$q_{i,j,T} = bp_{i,j,T} + \beta I_{j,T} + \sum_{m=1}^{12} \gamma_m e_m + \sum_{n=1}^{5} \delta_n r_n + E_{i,j,T} \tag{2.38}$$

where $q_{i,j,T}$ is the quantity of units of the good i in the month j in the year T ; $p_{i,j,T}$ the price for unit of the good i in the month j in the year T; $I_{j,T}$ a monthly index of economic activity, IMACEC[8], of the month j in the year T ; e_m a seasonal variable, $e_m = 1$ if $m = j$, $e_m = 0$ if $m \neq j$; r_n a dummy variable for electricity rationing, $r_n = 1$ in the months that in 1999 Chilean economy suffer an energy shortage as a result of an extreme draw that affect most of the hydroelectric power plants, and $r_n = 0$ for the rest of the months; $E_{i,j,T}$ an error of the regression for the good i in the month j in the year T; and b, β, γ_m, δ_n be the regression coefficients of the previously suitable variables.

Since there is no historical record on power bills, we will assume the same price elasticity for energy and power, assumption that is not far from the reality for the BT-1 tariff that is measured and billed on a linear energy-power charge (monomic price). For the case of the non-linear tariffs, BT-3 PPP and BT-3 PP, the monomic price is an approximation. It is reasonable to assume that the price elasticity obtained in this way is an approximation for peak load price elasticity.

For the good q_1 historical data from the DISCO on physical billing of residential energy consumption was used, as also for goods q_2 and q_3 was used DISCO historical data on commercial energy consumption corresponding to PPP and PP, respectively. The final tariffs were used, upgraded by CPI, where in the case of the tariffs BT-3 PPP and BT-3 PP, a load factor of 0,65 was used to determine a monomic price.

[8] IMACEC: Monthly Index of Economic Activity, calculated by the Central Bank of Chile.

The coefficients δ_n should take a negative value to represent the energy rationing suffered by the Chilean economy in November of 1998 and the period March to June of 1999. For each of the variables we use data for the period January of 1992 to December of 1999. In each point of the historical time series we assume that the demand curve intercepts a completely elastic supply curve, assumption that is consistent with the service obligation that the law imposes on DISCO, who are forced to supply all the demand at the corresponding regulated price. The fact of being able to identify the precise months when exist energy rationing together with large quantity of monthly data, allow as to use monthly regression, from where we will extrapolate annual parameters. The following Chart gives as the regression results.

Chart 2.1: Regression of Demand Results

Variable		Coefficient			
Quantity			q_1	q_2	q_3
Price	p	B	-726	-789	-520
IMACEC	I	β	820	270	181
Season factor 1	e_1	λ_1	17.297	37.823	24.698
Season factor 2	e_2	λ_2	6.636	35.390	23.092
Season factor 3	e_3	λ_3	8.755	35.562	23.179
Season factor 4	e_4	λ_4	24.786	35.880	23.390
Season factor 5	e_5	λ_5	35.205	36.285	23.669
Season factor 6	e_6	λ_6	43.409	36.241	23.647
Season factor 7	e_7	λ_7	61.185	42.321	27.708
Season factor 8	e_8	λ_8	54.451	42.460	27.802
Season factor 9	e_9	λ_9	45.629	39.893	26.099
Season factor 10	e_{10}	λ_{10}	32.251	36.518	23.834
Season factor 11	e_{11}	λ_{11}	22.783	37.509	24.505
Season factor 12	e_{12}	λ_{12}	26.364	40.464	26.473
Rationing 1	r_1	δ_1	-4.322	0	0
Rationing 2	r_2	δ_2	0	0	0
Rationing 3	r_3	δ_3	-5.160	-163	0
Rationing 4	r_4	δ_4	-1.949	-519	-357
Rationing 5	r_5	δ_5	-2.480	-3.208	-2.219
Mean Error	EM		5	2	1
Correlation	R^2		0,979	0,977	0,977

Variables of season factor were chosen fixed in the time, since it was observed that the difference among the consumption in the months of winter and in those of summer it doesn't change significantly during the period of analysis. Is obtained that the models represents in reasonable form the evolution of the demand, with R^2 near to 0,98 and a Fisher test with a probability close to zero (less than 0,0005) that all the defined parameters are null. The t-student test is useful to determine the probability that each parameter is null, and therefore not explanatory in the regression, obtaining in most of the cases that each parameter is significant with 95% of trust, if the certainty probability is smaller at 0,05. In particular, the prices parameters, our focus of interest to determine price elasticities, satisfy the t test with a confidence interval larger than 95%. Also IMACEC parameters for the three goods and the seasonal parameters for goods 2 and 3, satisfy the t test with a confidence interval larger than 95%. In the case of the seasonal parameter of good 1, it fails to satisfy the t test with a confidence interval larger than 95%. In spite of this condition, we kept the seasonal parameters to maintain the integrity of the group and the homogeneity of the models.

With regard to the rationing parameters, none demonstrated to be explanatory of the series. This is founded in the fact that each one of these coefficients affects only one value of the regression, for the specific month where the variable is one, but we kept these parameters since their presence doesn't degrade the value of the other parameters, in particular those of the prices, to be consistent with the fact that the country was affected by a severe draw and a mandatory energy rationing that finally appear to have no effect on energy consumption.

Also we tested some alternative model specifications with other explanatory variables such as a tendency variable and temperature. We find that IMACEC is capture consumption growth as well as the increase of the number of consumers, thus the tendency variable is redundant. The variable of temperature, very related with the brightness, was proven in substitution for the seasonal variables. In the case of the goods 2 and 3, it was proven through the t test that it was not an explanatory variable; and in case of the good 1, where the season parameters were not sufficiently explanatory, the variable temperature demonstrated bigger degree of significance, however, the representativeness of the price parameter diminished below 95% of trust, deteriorating the coefficient of interest.

Some rationing parameters were null, what indicates that rationing effect on those month consumption was not significant. Indeed, for the first two periods of rationing, November of 1998 and March of 1999, the effect of the rationing was smaller, since rationing measures were only taken during the last two weeks in November and only the last days of March. Also the observe differences between different types of consumers has to do with the way how rationing took place, either for programmed disconnection, voltage decrease, or agreements with big clients. The way how rationing measures was carried out and the capacity that customers has to displace his consumptions over the day, finally determine his decrease in consumption. Even though some coefficients of the rationing variables were null or not significant, they stayed as group in the model regression to have a common framework for the regression of the three tariff types.

2.5.2 Consumer Surplus

From the consumer point of view, in the optimum he equates the price of a good with the marginal benefit that it reports to him, and this is since the consumer solves:

$$Max_{\{q_1,q_2,q_3\}}\ V(q_1,q_2,q_3) - p_1q_1 - p_2q_2 - p_3q_3 \tag{2.39}$$

where the first order condition is:

$$\frac{\partial V(q_1,q_2,q_3)}{\partial q_i} = p_i \quad i = 1,2,3 \tag{2.40}$$

If $V(q_1,q_2,q_3)$ is linear in q_i, we have that this is another representation for the demand function of good *i*, and therefore it should be consistent with the demand function (2.36) previously defined. In this way, the consumer's utility function is similar to the sum of the integrated inverse demands functions for each good.

$$V(q_1,q_2,q_3) = \int_0^{q_1} p_1(q_1)\mathrm{d}q_1 + \int_0^{q_2} p_2(q_2)\mathrm{d}q_2 + \int_0^{q_3} p_3(q_3)\mathrm{d}q_3 \tag{2.41}$$

replacing the inverse demand function from (2.36) and integrating, it is obtained:

$$V(q_1,q_2,q_3) = \sum_{i=1}^{3}\left(\frac{a_i}{b_i}q_i(p_i) - \frac{1}{b_i}q_i^2(p_i)\right) \tag{2.42}$$

Thus to measure consumer surplus we use (2.43) and subtract expenditures.

2.5.3 Costs Functions

Because the cost studies used to set distribution tariffs are not made public, to obtain cost parameters we use reverse engineering. For that we use tariff decree prices and scale economy factors to recover the parameters of the cost function. We will assume that DISCO has a cost function as:

$$C_D(Q) = F + c_D Q \tag{2.43}$$

This function is used by the National Energy Commission (CNE). The Distribution Value Added calculated in the tariff studies determines the average cost per unit of coincident power with the peak of the distribution system. However, when tariff are set it is expected that electricity demand will growth, and to avoid DISCO excess profits, scale economy factors are calculated to adjust tariffs on incoming years.

In the 1996 tariff setting process, the CNE determined for a typical low voltage distribution area served by an aerial network the following economies of scale factors:

Chart 2.2: Economies of Scale Factors

Date	Factor
1 Jan 1997	0,9881
1 Jan 1998	0,9763
1 Jan 1999	0,9647
1 Jan 2000	0,9532

At the beginning of each period these factors multiply the original power price. Reproducing the CNE equation, the price per unit of power for the initial period 1996 can be obtain from (2.43) as:

$$\frac{C_D(Q_0)}{Q_0} = \frac{F}{Q_0} + c_D \tag{2.44}$$

where $C_D(Q_0)$ is total distribution cost of producing a quantity Q_0 in first year. In an equivalent manner we can define the cost per unit of power for the following period, where Q_1 is a function of Q_0 and the growth rate g_1:

$$\frac{C_D(Q_0(1+g_1))}{Q_0(1+g_1)} = \frac{F}{Q_0(1+g_1)} + c_D \tag{2.45}$$

The economy of scale factor between period 0 and 1 is obtained as the quotient between the average cost of each of the periods. Let f the fixed cost defined unitarily as $f = \dfrac{F}{Q_0}$, in this way, the economies of scale factor for the period 1 FEE_1 is given by:

$$FEE_1 = \frac{\dfrac{C_D(Q_0(1+g_1))}{Q_0(1+g_1)}}{\dfrac{C_D(Q_0)}{Q_0}} = \frac{\dfrac{f}{1+g_1} + c_D}{f + c_D}, \tag{2.46}$$

and let $\xi = \dfrac{f}{f + c_D}$. Then, with this normalization, the economies of scale factor equation for period 1 one can rewrite as:

$$FEE_1 = \frac{\xi}{1+g_1} + (1-\xi) \tag{2.47}$$

By symmetry, economies of scale factors equations can be obtained for the rest of the periods with respect to the initial period:

$$\begin{aligned} FEE_2 &= \frac{\xi}{1+g_2} + (1-\xi) \\ FEE_3 &= \frac{\xi}{1+g_3} + (1-\xi) \\ FEE_4 &= \frac{\xi}{1+g_4} + (1-\xi) \end{aligned} \tag{2.48}$$

FEE_i are known and they originate four equations in five variables g_1, g_2, g_3, g_4 and ξ, so we need a fifth equation to find a solution set. The fifth equation will be given by what was the electricity demand growth expected by the CNE for the whole period, that expected a 7.5% average growth rate for the whole period in the Central Interconnected System. From these we obtained growth rates and the fix component of the cost function ξ = 18%. Upgrading this last figure, through the growths, to the 1999 cost structure, we obtain $\xi_{1999} = 15\%$. Finally, applying the effective rate to December of 1999, we calibrate cost function parameters F = 948 [M$/month] and c_D = 9.10 [$/kW-month].

To calibrate the DISCO purchase power cots we use peak power nodal price in Santiago. To determine this price, the power nodal prices of Alto Jahuel and Cerro Navia were used, determined by the October 1999 nodal prices decree, giving weights of 0.661 and 0.339 to each other and applying the corresponding sub transmission charges as is established in the same CNE decree. With these we obtained that $c_{PM} = 5.22$ [$/kW-month] in December of 1999. To calibrate a competitive power purchase price we took the regulated effective nodal price of December 1999, minus 10% under the assumption that this free price has a similar pattern as the one observed between the regulated energy nodal price and the marginal cost of energy. In this way $c_{PE} = 4.70$ [$/kW-month]

The p_P value is the same as c_{PM}. For the preset price p_D it was considered the low voltage distribution cost (CDBT) effective in the tariff decree. Since many simplifications have been made as excluding value added taxes and electricity losses, the move the equilibrium point between the offer and the demand, unbalancing regulated revenues and costs more. To correct this problem the effective CDBT was adjusted to December of 1999 in +0,9%, so that DISCO profits are null. Thus $p_D = 10.80$ [$/kW-month] and $p_P = 16.02$ [$/kW-month].

For the coincidence factors and/or hours of use we used the ones settled down in the tariff decree, where $f_1 = 0{,}58$, $f_2 = 0{,}50$ and $f_3 = 0{,}75$.

2.6 Results

2.6.1 Base Situation, Physical Cap and Price Cap

With the last section parameters we carry three experiments to see the effects on resource allocation having as base case today situation where tariff charges are set distributing the costs within the different tariffs. The experiments are respect to:

- Ramsey prices where α_i $(i=1,2,3)$ is chosen to distribute the fix cost.
- DISCO profit maximization subject to a physical cap.
- DISCO profit maximization subject to a price cap, where price cap price weights are set equal to the social optimum weights obtained in the Ramsey solution.

Chart 2.3 present experiment results. In the first column we have the base case where the prices are determined by a cost assignment according to the following approach: when the CNE determines the Distribution Value Added it determines an average respect to peak power. In this way, from the costs (2.43) can be obtained:

$$p_D = \frac{C_D(Q)}{Q} = \frac{F}{Q} + c_D \tag{2.49}$$

In this case α_i =1 ($i=1,2,3$) on equations (2.7).

In the second column of the chart **2.3**, the Ramsey solution is presented, where α_i takes values different to one, being its value inversely related to the price elasticity of the service in question.

Under the Ramsey case the social surplus (consumers' plus producers' surplus) increases, although not significantly. The social surplus is of the order of $ 713 billions; the increase from the base situation is hardly $ 6.0.

Chart 2.3: Experiment Results				
Var.	**Cost Assignment st: Π_1=0**	**Ramsey st: Π_1=0**	**Max Π_1 st: Physical Cap**	**Max Π_1 st: Price Cap**
α_1	1.000	1.028	1.453	1.028
α_2	1.000	0.968	0.000	0.968
α_3	1.000	0.877	0.000	0.877
p_1 $/kWmonth	9.2	9.4	12.0	9.4
p_2 $/kWmonth	8.0	7.8	2.6	7.8
p_3 $/kWmonth	11.6	10.6	3.5	10.6
a $/kWmonth	8.1	7.1	0.0	7.1
q_1 kW	861,989	861,989	861,988	861,989
q_2 kW	299,952	299,953	299,967	299,953
q_3 kW	99,688	99,700	99,784	99,700
Q kW	720,681	720,690	720,759	720,690
Q_M kW	645,915	645,915	645,921	645,915
η_1	0.0000057	0.0000058	0.0000075	0.0000058
η_2	0.0000715	0.0000699	0.0000233	0.0000699
η_3	0.0013854	0.0012663	0.0004194	0.0012663
$\Delta\ \Pi_1$ $/month	0.0	0.0	103.3	0.0
$\Delta\ \Pi_2$ $/month	0.0	0.0	0.0	0.0
Δ Consumer Surplus $/month	0.0	6.0	-431.1	6.0
Δ Social Surplus $/month	0.0	6.0	-327.9	6.0

In the third column of chart **2.3** appears the solution of the firm optimum subject to a physical cap. Under this restriction the firm can affect the coincidence factors through α_i, but is restricted to maintain a global balance of peak power. In the optimum of this model α_1 that set prices for the most inelastic demand exceeds one, while α_2 and α_3 are made zero. Under a physical cap in global terms the DISCO has incentives to increase the number of peak power units sold that circulate in the system. Under these conditions, the DISCO polarizes its prices, moving up the price of the most inelastic good and lowering the price of the rest down to what is feasible. In this case DISCO profits increase by $ 103.3 with regard to the base case, but social welfare diminishes in $ 327.9 also respect to the base case in $ 333.9 respect to Ramsey solution.

Finally, in the fourth column of the chart 2.3, the results of the firm optimum are shown, subject to a price cap constraint. The parameters of the price cap are calibrated knowing the social optimum Ramsey result, where the weights of the price cap are set with the Ramsey solution. Also, the polynomial obtained in this way was evaluated, with the resulting prices in the social optimum, to determine the limit price cap. Under the conditions before described, the solution of the firm equals the Ramsey solution.

2.6.2 Information Asymmetries

If the regulator doesn't know consumers' demand, he cannot know ahead of time the quantities and the prices for the Ramsey solution, in the way of determining the weights of prices and the price cap. Conversely, if the regulator knew consumers' demand and cost functions, then it would not be necessary to establish a price cap regulation mechanism, since from the beginning the regulator can set directly optimal prices. The application of the price cap methodology is justified in light of information asymmetries between the firm and the regulator, where the objective is to have the firm to use his better knowledge to determine the prices in a socially optimal way.

The regulator, without knowledge respect to the quantities and the prices that leads to the social optimum, it should determine price weights and the price cap for the regulated company. A slanted regulator could be tended to determine the weighting favoring some type of clients and making worst others. Confronting a lack of information, a simple solution could be to use the current quantities to set the weights that in turn determine the price cap as long as the price of peak power was already appropriately set in a previous stage by the regulated. Further, information asymmetries can also be respect to the cost function or its parameters, as the peak load coincidence factors. Under this situation the base case has the power of being a case where the prices indeed reflect the costs involved, so if costs are deviated from social optimum setting some cross subsidies from the more elastic to the more inelastic consumers, social benefits decrease. An example with these two cases is presented in Chart 2.4. Where the first column present a price cap situation where price weights have been set according to the original quantities, and the second column represents a case where costs are assigned with a bias toward the consumers with a more elastic demand.

Chart 2.4: Asymmetries of Information Results		
Var.	**Max Π_1 st: Price Cap**	**Cost Assignment Deviation**
α_1	1.025	0.955
α_2	0.946	1.100
α_3	0.939	1.100
p_1 \$/kWmonth	9.4	8.9
p_2 \$/kWmonth	7.7	8.6
p_3 \$/kWmonth	11.1	12.4
a \$/kWmonth	7.6	8.9
q_1 kW	861,989	861,989
q_2 kW	299,953	299,951
q_3 kW	99,694	99,678
Q kW	720,686	720,673
Q_M kW	645,915	645,914
η_1	0.0000058	0.0000055
η_2	0.0000689	0.0000763
η_3	0.0013269	0.0014821
$\Delta\ \Pi_1$ \$/month	3.1	-10.3
$\Delta\ \Pi_2$ \$/month	0.0	0.0
Δ ***Consumer Surplus*** \$/month	1.5	-4.3
Δ ***Social Surplus*** \$/month	4.6	-14.6

The results of the simulation show that when prices weights in the price cap are defined as the quantities of the base case situation, the social benefit is lower with regard to the Ramsey case or price cap with the ideal weights, but in anyway it represents an improvement \$ 4.6 with regard to the base case situation with a standard cost assignment. When cost assignment is biased in the wrong direction social welfare decreases in \$ 14.6 with regard to the base case situation with a standard cost assignment.

2.6.3 Bounded Discrimination

As was observed in the case with a physical cap, the DISCO uses price discrimination up to the extreme where it covers all its costs through the price charged in the more inelastic good, being totally subsidized the other two goods. It happens that when the more inelastic good is network access, then DISCO pricing policy has a predatory effect on the others who need access services to provide a complete service to final users; situation that also can emerge under price cap regulation.

A way to diminish predatory behavior, is setting a price floor and a price ceiling, as Baumol and Willig has suggested, among others, where the price floor can be set as the marginal cost and the price ceiling as the stand-alone cost. Here we run a physical cap experiment setting a price floor where prices cannot be smaller than the marginal cost. Since the physical cap restriction assures for DISCO as a whole at most the average regulated price, setting the price floor as the marginal cost, automatically sets the stand alone cost as the ceiling price when services are priced according to marginal cost since the other services should recover the fixed costs. Also we run a price cap experiment setting price floors and ceilings but turned that for the price cap these constraints were not activated, since already in the unrestricted optimum the fixed cost is distributed within the three services. The results of the two experiments are presented in Chart 2.5.

Chart 2.5: Bounded Discrimination Results		
Var.	**Max Π_1 st: Phisical Cap** $\alpha_i \geq 0.85$	**Max Π_1 st: Price Cap** $\alpha_i \geq 0.85$
α_1	1.068	1.028
α_2	0.850	0.968
α_3	0.850	0.877
p_1 $/kWmonth	9.6	9.4
p_2 $/kWmonth	7.2	7.8
p_3 $/kWmonth	10.4	10.6
a $/kWmonth	6.9	7.1
q_1 kW	861,989	861,989
q_2 kW	299,955	299,953
q_3 kW	99,702	99,700
Q kW	720,693	720,690
Q_M kW	645,916	645,915
η_1	0.0000060	0.0000058
η_2	0.0000643	0.0000699
η_3	0.0012404	0.0012663
$\Delta\ \Pi_1$ $/month	15.5	0.0
$\Delta\ \Pi_2$ $/month	0.0	0.0
Δ ***Consumer Surplus*** $/month	-9.7	6.0
Δ ***Social Surplus*** $/month	5.8	6.0

The factors α_i has as a floor a value of 0,85, equivalent to the variable part of the distribution cost, as it was determined in the calibration of the model. As it was pointed out, the results of the firm optimum with a price cap and price floor didn't change, since the new restriction is not active. On the other hand, in the case of the firm subject to the physical cap, the results improve ostensibly from a social point of view. The price balance is achieved with the service 1 priced up to its stand alone cost and service 2 and access priced at their marginal costs. With regard to the base case, this solution implies an increase in the social benefit of $ 5.8, only slightly inferior to the gain obtained under price cap social optimum of $ 6.0. The increase of the social welfare obtained thanks to the demarcation of prices, of $ 5.8 is compared positively and significantly with the unrestricted physical cap case in that gave a welfare loss of $ 327.9.

The bounded physical cap has an additional advantage, if it is considered that in practice the regulator doesn't have perfect information to determine a priori discriminatory prices that show the way to the social optimum, thus, neither it can determine the optimal weights of the price cap polynomial. In this case, the best result that can be obtained with a price cap is the one previously obtained under information asymmetries with a welfare increase of $ 4.6. The physical cap doesn't have the information requirements that the price cap has, because the inclusion of the information asymmetries doesn't affect the result that we obtain.

If the base case is changed, from one with perfect information to a new base case with information asymmetries, the social welfare gain increases in all the cases. In particular, the firm optimum under price cap with information asymmetries (bounded or not) would be $ 19.3; while the firm optimum under bounded physical cap (with or without information asymmetries) would be $ 20.4. This social welfare gain is comparable with the ideal social optimum, with perfect information, of $ 20.6.

2.6.4 Non Discriminatory Access Charge

Another way to avoid some possible predatory practice in the access charges, is eliminating price discrimination of access charges definitively by setting its price equal to the direct cost. In the chart **¡Error! No se encuentra el origen de la referencia.** are shown the results of the firm optimum under physical cap and a price cap, but fixing the factor $\alpha_3 = 1$.

Under the restriction$\alpha_3 = 1$, in the case of the price cap the gain in the social benefit decreases notably with regard to the base case, while in the case of the physical cap the social loss decreases, compared to the original case. The structure of the solution is similar to the original one, in the variable parameters; the distribution price is made zero for the more elastic good, and the more inelastic goods recover the remainder of the costs not recovered by the access charge, fixed at mean cost, since $\alpha_3 = 1$.

Chart 2.6: Non Discriminatory Access Charge Results		
Var.	**Max Π_1 st: Phisical Cap** $\alpha_3 = 1.00$	**Max Π_1 st: Price Cap** $\alpha_3 = 1.00$
α_1	1.302	1.033
α_2	0.000	0.891
α_3	1.000	1.000
p_1 \$/kWmonth	11.1	9.4
p_2 \$/kWmonth	2.6	7.4
p_3 \$/kWmonth	11.6	11.6
a \$/kWmonth	8.1	8.1
q_1 kW	861,988	861,989
q_2 kW	299,967	299,954
q_3 kW	99,688	99,688
Q kW	720,688	720,682
Q_M kW	645,922	645,916
η_1	0.0000069	0.0000058
η_2	0.0000233	0.0000662
η_3	0.0013854	0.0013854
$\Delta\ \Pi_1$ \$/month	8.7	0.0
$\Delta\ \Pi_2$ \$/month	0.0	0.0
*Δ **Consumer Surplus*** \$/month	-40.0	0.5
*Δ **Social Surplus*** \$/month	-31.2	0.5

III CONCLUSIONS

Can be observed that the electric sector in the world, as well as in Chile, it is experiencing deep economic changes, more than technological. They are being carried out important efforts to improve the existent regulation, individualizing the activities potentially competitive, and then to promote the opening to the market.

It is as well as in beginning the electric sector was disintegrated in generation, transmission and distribution. However, today it is identified the commercialization activity like another detachable and potentially competitive activity.

It has been studied a lot how to enhance the commercialization activity, recognizing that a key ingredient to develop, it is the free access to the transmission and distribution nets. However, although the importance of the free access is recognized, it has not been studied as widely as it owes pricing the access to the electric nets.

Diverse methodologies have been developed to regulate the industries of nets, as well as particular mechanisms for the regulation of the access. The biggest advances are appreciated in the field of the local telephony. Although it is an industry of nets, it presents some differences with the electric case, as the by-directionality of the nets for example, and consequently the reciprocity effect that exists among the actors in a net of telecommunications that one doesn't give in the electric case. Another example of this difference, is the technology of information. In telephony it is easier to measure the use of the infrastructure that makes each agent.

There has intended a regulatory model for the tariffs and charges of distribution access, designed specifically for this industry, since it is bounded and it takes advantage of the practical characteristics of this service. This model is able to incorporate the combined advantages of different regulatory mechanisms existent.

It is demonstrated that the discrimination of final prices or of access it can be translated in a bigger social welfare, when being compared with the situation in that today is the regulator, and the tools and information of which prepares.

The yardstick competition methodology that at the moment is applied in Chile, to determine the prices of each one of the distribution goods, it is effective to incentivates the efficiency in the costs. However, to determine each one of the prices means to assign somehow, costs common to all them; way that is arbitrary in definitive. Also, with the information with which it counts the regulator to the moment to assign the costs, usually inferior to the one that possesses the regulated firm, it is not possible to carry out a perfect assignment. But, although you could achieve a correct assignment for cost of service, this doesn't imply that is achieved social optimum.

It was demonstrated that the social optimum is achieved fixing Ramsey prices, those that don't only consider the costs of each good, but also their demand functions, consequently their elasticities. It was proven that it is socially efficient to go up the prices to the goods with more inelastic demands and to go down the prices to those with elastic demands.

However, to determine Ramsey prices still implies a bigger requirement of information than in the simple assignment for costs, since the regulator would also require to know the functions of demand of each good.

Taking advantage of the advantages of information with which it counts the regulated firm, a model intended in that the own firm defines the prices subject to a restriction of type price cap. It was demonstrated that when the prices weights in the price cap, are appropriately elected, the optimal solution of the firm converges with the socially optimal solution, being determined Ramsey prices. However, to determine those precise weights, it also requires of a bigger degree of information, it implies knowing the functions of demand to foresee the socially optimal quantities and to fix them as weights.

Finally, an original restriction, denominated physical cap is designed, delimiting the discrimination of prices to a maximum of the stand alone cost and a minimum of the marginal cost; always combining these restrictions with the base costs determined by means of yardstick competition. It is demonstrated that with this model, the social welfare is increased, although it is not optimal, when comparing it with the situation for costs assignment, and moreover if it is compared with the assignment by deviated costs of the real costs, due to the asymmetries of information among the regulator and the one regulated.

The designed model, yardstick competition with enclosed physical cap, adapts to the effective regulatory structure in Chile, since it doesn't imply to change the form in that the Distribution Value Added is calculated, defined in the law, it only changes the tariff formulas that at the moment are under the responsibility of the National Commission of Energy. A degree of freedom is granted to the companies to define its tariffs and access charges, subject to a restriction that is technically easy of measuring, as it is it the balance of power. In this way, the regulator requires smaller quantities of information, very difficult of estimating, while for the other side, the firm uses the best information that has to come closer to the socially good prices.

Additionally, was evaluated the only effect of impeding the discrimination of prices in the access charge, being concluded that this carries a social loss.

There are left open all the model alternatives, depending from the degree of available information and the discrimination degree that it is willing to allow.

Finally, in this study gauged models of this segment of the industry are contributed, such as cost functions, with their relationship cost fixed variable cost, and, demand functions for different goods, with their elasticities and relationship with macroeconomic variables.

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