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WATER METERING SUCCESSFUL STORY: CHILE

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Abstract

In this report we provide an analysis of the implementation of water consumption metering for water and sanitation services in Chile. We describe the actual service system in place in the country. Our primary purpose is to provide a description of the organization of the sector, including utility companies; consumers, and regulatory institutions, accounts of the operation of the systems, including regulated tariff scheme, consumption metering, and billing and payment collection process. We also describe how the direct- to- demand subsidy program for water and sanitation services has been applied in the country to protect low-income households from the social negative impacts of the reforms. We then go on to describe the implementation and associated transition to a water-metering based system, focusing on the institutional design, incentives, and effects of the reform process in the sector. In addition, we provide a critical assessment of the process and describe some of the lessons from the experience that might be useful to other potential legal, economic, and institutional reform processes.

WATER METERING SUCCESSFUL STORY: CHILE

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1. Introduction

Water and sanitation services in Chile were traditionally perceived as a public good that should be provided by the state. This conception was behind the country's institutional organization of the sector since the early twentieth century. The state intervention resulted in low tariff levels and cross-subsidies in the provision of water and sanitation services. From an historical perspective, such intervention reached its maximum during the first half of the 1970s when tariff intended to recover cost of the service represented only about five percent of the total sector expenditure. Since the second half of the 1970s, and in parallel with the macroeconomic transformations, the military government started a process of legal, economic, and institutional transformations in sectors that were traditionally seen as the responsibility of the state. These sectors included telecommunications, electricity, and water and sanitation. In effect, since 1975 the government took the first steps in a long-run program intended to promote structural changes in the Chilean water and sanitation sector. The democratic government continued to implement those changes into the nineties. The transformation within the sector has included, legal reforms, changes in the organization of providers, changes in ownership of utility companies, the design of new regulatory institutions, design of a new regulated tariff scheme, and the implementation of a comprehensive direct subsidy program for the water and sanitation services to low-income households.

After twenty-five years of reforms in the water and sanitation sector, Chile represents a successful example of the implementation of a comprehensive water consumption metering-based system. The coverage of water services for urban areas in the country jumped from about 77 % in 1975 to 99% in the year 2000. Since 1990 100% of consumers in urban areas have been connected to micro-metering water systems. The implementation of the current tariff regulatory system has enabled the companies to cover operational costs and the required financial resources for implementation of investment and development programs. The new tariff scheme has also provided the correct incentives for consumers to save water whenever possible and an aggressive and massive subsidy program based on water-meter reading is in place to protect poor families.

The gradual introduction of the reforms has made it possible to complete the process without social disruption. Furthermore, the sector has new regulatory institutions that are responsible for protecting the consumer and ensuring that providers comply with the regulations. Despite changes and progress made in the sector, there are still several challenges that need to be faced in the future. Privatisation of the utility companies providing water and sanitation services in Chile have recently begun. Although coverage in water provision is almost universal for urban households, there are still important shortcomings in rural areas. Regulators are now focusing more on water quality issues that were postponed in the past because of the urgency to speed up progress in service coverage. Policymakers are now beginning to focus on water treatment and other environmental concerns.

The aim of the study is to explain how the Chilean water metering policy can be used as a tool for water and sanitation services demand management. We describe how the Chilean water and sanitation sector is organized, how the system of provision currently works, how it came about, and also the transition period. Further, we provide a critical assessment of the elements that were behind the successful implementation of the legal, economic, and institutional transformations of the sector, as well as its weaknesses and problems. The focus of the study is the water and sanitation provision system in urban areas of Chile. This is so because the reforms have been implemented mainly in this sector and also because most of the population of the country live in urban areas.[1]

The layout of this report is as follows. Section 2 begins with a description of the actual system for water and sanitation service provision in Chile. We consider here the organization of the water and sanitation sector, including utility companies, consumers, and regulatory institutions. Further, we describe the operation of the system with emphasis on its practical aspects, including the tariff system, consumption metering, consumption billing and payment collection procedures, and enforcement mechanisms to ensure compliance with payment for service provision. We end this section with a description of the subsidy program implemented since 1989 to protect low-income households from the tariff adjustment induced by the implementation of the reforms.

[1] Total population of the country in the year 2000 was estimated to be 15.2 million, almost 86% of the population lives in urban areas.

In Section 3, we turn our attention to the implementation and transition processes and related effects from the water and sanitation metering-based system in Chile. Our primary purpose in this section is to provide accounts of the context under which transformations and changes took place, the process, and the results from its implementation.

Section 4 is a critical assessment of the working of the water metering and tariff system as water management demand policy in Chile. We focus on what are the lessons to be learnt from this experience as well as the tasks that apparently will need to be completed in the future. We conclude in Section 5.

2. Description of the Chilean Water and Sanitation Sector

2.1 The Organisation of the Chilean Water and Sanitation Sector

Provision of water and sanitation services in Chile is under the responsibility of several utility companies, each of them being operating as a local natural monopoly.[2] Ownership of the providers is heterogeneous. In some cases providers are private, in many others, utility companies are state-owned. Mixed ownership is also present and seems to be the norm. Despite the heterogeneity in ownership structure, since the introduction of the legal and institutional reforms of 1988/1989, utility companies whose principal owner is the state are organized and must operate under a structure that is similar structure to the private companies.

The new institutional design of the sector was introduced in 1988. It considered the allocation of a franchise to each company to authorize its operation. The concession is transferable, indefinite, and is allocated for each of the stages in which the productive process involved in water and sanitation provision can be divided: water production, water distribution, water collection, and water treatment and disposal.[3] Taking into consideration only the urban areas of the country, and data from the state regulatory agency, by the year 2000 there were 44

[2] A natural monopoly exists when it is more efficient for one firm to serve the market than to have multiple firms serving the market.

[3] The franchise is given for each specific locality. The utility company holding the franchise is obligated to provide the service within the geographic region of that locality. In total, there are 317 urban localities with about 335 related systems [Morandé and Doña (1997) and SISS (2000)]. A sanitation system is defined as the set of installations, water sources, receptors of effluents, among other assets, with

utility companies in operation distributed among the 13 political-administrative regions into which the country is divided. These companies provide water and sanitation services in varying regions such as in the north, the desert, where water is a scarce resource and in the south region, where water is abundant.

Several utility companies are still under the control of the state through the Corporación de Fomento (CORFO). The private sector has just recently started to take control of some of the main utility companies in what is perceived as the first steps of the privatisation of the sector. Regarding the size of the companies, there is an important degree of variability. A list of each of the principal companies currently operating in urban areas at the regional level is provided in Table 1. Also shown there is the current number of customers per company and the stakeholder group. While EMOS S.A., the largest company in the country, located in the metropolitan region of Santiago, has over 1,200,000 customers (36.8% of the total number of customers in the country). There are a number of small-size companies, which provide services to less than 100 consumers. Figures in Table 1 suggest that the 13 companies listed there provide services for almost 90% of urban customers in the country.

According to the new regulatory design, utilities holding a franchise are under control of a state regulatory agency called Superitendencia de Servicios Sanitarios (SISS). The SISS is the regulatory institution for the national water and sanitation service sector, excluding the system of water provision in rural areas. The SISS was created by law as an autonomous, decentralized governmental agency, which depends on the President through the Ministry of Public Works. The SISS was created as a part of the process of legal, economic, and institutional transformation of the water and sanitation services sector started at the end of the 1980s. The SISS is responsible by law for the controlling the sector. The agency has normative responsibilities, including enforcement and compliance with norms relative to water and sanitation services provision. Furthermore, the SISS has a relevant role in the determination of the tariff formulas to be applied to consumers (see the discussion related to tariff design and tariff process in this report).

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feasible interaction at different stages of the sanitation service: water production, water distribution, water collection, and treatment and disposal.

Table 1

Customers Distribution and Stakeholder Group for Selected Companies and Region. Chile, 2000.

Region	Main Utility Company in the Region	Number of Customers.[a]	Urban Population	% Customers[b]	Stakeholder Group
I De Tarapacá	ESSAT S.A.	97.1	378.8	2.9	Chilean Fisco
II De Antofagasta	ESSAN S.A.	106.5	453.6	3.2	Chilean Fisco
III De Atacama	ESSAT S.A.	62.6	249.0	1.9	Chilean Fisco
IV De Coquimbo	ESSEL S.A.	132.3	426.4	4.0	Thames Water
V De Valparaíso	ESVAL S.A.	370.1	1,430.9	11.2	Anglian Water
VI DeO´Higgins	ESSEL S.A.	138.4	534.8	4.2	Thames Water
VII Del Maule	ESSAM S.A.	150.2	578.9	4.5	Chilean Fisco
VIII del Bío-Bío	ESSBIO S.A.	349.4	1,559.5	10.5	Thames Water
IX De la Araucanía	ESSAR S.A	142.5	577.7	4.3	Chilean Fisco
X De Los Lagos	ESSAL S.A.	125.4	696.4	3.8	Iberdrola
XI De Aysen	EMSSA S.A.	17.9	71.0	0.5	Chilean Fisco
XII De Magallanes	ESMAG S.A.	39.8	145.8	1.2	Chilean Fisco
Metropolitana	EMOS S.A.	1,220.8	5,915.9	36.8	SLDE-Aguas Barcelona
Total		3,313.3	13,018.9	89.0	

Sources: Superintendencia de Servicios Sanitarios, and National Institute of Statistics.

[a]Thousands of customers.

[b]Percentage of customers in the region over total customers in the country.

Specifically, the SISS has among its duties: i) studying, proposing, and enforcing compliance of technical norms relative to the design, construction, and exploitation of sanitation services; ii) monitoring and enforcing of norms relative to tariff per services provided by utility companies operating in the sector; iii) application of the franchise regime, including allocation, exploitation, transferences, and expiration of the franchise; iv) defining norms and executing control over industrial effluents; and v) applying penalties and other types of sanctions to violators of the existing regulations in the sector.

2.2 Operation of the System

We now turn our attention to describing the operation of water and sanitation services in Chile. We will focus on aspects of the regulation that pertain to the demand side of the system, including tariff structure and procedures, consumption metering regulations, consumption billing and payment collection process, and utility companies' enforcing payment mechanisms.

2.2.1 Tariff system

One of the main features of the current regulatory regime for the Chilean water and sanitation sector is the regulated tariff scheme. Tariff regulations are intended to introduce appropriate incentives to the development of the sector as well as economic incentives for consumers. The Law of Tariffs, D.F.L, introduced the current tariff system in 1988. No 70/1988. The associated operative rules were promulgated in 1990 under Supreme Decree (D.S.) No 453.

The legal structure that supports the Chilean water and sanitation tariff system was structured under the following principles: i) dynamic efficiency, ii) economic efficiency, iii) intelligibility, iv) equity, and v) self-financing [SISS, internet site]. The principle of *dynamic efficiency* is included in the tariff law and associated regulations by the introduction of the concept of a model firm that operates efficiently. For regulated tariff design purposes, a model firm is an idealized conceptual firm that performs an efficient operation, different from each of the real utility companies.[4] The concept of a model firm was introduced to allow the regulator to estimate the costs upon which to define tariff formulas independently of the actual firms operating in the sector. In addition, *dynamic efficiency* also means that productivity improvement in the production and provision of the water and sanitation service can be incorporated in the tariff formulas over time. It can be accomplished by designing the model firm for each tariff processes.[5]

The *economic efficiency* principle is considered in the tariff design under the concept of marginal cost. The very basic conceptual idea behind this principle is that marginal cost represents the opportunity cost of producing an additional unit of a good or service; therefore, it represents the amount of resources that society should allocate to the production of that good or service. The Chilean tariff law introduced this principle through the concept of *incremental cost of development*. It is defined as the "value equivalent to a constant per unit price which, when being applied to the incremental forecasted demand, generate revenues to cover incremental

[4] A model firm is understood to be a firm that in its design contains the following characteristics: a) provides sanitation services with a design that includes efficiency in services provision, b) operates with all feasible interconnections among companies and systems to achieve maximum efficiency, and c) the firm develops its activities under current law and norms, given geographic, demographic and technological characteristics. Each of the model firms must have an administrative and institutional design, and a physical scheme of the model system for the stages of the sanitation service being considered [Medina (2000)].

[5] Because tariff formulas are modified every 5 years, each provider has incentives to obtain efficiency gains that might be funded through **cost savings** obtained within that period.

operation efficient costs and the required investment from an optimised project of expansion of the firm, such that it should be consistent with a net present value (NPV) of the project equal to zero." [D.F.L. No 70/1988].

With regard to the principle of *intelligibility*, the legal tariff framework considers a tariff structure that is intended to provide appropriate incentives to guide decision of consumption and production to the economic agents involved (consumers and utility companies). The tariff structure considers tariffs per stage of service provision (production, distribution, collection, and disposal and treatment), per system of provision, and per seasonality in demand.

The *equity* principle being applied implies a non-discriminatory tariff policy among customers, except when there are different costs of service provision. Under this principle, the tariff system is designed in a way so that tariffs reflect the costs of water and related service provision at its different stages, eliminating cross subsidies for customers within a given system.

Finally, under the *self-financing* principle, the legal framework recognizes that it is possible that a firm that is being regulated with marginal cost-based tariff might not be able to become self-financing. The situation was considered by the introduction of the concept of *long run total costs*. These types of costs represent the cost of repositioning a model firm that is starting its operation, with the appropriate size to provide services to the annual demand corresponding to a period of five year.[6] The application of the tariff formulas should allow each company operating efficiently to cover its long-run total costs.

In principle, the regulation considers the tariff as a maximum price that utility companies might charge to consumers. As we mentioned before, tariffs are established based on the concept of incremental cost of development. The law requires that tariff be determined according to stage of the service provision and by system. The tariff structure also considers variable and fixed charges and explicitly differentiates by seasonal demand. In the event of differences in demand by season, tariff structure includes, for each stage of the service and system, the following items: variable charge in high demand season (tariff per cubic meter in $\$/m^3$), variable charge in low demand season ($\$/m^3$), and variable charge because of over

[6] The actual estimation of the long-run total cost is transformed in annual operation and investment costs. It represents the required revenue to the reposition of the model firm considering a time horizon of 35 years. We notice here that the annual demand for the period of 5 years is considered because, according to the regulation, a tariff term lasts for that period.

consumption ($/m^3) (applies only in high demand season).[7] In the absence of seasonality, there is only a uniform variable charge. Regarding fixed charges, the current tariff structure considers only a fixed charge per customer, which depends on the diameter of the connection [see an example in Table 2].[8] The explicit consideration of differences in demand by seasons is intended to introduce in the tariff structure the differences in the costs of service provision.

Table 2
Tariff Structure for Water and Sanitation Services for ESSBIO (One Tariff Group)[a]
(December of 2001)

	Chilean $	US $[b]
Fixed charge		
Customer	605.0	0.90
Variable charges		
Low demand season		
Water ($/m^3)	232.7	0.34
Sewage ($/m^3)[c]	204.2	0.30
High demand season		
Water ($/m^3)	227.0	0.34
Over consumption		
Water ($/m^3)	476.7	0.71

Source: Superintendencia de Servicios Sanitarios (SISS).
[a] The company has two tariff groups. Each of them applied on consumers living in some of the two service areas of the company.
[b] Consider an exchange rate of 675 $/US$.
[c] The sewage tariff applies for all consumers located in the Bío-Bío river Basin.

From a practical perspective, the Chilean tariff regulation explicitly considers administrative procedures for the process of tariff determination. In principle, the process considers the interaction of the SISS with each utility company for which tariff formulas are being regulated; however, the regulation of the tariff process allows also any interested party to participate. Specifically, the general public is allowed to make observations to the process. The law establishes that tariffs are defined for periods of five years. The regulation considers mechanisms of automatic indexation to adjust tariffs by inflation within that period. The determination of tariff –the tariff process- is implemented under a set of administrative steps that

[7] Charge because of over-consumption is applied on the amount of cubic meters that exceed the customer average consumption within periods defined as high seasonal demand.

[8] The two tariff processes implemented prior to the legal adjustments introduced in 1998 considered two additional types of fixed charges. They were related to the distribution stage of the service provision and included a fixed charge **for** equivalent connection to the distribution system and a fixed charge **for** equivalent union to the

are clearly identified in the legislation. The procedures to be applied in the process are intended to make the implementation of regulations a transparent process. In addition, the procedures also allow the regulatory agency (SISS) and utility companies the possibility to interact.[9]

Chronologically, the administrative process of tariff determination includes the following steps [Medina (2000)]. First, twelve months before the expiration of current tariff application, the regulatory agency SISS should make available to the public and to the utility company involved, the terms of references upon which tariff studies should be conducted. Second, companies and the general public have a period of 60 days to make comments on the terms of references for tariff studies. The comments should be communicated to the SISS. Third, the regulatory agency must respond to the comments within a period of 45 days before the deadline of the request. Fourth, the regulation establishes that regulator and the utility company should exchange their own tariff studies at least 5 months prior to the expiration of the current tariff formulas. The exchange of studies takes place formally in the presence of a public notary. Fifth, after the exchange of tariff studies is performed, the company has 30 days to inform to the SISS of eventual disagreements. Should discrepancies exist, they must be formally presented to the SISS along with the studies supporting company's opinion. Sixth, if within a period of 15 days after the company presentation of the discrepancies, there is no agreement between the regulatory agency and the company, the SISS is allowed to appoint a Committee of Experts.[10] The Committee must resolve the discrepancies by making explicit its opinion on the sources of discrepancies. The opinion of the Committee of Experts is definitive and mandatory for both parties. Seventh, and finally, 30 days before expiration of the application of the current tariff formulas, the Ministry of Economy should define the new tariff formulas and start formal

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water collection system. The changes in the legislation introduced in 1998 established that the cost recovered by fixed charges already mentioned, will be included in the variable charges.

[9] Since the adoption of the new regulations for the sector, three tariff processes have been successfully completed: 1989-1990, 1995-1996, and 1999-2000. The first two of them were conducted considering the initial regulation under which regulated companies had a passive role. In effect, at that time they were only allowed to make observations to the regulatory agency proposals. Given the legal adjustment of 1998, utility companies now have a more active role. In fact companies must now participate in the tariff process conducting their own tariff studies and tariff formula proposals parallel to that of SISS.

[10] The Committee of Experts is composed of three people. According to the regulation, one person is appointed by the SISS, another by the utility company, and the third person also by the SISS chosen from a list of names previously agreed with the company.

procedures in the Contraloria General de la Republica. The process is completed with publication of the tariff formulas in the Official Newspaper.

2.2.2 Metering Regulations

Water consumption metering system has a long tradition in Chile. Although it is not possible to identify any specific date when metering was introduced in the country, it is known that the initial steps to recover operational costs through tariff increase on the provision of water was complemented with a policy intended to improve payment collection and to achieve a universal coverage of metering systems for households connected to the distribution network at urban areas. Morandé and Doña (1997) report that while metering coverage for urban customers in Chile was about 90% in 1982, it was covering 100% of the connections in 1990. In addition, anecdotal information suggests that even houses built in the1960s already had a water meter system.

Water metering is explicitly considered in Supreme Decree No. 121, 1991, from the Ministry of Public Work of Chile. Among others, the Decree defines a metering device, and considers specific aspects such as payment and maintenance responsibilities, meter reading procedures, etc.. Specifically, article 69 of the Decree establishes that metering consumption of water must be performed using a meter instrument (in Spanish medidor) which should register such consumption in cubic meters.[11] Furthermore, the regulation considers that installation of a meter device is subject to customer charge, but maintenance and renewal of it is the responsibility of the utility company serving the area in which water service is being provided.[12] Calibration of metering devices is ruled by the Chilean Norms NCh 1730-1998, which include technical specifications for speed metering of cold water, and also in the NCh 2459, referred to the installation of metering devices of cold water for 3, 5, 7,and 20 m^3/h of maximum flow.

Utility companies must perform meter reading according to a pre-established frequency. The regulation in Supreme Decree 121/1991 establishes that meter reading must be in regular cycles of 30 days in the case of monthly billing and 60 days in the case of bimonthly billing, with

[11] Article 61 of the Supreme Decree 121/1991 defines meter (medidor) as the instrument to measure and indicate the volume of water that passes through it.

[12] In general, while maintenance of the interior equipment for the provision of water and water collection services is the responsibility of each customer; the utility company should provide the maintenance of the water connection to the public distribution network and union to the water collector network.

a maximum variation of 2 days. Further, billing must be in accordance with water consumption registered by the meter device.[13]

In the case of multi-apartment housing and multi-story buildings with only one connection to the public distribution network, Supreme Decree No. 453/1989 from the Ministry of Economy, established that the corresponding tariff should be applied considering each house or apartment as an individual residential service. To that purpose Supreme Decree 121/1991 established that in these cases, it should be considered for each apartment or house, the installation of metering device called re-metering (in Spanish remarcador), and one general meter device to register those individual consumptions as well as the common consumption.[14]

2.2.3 Consumption billing and payment collection

The consumption billing and payment collection procedures for water and sanitation services in Chile are thoroughly regulated [see Supreme Decree No 121/1991, Ministry of Public Work, and Supreme Decree No 453/1989, Ministry of Economy]. The regulations establish the practicalities of the process as well as the rights and obligations of the utility companies and consumers. The maximum tariff to be applied is those described in section 2.2.1. Variable tariffs must be applied on consumption given by the meter reading.[15] Furthermore, according to the regulations, the meter reading process must be established in regular cycles of 30 days in the case of monthly billing, and 60 days in case of bimonthly billing, allowing in both cases a maximum variability for the extension of the cycle of two days.

The regulation for billing and payment collection process also establishes that the period between meter reading and the actual bill emission should not exceed 10 days, giving the utility company the right to choose the billing date. Customers must be informed of the billing

[13] Regulation considers two types of billing frequency; namely, every 30 days, and every 60 days.

[14] Installation of the re-meter devices (remarcadores) will be charged to the customer, while maintenance and renewal is the utility company's responsibility. The aggregation of individual consumption in this case is defined as a second register for consumption. In cases where this register does not match the consumption register by the general meter device, the difference should be prorated proportionally in accordance with Law No 19.537 on common property of housing and buildings. It should be noticed that despite these regulations, every house or apartment owner that is part of a multi-apartment housing or multi-story building has the right to ask for individual metering and billing of its consumption through an individual meter that should be installed next to the re-meter devices needed to assess common consumption. It is mandatory for the providers of the service to accept this type of request; but the owner will bear the cost of such a device.

[15] Specifically, the regulation mandates that tariff to be applied should be that of the day on which the meter reading is performed. Whenever the meter reading cannot be performed, according to the regulation, the household

schedule. The regulation further mandates that the company must provide a bill to the residential location that receives the service within a maximum period of 5 days from the billing date, and to allow a deadline of at least 15 days within which to receive payment.

The regulation explicitly specifies the following minimum items that the company must include in the bill: a) name of the customer; b) address where the service is provided; c) customer ID number; d) meter identification; e) billing type; f) consumption and meter reading (including current and previous reading, date, and total cubic meters being billed under normal tariff, per over-consumption, etc.); g) amount billed by item (i.e., fixed charge, variable charges by water consumption, variable charge by water collection service, subsidies in cases where it is relevant [see section 2.3]).

After the customer receives the bill, payment should be made at specific locations for payment collection.[16] If a customer does not pay his bill, the utility company has the right to disconnect the household from the service. Under Chilean regulations, provision of water and sanitation services cannot be considered as a free good [Foster (1998)]. The regulatory framework establishes that in these situations the costs of disconnection and future reconnection after payment is received, is to be charged to the customer.

2.3 Water Consumption and Sanitation Service Subsidy Program

Prior to 1988 the Chilean water and sanitation service was still characterized by both an artificially low tariff level and a cross-subsidy scheme. In effect, customers who had different costs for provision were charged with the same (low) tariff levels. Under that system, the state was the provider of the service, and was charging low tariffs for all the population. That system experienced undesirable results because of the wrong incentives it provided for consumers and providers to conserve water, and was also socially regressive. After the application of the new regulatory framework of 1988/1989, providers had to charge tariff reflecting the long-run marginal costs for an ideal efficient provider. The tariff is intended to cover financial costs for

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is presumed to have a consumption level equivalent to the historic average consumption. Adjustment on the actual meter reading should be incorporated during the next reading cycle.

[16] Because customers in the country are not used to pay bills through regular mail, utility companies, including water and sanitation providers, electricity providers, and even telecommunication providers, have recently starting to decentralize payment collection. To that purpose, there are many specific payment collection stores called “centros de pagos”, they are typically located in super markets and others similar public areas closer to the customers. In fact, payment collection can be understood as the final vertical stage in the industry for the provision of water and sanitation services.

operation and development. Tariff is therefore applied to customers according to cost of water and sanitation services provided to them, thus preventing cross-subsidies.

In order to protect low-income households and probably to gain political support and justification for tariff reforms, since the end of the 1980s, the government has conceived and implemented a subsidy program to assist low-income families to pay for water and sanitation services. [Foster (1998)]. This program was established by the Law of Subsidy to the Water Consumption and Sanitation Service [Law No 18.778, February 1989] and its application is currently implemented under norms included in Supreme Decree No 195, Ministry of Finance, 1998. The subsidy law at its inception originally established that the subsidy program can cover up to 85% of the fixed and variable charges at a maximum of 20 cubic meters of consumption [Foster (1998)]. The goal of the subsidy program is to prevent expenditure in water and sanitation services from going beyond 5% of the household monthly income, as suggested by the World Health Organization (WHO). Initially the subsidy was allocated only at the request of eligible family; however, water companies have been helping to improve the payments of these subsidies by examining payment records to identify eligible households [Foster, et. al. (2000), and Foster (1998)]. Local municipalities are responsible for administering the subsidy program and reassess the eligibility of families receiving subsidies every three years.[17] Among other factors, eligibility is based on the region in which the family lives, cost of water, household monthly income and wealth, and family size.

The target group was initially defined as the poorest 20% of households in each region. Potential beneficiaries had to apply for the subsidy in their municipality. The application procedures entailed filling out a socioeconomic evaluation form (SEF), unless they had already done this for other purposes. By August 1991 the subsidy was only reaching 14.1% of the estimated potential beneficiaries. The government's view on this situation was that the eligibility criteria were too stringent, and this led to their relaxation. In 1991 a legal amendment was introduced to eliminate the requirement of consuming less than 20 cubic meters of water per month, to suspend the non-debt requirement until the end of the year, to authorize the water companies to submit applications on behalf of their customers until December (this was made permanent in 1994), and to extended the subsidy to families sharing a house and to housing

[17] Although local municipalities run the program, funding is provided by the central government through the Ministry of Planning, which transfers resources to the municipalities through the regional governments.

compounds sharing a water meter. By the end of 1994, 42% of the estimated potential beneficiaries received subsidies for their water and sanitation services consumption.

From a more practical perspective, the subsidy program works as follows. An eligible family joining the subsidy program is billed in the same fashion as those not covered by the program (i.e., all billing and collection of payment norms discussed earlier apply in their case). However, eligible families are billed only for that part not covered by the subsidy, the municipality then periodically the amount of subsidy pays to the utility company.

3. Implementation of the System and Description of the Transition Process

3.1 Evolution of the System

We distinguish three periods in the development of the Chilean water and sanitation sector. During the first period, which includes most of the twentieth century until 1975 several uncoordinated institutions and state organizations of Chile provided these services. The water and sanitation service was supplied by the state, which funded the investments and important parts of the operational costs of the system. Water-metering was already in use during this period, however, tariff levels were not sufficient to cover the operational costs of the service. The second period introduced the initial steps of the process that would evolve to the actual system. In effect, by the mid 1970s the Servicio Nacional de Obras Sanitarias (SENDOS) was created. The state-owned, national level company totally concentrated on state activity in the water and sanitation sector of the country. SENDOS operated in eleven of the thirteen regions of the country, while in the other two regions the independent firms known as EMOS and ESVAL provided these services. The creation of SENDOS in the seventies represented a significant change in approach and is perceived as the starting point for the next stage of the reforms of 1988/1989. In 1989 the General Law of Sanitation Systems (D.F.L. 382) was passed and the Superintendencia de Servicios Sanitarios (SISS) was created. It was during this third period that the transformation of the Chilean water and sanitation sector was consolidated. During this period the basis for the privatization process of the companies was introduced. The last two periods were characterized by a high level of public investment, which allowed the increase in coverage for water and sanitation services. In the final stage of this process the gradual tariff adjustment ended; therefore, prices now reflect the true cost of providing the service.

3.2 Coverage

Water and sanitation services in Chile were traditionally perceived as a public good. That conception implied that the state was responsible for the creating and expanding water and sanitation services to the population, especially during the twentieth century. As a direct result of efforts by the state, water provision is now almost universal for the urban population of the country.[18] In effect, whereas in the early 1960s water services were provided only to about 50% of the urban population, today it is almost 100%. Similarly, in 1965 while sanitation services was to less than 30% of the urban population, at the end of the last decade it was estimated to be well over 90% (see Table 3).

Table 3.
Water and Sanitation Services Coverage in Chile: Selected Years 1965-2000.

Year	Water Services (% of Urban Population)	Sanitation Services (% of Urban Population)
1965	53.5	25.4
1970	66.5	31.1
1975	77.4	43.5
1980	91.4	67.4
1985	95.2	75.1
1990	97.4	81.8
1995	98.6	89.4
2000	99.6	93.3

Source: Superintendencia de Servicios Sanitarios (SISS).

[18] There are several systems that provide water services for rural population. None of those systems operate under the regulatory design considered for the urban sector. In fact, each of the rural water provision systems is organized as a cooperative or committee. Supervision of systems providing water services in rural areas is responsibility of the Ministry of Health. Given the purposes of the study, we do not consider in the analysis the system of water provision for rural areas.

3.3 Tariff over Time

Before 1990 one of the main features of the tariff system in the Chilean water sector was that they did not reflect the true cost of providing the service. Water prices were on average less than what was needed to finance provision of the services. Even in regions with the highest costs of production, prices covered only 20% of the true cost [Serra (2000)]. Early 1n 1990 a new tariff system was applied. The target was to enable an efficient firm to self-finance its operation and development. This framework was gradually introduced. As a result, charges on water and sanitation services increased by an average of 90% in real terms in the first four years. The hike in prices was steeper in areas with higher cost. For example, in the northern regions tariff increase exceeded in some cases 500%. By 1998 average regional water tariffs ranged from U$0.45 to U$1.21 per cubic meter of consumption. Table 4 shows the evolution of average tariff over time in some selected providers throughout the country for the last five years. The introduction of price regulations intended to reflect the true costs made it necessary to design a subsidy for water demand consumption to mitigate the impact on the poor.

Table 4

Average Water Tariff per Selected Provider 1996-2000 (US$ / m3)[a]

Region and Utility Company	**1996**	**1997**	**1998**	**1999**	**2000**
North of the Country (desert): ESSAN	0.94	1.18	1.20	1.29	1.39
Center-North of the Country: ESVAL	0.48	0.62	0.63	0.68	0.76
Center of the Country: EMOS	0.26	0.31	0.31	0.32	0.39
Center-South of the Country: ESSBIO	0.38	0.43	0.44	0.45	0.48
South of the Country: ESSMAG	0.47	0.67	0.81	0.76	0.84

Source: Calculations by the authors based on information from SISS (several years) and Banco Central of Chile.
[a]Tariffs in constant US $ (2001). Figures were calculated dividing the total annual revenues from the franchise operation by the total amount of annual water cubic meters billed.

3.4 Water consumption over time

As indicated in the previous section, before 1990 prices for water and sanitation service did not reflect the true cost of providing the service. Furthermore, it has been estimated that in 1968 revenue from tariffs represented only 16% of total budget of the providers. That figure was even as low as 3% of the sector budget [Morandé and Doña (1997)]. Given the figures above and the cross-subsidies implied by them, a culture related to water care did not exist in Chile at that time. No historical records on average water consumption exist, but a conservative estimate based on information obtained from some of the providers suggests that since the end of the 1980s, average water consumption per consumer was reduced by about 50% after the tariff increase. The recent evolution of water consumption in Chile is shown in Table 5.

Table 5
Average Water Consumption in Chile, 1997-2000.

Year	Annual Consumption (m^3/customer)	Monthly Consumption (m^3/customer)
1997	276.9	23.1
1998	287.0	23.9
1999	274.3	22.9
2000	272,5	22.7

Source: Calculations by the authors based on information from Superintendecia de Servicios Sanitarios (SISS)

3.5 Non-payment Enforcement

During the period when water charges were below the cost of providing the service, there were not enough incentives to collect bad debts. The creation of SENDOS in 1977 represented a change of approach; until then, financing the service was not one of the government's priorities. As a result, there was a total lack of interest in trying to collect payments from debtors. During the 1980s, SENDOS significantly increased its revenues merely by being more energetic in collecting debt without changing water and sanitation services prices. In the 1990s a more commercial approach have been taken by providers. Among others explanations, the subsidy policy is believed to put incentives in place to pursue prompt payment.[19] In addition, companies were allow to suspend the connection to debtors customers, reducing the amount of bill in arrears from 7.9% of total billed amount in 1990 to 2.9% in 1994 [Serra (1990)].

[19] Eligibility criteria for the allocation of the subsidy included having no arrears with the water company or having negotiated the payment at the time of requesting eligibility for the program .

3.6 Consumer Protection over time

The structural changes introduced in the Chilean water sector in 1988 as well as the expectations at that time on future privatisation triggered the creation of an empowered enforcement unit within the SISS. Among the aspects under surveillance of the agency are: water quality (including bacteriologic, des-infection, physical, chemical, and radioactive, components established in the Chilean norm Nch409 Of84). Enforcement design includes self-reporting requirements from the utility companies, and auditing activities implemented by the SISS enforcement department. The SISS is also responsible on receiving and handling customers complaints as well as controversies between customers and utility companies. Complaints typically include problems related to consumption meter reading and quality of the service (water distribution, pressure, water quality aspects easy to monitor from consumers). The SISS not only play a role auditing, but also imposing sanctions.

4. Global Assessment of the Chilean Water and Sanitation Service System

4.1 Industrial Organization of the Water Supply System (maq)

The structure of the water and sanitation industry in Chile is determined by three basics elements: i) presence of economies of scale and scope, ii) spatial and geographic differences, and iii) the presence of externalities. The economies of scale are originated because of the high level of specific investment required in the stages of production and distribution of water. The economies of scope are produced because of the advantage in costs obtained when vertically integrating the water production and distribution, water collection, and treatment and disposal. The costs savings that can be achieved through the integration of these services are related to the joint utilization of networks, as well as the possibility of having a process of joint billing, which might even include the disconnection in case of non-payment. The geographic differences in Chile are produced because of the differences in density of the customers between localities and the differences in the availability of water within the territory. The spatial density in the served area will define the characteristics of productive processes, and through it, the costs of operation and investment per customer.

In Chile it is possible to distinguish three types of areas for water provision: urban (more than 3,500 inhabitants), rural concentrated (between 150 and 3,000 inhabitants and at least 15

houses per square-kilometer), and rural dispersed. The first two require collective solutions, while the last one requires individual solutions. The geographic differences define a patter of relative higher water availability when moving from the northern to the southern region of the country. Furthermore, the relative closeness from the served locality to the coastal zone determined the possibility of using lower costs alternatives for water treatment. Finally, the externalities present in the sector determine the existence of discrepancies between the social and the private value for water and sanitation services. This is so because widespread and adequate access to water and sanitation services is essential for public health and individual welfare. Households without water and sanitation services are likely to be more inclined to get diseases, which are then transmitted to other families. These perhaps help to explain why in the past water companies have been in hands of the government or have kept level tariffs that not reflects the true cost of supplying the service.

The above characteristics are probably behind the idea of allocating a franchise for the operation of providers within a given locality or geographic area, being each of the companies a monopoly within the franchise location. To avoid that a deregulated market end producing an operation level lower that what is socially desirable, some of the companies still are under the state ownership, and others are overseeing and regulated in both service quality and tariff.

4.2 Tariff Design and Implementation

The tariff system for water and sanitation services in Chile was considered in the legal reforms of the sector in 1998-1999. From our previous descriptions and accounts on the Chilean sanitation sector, the main characteristics of this tariff system are:

i) Price signal for providers. Tariff design in Chile incorporate not only the need to cover current operational costs, but also the required funding and returns for investment to ensure the development of the sector in anticipation of future demand. On one hand, water production and sanitation services have very high fixed costs and low marginal costs, on the other hand water and sanitation service demand is expected to relatively inelastic, at least from a social perspective. Under that market structure for water services, it is likely that when demand increases, prices would eventually increase rapidly because firms can not increase output beyond

fixed capacity. Prices that provide right incentives to suppliers to expand fixed capacity as demand increases avoid future deficit in the provision of sanitation services.

ii) Tariff as a signal for consumer decisions. The tariff design is intended to provide a clear signal of the true social cost of water production and provision as well as the related sanitation services. Tariffs are in principle a way to generate the right incentives in the context of a decentralized system where million of consumers take daily decisions on how much water to use and how to use it.

iii) Avoiding cross-subsidy. The Chilean tariff structure for water and sanitation services explicitly pursue to avoid cross-subsidies. Under the current tariff system, it is likely that any two consumers receiving water and sanitation services from a different system in different regions will face different costs. For example, as a result of the tariff processes implemented under the current tariff regulations, water tariff in the north region, where water is a scarce resource are higher than those that are faced by customers in the south, where water is available, and therefore the cost of provision are lower.[20]

iv) Gradual Implementation. Tariff increase was gradually introduced after the first tariff process was completed in 1990. The tariff increase was trespassed to consumer between 1990 and 1995.

v) Tariff term. The length of the tariff term should be long enough to allow providers to avoid costs associated to tariff renegotiation and also make it possible that they be able to recover efficiency enhancing investment. However, at the same time, tariff term should short enough to trespass on customers the efficiency gains through the model firm. As usual a trade-off seems to be present in the decision.

[20] It is believed that cross-subsidies are still present to some extent. That might be the situation because the actual tariffs for systems that are closed to each other from a geographic perspective are obtained by averaging the specific tariffs for each system.

4.3 Tariff Process

The new model for designing tariff formulas in water and sanitation services in Chile has been applied since 1990. In that period, and according to the current regulatory framework, three tariff processes have been completed. The main features and lessons from that processes are:

i) Transparency. One of the main features of the tariff process is the transparency in its implementation. In effect, all interested parties know in advance the regulatory steps, the associated timing, and rights and obligations.[21]

ii) Participation. Although the regulatory framework initially allow only participation of the regulatory agency (SISS) and the regulated company, part of the reforms introduced in 1998 where intended to increase participation and the transparency of the process, allowing also the possibility of intervention of the general public.

iii) Information requirements. The implementation of the tariff regulations requires that the regulator interact with providers. In particular, the regulator should be able to obtain detailed information on several aspects related to costs and operation of each utility company whose tariff formulas are being regulated. A potential difficulty faced by the regulator in this situation is known as an asymmetries information problem. This type of problem exists because the regulated firm holds valuable information from the regulator. One way to avoid this problem, which have been considered in anticipation of the privatisation of companies, is that the state be able to keep a participation in the company ownership.

iv) Protection for low-income families. Because the tariff process have implied an important increase in tariff levels; achieving in some cases tariff levels that more than double the levels previous to the regulatory reform, the implementation of the subsidy to the demand program

[21] However, some authors have pointed out that during the implementation of the first tariff process in 1989-1990, not all formalities were followed. In particular, some utility companies complaint that they did not have the chance to effectively participate in the process, having instead a passive role. The situation changes during the implementation of the second and third tariff process in 1994-1995, and 1999-2000.

have clearly improve the acceptability of the reforms. It is also likely that the subsidy program has make politically viable the regulatory reform process.

4.4 Positive factors related to metering

Water consumption metering-based has been historically present in the Chilean sanitation sector. As we have previously mentioned, since 1990 the coverage of micro-metering devices to estimate water consumption and related services is universal for urban customers connected to the public distribution system.

Metering for water consumption have shown to have many advantages in the Chilean system, among others:

i) Information. The presence of meter devices for water consumption allows each agent to keep track on water consumption per period. The provision of that information makes possible better decisions. Further, metering provide utility companies an objective non-discriminatory instrument to charge consumers based upon their consumption decisions.

ii) Avoiding free riding. Installation of water metering system to estimate water consumption from individual households eliminate the potential incentives for free-riding, which are presumable present with collective water provision services. The problem of free-riding emerge because individual are not able to coordinate actions regarding how much water to consume. In effect, it is likely that while in metering based consumption each agent perceive the total cost of an additional consumption unit, he/she only perceive a fraction of the cost in the context of a collective water provision system.

iii) Tariff implementation. In the Chilean regulated tariff scheme, metering devices play a key role, providing the necessary information to implement in practice the system.

4.5 Quality of the Water Supply Service (abastecimiento, water quality, consumer service

The SISS is responsible of ensuring that utility companies provide adequate service and water in compliance with the existing norms. Water quality is measure as a function of parameters bacteriologic, of des-infection, physical, and chemical. Table 6 shows the situation of providers on quality requirements. The table presents partial outputs from utility companies efforts and parallel auditing activity implemented by the SISS.

Table 6 shows that main problems for providers are related to non-compliance of physical requirement and also with chemical norms. Compliance with physical parameters is what presents the highest level of non-compliance. It includes measures of water opacity, colour, flavour, and smell. It is believed that the problem is related to still not adequate treatment infrastructure for the production stage in those localities that are served with superficial water. To solve this problem, the SISS approved in August of 1999 a document containing instructions on "quality of water sources" and distributed it among utility companies. In that document, it was established a classification of water sources being used to provide water to the population. The classification consider water characteristics and it define for each of the items classified the required treatment. Compliance with this instruction is mandatory since January of 2000.

Table 6
Providers Compliance Status by Type of Water Quality Parameter

	N° of services 2000			N° of services 1999		
	Compliant	Non-compliant		Compliant	Non-compliant	
	N°	**N°**	**%**	**N°**	**N°**	**%**
Bacteriologics	330	5	1.5	323	8	2.4
Des-Infections	334	1	0.3	325	6	1.8
Physics	211	124	37.0	160	171	51.7
Chemicals	273	62	18.5	285	46	13.9

Source: Superintendencia de Servicios Sanitarios (SISS), 2000.

The SISS has also among its duties surveillance of quality service. To that purpose each provider must maintain an information system on customers complaints. Further, each of utility companies must periodically report this information to the SISS. On average, the system registered about 24 complaints per 1,000 customers per year. Almost 40% of these complaints are related to discrepancies on the billed cubic meters, about 30% has to do with water quality problems, 9% is related to discrepancies on the application of tariff formulas, and 3% has to do with inappropriate service to consumers. However, the number of actual sanctions imposed by the SISS is rather low. During year 2000 were imposed 37 penalties to providers, 17 of them

because of tariff and billing procedural problems, 10 because of non-compliance with water quality parameters, and the rest because of other types of non-compliance.

It seems that the SISS has been changing the norms to ensure good quality service from providers. Even though franchise for operation are indefinite, they can be revoked because of serious non-compliance from providers.

4.6 Subsidies for the poor

The subsidy consists in a percentage of the bill that is covered by the government. Under this scheme, prices are set for cover the true cost of providing the service, meanwhile the subsidies are paid to the companies by municipalities where lives households who are not able to pay the water bills. These families meet certain poverty-related criteria. Government resources are used to cover part of the minimal or subsistence consumption.

The subsidy is intended to benefit the 20% poorest of the population. In practice it provide a subsidy for the first 15 cubic meters of the monthly consumption, representing between 40% and 85% of the total billed. The subsidy rate is higher in areas where water charges are higher and the average income of the poorest 10% of the population is lower [Serra (2000)]. Eligibility criteria initially included having no arrears with the water company, or having negotiated payment thereof, besides of consumption lower than 20 cubic meters per month. The main advantage of direct to the demand subsidies is that they eliminate the cross subsidies that was present when water charges were below the cost of providing the service. Benefits are reach only to the target population. In addition, the subsidy scheme also allows reducing the government's expense, releasing resources toward other public areas. Moreover, this system facilitates to define regulated tariffs according to economic criteria [Gómez-Lobo (2001)]. Finally, direct subsidies that are well designed minimize distortions on firms and customers behavior [Foster et. al., (1998)].

The main drawbacks of direct subsidies are their administrative costs, higher than subsidies to the tariff, and the difficulty of designing suitable eligibility criteria [Foster et al, (1998)].

Some aspects of the performance of the Chilean subsidy scheme to water demand have been evaluated by Serra (2000). He has suggested that the subsidy program has been quite successful in attaining the target population. By the end of 1997 the subsidies were covering 95%

of total estimated potential beneficiaries. Even more, 73% of beneficiaries were in the poorest group as measured by their SEF score. However, although the subsidy program has been continuously improved over time, the goal of none family spending more than 5% of its income on water and sanitation service has not yet been achieved. There are high regional disparities, the bill for consuming 15 cubic meters of water range from 2.8% to 11.9% of average family income in the lowest income decile nationwide, depending on regional income and the pricing zone. In spite of that, at the aggregate level, the after-subsidy bill for 15 cubic meters of water consumption accounts on average for 5.5% of the mean income of the family in the first decile. Beneficiaries of the water consumption subsidy and government annual expenditure are shown in Table 7. In 1997 the 17% of the Chilean population was benefited with the water consumption subsidy [Riesco (2000)].

Table 7
Water Consumption Subsidy: Beneficiaries and Expenditure, 1990 – 1998

Year	Estimated Potential Beneficiaries[a]	Actual Subsidies Granted[a]	Coverage[b] %	Expenditure[c]
1990	424.6	21.8	5.1	5.5
1991	424.6	177.7	41.9	414.3
1992	441.0	315.9	71.6	3,553.0
1993	443.1	351.9	79.4	6,989.0
1994	454.0	389.7	85.8	11,230.2
1995	461.5	399.2	86.5	14,657.6
1996	466.5	442.5	94.6	18,985.5
1997	466.5	444.0	95.2	22,585.4
1998	466.5	n.a.[d]	n.a.[d]	24,381.1

Source: Calculations by the authors based on information from the Ministry of Economy.
[a] Figures in thousands of people.
[b] Ratio of actual subsidies granted over estimated potential beneficiaries.
[c] Figures in thousands of US $. Calculated by dividing expenditure in subsidy program in Ch$ at current prices by the annual average exchange rate (Ch$/US$) for 2001.
[d] Not available.

5. Conclusions

Structural reforms in the Chilean water and sanitation sector have been gradually introduced in the last 25 years. These changes have to do with the design of new legal rules, institutions, and economic incentives for providers and consumers. The main effects of the reforms are related with the increase in coverage for service provisions, ownership and organization of the firms, and the introduction of a new regulated tariff scheme.

From a more practical perspective, the Chilean case illustrate that it is possible to use economic incentives to improve the performance in water and sanitation service provision. It also suggests that changes can be achieved mitigating social impacts.

One of the elements that should be given careful consideration on the implementation of the successful water metering-based consumption system in Chile is that individual meters have been long present in the country as a management tool for water provision. Further, it seems very possible that viability of the transformations and its impacts on tariff increase have been achieved through the design of an reasonable well targeted subsidy direct to the demand program explicitly intended to protect low income families.

Despite the progress that has been made, the sector faces new challenges. Ensuring water quality seems to be a priority for the almost universal coverage already achieved in urban areas. Coverage for rural areas, a sector not considered in this report, seems also be in need of an institutional design, and new regulatory framework. The increasing pressure for water treatment and others environmental related issues are also been anticipated by policymakers and analyst of the sector. Finally, the privatisation process of the providers is just starting, without doubt new regulatory challenges and lessons need to be address in the future.

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