PRIVATE SECTOR PARTICIPATION AND REGULATION OF WATER AND WASTEWATER UTILITIES: Theory, empirical evidence and implications for Chilean privatization

by

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Abstract

This paper analyzes and discusses fundamental elements of economic theory related to natural monopolies' regulation, and analyzes empirical evidence, with the goal of generating implications for Chilean water and wastewater utilities, with respect to processes of private sector participation (PSP). The first part of this paper analyzes the water and wastewater sectors of Chile in the context of Latin America, and describes the distinct forms of PSP in those sectors. The second part of this paper reviews theory and empirical evidence, both international and Chilean, regarding efficiency and ownership (private versus public). Finally, this paper analyzes themes related to technology, cost structure and economies of scale in the water and wastewater sectors. This paper shows that mixed-ownership companies have functioned more efficiently than their private counterparts. This paper concludes that the Chilean large-scale privatization of mixed ownership companies (through the sale of the companies assets) is partially justified from the point of view of attracting economic resources for the wastewater treatment sector, but does not have much justification if the desired end is a large increase in operational efficiency. This paper also concludes that the problem with the reform of the water and wastewater sectors in Chile, has been one of analyzing the future cost of greater regulation, along with the implicit risks that accompany a large PSP through the sale of company assets, versus the possible benefits resulting from securing necessary capital for further development of the water and wastewater sectors. Therefore, engineers and experts in regulation and finance should work in cooperation to analyze the PSP process in greater depth and correspondingly reduce the implicit risks that are inherent in such a reform.

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1. INTRODUCTION

The processes which permit private sector participation (PSP)[1] in partial or total form (such as the sale of assets, which Chile has begun) can be considered as relatively new (England, 1989, Chile, 1990, Argentina, 1994). In Latin America, Chile has the most developed program of PSP in the water and wastewater sectors. Historically, Chile has allowed PSP in the water and wastewater sectors in different ways. Before 1989, service in these sectors was provided mainly by state companies,[2] and PSP was seen in water and wastewater sectors mainly by the provision of service contracts (e.g. maintenance, engineering design, subcontracting the construction of new projects, metering and billing) to the public utilities. Since 1989, the participation of privately owned companies in this market has taken place by allowing them to apply for concessions. Also, since 1989 PSP has been allowed through participation in the ownership of State companies. As a result, in 1989 the State water and wastewater companies were incorporated, and part of the share (about one third) of the two main companies in Chile (EMOS and ESVAL) went public in the local stock market. Currently, the remaining part of the State companies shares is held by the state institution, the Chilean Corporation of Development (Corfo). Today, these utilities are known as Corfo companies, which some of them are mainly mixed companies (public-private ownership). Thus, Corfo companies are one of the first cases in Latin America where private sector participation through ownership of assets, in the water and wastewater utilities has been allowed.

In the last 5 years, the large amount of advertising on the subject of PSP in water and wastewater companies in Latin America, has created many expectations, but it is important to not overestimate the extent of PSP in the water and wastewater sectors in the region (CEPAL, 1996).[3] In many Latin American countries, the public opposition to this type of reform has delayed many of PSP projects. On the other hand, the international experience and empirical evidence on PSP in the water and wastewater sectors is relatively scarce, and therefore, there is no consensus with respect to many issues, such as benefit and risk of PSP, among other issues (e.g. quality of service). In addition, in this type of monopoly as well in the electrical sector, there is still no consensus in themes related to efficiency and ownership (public versus private). Empirical evidence from these two natural monopolies shows that once an adequate regulatory framework is in place and competitive pressures are in the market, public utilities can perform as well as private ones. The empirical evidence from the US and Chile presented in this paper about ownership and efficiency in the water and wastewater sector does not validate the theoretical assumption about private sector will perform more efficient than the public sector.

Another controversial issue about water and wastewater systems which has not been addressed deeply in the economic sphere, is the issue of economies of scale. With respect to economies of scale, most economists tend to place all natural monopolies (electricity, water, telecommunications, etc) in the same basket, in the sense that believing that in a natural monopoly economies of scale are evident or by assuming that a larger system will present a higher the probability of achieving economies of scale. On the other hand, sanitary engineers are always worried about the diseconomies of scale in this type of systems (network

[1] There are various forms of PSP, some of which include, concessions, service contracts, administration contracts, total sale of assets or partial sale of assets (mixed ownership), BOT (Build, Operate and Transfer) and other variations. When I refer to a total PSP or privatization, this corresponds to a total sale of assets (outright sale). Cases of outright sales in the water and wastewater sectors are very rare, with England being the most prominent case. For different forms of PSP applied in Latin America, see Rivera (1996).

[2] Before 1989, only few private system could be found. Most of privately systems were organized as small community services, which were providing the service to some small industrial complex, small rural villages, or in some small summer resorts. In sum, it could be said that before 1989, existence of privately owned companies providing the services were almost nil.

[3] For an excellent review of the state of PSP in the water and wastewater sectors in Latin America, see CEPAL reports prepared by the Division of Environment and Development. Report LC/R 1697, 1996.

system), since most of the engineering models/studies (deductive studies) as well the evidence from real systems shows that increasing the size of a system or aggregating different small and medium systems does not implicitly implies gain in economies of scales. Therefore, in this paper both approach (engineering and economic) approach to evaluate economies of scales are described, and some evidence is presented with the purpose to show that economies of scales in water/wastewater systems are not as evident, and should be considered carefully in a process of market segmentation for PSP.

Even though the Chilean experience with PSP is the longest established, the experience in Argentina can be considered as the most aggressive with respect to PSP of water/wastewater services in Latin America, since Argentina has concessioned the majority of the country's systems to the private sector. Even though Argentina has concessioned most of its systems, the State still owns the most of the companies assets. On the other hand, the Chilean experience can be considered the most aggressive with respect to asset sales, since part of the assets of the main company Empresa Metropolitana de Obras Sanitarias (EMOS), which served about 35% of the total Chilean population was sold by placing shares in the Chilean stock market. The Chilean systems where the first attempt of corporatization of water and wastewater in Latin America. Argentina, using the PSP form of concession have allowed PSP in most of their systems, being Buenos Aires, the largest concession in Latin America, which have not escaped criticism from the experts.[4] Outside of the context of Latin America, one of the most prominent aggressive experiences with respect to PSP of water and wastewater systems, has been that of UK, which, like Argentina, has not escaped criticism from the experts in the field (Martin and Hartley, 1998, Rees, 1994, Cowan 1995).[5]

International experience demonstrates that the process cannot be generalized with respect to the benefits and risks associated with PSP in water and wastewater systems, since all countries and cases have very specific characteristics and therefore all the elements and variables must be evaluated on a case by case basis. The UK and Argentinean experiences have been mentioned as an illustrative example, with the goal of illustrating the regulatory process for the water and wastewater sectors, which has very specific characteristics,[6] is complex and has high risks which may not lead to a gain in economic welfare. Thus, it is imperative that these factors be considered in the regulatory framework before undertaking a PSP process.

In the process of PSP in the water and wastewater sectors, there are a series of elements which must be evaluated before embarking. Among some of these elements are: (1) commitment of the parties (Hill and Abdala, 1993; Spiller, 1993); (2) asymmetry of information and regulatory capture (Bitran and Serra, 1995, Rees, 1995, Stigler, 1971); (3) form of regulation and alternatives for applicability of parameters (benchmarking) or of comparative regulation (yardstick regulation), (Madrid-Aris and Montero, 1998; World

[4] In the specific case of Argentina, the criticism was directed at various aspects of the system. Some of these were the inefficient design of the regulatory/tariff system, which was designed with a very low level of metering, and therefore did not create many incentives for conservation of water. Another criticism was related to the renegotiations of the concession contract, after privatizing the system (discount coefficient of the proposed equal to K=0.73, for a value of K=0.83). The renegotiation was argued under the supposed incorrect wrongly estimation of the future investment program (World Bank, 1996).

[5] The regulatory system of Great Britain, left large deficiencies in the areas of price renegotiation, costs passthrough, which obviously were capitalized on by the operators, with brought on a series of price-cap renegotiations of the Price-cap K-factor, which generated a large increase in rates. Additionally, the form of regulating the private companies "regulatory capital," created incentives for private sector rent-seeking type activities.

[6] The water and wastewater sectors are very capital intensive (2 to 3 times more intensive with respect to asset/revenues ratio than electrify and telecommunications, Madrid-Aris and J.P. Montero 1998). These sector generates important environmental and health externalities. These sectors have unique physical characteristics as well as natural monopoly characteristics and therefore it is difficult to generate competition. Other important characteristic is the fact that people perceives water as a basic need good and a public good, principally because it is directly related with the costs of health and its externality may affect not only those that have the service, but the entire population. Additionally, surveys show that the residential users "willingness to pay" for these services is very low, and much lower than compared with other natural monopoly services (e.g. electricity). Finally, most of the assets are underground, therefore its valuation is difficult and implies a high level of risk.

Bank, 1996; Bitran and Serra, 1995; Cowan, 1995); (4) problems with vertical integration and contracts (Helm and Jenkinson, 1997); (5) asymmetry of information and its implications for investment; (6) independence and discretionality of the regulatory entity (Helm, 1994); (7) physical characteristics of the water and wastewater systems and the level of investment required; (8) demand structure (rural versus urban, industrial versus residential, etc.) and the externality which this demand generates; (9) indirect costs due to inadequate provision of services (especially in terms of health); (10) the type and quality of regulatory framework and the form of tariff regulation (tariff structure, cost allocation, etc.); (11) the alternatives for possible forms of PSP and the implicit risks in their implementation; (12) the political influence the large private operators may have on the government institutions; and (13) others. Each one of the preceding topics are of extreme complexity and require an in-depth empirical, as well as theoretical analysis, prior to initiation of the PSP process, or the start of a PSP modification as described in *Nueva Legislación Sanitaria de Chile,*[7] *(New Sanitation Legislation of Chile)*, where the sale of mixed-ownership companies (Corfo companies) is considered.

Obviously the present study does not attempt to completely cover the complex topics previously mentioned, but it has been designed in a very simple and illustrative fashion to review theory, using a wide variety of empirical evidence. This work, in the first part, analyzes the sanitary systems of Chile in the context of Latin America. In the second part, the distinct forms of PSP in the sanitary systems are described. Later, the Chilean and international empirical evidence will be reviewed with respect to efficiency and ownership (private versus public). Finally, this paper analyzes the themes related with technology, cost structure and economies of scale in the water and wastewater sectors. The purpose of covering such a wide spectrum of themes is to introduce the reader to economic theory of natural monopolies, and at the same time, generate general implications for Chile and be able to suggest future areas of investigation.

The empirical evidence from the U.S. and Chile presented in this paper present a series of important questions on efficiency of public versus private companies. On the other hand, on a more theoretical level, it is important to explore new forms of PSP, and their applicability to developing countries. Finally, the cost structures and economies of scale generate important implications for Chile and defines possible areas of investigation in this field.

The remainder of this paper will be presented in the following order: section 2 addresses the Chilean situation and demand for investment in sanitary systems is described within a Latin American context. Section 3 presents the various forms of PSP in the water and wastewater sectors, their applicability and feasibility to generate competition. Section 4 presents in a simple and brief format, a review of studies on ownership of property (private versus public), efficiencies of U.S. companies and an analysis of Chilean companies. Section 5 introduces the reader to themes normally forgotten in economic theory of regulation of water and wastewater companies--technology, cost structure, and economies of scale. The final section includes a summary and conclusions.

2. CHILEAN WATER/WASTEWATER COMPANIES IN A LATIN AMERICAN CONTEXT

Before embarking on more theoretical issues, it is important to analyze the general characteristics of the Chilean systems within the context of Latin America. It is important to analyze the sanitation systems within their regional context from the point of view of capital acquisition since the majority of other Latin American countries also need large amounts of capital to develop the water and wastewater sectors.

[7] In February of 1998, Chile officials proposed the *New Sanitation Legislation* which was approved in April of 1998. Some of the objectives of this new law are: (1) free-up resources of public investment in order to redirect them to other social priorities; (2) introduce new forms of competition which will drive tariffs to new efficient levels; (3) assure a minimum level of deconcentration which permits the maintenance of an adequate level of indirect competition or substitution; (4) limit fixed charges to those which are independent of the level of production.

2.1 Brief Review of the Sanitation Systems of Some Latin American Companies

Table 1 summarizes the principal indicators related to water/wastewater systems from various Latin American countries.

TABLE 1: General Characteristics of Urban Water/Wastewater Sectors of Latin America

Country	Urban Population	Water Coverage (1994)	Sewer Coverage 1994	Treatment of Sewer Waters	Type of Service	Regulatory System
Argentina	87%	72%	36%	Less 5%	Municipal	Decentralized
Brazil	71%	88%	39%	Less 2%	Municipal	State: non-uniform
Chile	84%	**99%**	**88%**	**Less 5%**	**Regional**	**National-centralized**
Colombia	72%	75%	60%	Less 1%	Municipal	National-centralized
Mexico	74%	67%	63%	Less 10%	Municipal	Confused
Panama	77%	68%	41%	Less 3%	Regional	National-centralized
Peru	71%	71%	61%	Less 5%	Municipal	National-centralized
Puerto Rico	73%	98%	50%	99%	National	National-contractual
Venezuela	92%	76%	65%	Less 5%	Municipal	To be defined

Sources: World Bank (1997), World Development (1994), WHO (1997), Madrid-Aris, Hewitt and Nussbaum (1998).

It can be deduced from the preceding table that Chile possesses the highest coverage for potable water and sewerage in Latin America, reaching 99% for potable water and 88% for sewage systems. On the other hand, Chile has a large deficiency in the treatment of sewage waters, just as the remainder of Latin America. In the majority of Latin American countries, the provision of these services is carried out by the municipalities, with the exception of Chile and Panama, where it is on a regional level. The tendency of the regulatory systems is, in general, to be centralized. Argentina is the only country which has a decentralized system.

The high percentage of coverage in Chile in the potable water sector and the collection of sewer waters demonstrates that the necessity of future investment should be directed principally toward the wastewater treatment sector. The investment necessity in the wastewater treatment sector for the period 1998-2002, reaches US$693 million (Madrid-Aris and Montero, 1998). From a regulatory point of view, it is important to note that the wastewater treatment sector is much more capital intensive than the potable water sector and wastewater collection sector. It is important to analyze the sector intensity of capital in order to select the appropriate PSP and regulatory systems.[8]

[8] Normally in the U.S., for activities or sectors which are intensive in capital, rate of return or incentives regulation systems are preferred in order to create incentives for the private sector investment. Incentive regulation is an alternative to standard rate of return which is now prevalent in many industries in the US. (e.g. profit-sharing is a particularly popular). The continuum bracketed by price caps and rate of return regulation is generally termed as "incentive regulation." Note that the possible efficiency gains in highly capital intensive sectors are limited since operational costs represent a low portion of the total costs. Even further, in the case of Chile, for new projects, the alternative of efficiency gains does not exist as it does with older systems. When there are inefficiencies, some people recommend allowing PSP through the implementation of a incentive regulation or price-cap type of regulation. It is important to note that the application of "pure price-cap" regulation to water and wastewater systems in developing countries has not been studied from a theoretical or practical perspective. Pure price-cap regulation for developing countries could presents a series of inconveniences due to uncertainty of key factors, as result of lack of accurate information and lack of metering in the systems. Thus, in reality a pure price-cap implementation may not generate gains in efficiency in LDCs and instead may generate rents or excessive net returns or losses as a result of asymmetry of information and the level of uncertainty in the fundamental variables which regulate prices (consumption, investment and others).

In sum, it can be concluded that Chile requires large investments mainly for the wastewater treatment sector, which is capital intensive. This suggests that regulatory authorities in Chile should investigate the alternatives of the different forms of PSP so that they are adequate for the type of investment which the country needs (wastewater treatment), and the efficient way to regulate this specific sector (wastewater treatment). Also, a special emphasis should be placed on the possible types of competition to implement for this type of investment, especially for competition for product and competition for service.[9]

2.2 Characteristics of Some of the Water/Wastewater Systems of Latin America

Table 2 contains some of the principal indicators for the water and wastewater sectors from five Latin American cities, which have permitted to some degree, or are going to permit, PSP (the case of Panama), or are going to further investigate privatization (as in the case of Chile). The evidence from the natural monopolies in the electricity and telecommunications sectors, validates the assumption of the experts that the water and wastewater sectors are the last natural monopoly to be privatized in the majority of cases and that total privatization of it represents great challenges. In the five countries mentioned, a strong privatization process was implemented which included the sale of telecommunications and electricity (Mexico is the only exception in this sector) before permitting the privatization of the water sector. The only country which has permitted PSP in the ownership of sanitary services has been Chile.

TABLE 2: Principal Sanitation Indicators from Latin American Cities

PARAMETER	Panama-Metro 1998	Buenos Aires 1993	Mexico City 1993	Lima (Peru) 1991	Santiago (Chile) 1993
Population served (millions)	1.3	10	8.5	6.5	4.7
Population with potable water connection or coverage	82%	70%	97%	75%	99%
Population with sewer service	52%	58%	63%	61%	91%
Workers per 1,000 connections	8.6	3.4	14.4	4.7	2.2
Metered connections	45%	20%	NA	8%	99%
Losses of water	49%	45%	33-47%	41%	34%
Consumption of water (lts/person/day)	473	550	352	236	260
Ownership	Public	Public	Public	Public	**Public-Private**
Form of PSP	To be concessioned	Concession	Service contracts	Public reform & service contracts	Public reform & service contracts

Sources: CEPAL (1997), Madrid-Aris, Hewitt, and Nussbaum (1998), Rivera (1996), Shirley (1998), *World Development Report* (1994).

In coverage and metering of potable water, Chile situation is only comparable with developed countries. On the other hand, the levels of metering or measurement in Chile theoretically reach 100%, while in many developed countries the levels are much less (for example, in England the levels of metering are less than 10%). Nevertheless, investment is required to expand the systems of sewage collection and expand actual

[9] In the case of Chile, investments would be in treatment plants such as the Southern Plant of Santiago and others, where special emphasis should be placed on the type of competition feasible to achieve for efficient gains. For examples in this type of investment, if competition for the product is selected, the gains in efficiency may be generated in various forms, for example, through solicitation of turnkey type operations or EPC (engineering, procurement and construction) or through BOT and BOOT (build, operate, own, transfer) projects and their variations.

coverage (88%). On the other hand, the situation of the wastewater treatment system is not very flattering: less than 5% of the effluent is treated.

The levels of per-capita consumption of water, in general, are correlated with the incentives that the tariff structure generates for the conservation of water, with levels of metering, with the public education policies for conservation and with climatic factors. The high consumption rates of Buenos Aires has its roots in the low levels of metering and in the tariff structure, which does not possess penalties for over-consumption. The high levels of consumption in Panama are principally due to the tariff structure, which defines a very high fixed block of basic consumption, equivalent to 8000 gallons per connection per month and does not generate a marginal cost signal which would create incentives for conservation of water and reduction of domestic losses (Madrid-Aris, Hewitt, and Nussbaum, 1998).

With respect to the number of employees per 1,000 connections, it is important to note that the large difference between the five systems is due to the fact that some systems (as in the case of Chile) have extensive PSP by using service contracts (development of new projects, maintenance, metering, billing, collection, etc. are carried out by privates companies). But, from Table 2 it is clear that it can be concluded that the Chilean sanitary systems do not suffer the same overpopulation of personnel which many sanitary systems in developing countries typically have and, therefore, operate efficiently with respect to personnel[10].

It is important to note that three of the five cities are facing serious environmental problems which impact the costs of production of water. For example, in Lima, two thirds of their water depends on river water, which is highly contaminated. The other third is provided by deep wells, which have problems with salt intrusion. In Mexico City, two thirds of the water is taken from deep wells where the static levels of the aquifer are dropping. The other third comes from rivers, a large distance from the city, with a quality of water that is deteriorating due to sewage water discharges. Only in Santiago and Buenos Aires do they still posses clean sources of water. From the preceding, it can be concluded that the marginal costs of new sources of water, will be much greater in the other cities in Latin America in comparison to Santiago.

2.3 Average Tariffs of the Principal Cities of Latin America

It is important to note, through the comparison of average prices, that the level of efficiency of a company, cannot be determined due to conceptual and empirical problems. For example, the costs of the sanitation companies depend largely on the hydrological characteristics of the systems, topographic and demographic characteristics, the size of the company, direct or crossed subsidies which may exist, future plans of investment and its inclusion as part of the tariff, and many other factors. Table 3 shows the average tariffs for water and sewer services for Panama, Buenos Aires, Lima, and Santiago. The values of Mexico only include the tariffs for potable water.

TABLE 3: Average Tariffs in Latin America for Water and Sewer Service (per m3)*

AVERAGE TARIFF	Panama Metro (1)	Buenos Aires (1)	Lima (1)	Mexico City	Santiago(1)
Average Tariff per m3 (yr)	0.32 (1998)	0.66 (1994)	0.29 (1994)	0.30 (1993)	0.39 (1994)

Source: Madrid-Aris, Hewitt and Nussbaum, 1998.
Notes: (1) Includes charges for sewer service
*Total income calculated as net value (without taxes) divided by volume of water billed.
**Corrected value. Corresponds to the value necessary to cover costs.

[10] In general, considering that a company assigns service contracts for construction works and maintenance, the average values of a company moderately efficient vary between 3 and 5 employees per 1,000 connections. Given this fact, it could be assumed that Chilean companies have arrived at a high level of efficiency judging from the number of personnel per 1000 connections.

From the average prices of Table 3, it can be concluded that on the average, the tariffs of Panama, Lima, and Santiago, for potable water and sewer services are very similar.

3 FORMS OF PSP AND COMPETITION

3.3 Brief Review of the Theories Related to Natural Monopolies

Water and wastewater systems, by nature are a natural monopoly and are characterized by various elements, among which the most significant are the following: (1) the high useful life of their investments, (2) the immobility and non-alternative use of the majority of the investment (sunk investment), (3) high level of fixed costs, (4) decreasing average costs in the long run.[11]

It is also important to mention that by nature water and wastewater systems are more monopolistic than telecommunications and electricity systems. For example, in telecommunications, cellular systems compete with fixed line systems. In electricity, competition can also be achieved with sources which may be hydroelectric, thermoelectric, carbon, gas or another combustible (cogeneration plants). Even more, in electricity you can even introduce some level of competition in the generation sector and, at times, in transmission. On the other hand, competition for water are very limited. Multiple lines of transmission through a city would not make sense and the required investment would not be economically feasible, therefore competition in the distribution is not feasible. Limited competition can be achieved in the production of water, but it is limited by the physical and hydrological conditions. In addition, water does not have a substitute. In sum, there is not doubt that water and water systems are natural monopolies.

There are various theories which discuss government intervention in natural monopolies. The majority of these point out that state ownership reduces asymmetry of information (Shapiro and Willig, 1990) and that the state follows social goals, therefore government places more emphasis in general welfare issues, rather than profits, which is the man goal of the private sector. By comparison, private enterprises may not achieve the social benefits which politicians would like to achieve (Sappington and Stiglitz, 1987, Shapiro and Willig, 1990). Others argue that the benevolence of the state is only a myth, which is reduced to pure theory. On the other hand, it is argued that governments and special interest groups (Olson, 1965) may be concerned with their own agendas without considering social benefits. The "Public Choice" theory argues that public administrators and politicians would use control of the state-run companies to satisfy their own interests or agendas, without importance to the efficiency of the companies or social benefits, which would become a second objective.

It is important to note that once PSP has been permitted or a natural monopoly has been completely privatized, even though there is competition,[12] a financing system and an efficient regulatory framework (difficult to implement in reality), the situation does not improve much. Special interest groups will continue to exist, which implies that once a monopoly has privatized, it may pursue rent-seeking activities, through a collusion between the operator and special interest groups, through a fusion of companies to eliminate competition and eliminate alternatives of compared regulation, or through special interest groups which may reformulate the regulatory framework and again bring about non-benevolent activities.[13] On the other hand,

[11] This mainly occurs in developed systems (high level of coverage). For example, in systems like the ones in Latin America, where large capital investments are required to achieve coverage, in general, the average costs in the medium-term and at times the long-term, are increasing, given the large amounts of required capital investment.

[12] A privatization of a water and/or wastewater system does not ensure competition or efficiency gains. This is true under a public or private regime, and is a function of selecting the adequate form of PSP and having an adequate regulatory framework.

[13] For information related to theory on the problems of natural monopoly regulation, see Buchanan (1980), Goldberg (1976), Lafont and Tirole (1993), Schmidt (1996), Shapiro and Willig (1990), Williamson (1976), Kahn (1988).

competitive proposals on pricing or bidding, even if for service contracts, administrative contracts, assigning of concessions or other types of PSP, in general, do no totally resolve some of the important LDCs problems, such as quality of service (Williamson, 1976) and coverage. Also worth mentioning is that today some PSP models are promoted where they compete for quality of service, which complicates the activities of the regulator even further, allows rent-seeking more easily, and increases the weight of regulation.[14]

3.4 Forms of PSP in Water and Wastewater Services

Table 4 shows the most common forms of PSP in the water and wastewater sectors. Normally, people tend to relate asset ownership and investment with corresponding levels of risk. It is worth mentioning that the risk involved in the process of privatization is not only dependent on the form of PSP (asset ownership, investment and operation), but also on the regulatory and tariff framework. For example, if a concession is awarded with a conceptual regulatory-tariff framework which permits the alternative of extraordinary revision of prices (tariffs) before the regulatory lag (revision period),[15] therefore, in this case the risk is not only assumed by the concessionaire or private party in totality, part of the risk may be passed to the public sector, or in other words to the consumers.[16] On the other hand, normally a tariff regimen possesses an indexation system or automatic readjustment of tariffs, which generally has a unitary or polynomial form.[17] Normally if a polynomial index is used, it must contain the endogenous variables related with the cost of production. In the case, of the existence of exogenous variables as part of the index, may transfer part of the risk to the consumer, and therefore the risk is shared and in many cases, the implicit risk of the investment is reduced.[18] On other occasions, the private entity solicits a state guarantee for the investments, and, therefore, part of the risk is passed to the public sector. The preceding was detailed in order to illustrate that with respect to the issue of risk in PSP, the regulatory problem is very complex and does not simply reduce to the analysis presented in Table 4, which many people assume.

Service contracts are the simplest form of PSP, through which, improvements may be seen in the costs of operation. In general, these services are assigned to activities, which are not capital intensive. This form of PSP, in general, does not create significant costs of regulation and the regulatory entity does not run the risk of falling into regulatory capture, such as with a concession contract. The system of service contracts, in general, is very common when the public sector wishes to maintain ownership of the assets, but would like to increase the efficiency of the system. With this form of PSP, the public sector continues to assume the commercial risk and must finance capital investment works. The typical forms of service contracts are: maintenance, emergency repairs, meter reading, billing and collections, equipment rental, and design and construction of new projects. PSP, through service contracts, is used extensively in Chile in all the various

[14] In these models, the price is a restricted variable and competition is for levels of quality which are trying to be achieved. From a theoretical perspective, the application of these types of models to developing countries has not been analyzed in depth. It is important to note that these models are difficult to implement since the variables to measure regarding quality of service, in some cases, are subjective and the control and monitoring of these variables is very costly.

[15] In general, tariff revision is performed every five years. In some cases where the systems present large uncertainties, a shorter time frame is selected (such as 3 to 4 years).

[16] In general, one of the variables which the private sector places special emphasis on prior to investing in this type of business is the tariff structure and what is referred to as “regulatory lag”, or time between revisions of tariffs.

[17] The automatic indexation of tariffs is used to permit a progressive adjustment which reflects variations in the costs which affect the provision of services. To protect the provision of services from the risks of production cost increases, in general, unitary indexation formulas (consumer price index, wholesale price index, price index of imported products, etc.) or polynomials (which should reflect the service cost structure) should be used.

[18] In some cases, the improper use of these indices reaches extreme levels which risk the private investment through debt, which to a large part is assumed by the public sector. In other cases, in addition to transferring the risks to the public sector, large rents are generated as a result of the change in certain variables (for examples taxes), and therefore, the private sector has incentives to propose to the local authorities that they raise taxes since in this way rents are generated and larger net return is obtained.

forms and so their application is not new. Therefore, it can be assumed that possible improvements through generation of competition for these types of contracts would have already been achieved (see Section 4.3.2) and the expected additional gain would be very limited.

TABLE 4: Most Common Options for PSP in the Water and Wastewater Sectors

Alternatives for PSP	Asset Ownership	Investment	Operation/ Management
Forms of PSP using contracts			
Service Contracts	Public	Public	Public and/or Private
Administration/Management Contracts	Public	Public	Private
Lease	Public	Public	Private
Concession	Public/Private	Private	Private
Forms of contracts and ownership			
BOT (BOOT) (Build, Operate, Own, Transfer) BOO (Build, Operate and Own)	Private and later Public (Private)	Private	Private
Inverse BOOT	Public and later Private	Public	Private
Forms of PSP through ownership			
Mixed ownership or mixed companies	Public and Private	Public and Private	Public and Private
Total sale or private company	Private	Private	Private
Forms of PSP through ownership and contracts			
Mixed property, with separate private operation.	Public and Private	Public and/or Private	Private
Private System with separate private operation.	Private 1	Private 1 or Private 2	Private 3 – distinct from Private 1 and 2

Administrative contracts are those in which the public sector receives support for the improvement of the company's administration. This is realized through contracting special consultants in this area, or simply transferring the administration of a public entity to a private entity. In the majority of the cases, the private company generates their income based on predetermined goals, such as reduction of administrative or operational costs, reduction in non-accounted for water, increases in collections, and others. These types of contracts provide great incentives for improvements in the efficiency of systems. These types of contracts, potentially, would be a good option to increase productivity in systems within developing countries, especially Latin America, but are very seldom used. This could be attributed to a variety of factors: (1) the method is not very well known in the region, and subsequently, public administrators do not wish to experiment with new things, and in many cases they select other options, which may be inferior based on their incentives for achieving efficiency; (2) the applicable labor unions in general oppose these types of arrangements since improvements in efficiency may represent cuts in personnel; (3) there is a scarcity of companies which provide these types of services due to such little demand, and consequently there is not much in the offerings of support.[19]

Lease contracts involve the private company leasing the public utilities installation for a period of time, which usually varies from 5 to 30 years. The private company is responsible for the operation, maintenance and administration of the system, and in some cases even for investment. In the majority of cases the public sector continues to be responsible for providing investment capital for new projects and tariff policy. With this option, the risk of investment is assumed by the public sector and the risk of the commercial aspect is

[19] The lack of local companies which provide this service, may implicate the creation of a market of international companies with experience in the matter.

assumed by the private entity. With this type of contract, it is common to have tariff and cost re-negotiation periods using price-indexed formulas. In this way, savings realized by the lessor may be passed on to the consumer.

Under the form of concession, the private company has all the responsibilities of service, operation, maintenance, administration and even investment for expansion of services. In general, the concession option applies in cases where the systems require large investments, which the public entity is not capable of achieving, and does not wish to invest resources in the sector. Concessions are usually for a time period of 20 to 30 years.

Service contracts of the form BOT (BOOT) (build, operate, own, transfer), inverse BOOT and all the associated variants are in general applied to specific projects and are used widely in the design and construction of drinking water treatment plants and sewage treatment plants.

Mixed ownership results when the ownership of the company's assets (or in some cases in charge of operations) is a combination between the private and public sector. The Chilean case (e.g. EMOS, ESVAL companies) would correspond to mixed ownership of assets. Also, it is feasible to have mixed ownership, but with a private operation through administrative/management contracts, a lease or a concession.

Table 1 includes two forms of PSP, which may be feasible to implement in Chile. They correspond to systems of ownership and service contracts at the same time, but the operation is separated from the ownership. These are referred to as "mixed ownership with separate private operation" and "private system with separate private Operation." I have proposed these two forms of PSP, *where ownership and/or investment is separated from operations, mainly* for three economic and regulatory reasons: (1) The form where there exists a separation of ownership and/or investment with respect to operation is a form adopted lately in some developed countries (for example, a concession which separates investment from operation); (2) these forms of PSP potentially may correspond to a feasible option for Chile and Latin America, where information is limited (asymmetric) and the possibility for rent-seeking activities is high;[20] (3) theoretically, this option compared with other forms of PSP where *investment and operation are not separated*, may present various advantages. Some of these advantages would be: (1) this form partially reduces the principal-agent problem;[21] (2) this form also partially reduces the risks of rent-seeking activities; (3) this form theoretically presents less regulatory risk in developing countries; (4) it has the potential to generate larger economic efficiencies through creation of a system of incentives to reduce operational costs and there are no incentives to alter capital and operational accounts, which exists in a traditional concession type of framework;[22] (5) theoretically with this form it is easier to break down asymmetry of information between the regulator and regulated; and (6) it may generate more competition than other forms of PSP (for example, a normal concession).

[20] It should not be assumed that by separating ownership from operations the probability of generating rents cannot be completely eliminated. Today, water and wastewater operators have created their own independent operational subsidiaries and therefore the ownership and operation may fall in the hands of the same group without the regulator realizing.

[21] For more detail regarding agency theory, see Ross (1973), and Buchanan et al. (1980). For a practical review, see Bitran and Serra (1996).

[22] In theory, a regulatory system of pure price-cap type (also referred to as "incentive price-setting"), when applied to a concession, should improve efficiency. The preceding may not occur in practice in less developed countries where information is of low quality, incomplete, inaccurate and the asymetry of information is high. The application of this regulatory price system may create incentives for private operators to alter their cost accounts and demonstrate a low level of profit in order to solicit a price renegotiation (or to solicit a transfer of costs if the regulatory framework permits it), or to underinvest. Note that the solution to deal with informational problem is a variant of what historically been called "sliding scale." The traditional sliding scale involves a formula by which a firm is allowed to retain a fraction of the excess in its earned rate of return over a prescribed norm.

In general, this form of PSP is implemented within a rate of return type of regulatory system,[23],even though its implementation would appear feasible under the Chilean system of the model (theoretical) company.[24] With this form of PSP, two companies together make up the system so that there is a complete separation of asset ownership and operations. One company is in charge of the assets (in charge of investments), but the regulating entity solicits operations contracts publicly to companies independent of the asset-owning company, under a system of competing bidding. The fundamental objective of this type of PSP is to try to separately maintain the capital accounts and operational costs.[25] For example, if ownership and operations are found in the same company, a reduction in the cost of capital (lower international interest rates) would imply a passing of the savings to the users through a reduction in tariffs, but this could not always occur in the case where operations and capital accounts are together, since there is an incentive for the private sector to transfer the cost of capital savings, as an artificial increase in the account for operational costs, thus, generating rents (utility of the company increases) and subsequently the tariffs are maintained. These various forms of PSP have been presented with the purpose of showing the *very large necessity for further investigation into new forms of PSP in the water and wastewater sectors in the context of developing countries*, where they typically suffer from inefficiencies and restrictions with respect to the quality of the systems, quality of information, uncertainty regarding the status of assets, low level of capital resources and financing for regulation, and inefficient systems for the resolution of conflicts, among others.

From the preceding, it can be concluded that before opting for a total privatization (sale of assets) of a water utility, the feasibility of implementation and obtaining capital should be evaluated for the various forms of PSP so that they may be viable alternatives with a low level of regulatory risk.[26] For Latin America, there is a large necessity to evaluate, from a theoretical as well as empirical viewpoint, the benefits and risks of the different forms of PSP and contracts presented in this paper, which create a separation between operations and ownership. Their feasibility of implementation should also be evaluated. For the case of Chile, these forms of PSP should be seriously studied within the Chilean context, since the availability of national capital through pension fund companies (Fondos de Pensiones – AFP) and international capital, would appear to be a viable alternative for implementation with low risk and could generate high-social benefits.

[23] Rate of return models are widely used in the U.S.. Recently however, the pure rate of return model has been modified in order to eliminate the incentives to over-invest (Averch-Johnson effect) and not eliminate inefficiencies. The modified rate of return models which are called incentive regulation is a combination of the rate of return system and price-cap. For example, a sliding-scale rate of return correspond to a modified rate of return or a incentive regulation. Theoretically, these new models create incentives to improve efficiency and attract capital. An incentive regulation might create good incentives for the attraction of capital in Chile. Theoretically, price-cap models are applied to create incentives for efficiency improvements, but in many cases, with continuous price renegotiations (such as those in England), the price-cap systems have implicitly transformed into pure rate-of-return systems, which is to say, they are ensuring an implicit rate of return (for more details, see Beesley and Littlechild, 1989; Rees and Vickers, 1995) and efficiency is not seen.

[24] The actual regulatory price system in Chile (implemented in 1989) is sufficiently complex and sophisticated, and utilizes a price-cap, which is estimated based on the theoretically efficient model company (efficient firm modeling, by using benchmarking techniques). For more details on the Chilean model company price regulatory system, see Palominos, 1994.

[25] In a concession, such as the ones applied in Latin America, in general the concessionaire invests and operates the system and therefore. the capital accounts and operational costs are managed by the same person.

[26] Unfortunately, international experience regarding these cases of outright sales of assets is very limited. However, the evidence from Great Britain shows that the net return from companies after a PSP and the affect on tariffs, is not that promising (Martin and Hatley, 1998).

4.- THEORY AND EVIDENCE REGARDING EFFICIENCY AND OWNERSHIP

4.1 Theories on Property and Ownership

There are various lines of theory regarding ownership of water utility companies. These include literature on property rights, public choice, and regulated monopolies. The literature on property rights is generally associated with the names Alchian, Becker and Demsetz, and suggests that public ownership attenuates property rights and therefore reduces the incentives for a reduction in costs. The theory of public choice, particularly the theory of bureaucracy associated with Buchanan and Niskanen, also suggests that the public sector does not function as efficiently as the private sector. Finally, the theory of regulation asserts that excessive regulation decreases efficiency. However, the idea of regulation of a natural monopoly is the protection of the user against monopolistic rents, which could possibly be generated. Finally, Liebenstein (1966) argues that monopolies generate what is known as X-inefficiency, without importance to ownership.

Given that the majority of the theories assure that the private sector would function more efficiently than the public sector, there is a tendency to generalize and assume that a PSP implicitly brings with it an efficiency gain, and therefore PSP would be convenient for social welfare. Given the preceding, in the US at the end of the 1970s, a profound debate began with the goal of empirically validating the general assumption regarding efficiency and ownership, with the goal of analyzing empirical evidence, primarily from the U.S. The large quantity of econometric studies about property and efficiency were performed for some sectors (e.g. electricity, water and others) in the last few decades. These studies still does not present conclusive evidence with respect to efficiency improvements by the private sector as compared to the public sector in the management of natural monopolies.

The important contribution of all these studies is that they demonstrate that *once an adequate regulatory and institutional framework is in place (as the US and Chilean case), and with the introduction of competition from the private sector, public companies increase their levels of efficiency to the level of the private companies.* This paper will now present a brief review of some of the empirical studies applied to the electricity sector and the water and wastewater sectors, in a way in which the results can be analyzed and will generate some implications for the Chilean case.

4.2 Empirical Studies on Efficiency and Ownership in the Electricity Sector at an International Level

A large portion of the econometric studies on efficiency and ownership have been applied to the electricity sector in the U.S. After decades of various empirical studies which have fueled the debate[27] between efficiency of public versus private companies, there still does not exist clear evidence regarding the superiority of the private sector.

In the review performed by Vickers and Yarrow (1988, pp. 40-43), it was concluded that there is not sufficient evidence to select between a public versus a private company with respect to technical and economic efficiency. The study performed by Peters (1993), reviews the large quantity of literature related to efficiency of public versus private companies in the electricity sector. The study also concludes that the prevailing results of the various studies are ambiguous and do not indicate a preference between the public and private forms. This study concludes that the empirical evidence discredits the attenuation theory.[28]

[27] This debate began last century. For an interesting historical review which covers this debate from its beginnings, see Hausman and Neufeld (1994).

[28] The fundamental proposition of the theory of attenuation is that the attenuation of property rights in public companies, as a result of the high cost of property transfer, reduces the incentives for efficient behavior on the part of managers, and so the theory assumes that private companies would be relatively more efficient than public.

Another recent study was conducted by Pollit (1993). This study compares a sample of 95 companies in the electricity sector, operating in nine countries in 1986. The results of the study do not offer conclusive evidence on the superiority of efficiency in the costs of private companies.[29] On the other hand, the evidence of Pollit, also demonstrates that well-run public companies can have efficiencies equal to those of private companies. The results of the study appear to be consistent with the general view in the U.S. that efficiency of monopolistic type companies depend on the degree of competition to which they are subjected and the quality of regulation and institutions. The evidence from Great Britain shows that privatization forced competition in the electricity market and thus increases in productivity and labor were seen. The same is true for the case of Argentina (Perez-Arriaga, 1994). In the case of Great Britain, the companies associated with distribution continue to be natural monopolies and their functioning has not appeared to change much since having privatized. The same appears to be true for the distribution systems in Chile, judging by the cases reported by Galal (1994).

Finally, it is interesting to review one of the more recent studies from the U.S. which analyzes this theme. Koh, Berg and Kenny (1996) performed a detailed and sophisticated study. The study had as an objective to analyze ownership and efficiency, and corresponded to an extension of the work by Atkinson and Halvorsen (1986), where they include the effects of regulation, ownership and market structure. The sample used corresponds to 121 private firms and 61 public firms from the U.S. One of the objectives of this study was to explain the concentration of public ownership in small systems of electricity generation and the concentration of private ownership in the larger systems. In the U.S., of the systems which generate less than 3,000,000 MWhs, 197 companies are public and 50 are private. While in systems larger than this, there are 118 private and only 25 public companies. This study, with its consideration of the market structure, demonstrates econometrically that for smaller systems of electricity generation, public companies are more efficient than private and the opposite also holds true for larger systems. The author argues that public companies are more efficient in the smaller systems for the following reasons: (1) the utility board of public companies can better supervise and control the costs of these systems than in larger systems; (2) smaller systems are able to obtain capital at a lower cost since the municipal bonds of the U.S. are exempt from taxes. Finally, from this study, it can be concluded that the lack of political pressure for a large-scale privatization of the electricity sector in the U.S. is due to the fact that each group (public as well as private) has situated themselves in the sector of the market where they possess the most comparative advantage.

4.3 Empirical Studies on Efficiency and Ownership in the Water/Wastewater Sector of the U.S.

4.3.1 Brief Introduction to the Water/Wastewater Market in the U.S.

In the U.S., PSP in the water and wastewater sectors does not represent a major portion of the total market. It is estimated that the private sector only obtains from 18% to 20% of the total revenue which the potable water sector generates. In the wastewater treatment sector, nearly 95% of the revenues are still in the hands of the public sector (*IBJ*, Volume XI, p. 6, 1998). In the U.S., in the water production and distribution sectors, various forms of PSP may be found, such as concessions, joint ownership, administrative contracts, service contracts, etc. In the wastewater treatment sector, the most common form of PSP is through ownership and systems operations.

Now one might ask, why is PSP in the water/wastewater sector of the U.S. so low compared to the electricity sector, where participation of the private sector began more than a century ago? There are many reasons which are political and/or economic in nature. Some of the political reasons worth mentioning are: (1) the percentage of personal disposable income, destined for payment of these services is very low

[29] This study follows the know-concept of technical efficiency proposed by Farrel (1957). Technical efficiency is measured through achievement of an estimated technical production frontier, and through an efficient cost structure which the company minimizes with respect to inputs prices. In this way the company may be technically efficient, but not minimize their costs (non-allocative efficient).

compared with other services (electricity, or telecommunications), and therefore, there has not been a large private lobbying effort to privatize these services; (2) in the U.S., water is considered a public good and in the majority of cases, the assets pertain to small communities, such as municipalities, counties, etc., and there is a large opposition for passing these operations to private hands; (3) in general, in the U.S., water and wastewater systems, are tax-free and in other cases are taxed at low levels, which does not make it a priority of budgeting authorities. This is the opposite of the energy sector, where taxes are very high (direct and indirect taxes), and therefore policy makers have given this sector a higher priority.[30] From an economic point of view the reasons are very clear: (1) based on the technical and economic studies, it can be argued that more privatization is not justified and it would only increase regulatory risk.[31] The majority of the studies demonstrate that public companies posses the same level of efficiency, technical as well as economic, as private companies. This comparable efficiency between public and private companies is due to the fact that once private companies enter the market of large- and medium-sized companies, the rest of the sector automatically begins to be more competitive, reducing their costs and tariffs to be on par with those of the private systems;[32] (2) the attraction of capital for this sector in the U.S. is not such a limiting factor as it is in developing countries, where they are forced to consider privatization.

4.3.2 Empirical Studies on Efficiency and Ownership in the Water/Wastewater Sector

Mann and Mikesell (1976) performed a study of this type and found that the costs of operation of public companies was lower than for private companies. This study included the variation of environmental norms and regulations, but did not include control variables for differences in salary. Later, Crain and Zardkoohi (1978), found evidence of lesser costs of operation for the private sector. This study included salary differentials but omitted environmental and regulatory differences.

Feigenbaum and Teeples (1983) focused on the problem of ownership and efficiency through hedonistic pricing, using a Cobb-Douglas production function. The results of this study delivered a better explanation of the specific costs of operation, such as labor costs, energy costs, and others. This study found significant differences in efficiency between the public and private companies.

Byrnes, Grosskopf, and Hayes (1986), with the purpose of verifying the previous studies which principally used production functions for costs, performed a study with a different focus by applying linear programming techniques, with the goal of constructing a production frontier function, without imposing a functional restriction. Note that the previous studies were only able to compare average functioning of public and private companies. The sample analyzed covered 68 public companies and 59 private companies in the U.S. The results of the study were very similar to those of the study by Feigenbaum and Teeples, reiterating that it is not possible to assure that private companies are more efficient than public companies. The results of this study are not inconsistent with those of Bruggink (1982), since this study focused more on technical and productive efficiency, and not in operational costs.

Teeples and Glyer (1987) performed a study of 119 water companies in Southern California. The study considered a dual-cost function where a second order translogarithmic function was used. The study tried to respond to the question on the type of ownership most appropriate for various distribution systems of water.

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[30] I would like to thank Professors Steven Renzetti and Julie Hewitt for providing suggestions in the development of this topic.

[31] One of the greatest fears of a large privatization in the US. is that it may produce a concentration of these systems in the hands of large French operators. Today, only one French operator has more than 10% of the earnings of the private sector in these types of services in the U.S. Private North American companies which operate these types of services are small compared with the French operators. For example, American Water Works is the largest operator company of water services and its sales are only U$938 million, while that of the French company, Suez Lyonnaise des Eaux, has sales in excess of U$33,000 million.

[32] See the report on competition by the American Metropolitan Sewer Association (AMSA).

The type of ownership used was related to companies from cities, districts and publicly traded companies, since they provided service to not only one but multiple service areas. The average results were consistent with the previous studies--a greater efficiency was not detected for private companies than for public. Also, it was found that a different type of ownership could be specified for each type of water distribution system.

Bruggink (1982), performed a sophisticated and complete econometric study where a series of control variables were included, such as production ranges, environmental norms, regulatory systems and salary differences. This study focused on municipal companies in the U.S. The study found that the costs of public companies were a little less than those of private companies. Bruggnik argued that this difference was due primarily to the following factors: (1) public companies operate in a hostile environment of private companies and therefore must justify their existence; (2) the public sector is capable of attracting better managers and administrators since they offer contracts of longer term (tenure); and (3) the public sector does not have the so-called liberal accounting (excessive expenses such as per diem, etc.) and non-salaried which the private sector has. This element should not be underestimated in a case of PSP since, in general, the salaries in private companies and foreign companies are considerably higher and produce a considerable tariff impact, especially in less-developed countries.[33]

Finally, one of the more recent studies of this type, was performed by Brattacharyya, Harris, Narayanan and Raffee (1995). This study used a stochastic production frontier function to determine inefficiency and relate it with the type of ownership. The sample included 190 public companies and 31 private companies. The results indicated that when an operation is small, a private company would be comparatively more efficient; and when the scale of operations is larger, public companies would be more efficient. These results should be considered with caution since the specification of the inefficiency function used in the study is somewhat subjective. It is important to note, that the results from studies applied to electric companies are opposite to this. On the other hand, the majority of the empirical studies demonstrate that the operational costs of both types of ownership are almost identical and in many cases less in public companies. Therefore, assuming that at times the cost of capital in the public sector for small companies is less than for private companies (the majority of the municipal bonds issued to raise money for this type of work are exempt from capital gains taxes in the U.S.), there is no reason to assume that the private sector is more efficient in smaller systems. On the contrary, in larger projects the cost or weight of regulation is less and the private sector is more competitive in raising capital, and therefore the private sector should be more efficient in the larger systems.

Of all the previously mentioned studies, the common denominator that would be important to point out is related to the fact that once competitive forces are introduced in the market *through the introduction of the various forms of competition, this creates large incentives for public companies to improve their efficiency.* During periods of privatization in the water and wastewater sectors of developing countries, it is interesting to reflect on the types of comparative studies previously mentioned.

In the majority of the cases, the empirical evidence supplied by the studies applied to developed countries, demonstrates that PSP in water/wastewater sectors, when no capital is required, and under an efficient regulatory framework, would be justified as a general form of competitive pressure and a means to improve efficiency. Experience from the U.S. shows that the strategy applied there has functioned relatively well, from the point of view of improvements in efficiency and reduction in the risks and weight of regulation. The evidence presented suggesting a partial privatization to improve efficiency would seem to be an adequate strategy for less-developed countries since a total privatization also brings various risks, among which would be: (1) the risk that the hoped-for efficiencies are not attained; (2) the weight of regulation may increase considerably, especially for smaller systems; (3) the risk of falling into regulatory capture; (4) the risk that the private sector generate super-normal rents through typical rent-seeking types of activities; and

[33] The average cost of a manager (including non-salary payments, bonus, expenses, etc.) in international companies for management functions in water-related utilities in LDCs in some cases reaches U$400,000 per year.

finally (5) a total privatization. A total privatization eliminates the parameters of comparison between the public and private sector since comparative or yardstick regulation between the two types of ownership is no longer feasible (as in the case of Great Britain). Also, a total privatization reduces the feasible number of different benchmarking parameters to be used in the future. It is important to consider that for a partial privatization, it is possible during the first phase to evaluate the possible gains and perform cost-benefit studies on the possible risks and benefits in order to consider a total privatization later on.

The next section will now evaluate the empirical evidence of Chile in relation to efficiency and ownership.

4.4. Empirical Evidence from Chile on Efficiency and Ownership

4.3.1 Efficiency in the Sanitation System

When one talks of efficiencies in the sanitation system, there are various types of efficiencies, among which we can mention technical efficiencies, such as the reduction of losses, incorporation of new technologies and among others, allocative efficiencies, where use of resources may be considered through use of labor and capital. The gain of these types of efficiencies, in general, brings a general benefit which transforms into an economic efficiency and a social wellbeing. It is important to note that the efficiency of a sanitation company cannot be measured through percentage losses of water, as many erroneously assume.[34]

In the Chilean case, the participation of the private sector through service contracts is vary ample. Therefore, it can be assumed that technical efficiency would be present in the system,[35] private as well as mixed companies. Analyzing the average number of employees per 1,000 connections (Table 2) and the number of employees per MMm3 (Table 5), it appears that there is not much room for improvements in efficiency, especially when it comes to operational costs related to labor in mixed companies.

4.3.2 Evidence from Chile Regarding Efficiency and Ownership in the Water and wastewater sectors

The empirical evidence of the sanitation systems of the U.S. obliges us to ask two fundamental questions of the Chilean case. They are: (1) are the Chilean mixed companies equally as efficient as private Chilean companies? (2) Since the introduction of private companies in 1989 and the subsequent introduction of competitive pressure on mixed companies, what improvements have been seen in these companies with respect to private companies?

We will attempt to respond to the two preceding questions by using accounting data, and specifically, return on assets, of the Chilean private, and mixed companies (see Table 5). From Table 5, it is important to analyze the company EMOS, from an economic point of view and through the social welfare which it creates. The company EMOS possesses a large portion of the national market and this company appears to be one of the more efficient. Even further, EMOS has the lowest tariffs, the lowest level of water loss index, and its net returns are far superior than the general average, and much better than private ones

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[34] There are cases in which efficient water and/or wastewater companies may have a high percentage of losses since water companies reduce physical and commercial losses to a level where the marginal benefits are larger than the marginal costs. For example, with the case of the company EMOS, to tear up streets and replace piping is more expensive than increasing the plant size of Vizcachas and treat a larger a volume of water, which maintains losses at the same level. The decision to increase production (in place of reducing losses) is the solution more economically efficient.

[35] For example, when water companies begin to solicit works for the capture of groundwater in Chile, the only technology used was percussion drilling, without importance to the type of geology. Later, the private sector moved to a type of tricone rotation (DHT drilling) and reverse drilling. Today, the four technologies compete with each other and are selected according to their comparative advantages with respect to the type of soil involved. This is a clear signal that the private sector has achieved a technological change, with the end result of gaining efficiency and reducing costs.

Some general hypotheses are now presented in order to explain the results displayed in Table 5. Obviously, the hypotheses presented here must be evaluated empirically. The increase in average rate of return for the mixed (public) companies, appears to be due to the different cost curves (operational and capital) which the public and private companies face. As the evidence from the U.S. indicates, this could be for various reasons: (1) the public sector is acquiring better administrators and managers due to the employment security offered; (2) the capital cost of the public sector could be less than that of the private sector; (3) the salaries of the private sector and benefits of the non-salaried accounts may have raised the operational costs of the private sector; (4) depreciation rates may be distorting costs between the private and public companies; (5) it could be that the average costs to private companies in maintaining residential accounts is more than for the public sector, as has been the case in the U.S. (Meyer, 1975), or on the other hand, the average cost of commercial accounts is less for the private sector than for the public sector.

TABLE 5: Production of Water, Losses, Labor Intensities, Tariffs and Return

COMPANY	**Water Losses**	***Number of Connections***	***Production* (MMm3)**	**# Employees per MMm3 produced**		**Average Tariff ($/m3)**		**Net Return (%)**		
PUBLIC AND MIXED COMPANIES				**1997**	**1996**	**1997**	**1996**	**1997**	**1996**	**1995**
ESSAT S.A. (*)	45.4%	86,252	25.3	8.06	7.98	528.4	471.8	7.4	3.7	1.8
ESSAN S.A.	37.5%	94,854	24.3	8.24	8.58	620.0	597.6	13.1	9.8	8.3
EMSSAT S.A.	45.7%	60,431	12.9	9.54	9.21	411.1	407.4	6.3	6.3	0.6
ESSCO S.A.	21.6%	120,406	27.1	8.10	9.79	343.0	328.0	5.6	6.4	6.3
ESVAL S.A.	40.6%	385,672	87.1	6.21	6.03	311.9	305.6	6.7	8.6	5.5
EMOS S.A.	21.3%	1,091,128	368.6	3.87	3.85	168.7	165.5	10.6	12.4	12.7
ESSEL S.A.	41.3%	131,247	31.9	7.17	6.53	256.7	246.9	6.5	5.8	4.1
ESSAM S.A.	43.9%	137,077	32.9	5.61	5.40	273.7	261.6	6.3	6.1	4.3
ESSBIO S.A.	35.6%	320,613	82.7	5.74	5.92	256.4	243.8	10.0	9.0	7.4
ESSAR S.A.	33.3%	132,259	29.5	7.41	7.91	264.3	254.0	11.5	14.3	10.2
ESSAL S.A.	39.5%	109,752	24.6	7.85	7.75	302.8	289.9	4.8	5.0	4.0
EMSSA S.A.	41.9%	15,869	3.6	10.18	8.85	331.7	327.0	3.2	2.7	-1.1
ESSMAG S.A. (*)	45.8%	34,344	9.9	9.76	9.12	401.5	298.0	10.2	2.2	2.4
Average Public and Mixed Companies	31.1%			7.52	7.46	343.9	322.8	**7.86**	**7.10**	**5.12**
Private Companies										
COOP STO. DGO.		2,170	1.3	27.33	17.33	221.9	213.9	2.2	6.5	
AP MANQUEHUE		2,172	3.9	8.60	9.19	246.4	242.9	4.8	5.5	0.0
AGUAS CORD. S.A (**)	17.0%	75,087	51.2	3.52	4.39	188.5	182.9	0.7	-7.2	15.0
SERVICOM. S.A.		11,823	3.2	6.20	10.50	167.2	164.3	1.6	9.4	
V. DOMINICOS S.A.		2,146	3.7	1.78	3.33	199.9	194.2	11.4	12.3	15.7
AGUAS X S.A.		28,127	7.6	6.54	6.24	256.8	244.8	4.7	5.4	
Average: Private Companies	17.0%			9.00	8.50	213.45	207.1	**4.23**	**5.32**	**10.23**
Municipal Companies										
MAIPU (**Municipal**)		134,216	41.5	4.14	3.85	177.9	172.3	8.6	20.1	
Average: Municipal		134,216	41.5	4.14	3.85	177.9	172.3	**8.6**	**20.1**	
Average: General				**7.79**	**7.59**	**296.4**	**280.6**	**6.81**	**7.22**	**6.08**

Notes: (*) tariff change in 1997; *(**) in 1995 the company know today as Aguas Cordillera, corresponded to Aguas Lo Castillo.*

Source: SAE (1998), SISS (1998), Morande and Doña (1996).

Statistics on water loss and financial status in 1995 for the private companies of Morande y Doña (1996).

Finally, I would like to propose a hypothesis, theoretical in nature to explain previous results. Under a relatively modern and efficient system of regulation and institutional structure, such as the case in Chile, a joint system of ownership and operation (state and private), within a natural monopoly with specific characteristics such as the sanitation system *which provides a public good and generates important externalities*, appears to be a formula which functions relatively well. *This can be explained from the point of view of a checks and balance system*, among other things. If both public and private companies are part of the ownership and operation, the public sector, just as the private, has access to the same information (which is not true for a concession or total privatization), which is to say, there is less asymmetry of information. This fact causes the public sector to limit certain private free-riding (opportunistic) activities, which they otherwise might have pursued given the independent management of a natural monopoly of this type. On the other hand, the presence of the private sector in the ownership of a natural monopoly, creates influences through the board of directors, to guarantee adequate returns for the investors, which therefore generates pressure which forces the mixed company to be efficient and incorporate modern systems of administration and project execution, and through these methods, thus, efficiency gains and social benefit are achieved.

The results and corresponding hypotheses presented suggest a series of investigation lines related with the development and better understanding of the cost curves for both the public and private sectors. The studies should be conducted by separating the analyses per type of cost (operational and capital) and per functional categories (production, distribution, collection, and treatment) and correlated with other variables (user types, system types, etc.) in such a way that deficiencies may be explained and a better understanding may be obtained of the cost structure and economies of scale of the Chilean systems.

It is important to try and propose some hypotheses which justify the decreasing profits of the private sector and the increasing profits of the public sector. First off, the weight of regulation has not been increased during the last three years for the private companies and, therefore, this does not appear to be a valid justification. Another hypothesis could have its roots in the pressure which the public companies have received recently with respect to the threat of more privatization. This could have created incentives for the public sector to operate more efficiently than the private sector, simply to justify their existence. The second hypothesis is related to the incentives which the private sector has to reduce regulatory lag, and therefore the private companies would intentionally demonstrate deficient results as a means to justify tariff revisions or modify the model tariff system.

Now, the crucial question in the process of increasing PSP in Chile and in the theme of improvements in efficiency is the following: ***Will an additional improvement in efficiency be seen with more introduction of the private sector (total privatization) into the water and wastewater systems in Chile?*** *Based on the empirical evidence presented in this paper, it appears that the future gains in efficiency by mixed companies would be limited if not altogether non-existent.*

5. TECHNOLOGY, COST STRUCTURE AND ECONOMIES OF SCALE

5.1 Technology, Cost Structure, and Economies of Scale

Technological changes are much more easily noted in the sectors of telecommunications and electricity than in the water and wastewater sectors.[36] This limits the gains in efficiency due to possible technology changes in the water and wastewater sectors. Examining closely the cost structure of water/wastewater companies may indicate that gains in efficiency due to achievement of economies of scale, would be present

[36] The technological advances in drinking water production systems and distribution are very limited. Lately, some technological advances have occurred in wastewater treatment systems. It can be said that the most significant advances have occurred in the area of remote metering. Remote metering applicability to developing countries is very limited due to various factors, such as physical restrictions on the location of the meters, initial costs, and technological complexity in its maintenance, among others. Actually, the applicability of these technologies in developing countries is therefore minimal, if not non-existent.

in all areas of the system. However, we can take advantage of these, according to the case at hand, until the point where competition is possible.

There are very few published empirical studies on economies of scale for water and wastewater companies in developed countries, and even less for developing countries. As a result, there are a number of important questions relating to the cost structure of companies and in particular with the presence of economies of scale, which remain unanswered. In general, regulation theory economists assumed that increasing economies of scale in this type of systems were obvious, but studies have shown that they are not so obvious as previously thought. Some experts qualify this area of economics as the area of economic ignorance (Perfloff and Wingo, 1969). Economies of scale are difficult to determine since in the structures of public systems, each component has its own cost which contributes to the aggregate cost function. This aggregate cost function is far from being understood since the costs of the system are affected by the type of area (topography, etc.), the characteristics of the area being served (residential, industrial, population density, etc.), the type of demand (peak demand, hourly or seasonal) and the type of system.[37] This causes the possible economies of scale in the production of water to be offset by diseconomies of dispersion and other elements.

To understand the type of costs of these networked-type systems, there are two schools of thought: the first is the "*inductive or statistical*," which tries to derive empirical generalizations through samples and cross-sectional studies, or time series studies for a group of cases. This is the traditional method used by economists. The second school of thought is the "*deductive or engineering data.*" This predicts behavior through application of logic postulates and fundamentals. Controlled theoretical situations are generated and examined in search of explanations and basic interrelations between determined cost elements. Analogies and models are used to develop analytical relations to a more desegregated level than that used in the inductive or statistical model. This is mainly the method used by engineers. A third type also exists and is referred to as engineering-statistical, which combines both of the preceding methods to study the situation.

The general lack of a conceptual framework, which could serve as a base for this type of study, is due partially to the problems the majority of the studies encounter. The problems are: (1) the development of statistical correlations which are based on the use of aggregate costs of a variety of services having different cost functions, as the dependent variable; (2) the inability of the statistical studies to satisfactorily account for the variables at hand, such as quality of service (the cost of good quality water is distinct from that of poor quality water), the topography of the city or the system, the mix of socioeconomic strata and population distribution among other factors; (3) the lack of distinction between operational cost and the cost of capital (this may be due to a non-uniformity of accounting systems); and (4) in general, each estimate the cost of production for service, neglecting the social and private cost. The preceding is detailed to warn the reader about the fact that some of the results of these studies should be examined or used with caution, without generalizing the situation in the water and wastewater sector.

Byrnes, Grosskopt, and Hayes (1986) conducted a study using a sample of small- to medium-size companies where 68 companies were public and 59 were private, from the U.S., and all were selected randomly from larger sample. Unfortunately, this study does not use a control variable for volume of water produced, through extension of the network, or other variables and therefore the results are aggregate. From these results (Table 6), it is only possible to confirm that the general theoretical assumption of achievement of economies of scale is not as obvious as was thought. This variability in achieving economies of scale is mainly due to the network elements previously mentioned.

[37] For example, a water extraction system using deep wells, involves higher pumping costs and drilling costs; while the cost of treatment and damming is minimal, by comparison, for superficial sources of water.

Table 6: Economies of Scale in Public and Private Systems in the U.S.

Property (number of companies)	Increasing Economies of Scale	Constant Economies of Scale	Decreasing Economies of Scale
Public Companies (68)	18 (26.5%)	24 (35.2%	26 (38.2%)
Private Companies (59)	19 (32.2%)	16 (27.1%)	24 (40.7%)
TOTAL (127)	**37 (29.1%)**	**40 (31.5%)**	**50 (39.4%)**

Source: Adapted from Byrnes, Grosskopt, and Hayes (1986), p. 341.

Kim (1987), using a multiple model for the costs of urban water systems, found that commercial service is characterized by economies of scale, while residential service presents decreasing returns to scale. The recent work of Boisvert and Schmidt (1997) shows that economies of scale may be found in the functional categories of storage and collections for small rural systems, which are offset by the decreasing economies of scale which the distribution systems present.

It is important to note that *one of the principal errors in the PSP design process is to assume that combining various small- and medium-sized water/wastewater companies to create one megasystem automatically brings an increase in efficiency through reaching economies of scale.* On the contrary, the formation of larger systems may have various disadvantages, especially in developing countries. Some of these may be: (1) The probability that the system will achieve diseconomies of scale due to dispersion factors, and other factors. (2) the larger the system, the larger the economic sum involved in the sale and operation of the system. From rent-seeking point of view, the larger the amount of money involved in the operation of a system, the higher the probability that rent-seeking activities will take place.[38] Thus, aggregation of systems could be a disadvantage and should be considered while defining horizontal and vertical structures of systems. (3) From the perspective of environmental externalities, larger systems pose more environmental risk than smaller ones. (4) The aggregation of many smaller systems into one megasystem eliminates the possibilities for improvement of regulation through the use of tools such as benchmarking, and yardstick regulation (Madrid-Aris and Montero, 1998, World Bank, 1996, Cowan, 1995) and increases the risk of regulatory capture. (5) The aggregation of systems increases the probability of transforming a state monopoly into a private monopoly. (6) Finally, the aggregation of systems limit competition in the private sector and also limit the possibilities to develop domestic entrepreneurial capacity for the future management of the systems. This fact has mainly resulted in total dependence on a small group of large international water operators, which limit competition, and therefore feasible efficiency gains that can be reflected in price reduction.[39]

Evidence from the U.S. appears to validate many of these previous points, since, on the one hand, the smaller systems[40] in the U.S. exhibit costs equal to or less than the larger systems, and on the other hand,

[38] Empirical evidence shows that for developing countries, rent-seeking activities have the strongest negative impact on the economic growth of the country. For a recent and interesting study on corruption (which corresponds to one of the distinct forms of rent-seeking) and economic growth, see Mauro (1995).

[39] It is worth mentioning that the operation of water systems is much less complex than electricity systems. There is sufficient entrepreneurial capacity in Latin American to operate water and wastewater systems. Unfortunately, policy makers in Latin America have closed the doors to competition for local alternatives as well as operators from the U.S. This limitation of competition is rooted mainly in two facts; (1) the concession of extremely large-scale systems, for which the competitive advantages have not been adequately evaluated; and (2) the large bidding requirements (e.g., management experience) imposed in the process of companies selection, which totally limits the alternative of local companies and US companies. Thus, the tendency for Latin American water systems is to be transformed into systems managed by a select group of large-scale European operators which limit the gains in competition, which can lead to efficiency gains.

[40] As an anecdotal example, the treatment and distribution systems for reclaimed water of Irving Ranch in Southern California, which operates with less than 100,000 users, has costs of U$0.23 per m3. This cost is significantly less than most of Latin American

some small systems achieve economies of scale, while other larger systems do not achieve economies of scale. The current tendency in the U.S. to create smaller systems demonstrates that there must be some economic advantage which justifies their creation. The U.S. market has been structured in such a way as to create competition through the participation of a large number of companies, small and medium-sized,[41] has reduced the possibility that the market be transformed into a monopoly in the hands of international operators. Consequently, the structure of the systems and the market of companies providing this type of service has reduced the possibility of rent-seeking type activities and has transformed into gains in efficiency and social wellbeing.

The preceding evidence generates certain implications for the case of Chile. If a regulatory modification is implemented with respect to the vertical and/or horizontal structure of the sanitation companies, they should look for and design homogeneous and consistent methodologies with the goal of studying the phenomenon of the cost structures of the systems and companies, together with economies of scale phenomenon. This is useful for the improvement of the future regulatory framework.

5.2 Cost Structure and Marginal Costs

The studies related to the factors, which affect total marginal costs, and their implication in the setting of tariffs, are interesting to analyze. From these studies several implications are made which may be valuable for the Chilean case study. The studies of Teeples and Glyer (1987), Renzetti (1992) and Boisver and Schmidt (1997) demonstrate that marginal costs increase considerably with distance or length of the distribution system. From a hydraulic engineering perspective, these results are consistent with the loss of charge due to interior buildup of pipe surfaces (which increases through time due to corrosion) and the charge line which must be maintained for efficient operation. The studies by Renzetti (1992), Munasinghe (1992) and Russell and Shin (1990) found that marginal costs increase significantly during periods of high peak demand (summer months). All the studies are based on companies from developed countries, but there is not much evidence to support the conclusion that the same would apply to developing countries like Chile. The empirical evidence demonstrates that for many urban cities in developing countries, marginal costs for the next available unit of water may be two to four times more than the average cost of the existing sources.[42] Cost structures demonstrate that marginal cost, in general, is highly affected by physical restrictions, such as hydrologic resources and location of the next unit of water, which relate to the cost of production of the next unit of water[43] and not mainly by lack of competition.

The preceding issues are of extreme importance in the definition of objectives for conceptual framework and tariff structures, and the applicability of marginal costs on future tariff structures. Given that the New Sanitation Legislation in Chile will consider the modification of future tariff structures, the performance of studies of this type are fundamental for the definition of a new tariff structure which complies with the required fundamental objectives.

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systems. It is worth mentioning that treatment of reclaimed water is usually high-cost due to tertiary treatment systems which are required to achieve the quality standards established by the Clean Water Act.

[41] The largest private operating system in the U.S. is located in the City of Atlanta, and does not serve more than 3 million people. This is equivalent to one quarter of Buenos Aires and in size is less than the company of EMOS in Chile.

[42] See Munasinghe (1992), Biswas (1997), Cuevas and Lauria (1998), World Bank (1993).

[43] In water systems such as the Latin American systems where there is no treatment, in general, the cost of production of crude water reaches significant levels and, in many cases, represents more than 50% of the operational cost.

6. SUMMARY

Based on the empirical evidence presented in this paper the following may be concluded: (1) that a major privatization of the water and wastewater services in Chile is justified, principally from the point of view of attracting capital for the wastewater treatment sector, and future benefits should be evaluated within the context of the implicit risks which this reform presents; (2) with a further privatization of the water and wastewater services, the expectations for gains in efficiency by Corfo companies (mixed companies) is limited; (3) if Chile considers the incorporation of foreign capital for the sector, adequate incentives should be created in the regulatory framework to attract capital since competition for the capital is ample in the context of Latin America; and finally, (4) if net return is considered as a variable that measures efficiency for a company, then it can be concluded that Chilean mixed companies have achieved a higher level of efficiency that those of private companies.

This paper demonstrates that the problem faced by Chilean authorities with the reform of the water and wastewater sectors is basically similar to the problem faced by the U.S. roughly 15 years ago. Competitive pressures were present in the market, according to the existing physical systems, but the feasibility of achieving gains in efficiency was very limited. The public sector required a large amount of capital resources, especially for the reposition and repairs works and for treatment capacity, but at the time, there was a desire to limit the regulatory risk associated with passing a natural monopoly from the hands of the state to private enterprise.[44]

Given the factors mentioned, Chilean policymakers should enrich their knowledge and take advantage of the experiences and lessons from the U.S., as well as from other countries which may provide valuable lessons for the Chilean case. The evidence presented in this paper shows that the problem in Chile reduces basically to a problem of finance (how to efficiently attract capital), theory of regulation (how to reduce the risk and weight of regulation), and sanitary engineering (how to define an optimal vertical and horizontal separation of the systems to maximize gains). Finally, it is important to take into account that there may be other alternatives for obtaining capital through the application of various forms of PSP and creating an adequate regulatory framework, which may not imply the sale of assets of Chilean sanitation companies.

7. CONCLUSIONS

The government of Chile is presently proposing a process of total privatization (sale of mixed companies). The water and wastewater sectors, aside from being a natural monopoly, presents a series of very special characteristics which oblige us to think about the new and complex process. Based on economic theory, as well as regulation and institutional theory, together with empirical evidence presented in this paper, in the actual situation of the Chilean sanitation companies and current regulation, it is important to mention a series of future lines of investigation. The proposed lines of investigation are as follows:

Chile needs large investments for the wastewater treatment sector which is very capital intensive by nature. This would suggest that Chilean authorities should investigate regulatory alternatives and forms of PSP which are suitable for the type of investment which the country requires. Additionally, a special emphasis should be placed on all the types of competition feasible to implement for this type of investment, especially in competition for product and competition for service.

The present paper concludes that before making a decision on the case, with respect to total privatization (sale of assets) of Chilean sanitation companies, the feasibility of implementation should be

[44] Note that the public water and wastewater sectors in the U.S. have placed a special emphasis on avoiding a high concentration in one private company (management or ownership of these services) in order to avoid what occurred in France.

evaluated and the different methods of obtaining capital from the various forms of PSP, since there may be viable alternatives which pose *less regulatory risk*. There is also a necessity to evaluate the benefits and risks associated with new forms of PSP which should be feasible to implement, and reduce regulatory risk, as well as the propositions made in this paper, which were to *separate ownership from operation in the PSP structure and/or contracts.* These new forms of PSP should be further studied from a theoretical, as well as empirical, point of view. In a Chilean context, because with the availability of national capital through the Private Pension Funds Companies, international capital markets would appear to be a viable alternative to be implemented, with less regulatory risk, which could generate high social benefits.

Also, further investigations should be performed to understand in a better way the cost curves associated with mixed and private companies. These studies should emphasize separation by type of account (operational costs and capital) and by functional category (production, distribution, collection, and treatment) and correlated with other variables (user type, system type, etc.) in such a way as to find a reasonable explanation for the differences in actual net returns (or efficiency levels). A better understanding of the costs of the systems and companies would provide guidelines for the improvement of the regulatory framework currently proposed by the *New Sanitation Law*, in case reforms in vertical and horizontal structures are pursued.

Finally, the knowledge of the marginal cost structures is of paramount importance in the definition of objectives for the conceptual framework and tariff structures and the applicability of marginal costs in future tariff structures. Given that the *New Sanitation Law* is considering the modification of the tariff structure, the performance of these types of studies, and examination of international experiences, is fundamental for the definition of a tariff structure which will comply with rate objectives of efficiency, equity and conservation of resources, and at the same time, create incentives for obtaining private capital.

REFERENCES

Atkinson, S., and Robert Halvorsen, "The Relative Efficiency of Public and Private Firms in a Regulated Environment: The Case of U.S. Electric Utilities," *Journal of Public Economics*, 29, 281-294, 1986.

Amstrong, M., S. Cowan and John Vickers. *Regulatory Reform: Economic Analysis and British Experience*. Cambridge, Massachusetts: The MIT Press, 1994.

Appelbaum, Elie, and E. Kats, "Seeking Rents by Setting Rents: The Political Economy of Rent-Seeking," *The Economic Journal*, 97, September 1987.

Baumol, W., J. Panzar and R. Willig. *Contestable Markets and the Theory of Industry Structure*. New York: Harcourt Brace Jovanovich, Second Edition, 1989.

Baumol, W., J. Panzar and R. Willig, "Contestable Markets: An Uprising in the Theory of Industry Structure: Reply," *American Economic Review*, Vol 73, No 3, pp. 491-496, June 1983.

Bhattacharyya, A., T. Harris, R. Narayanan, and K. Raffee, "Specification and Estimation of the Effect of Ownership on the Economic Efficiency of the Water Utilities," *Regional Science and Urban Economics*, 25. pp. 759-784, 1995.

Beesley, M, and S. Littlechild, "The Regulation of Privatized Monopolies in the United Kingdom," *Rand Journal of Economics*, Vol 20, No 3, 1989.

Bishop, M., John Kay, and Colin Mayer. *The Regulatory Challenge*. London: Oxford University Press, 1995.

Biswas, Asit, "Water Development and Environment." in *Water Resources: Environmental Planning, Management and Development*, ed. Asit K. Biswas. New York: McGraw-Hill, 1997.

Bitran, Eduardo, and Pablo Serra, "Regulation of Privatized Utilities: Lessons from the Chilean Experience." Work presented for the OECD Advisory Group on Privatization, Paris, October, 30-31, 1995.

Boisvert, Richard, and Todd Schmidt, "Tradeoffs Between Economies of Size in Treatment and Diseconomies of Distribution for Rural Water Systems," *Agricultural Resources and Economics Review*, 27(2): 237-247.

Bruggink, Thomas, "Public Versus Regulated Private Enterprise in the Municipal Water Industry: A Comparison of Operating Costs," *Quarterly Review of Economics and Business*, Vol 22, pp.11-125, 1982.

Buchanan, James, R. Tollison, and G. Tullock, Eds. *Toward a Theory of Rent Seeking Society*. College Station: Texas A&M University Press, 1980.

Byrnes, Patricia, S. Grosskopf, and Kathy Hayes, "Efficiency and Ownership: Further Evidence," *The Review of Economics and Statistics*, Vol 68, 337-341, 1986.

CEPAL, "Progress in the Privatization of Water-Related Public Services: A Country by Country Review," Draft, 1996.

Cote, D., "Firm Efficiency and Ownership Structure: The Case of Electric Utilities Using Panel Data," *Annals of Public and Cooperative Economics*, Vol. 60, 431-451, 1989.

Cowan, Simon, "Regulation of Several Market Failures: The Water Industry in England and Wales," *Oxford Review of Economic Policy*, Vol. 9, No 4, 1995.

Cowan, Simon, "Competition in the Water Industry," *Oxford Review of Economic Policy*, Vol. 13, No 1, 1997.

Crain, Mark and Asghar Zardkoohi, "A Test of the Property Rights Theory of the Firm: Water Utilities in the U.S.," *Journal of Law and Economics*, 21, 395-408, 1978.

Cuevas, Alfredo and Donald Lauria, "Assessing Consequences of Political Constraints on Rate Making in Dakar: A Monte Carlo Approach." Work presented in the Conference of Political Economy in Water Prices, World Bank, Washington D.C., November 3-5, 1998.

Demsetz, H., "Why Regulate Utilities," *Journal of Law and Economics*, 11, pp. 55-66, 1968.

Environmental Business Journal (EBI), "Water and Wastewater Markets," San Diego, California, June 1998.

Farrel, M.J., "The Measurement of Productive Efficiency," *Journal of Royal Statistics Society*, Series A-120, 253-281, 1957.

Feigenbaum, Susan, and Ronald Teeples, "Public Versus Private Water Delivery: A Hedonic Cost Approach," *The Review of Economics and Statistics*, Vol 65, pp. 672-678, 1983.

Galal, A., "Chapter 9: CHILGENER," and "Chapter 10: ENERSIS," in Galal, A., L. Jones, P. Tandom, and I. Vogelsang. *The Welfare Consequences of Selling Public Enterprises*. Oxford University Press, 1994.

Gilbert, R., and E. Kahn, Eds. *International Comparison of Electricity Regulation*. Cambridge: Cambridge University Press, 1995.

Goldberg, Victor, "Regulation and Administered Contracts," Bell Journal of Economics, Vol 7, pp.426-448, 1976.

Goldberg, Victor, "Toward an Expanded Economic Theory of Contract," *Journal of Economic Issues*, Vol 10, pp.45-61, March, 1976.

Hausman, and W.J., Neufeld, J.L., "Public Versus Private Electric Utilities in the United States: A century of Debate over Comparative Economic Efficiency," *Annals of Public and Cooperative Economics*, Vol. 65, pp. 599-623, 1994.

Helm, Dieter, "British utility Regulation: Theory, Practice, and Reform," *Oxford Review of Economic Policy*, Vol 10, No 3, 1994.

Helm, Dieter and Tim Jenkinson, "The Assessment: Introducing Competition into Regulated Industries," *Oxford Review of Economic Policy*, Vol 13, No 1, 1997.

Hill, Alice and Manuel Abdala, "Regulation, Institutions, and Commitment: Privatization and Regulation in the Argentinean Telecommunications Sector," Research Paper, April 1993.

Hirshhorn, R., and Kaell, A., "A Framework for Evaluating Public Corporations," *Annals of Public and Cooperative Economics*, Vol 59, pp. 141-157, 1988.

Jarrel, Gregg, "The Demand for State Regulation of the Electric Utility Industry," *Journal of Law and Economics*, 1978.

Jones, Douglas, "Regulatory Concepts, Propositions, and Doctrines: Casualties and Survivors," *Journal of Economic Issues*, Vol XXII, No 4, December 1988.

Kahn, A.. *The Economics of Regulation: Principles and Institutions*. New York: John Wiley and Sons, 1988.

Kim, Youn, "Economies of Scale in Multi-Product Firms: An empirical Analysis," *Económica*, 54: 185-206.

Klein, B., R. Crawford, and A. Alchian, "Vertical Integration, Appropriate Rents, and the Competitive Contracting Process," *Journal of Law and Economics*, No 21, 1978.

Koh, Dong-Soo, Sanford Berg, and Lawrence Kenny, "A Comparison of Costs in Privately Owned and Publicly Owned Electric Utilities: The Role of Scale," *Land Economics*, 71(1) 56-65, 1996.

Krueger, Anne, "The Political Economy of the Rent-Seeking Society," *American Economic Review*, Vol 64, No 3, pp. 291-303, June 1974.

Levy, Brian and Pablo Spiller. *Regulations, Institutions and Commitment: Comparative Studies of Telecommunications*. New York: Cambridge University Press, 1996.

Liebenstein, Harvey, "Allocative Efficiency vs X-Inefficiency," *American Economic Review* 56, 392-415, 1966.

Lopez de Silanes, Florencia and Robert Vishny. "Privatization in the United States," *Rand Journal of Economics*, Vol 28, no 3, 447-471, 1997.

Madrid-Aris, Manuel, Julie Hewitt and Matt Nussbaum, "Privatization and Latin American Water Rates Comparison," research paper, Miami, 1998.

Madrid-Aris, Manuel, and Juan Pablo Montero, "Privatización y Regulación de Empresas Sanitarias: Implicancias para Chile." Paper published in Quinta Jornada de Hidraúlica Fco. Javier Dominguez Proceedings, Catholic University, Santiago, Chile, 1998.

Mann, P.C., and J.L. Mikesell, "Ownership and Water System Operation," *Water Resources Bulletin*, 12(5), pp. 995-1004, 1976.

Manzetti, Luigi, "Regulation in Post-Privatization Environments: Chile and Argentina in Comparative Perspective." Working paper, Department of Political Science, Southern Methodist University, Dallas, Texas, 1996.

Martin, Stephen and Keith Hartley, "Comparing Profitability in the Public Utilities, Defense and Pharmaceuticals,," *Journal of Public Policy*, p.p. 81-105, 1998.

Mauro, Paolo, "Corruption and Growth," *The Quarterly Journal of Economics*, pp. 681-712, August 1995.

Meyer, Robert, "Publicly Owned Versus Privately Owned Utilities: A Policy Choice," *The Review of Economics and Statistics*, pp. 391-399, November, 1975.

Morande, Felipe and J. Doña, "Los Servicios de Agua Potable en Chile: Condicionantes, Institucionalidad y Aspectos de Economía Política." Working Paper, ILADES, Santiago, Chile, Julio, 1996.

Munasinghe, Mohan. *Water Supply and Environmental Management: Developing World Applications: Studies in Water Policy Management*. Boulder, Co., Westview Press.

Niskanen, W.A., "Bureaucrats and Politicians," *Journal of Law and Economics*, 18, pp. 617-634, 1975.

Ordover, Janusz, R. Pittman, and P. Clyde, "Competition Policy for Natural Monopolies in a Developing Market Economy," *Economics of Transition*, 2(3), 317-343, 1994.

Olson, Mancur. *The Logic of Collective Actions*. Cambridge. MA: Harvard University Press, 1965.

Palominos, María, "La Regulación y Sistema Tarifario de los Servicios de Agua Potable y Alcantarillado en Chile," Trabajo presentado en la Conferencia Sobre Privatización de Empresas de Agua, Murcia, Spain, November 1994.

Perez-Arriaga, Ignacio. *The Organization and Operation of the Electricity Supply Industry in Argentina*. London: Energy Economic Engineering Ltd., 1994.

Perloff, H., and L. Wingo. *Issues in Urban Economics*. Resources for the Future: Washington D.C., 1969.

Peters, L., "Non-Profit and For-Profit Electric Utilities in the United States: Pricing and Efficiency," ," *Annals of Public and Cooperative Economics*, Vol. 64, 575-604, 1993141-153, 1986.

Pollit, M.G. The Relative Performance of Publicly Owned and Privately Owned Electric Utilities: International Evidence. Ph. D. Dissertation, Oxford, 1993.

Posner, Richard, "Theories of Economic Regulation," *Bell Journal of Economic*s, Vol 5, pp. 335-358, 1974.

Renzetti, Steven, "Evaluating the Welfare Effects of Reforming Municipal Water Prices," *Journal of Environmental Economics and Management*, 22(2), 147-163, 1992.

Renzetti, Steven, "An Empirical Anaysis on Water Pricing Reform" Work presented in the Conference of Political Economy in Water Prices, World Bank, Washington D.C., November 3-5, 1998

Ress, Judith, "La Regulación de los Sistemas de Agua Potable y Alcantarillado en el Reino Unido: La Experiencia de los Primeros Cinco Años," Trabajo presentado en la Conferencia Sobre Privatización de Empresas de Agua, Murcia, España, Noviembre de 1994.

Rees, R. and J. Vickers, "RPI-X Price-Cap Regulation." In *The Regulatory Challenge*, eds. M. Bishop, J. Kay and C. Mayer. London: Oxford University Press, 1995.

Rivera, Daniel. *Private Sector Participation in the Water Supply and Wastewater Sector: Lesson from Six Developing Countries*. The World Bank, Washington D.C., 1996.

Rowley, Charles, "Rent Seeking Versus Directly Unproductive Profit-Seeking Activities." In *The Political Economy of Rent-Seeking*, eds. Charles Rowley, Robert Tollison, and Gordon Tullock. Boston: Kluwer Academic Publishers, pp. 15-32, 1988.

Ross, S., "The Economic Theory of Agency: The Principal's Problem," *American Economic Review*, 63, pp. 134-139, 1973.

Russell, Clifford, and Boo-Shing Shin, "Public Utility Pricing: Theory and Practical Limitations." In *Marginal Cost rate Design and Wholesale Water Markets, Advances in the Economics of Environmental Resources*, ed. Darwin Hall, Vol 1, Greenwich: JAI Press, 1996.

Sappington, David, "Incentives in Principal-Agent Relationships," *Journal of Economics Perspectives*, Vol 5, No 2, pp. 45-66, 1991.

Sappington, David, and J. Stiglitz, "Privatization, Information and Incentives," *Journal of Policy Analysis and Management*, Vol 6, pp. 567-582, 1987.

Shapiro, C. and R. Willig, "Economic Rationales for the Scope of Privatization," Economic Rationales for the Scope of Privatization." In *The Political Economy of Public Sector Reform and Privatization*, eds. E.N. Suleiman and J. Waterbury. Boulder, Co: Westview Press, 1990.

Shirley, Mary, "Reforming Urban Water Systenms: A Tale of Four Cities," draft, World Bank, 1998.

Spiller, Pablo, "Institutions and Regulatory Commitment in Utilities' Privatization," *Industrial and Corporate Change*, 2, pp. 387-450, 1993.

Stigler, G.J. "The Theory of Economic Regulation," *Bell Journal of Economics*, Vol 2, 3-21, 1971.

Tambunan, T., "Some Issues with Respect to the Relative Efficiency of Public Enterprises," *Annals of Public and Cooperative Economics*, Vol. 64, 451-463, 1993.

Teeples, Ronald and David Glyer, "Cost of Water Delivery Systems: Specification and Ownership Effects," *The Review of Economics and Statistics*, Vol 69, pp.399-408, 1987.

Thiemeyer, T., "Economic Theory of Privatization," *Annals of Public and Cooperative Economics*, Vol. 57, 141-153, 1986.

Vickers, John, and George Yarrow. *Privatization: An economic Analysis*. Cambridge, MA: MIT Press.

World Bank. *Reforming Provincial Utilities: Issues, Challenges and Best Practice*. Report no 15063-AR, World Bank, Infrastructure Division, Washington D.C., 1996.

Williamson, Oliver, "Franchise Bidding for Natural Monopolies in General and with Respect to CATV," *Bell Journal of Economics*, 7(1), 73-104, 1976.

World Bank, *Water Resources Management*, World Bank: Washington D.C., 1993.

World Bank, Infrastructure Division, "Argentina Reforming Provincial Utilities: Issues, Challenges, and Best Practice," World Bank Report No 15063-AR, Enero, 1996.

World Health Organization. *Mid-Decade Evaluation of Water Supply and Sanitation in Latin America and the Caribbean*. WHO, Division of Heath and Environment, Washington D.C., 1997.