

WATER UTILITIES IN CHILE

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1. INTRODUCTION

Natural monopoly regulation should ideally meet the objectives of inducing firms to produce the socially efficient quantity (allocative efficiency), inducing the firms to produce at minimum cost, (productive efficiency) while letting the firm to obtain enough revenues so as to cover its costs.¹

Since 1989, the regulatory scheme established in Chile for price setting in electricity distribution, local telecommunications and water supply has been one based on the construction of a hypothetical efficient firm to benchmark utilities.² Unlike the yardstick schemes used in countries like, for example, the U.K., in which the reference used for benchmarking is the behavior of existing firms (using their average behavior or the behavior of the most efficient one), the scheme used in Chile uses as a benchmark a hypothetical firm.³ The latter is commonly referred in the Chilean legislation as model firm⁴; term that we will retain in what follows. This model firm is supposed to produce the quantity demanded by the market at the minimum cost that is technically feasible, given predefined quality standards and available information. The scheme separates the costs used for price determination from the firm's real costs, so that it will only be able to obtain a normal return if it behaves according to the model firm. Thus, any "inefficiencies" (i.e., costs higher than predicted by the model firm) will not be passed through to final consumers but borne by the utilities, which in most cases are private entities. In this sense, the mechanism offers the advantages of an incentive based mechanism while maintaining some of the characteristics of the rate of return regulation (Newbery (1999)).

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¹ Optimality subject to a self financing constraint corresponds to the Ramsey criterion.

² Note that most public utilities in the country are privately owned.

³ See Vogelsang (2002) and Newbery (1999) for an overview of different regulatory practices.

⁴ In Spanish "empresa modelo".

⁵ If there are economies of scale, then the tariffs are adjusted to set them equal to the average cost which is consistent with the Ramsey criteria.

This type of regulation seeks to emulate competition in the markets where natural monopoly exists. To this end, it uses marginal cost criteria to set the prices, attempting to attain allocative efficiency.⁴ In addition, a self-financing constraint is imposed exogenously by the regulator since it will not be automatically satisfied as it is in perfect competition. Under the mechanism, prices are set so that the model firm, that starts its operations at the beginning of the regulatory period and offers the services with a predefined quality at the minimum possible cost, obtains a normal return on its investments, to guarantee that the consumer pays a fair price for the service.

In spite of its importance (recall that utilities in three sectors are priced using a model firm), there has been very few research on the static and dynamic efficiency properties induced by this regulation mechanism.

A number of practical problems have arisen throughout the years in the application of the concept of the model firm. These problems have been treated in a very discretionary way between sectors and within a given sector from one price setting process to the following. It is often the case that the regulator's objective has been to avoid large fluctuations in prices. However, there is no general policy agreement about the most efficient way to deal with these problems and how to solve them consistently within the framework of the model firm.

The main problems that have arisen are related with the issue of obsolescence of the firm's assets due to technical progress, existence of capital gains in some of the firm's assets, changes in the norms and standards, and indivisibilities in certain relevant investments. These problems arise because the model firm regulation assumes that the model firm starts from scratch each time a new regulatory period starts.

In this paper, we analyze the incentives and problems that this fact generates since it creates discrepancies between the initial conditions that the model firm and the real firm face. The purpose of the paper is to define conceptually and practically the model firm in a coherent way. The focus of the paper is centered in the regulation of the water sector⁶.

2. BENCHMARKING WITHOUT HISTORY

The model firm is an abstraction designed to simulate the cost of providing the water service required by the public, given the current norms and the geographic and technological restrictions which the sole provider faces. It is defined in the Law as: "a firm designed with the purpose of providing the required water services efficiently considering the current norms and the geographic, demographic and technological restrictions in which it will have to operate". The model firm complies with the productive efficiency principle since it only incurs in the costs that are

⁶ This is because of brevity, since most of the problems analyzed are also present in fixed telecommunications and electricity distribution.

absolutely necessary for investment, operation, maintenance and management necessary to provide the service.

The model firm does not consider the history for price determination. In fact, it is assumed that it starts its operations at the beginning of the regulatory period. It is built assuming that the most efficient technologies and conditions are available at the moment of the price fixing and many of the operational and physical restrictions that the real firm faces are not considered in the model firm that starts operations afresh. These differences in the conditions that the model firm and the real firm face can produce significant economic rents or losses to the real firm, which are induced by the regulation and may affect the prices being determined without an economic justification.

In the rest of this section, we analyze five issues that have raised problems in the use of the concept of model firm in many of the price fixing processes.

2.1. Treatment of Assets of Infinite Lifetime: The case of Startup Costs

This is the case of the investments made to start the firm’s operations. For the Long Run Total Cost determination, all the investments and costs associated with the replacement of the model firm that starts its operations are considered. A number of authors, (San Martín *et al.* (2001), and Drexler (2002 b)) have questioned the fact that each regulatory period the model firm considers an amount for starting up the firm, which is an expense that the real firm does not have to incur every five years, and hence increases the prices in an unjustified way while originating a rent attributable to the regulation.

To see whether this is the case, the Long Run Total Costs of the replacement project has to be considered. According to the regulation it is given by:

$$(1) \quad \frac{1}{r} \left[1 - \frac{1}{(1+r)^{35}} \right] \text{CTLP} = I_0 - \frac{\text{Residual value}_{t=35}}{(1+r)^{35}} + \sum_{t=1}^{35} \frac{C_t}{(1+r)^t}$$

where CTLP is the annualized long run total cost; I_0 is the necessary investment to replace the firm at time 0; C_t is the annual operational cost associated with the replacement of the firm and r is the rate of capital cost. Equation (1) implies that any investment deemed as necessary for the provision of the water and sanitation service will be totally financed over a period of 35 years. If the lifetime of the asset is greater than 35 years, there will be a residual value at the end of the valuation period that is discounted for the calculation of the CTLP, so that the investment is exactly financed.

Assuming that the operational costs are zero, the CTLP can be written as:

$$(2) \quad \text{CTLP} = \left[I_0 - \frac{\text{Residual Value}_{t=35}}{(1+r)^{35}} \right] * r \left[\frac{(1+r)^{35}}{(1+r)^{35} - 1} \right]$$

Assume further that the firm starts its operations exactly at the beginning of the period for which the prices are being set. Assuming that there are no economies of scale, and that the only cost of provision is a startup cost of an amount G , prices are determined to assure the financing of the firm. If the regulation assumes that the residual value of the startup investment is equal to zero, that is, it depreciates completely in the 35 years considered in the valuation period, the CTLP calculated from equation (2) becomes:

$$(3) \quad \text{CTLP} = G * r \left[\frac{(1+r)^{35}}{(1+r)^{35} - 1} \right]$$

Since applying the price to the demand from the regulated period must generate enough income to finance the total cost incurred during the period, the tariff is obtained from the following equality:

$$(4) \quad \begin{array}{l} \text{Total Income} = \text{Total Cost} \\ \sum_{i=1}^5 \frac{t * Q_i}{(1+r)^i} = \sum_{i=1}^5 \frac{G * r \left[\frac{(1+r)^{35}}{(1+r)^{35} - 1} \right]}{(1+r)^i} \end{array}$$

Where t denotes the tariff and Q_i is the demand for the firm's services in year i . Assuming a constant annual unitary demand, the price that the regulator determines can be written as:

$$(5) \quad t = G * r \left[\frac{(1+r)^{35}}{(1+r)^{35} - 1} \right]$$

Therefore, assuming that the demand does not change during the whole period of operation of the firm, the regulated (real) firm's revenues will be greater than the cost

$$(6) \quad G * r \left[\frac{(1+r)^{35}}{(1+r)^{35} - 1} \right] \sum_{i=1}^{\infty} \frac{1}{(1+r)^i} = G\delta > G$$

since δ is greater than 1. Therefore, if the treatment of the startup investment does not consider the infinite lifetime of the asset, it will generate a regulatory rent based on the concept of model firm without memory that translates into greater total costs and hence a higher final price. This rent does not have an efficiency justification. However, if the regulation assumes no depreciation for this type of asset and therefore its residual value at the end of the period is identical to the original investment, the price would be equal to:

$$(7) \quad t = G * r$$

That is, the amount allowed into the price would be equal to the opportunity cost of the employed resources, and there would be no regulatory rent because of this concept.

2.2. Treatment of Capital Gains between Price Fixing Periods

The debate regarding the treatment of the capital gains in some assets, specially land values and water rights, is whether this assets should be valued at their current market price or at its acquisition price which is usually lower than the price faced by a model firm that starts from scratch. The model firm regulation scheme without history acknowledges the capital gains experienced by the assets valuing them at their market price every five years. This allows the real firm to obtain the capital gains just from holding the assets that appreciated since the asset price increase translates into higher prices of the final service provided.

To analyze this argument, it is important to keep in mind that land and water rights are assets offered inelastically. If the demand for the flow of services they provide increases, the price of the asset would increase giving their owners a capital gain independently of the market structure of the final service market. From an efficiency point of view, assets must be valued at their market price which reflects their opportunity cost. Only facing the right prices, the agents can make appropriate decisions. For this reason valuing the assets at their historic price is incorrect, since in this later case the price charged to consumers would not reflect the real cost of producing water.

Capital losses also have to be considered. If, for some reason the asset price decreases, in a competitive setting, assets owners would suffer a capital loss. The model firm scheme emulates this result since the regulated firm would also suffer the loss and the tariff would be reduced reflecting the lower shadow price of the asset. In sum, in the case of the assets subject to capital gains or losses, the model firm scheme satisfies the regulation's declared objective of emulating competition.

Another case of an asset subject to a capital gain is the breaking and replacement of the pavements required to replace the distribution and collection network, since it is an asset produced at period t whose production cost increases due to changes in the market conditions. Since the asset depreciates slowly and its implicit price increases, its owner gets a capital gain.

A firm that starts operations in an urban setting will have to break the pavement to install the network and after concluding, it will have to replace it. As the city develops, the cost of replacing it increases as it becomes more costly to intervene the city. Therefore, if the model firm is rebuilt every five years, higher costs will have to be charged with each regulatory period, resulting in higher water tariffs, even though the real firm with assets with lifetime greater than five years only incurs in the cost acknowledged in the price determination only when the lifetime of the asset concludes. Hence, the real firm would be obtaining an unjustified rent since higher costs are being considered after each regulatory period.

However, this rent reflects changes in the market situation, since as the city grows, it becomes costlier to break the pavement and replace the underground networks. Under the objective of emulating competition, therefore, this is a capital gain that has to go to the owner of the network.

2.3. Differences in the Initial Conditions

2.3.1. *Complying with existing norms*

By law, the model firm has to comply with all the norms and standards that are in place at the moment the price is calculated. The real firm, however, usually has a period of time to comply with the norms that were introduced after it started its operations. This implies that the price that the utility can charge to its customers includes costs of complying with the norms, even if in reality it is not satisfying them. The inclusion of these costs in the prices would generate unjustified rents for the utilities during the time period that the firm has until complies with the norms.

To show this, all the assumptions previously used to study the effects of the startup investment are used. In addition, it is assumed that the only cost for the provision of the service is an investment of an amount N that corresponds to the investment in infrastructure that satisfies the norms and standards required for the sanitary sector. In this case, the CTLP corresponds to:

$$(8) \quad \text{CTLP} = N * r \left[\frac{(1+r)^{35}}{(1+r)^{35}-1} \right]$$

In addition, assume that there will be no further changes in technology or in the existing norms, and that the lifetime of the assets is 35 years (to avoid having to deal with residual values). Under these assumptions, the tariff set by the regulator corresponds to:

$$(9) \quad t = N * r \left[\frac{(1+r)^{35}}{(1+r)^{35}-1} \right]$$

Assume further that the real firm has an infrastructure that does not satisfy the current norms. The cost of this infrastructure is equal to M , with $M < N$. The real firm has a period of s years to comply with the norms. Therefore, during s years it gets a rent equal to the difference between the tariff determined with the investment that meets the norms and the tariff determined with the investment in infrastructure that it really has installed. However, to fully finance the investment of size M , there are still $(35 - n)$ annuities to be paid where n is the period when the change in the regulation takes place. Therefore, the total rent due to the change in the norm or standard, obtained during the s years corresponds to:

$$(10) \sum_{i=1}^5 \left[\frac{N * r * \left(\frac{(1+r)^{35}}{(1+r)^{35} - 1} \right) - M * r * \left(\frac{(1+r)^{35}}{(1+r)^{35} - 1} \right)}{(1+r)^i} \right] - \sum_{i=n}^{35} \frac{M * r * \left(\frac{(1+r)^{35}}{(1+r)^{35} - 1} \right)}{(1+r)^i}$$

The question is who should benefit from this rent: consumers or producers. Marginal cost pricing has to operate within the existing property rights system. Therefore, the model firm should recognize the norms only to the extent that they are actually met by the real firm and the rent should be transferred to the consumers.

2.3.2. *Technological obsolescence*

The model firm uses the best technology available at the moment of the price fixing. However, these assets last longer than five years. If there is technological progress, in the next price fixing process the new model firm will be based in the lower cost alternatives. Hence, the real firm faces a risk of technological obsolescence and potential losses that would not be compensated in the prices. If the capital cost rate reflects all the risks that the firm faces, then the obsolescence risk should also be included in the rate leading to higher prices. Currently, the Law does not consider any adjustment because of this concept and hence the utility has to afford this risk.

Given the same assumptions made for the earlier cases and assuming further that to produce water an investment of an amount *O* has to be made. This investment has a lifetime of 35 years. Under these assumptions the price that the regulator sets is:

$$(11) \quad t = O * r * \left[\frac{(1+r)^{35}}{(1+r)^{35} - 1} \right]$$

During five years, the real firm charges this price, and hence the revenues that it gets during this period is:

$$(12) \quad \sum_{i=1}^5 \frac{t}{(1+r)^i} = O * r * \left[\frac{(1+r)^{35}}{(1+r)^{35} - 1} \right] * \sum_{i=1}^5 \frac{1}{(1+r)^i} = \gamma O$$

where γ is less than one. That is, the revenues generated from the application of the prices during the regulatory period only finance a part of the investment.

Assuming that the next time prices are set, the best available technology has a cost equal to *P*, with $P < O$, and that there will be no further technology improvements, the price set by the regulator corresponds to:

$$(13) \quad \bar{t} = P * r * \left[\frac{(1+r)^{35}}{(1+r)^{35} - 1} \right]$$

If the real firm decides not to adopt the new technology, until the assets it currently has reach their lifetime, it will suffer a capital loss equal to:

$$(14) \quad \sum_{i=6}^{35} \frac{\bar{t}}{(1+r)^i} - (1-\gamma)O$$

If instead, it decides to adopt the new technology immediately, its loss is equal to: $(1-\gamma)*O$.

Under competition, if a new technology that reduces production costs becomes available, the first firms that adopt it will earn economic rents, which in turn will act as an incentive for the rest of the firms to adopt it also, pressing the market price to decrease with the corresponding benefit for the consumers. In this scenario, the firms that have to switch to the new technology suffer a capital loss. In this sense the model firm without history scheme replicates this result. There is, however, a fundamental difference between a competitive scenario and the model firm scheme that is related with who bears the risk of obsolescence. In a competitive scenario, the risk of obsolescence is borne by the firms. But if the objective of the regulation is to emulate competition subject to a break-even constraint for the firm, the transfer of risk requires to be compensated allowing a higher rate of capital cost.

2.4. Investment Indivisibilities

In the model firm scheme, indivisibility is understood as the existence of assets that can be built in any size but the cost of building \bar{K} at once is less than the cost of a sequence of investments ΔK that also generate \bar{K} .

The model firm is built to satisfy the annualized demand for the five-year regulatory period. However, a firm that makes its investments based in an optimized growth trajectory to minimize the total cost of provision with a time horizon of n years must have during the regulatory period a productive capacity larger than what is strictly necessary to satisfy the expected demand for that period.

The problem posed by the indivisibilities, comes from the fact that the regulator does not consider in the calculation of the tariff investments larger than the ones required to satisfy the demand of the regulatory period. Hence, regulated firms that optimize their investments, will not break-even, since its costs will not be covered by the tariffs.

If, in turn, the real firm invests only to satisfy the demand in the current regulatory period, it would break even exactly during the regulatory period but the investment in capacity would be inefficient, having to incur in higher costs of provision in the future.

To illustrate this point, assume that there are two regulatory periods 1 and 2 and that Q_1 and Q_2 correspond to the annual demand in each period with $Q_2 > Q_1$. In addition, Q_2 corresponds to a steady state demand. To satisfy the demand, the firm has to invest in asset K of infinite lifetime. An investment of an amount K_1 to

satisfy the first period demand and an amount K_2 to satisfy the second period demand, with $K_2 > K_1$. Assuming no other costs, the tariffs of each period are given by:

$$(15) \quad \sum_{i=1}^5 \frac{t^* Q_i}{(1+r)^i} = \sum_{i=1}^5 \frac{CTLP_K}{(1+r)^i}$$

Assuming, for simplicity, that the demand is constant within each regulatory period, the tariffs set by the regulator are:

$$(16) \quad t_1 = \frac{CTLP_{K_1}}{Q_1} = \frac{K_1 * r}{Q_1}; t_2 = \frac{CTLP_{K_2}}{Q_2} = \frac{K_2 * r}{Q_2}$$

where $t_2 < t_1$.

Therefore, if the real firm wants to make its capacity investments decisions, based in the long run demand, making an investment of an amount K_2 in the first period, it would not break even, since this period's tariff will not cover the capital cost of its investment.

3. CONCLUSIONS

The model firm scheme attempts to emulate a competitive scenario and to be a high power price setting mechanism. The definition of a model firm that starts from scratch at the beginning of each regulatory period tries to favor the adoption of new technologies and the attainment of economic efficiency. The main objective of the model firm is to make the costs used for price setting, independent from the costs of the real firm. As it happens under competition, in which the firm is a price taker, each firm has to adjust its costs to the efficient ones reflected in the price.

Dynamic efficiency is introduced in the regulation by means of the definition of the model firm that has no history and is assumed that it starts from scratch each time prices are set. The purpose of defining a new firm every five years is to provide the incentives for the real firm to adopt any technological innovation and to expose it to the same risks that it would face in a competitive environment. If, for example, a lower cost technology appears, the most efficient firm in the market will determine the prices. All the firms present in the market that have a different technology will suffer a capital loss and will have to adopt the new technology if want to stay in the market. The regulation without history emulates this scenario, and every five years a new model firm is developed that forces the real firm to adjust to the changes that have occurred in the market.

On the contrary, a model firm that considers the history would make the technology adoption decision endogenous to the regulated prices. Given the cost of the best available technology at that moment of the price fixing, the model

firm is designed to obtain null benefits using that technology. If, at the end of the regulatory period, a new lower cost technology appears, the regulation with history would imply that, at the prevailing prices, the technology adoption would be profitable if the real firm can obtain the productivity gains from it, conflicting with the price adjustment required to transfer to the consumers the benefits from the productivity gains from the new technology.

Hence, the model firm without history has economic sense when the benchmark for the regulation is competition. However, within this definition of the model firm there are certain sources of regulatory rents for the real firm. This is the case of the startup investments and the costs of meeting the prevailing regulations.

4. REFERENCES

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