Water for Life: The Impact of the Privatization of Water Services on Child Mortality

Sebastian Galiani
Universidad de San Andres

Paul Gertler
University of California at Berkeley and NBER

and

Ernesto Schargrodsky*
Universidad Torcuato Di Tella

June 30, 2002

Abstract: In the 1990s Argentina embarked on one of the largest privatization campaigns in the world as part of a structural reform plan. The program included the privatization of local water companies covering approximately 30 percent of the country's municipalities. Since clean water and sewage treatment are critical to control the spread of infectious and parasitic diseases; access expansions, quality improvements, and tariff changes associated to privatization may have affected health outcomes. Using the variation in ownership of water provision across time and space generated by the privatization process, we find that child mortality fell 5 to 7 percent in areas that privatized their water services overall; and that the effect was largest in the poorest areas. In fact, we estimate that child mortality fell by 24 percent in the poorest municipalities. These results suggest that the privatization of water services prevented approximately 375 deaths of young children per year. We check the robustness of these estimates using cause specific mortality. While privatization is associated with significant reductions in deaths from infectious and parasitic diseases, it was uncorrelated with deaths from causes unrelated to water conditions.

JEL: D60, H51, I10, I30, L33, O12
Keywords: privatization, child mortality, water provision, and poverty.

---

* Sebastian Galiani, Universidad de San Andres, Vito Dumas 284, (B1644BID) Victoria, Provincia de Buenos Aires, Argentina, Tel: (54-11) 4746-2608, sgaliani@udesa.edu.ar. Paul Gertler, Haas Business School, University of California at Berkeley, Berkeley, CA 94720-1900, US, Tel: (510) 642-1418, gertler@haas.berkeley.edu. Ernesto Schargrodsky, Universidad Torcuato Di Tella, Miñones 2177, (C1428ATG) Buenos Aires, Argentina, Tel: (54-11) 4784-0080, eschargr@utdt.edu. This paper has benefited from comments by Alberto Chong, David Levine, Florencio Lopez-de-Silanes, Ted Miguel, Pablo Spiller and seminar participants at UC Berkeley, University of Washington at St. Louis, UTDT and UNLP. We are also grateful to Pablo Cafiero M.D., Liliana Clara M.D., and Enrique Calderon M.D who provided expert information on water-related diseases in Argentina, and to Matias Cattaneo and Juan Pantano who provided excellent research assistance.

At the 2000 Millennium Summit, member countries of the United Nations unanimously agreed on a set of eight goals to reduce poverty by 2015; among them are reducing child mortality by two-thirds and cutting in half of the number of households that do not have access to safe water. These goals are related in that clean water is critical to containing the spread of infectious and parasitic diseases. Indeed, each year more than 3 million children die from preventable water-related diseases (World Bank, 2002), and a number of studies have found that access to safe water is associated with better child health (Merrick (1985), Behrman and Wolfe (1987), the Cebu Team (1991), Esrey et al (1991), Lavy et al (1996), Lee et al (1997), inter alia).

While all countries have committed to increasing access to safe drinking water, there is little consensus on how to actually achieve these goals. One increasingly popular proposal is to turn water provision over to the private sector. Governments who privatize water systems are typically motivated by potential efficiency gains. They hope that these efficiency gains will be translated into expanded access and improved service quality, and thereby improve health outcomes. While there has been only limited experience with the privatization of water services (World Bank, 2002), a number of authors have reported large gains in productivity and profitability associated with privatization in other sectors (Megginson et al, 1994; Barberis et al, 1996; Frydman et al, 1999; and La Porta and Lopez-de-Silanes, 1999).

However, in the water sector, it is not clear whether any efficiency gains from privatization would necessarily be translated into improved health outcomes or help to alleviate poverty. Private companies may provide sub-optimal service quality levels because they fail to take into account the significant health externalities that are present in this industry (Shirley, 2000). In this case, privatization of water services may actually negatively affect health outcomes. In addition, some fear that privatization may hurt the poor (Estache et al, 2001). If private companies raise price, enforce service payment, and only invest in lucrative high-income areas, then the efficiency gains from privatization might be obtained at the cost of excluding the poor

from access to water services. Health outcomes of the poor may actually worsen under privatization.

In this paper, we examine the impact of the privatization of water services on child mortality in Argentina. Our study focuses on young children because they are particularly vulnerable to water-related diseases due to weak body defenses, higher susceptibility, and greater exposure from inadequate knowledge of how to avoid risks (WHO, 2002a). There are two main disease transmission mechanisms generated by the lack of appropriate water systems: waterborne diseases that occur by drinking contaminated water, and water-washed diseases that occur when there is a lack of water and sanitation for household hygiene. Young children worldwide suffer from several deadly diseases that could easily be prevented through the interruption of these transmission mechanisms by access to safe and sufficient water supply and provision for the hygienic removal of sewage (WHO, 2000). Diarrhea alone accounts for approximately 15 percent of all child deaths worldwide (UNICEF, 2001). In Argentina, diarrhea, septicemia, and gastrointestinal infections are three of the top ten causes of death for children under five (Ministerio de Salud, 1999).

Our analysis takes advantage of the fact that local municipal governments are responsible for delivering water services and only some of the municipalities privatized those services. Between 1991 and 1999, about 30 percent of water companies covering approximately 60 percent of the population were privatized. This variation in ownership across time and space provides a potential instrument to identify the causal effect of privatization on child mortality.

A major methodological concern, however, is that local governments choose to privatize water services, and that choice may not be orthogonal to unobservable factors that also affect mortality. We address this concern in three ways and believe that the link between the privatization of water systems and child mortality is causal.

First, the privatization of public water systems represented a small part of a massive program that transferred to private hands almost all of Argentina's state owned enterprises

(SOEs) during the 1990s. The privatization process was in turn part of a larger program of structural reform intended to revert decades of economic decline and fiscal deficits. The municipalities that privatized were much more likely to be governed by the same political party as the central government who sponsored the larger privatization wave, while the municipalities that did not privatize were much more likely to be governed by opposition parties. Therefore, the institutions suggest that the fiscal crisis and politics drove the decision to privatize, rather than unobservable idiosyncratic shocks.

Second, we analyze the determinants of the whether and when a local government privatized, paying special attentions to time varying factors that may be correlated with mortality. The results of our adoption models show that it was location specific fixed factors that explain which municipalities were privatized, and not time varying economic factors. This result suggests that municipality fixed effects will likely control for any correlation between the decision to privatize and unobserved heterogeneity in the analysis of the impact of the privatization of water services on mortality.

Third, our causal model predicts that water privatization should affect child mortality from water-related diseases but it should show no effect on deaths from other causes. We find that the effect of water privatization on child mortality emerges from a reduction in the number of deaths caused by infectious and parasitic diseases, while privatization is uncorrelated with deaths from causes unrelated to water conditions.

Another major concern is the possible heterogeneity in responses to privatization. In this case, the localities that did not privatize would not be good comparisons to the treatment localities. In order to investigate this possibility, we estimate the impact of water services privatization on child mortality using a combination of methods: straight difference-in-differences, difference-in-differences on the observations that have a common support based in propensity scores, and matched difference-in-differences. We find no significant differences in the estimated impacts by methods, but do find an increase in power.

In the end, despite the concerns about potential negative health effects, we find that the privatization of water services is actually associated with a reduction in child mortality of 5 to 7 percent. Moreover, we find that most of the reduction in mortality occurred in low-income households, where the network expansion was the greatest.

1. THE ECONOMICS OF WATER SERVICE DELIVERY

Water systems include both the supply of clean water and the treatment and removal of sewage. These services are a natural monopoly involving large fixed costs and significant economies of scale (Noll et al, 2000).[1] There is typically little competition to a well functioning water system from alternative sources (Foster, 1999; Estache et al, 2001). The main alternative is household self-provision through pumped wells, rainwater catchments, cesspools and septic tanks. Self-provision suffers from low quality and high cost (Abdala and Spiller, 1999). Similarly, the sale of drinkable water from private vendors is substantially more costly and therefore does not present serious competition either. Finally, the average asset lives of water system physical plant are very long and therefore impede any potential dynamic competition.

The water sector is also characterized by the presence of significant externalities. Most water-related diseases are contagious. This generates positive externalities in the provision of clean water across society. Similarly, the proper elimination of sanitation residuals and treated industrial waste prevents negative externalities through the pollution of natural bodies of water and other natural resources.

Another special feature of water supply is that, as human life depends on access to drinkable water, the demand for water is perfectly price inelastic at survival levels. Of course, demand exhibits some price elasticity at levels for which water is used for other non-survival household and productive uses.

[1] For example, fixed costs represent more than 80% of water service costs in the United Kingdom (Armstrong et al, 1994).

These features, natural monopoly, the presence of significant externalities, the pursuit of universal coverage, and the inelasticity of demand, have historically justified public intervention in the water sector. Most countries supply water services through the public sector, and private entry into water provision has been limited. However, there are growing calls to consider allowing a regulated private sector to deliver water services (World Bank, 2002).

Private supply has the advantage of providing strong incentives for cost reductions and other productivity enhancements. In contrast, these incentives are weak under public ownership, where typically agents cannot reap the results of their effort and innovation. In fact, empirical evidence from several sectors strongly suggests that service quality, productivity and profitability rise significantly following privatization (Megginson et al, 1994; Barberis et al, 1996; Frydman et al, 1999; La Porta and Lopez-de-Silanes, 1999).

Nonetheless, the weak efficiency incentives in public firms can represent a social advantage when cost reductions by private suppliers come at the expense of undesirable quality deterioration or reductions in access by the poor. In particular, unregulated private providers may undersupply the socially optimal quality of water in the presence of externalities because they fail to take into account the marginal social benefits in their decisions. Similarly, private owners may exclude low-income households from the network by raising prices, strictly enforcing payment, and concentrating their investments in high-income areas.

However, the fear of quality deterioration or access exclusion can only be genuine when quality is non-contractible (Shleifer, 1998). In the water industry, information asymmetries in service quality are relatively unimportant, and regulatory agencies can monitor water quality, pressure, repair delays, and shortages. Network expansions and universal provision can also be enforced through regulation.

The arguments in favor of private provision are even stronger when we consider non-benevolent governments. Politicians may use the control of state firms to channel benefits for themselves and their supporters (Shleifer and Vishny, 1994). Excess employment, corruption,

subsidies, and pork barreling are typical of SOEs around the world. As Shleifer (1998) explains it, state companies not only are unproductive because of the lack of incentives of their managers, but also because inefficiency results from the political use of SOE resources.

Finally, the process of resource allocation within the aggregated public sector does not guarantee the assignment of funds to the most profitable projects. The chronic under-investment in physical capital that plagues many SOEs is aggravated for debt-ridden governments with large fiscal deficits. Privatization can significantly improve the access of the firms to the capital markets and therefore their ability to invest.

2. THE ARGENTINE PRIVATIZATION PROGRAM

The privatization of public water systems in Argentina represented a small part of a massive program that transferred almost all SOEs to private hands during the 1990s. The privatization process was, in turn, a part of a larger program of structural reform intended to revert decades of economic decline.

In the late 1980s Argentina was experiencing growing inflation driven in large part by printing money to finance huge fiscal deficits. The deficit averaged approximately 9% of GDP during the decade (Heymann and Navajas, 1989). While federal and provincial overspending generated the lion's share of these deficits, a non-trivial portion was due to significant SOE losses. By the end of the decade the ruling Radical government was unable to balance the budget. Further deficit spending could not be financed through printing money or new debt issues. In 1989 the country entered a period of hyperinflation that lead the Radical government to resign six months before the official end of their administration.

The newly appointed Peronist government immediately launched an ambitious structural reform program designed to reduce the budget deficit, control inflation and put the country back on a positive growth path. The program consisted of financial and trade liberalization, a monetary currency board, the decentralization of health and education services, the reform and

privatization of the national pension system, the emancipation of the Central Bank, a general deregulation of economic activities, and the privatization of SOEs.

The privatizations were intended to reduce the budget deficit (Galiani and Petrecolla, 1996; Gerchunoff, 1992; Heymann and Kosacoff, 2000). The acquiring firms paid the government substantial sums for the privatized companies in the form of cash and Argentine external debt bonds. In addition to the revenues from privatization, the government no longer needed to cover SOE losses from the budget.

The privatization was also intended to reverse a long period of physical infrastructure neglect (Chisari et al, 1999). During the 1970s and 1980s there was little capital investment in most public utilities and indeed much of the physical infrastructure had seriously depreciated. After this long period of negative net investments, huge capital inflows were needed to improve both the quality and access to SOE services. While the public sector had no capacity to finance those capital investments, private firms generating positive cash-flows were able to obtain private financing. Indeed, the transfer of the SOEs to the private sector, mostly to large foreign companies, greatly improved the firms' investment and access to credit markets (Heymann and Kosacoff, 2000; Galiani et al, 2002). Most of the privatized firms sold equity and bonds in international capital markets.

Argentina implemented one of most ambitious privatization programs in the world. Table 1 summarizes the main federal privatizations, the income received from the sale of the companies, and the timing of privatization. The privatized SOEs were mainly large natural monopolies in sectors such as electricity, oil and natural gas, telecommunications, transportation, mail service and water systems.

The privatization program was enormous relative to the size of the economy. According to the official statistics (CEP, 1998; and Central Bank), 154 privatization contracts were signed during the 1990s. The privatization revenues collected by the federal government reached more than 19 Billion US dollars. This figure understates the true amount of revenues obtained from

privatization, as it does not include revenues from royalties received from SOEs that were privatized as concessions and revenues from the privatization of provincial and local SOEs. As a percentage of public resources, privatization revenues were particularly important during the initial years of 1991 and 1992, when they represented more than 1% of GDP and approximately 10% of public revenues (Heymann and Kosacoff, 2000).

The privatization of the water sector was but a very small portion of the overall privatization program. In fact, the water companies represented only a small fraction of the total SOE production (3.5 percent) and a tiny share of GDP (0.3 percent).

3. THE PRIVATIZATION OF WATER SERVICES

From 1870 through 1980, water services in Argentina were provided by the federal company Obras Sanitarias de la Nación (OSN) and a number of non-for-profit cooperatives. In 1980, OSN's jurisdiction was restricted to the federal district and 13 municipalities of the suburban Greater Buenos Aires area. While OSN remained under control of the federal government, the responsibility for public water services in the rest of the country was transferred to local governments (Artana et al., 2000). Thus, federal public, local public, and cooperative companies provided water services before privatization began. Most of the companies provided both water and sanitation; however, a few supplied only clean water. In those cases, there was no sewage service in the community.

Between 1991 and 1999, public water companies servicing about one-third of the country's municipalities and covering almost 60 percent of the country's population were transferred to private control. Table 2 shows the ownership status of the companies providing water to the municipalities at the end of the decade. Figure 1 depicts the percentage of municipalities and population served by private water companies by year. Notice that the rate of privatization of municipalities was slow in the first half of the decade, but accelerated in the second half.

Rather than selling the assets to the private firms, water services were transferred to the private sector through concessions.[2] In some cases, the privatized companies paid a canon to the government for the use of the public assets. For example, in the provinces of Cordoba and Corrientes, where a canon is paid on an annual basis, the royalty payments represented about 0.4% and 0.1% of the fiscal revenues in 1999, respectively. In other cases, such as OSN in Buenos Aires, the royalty was set at zero and firms competed for the concession by offering the lowest tariff. Thus, the revenue from the water service privatization royalties constituted at best a very small share of the public budget.

The largest privatization was the transfer of the federal company OSN to a private consortium, Aguas Argentinas. The analysis of this privatization, described in Abdala and Spiller (1999), Artana et al (2000), Shirley (2000), and Noll et al (2000), illustrates the changes experienced by water systems in Argentina after the transfer to private operation.

3.1 Privatization in Buenos Aires

In May 1993 Aguas Argentinas, a consortium lead by the French company Lyonnaise des Eaux, won a 35-year concession to provide water services previously provided by OSN. The terms of concession stipulated that 100% of households had to be connected to water service and 95% to sewerage service by the end of the 35-year period. It also established service quality and waste treatment standards. The canon was established at zero, and the consortium won the concession by offering the lowest tariff.

Water use fees in Buenos Aires were initially lowered by 26.9 percent as a result of the bid. However, thirteen months after privatization, the regulator authorized a 13.5 percent increase in the usage fee, and a significant increase in connection fees. The increase in the connection fee was controversial as it was very close to the monthly household earnings level for

[2] This is the most common method of privatizing water services worldwide (Noll et al, 2000).

the official poverty line. In response to protests, the connection fee was quickly lowered and replaced with a small fixed charge that was added to the water use bills for all clients. This explicit network expansion cross-subsidy allowed the firm to reduce the connection fees to about one tenth of the previous levels.

The enforcement of service payment was toughened after privatization in Buenos Aires. While delinquency was high for OSN, the private operator was allowed to cut service to customers with three unpaid bills (although it may be reconnected under the regulator's request). According to Artana et al (2000) and Water World Vision (2000), 90 percent of customers regularly pay the service fees, although only 60 percent do it on time.

Privatization drastically increased efficiency and profitability. Before privatization, OSN was overstaffed as indicated by the fact that employees' average age was above 50 years and absenteeism was high. During the first year under private management, the number of employees was reduced from 7365 to 3800. The employment reduction, together with the increase in coverage and production, expressed in the large productivity increase demonstrated in Figure 2. While labor productivity was low and flat prior to 1993, it went through the roof after privatization. In fact, soon after the privatization, the financial performance of Aguas Argentinas became outstanding. After a first year of negative returns, it reached high profitability rates (Artana et al, 2000).

A major question was whether these efficiency gains were translated into service quality improvements. OSN had invested very little in infrastructure during the decade prior to privatization (Galiani et al, 2002). Low revenues and inefficiencies led to such low investment levels that they were not even sufficient to replace depreciating assets and maintain current supply. In 1985 OSN investment was 67.8 percent of what was needed to maintain current supply, and only 19.5 percent in 1990. In the late 1980s, water coverage as a share of population was contracting, spilled water rates were very high, pressure and service quality were low, and summer shortages were frequent (Abdala, 1997; Artana et al, 2000).

Things improved dramatically after the privatization. The private company was able to invest a substantial amount in the physical infrastructure and in service quality. For the ten years before the privatization, OSN invested an average of 25 Million US dollars annually. From 1993 through 2000, Aguas Argentinas's investment jumped to around 200 Millions per year. Table 3 shows large increases in water and sewage production, reductions in spillage, and significant service enhancements. In addition, summer water shortages disappeared, repair delays shortened, and water pressure improved.

The investments also paid off in terms of increased access to the network. The number of connections to the water and sewage networks in Buenos Aires expanded by 30 percent and 20 percent, respectively, after privatization (Table 3). Figure 3 pictures the log of the number of households connected to the OSN-Aguas Argentinas water and sewage network by year from 1986 through 1999. While the number of households connected was relatively flat from 1986 to 1993, the network grew rapidly each year after privatization.

Moreover, the network expansion was concentrated in the poorer suburban areas of Greater Buenos Aires. Since 98% percent of households in the city of Buenos Aires were already connected to water services before privatization, most of the expansion in access necessarily had to be among lower income households in the suburban areas. Indeed, Table 4 shows that 84.6 percent of the new connections were to lower-middle and low-income households.

3.2. Access to Water Services

While the data for Buenos Aires show that the privatization improved service quality and expanded access to water services, we are unable to similarly assess the impact of privatization for the rest of the country. We are, however, able to say something about the effect of privatization on access to water services. Even though increased access may not be the only mechanism through which privatization can affect child mortality, it is likely to be among the more important causal channels. Indeed, acquiring water services for the first time seems to be a

bigger change relative to service improvements to households with existing water and sewage connections.

We evaluate the impact of privatization on access to water services using data from the 1991 Census and from a 1997 Encuesta de Desarrollo Social Survey (EDS). The EDS was a stratified random sample of about 40,000 households from urban municipalities with more than 5000 inhabitants and asked the questions about household connections to water and sewage services identical to those asked in the Census.

To identify the effect of privatization on access to water, we exploit the fact that by 1997 a number of municipalities had already privatized their water services (Figure 1). Using the data from municipalities in the EDS survey, we calculate the difference-in-differences estimate of the impact of privatization on the proportion of households who had access to the water network. The difference in difference estimator compares the change in the proportion of households connected to water services in municipalities that privatized to the change in the proportion connected in municipalities that did not privatize water services. A municipality is in the privatized group if the privatization of water services occurred between 1990 and 1996.

The results, reported in Table 5, show a significantly larger increase in the proportion of households connected to water services in the municipalities that privatized than in municipalities that did not.[3] The estimated impact is even higher when we exclude the capital city, where 98 percent of households were already connected to water service before privatization. Specifically, the results suggest that the number of households who were connected to the water network increased by 11.6 percent in the privatized areas.

This estimate, however, most likely substantially underestimates the impact of privatization on access. This is because the EDS grossly under-sampled poor areas and access

[3] We obtained very similar results when we consider the proportion of population rather than the proportion of households.

expanded most in poor areas where fewer households were connected at baseline.[4] Indeed, Table 4 showed that connections increased the most among the poor in Greater Buenos Aires. Artana et al (2000) reports that after privatization in Corrientes, one of the poorest provinces in the country, the number of connections to the water network in the province rose by 22 percent and the number of sewerage connections increased by 50 percent.

4. THE DETERMINANTS OF PRIVATIZATION

Between 1991 and 1999 about 30 percent of local water systems were privatized and the privatizations took place at different points in time. We propose to exploit this variability in firm ownership across time and space to identify the causal effect of privatization on child mortality. However, the identification of the causal effects is complicated by the possibility that privatization is a choice and may be correlated with other unobserved factors that also affect mortality. We will control for unobserved factors that are constant over time by using municipality fixed effects. However, privatization could also be correlated with municipality time varying shocks that also affect the health of the population. For example, economic shocks may affect both the privatization decision and child mortality. We investigate this issue by analyzing whether the decision to privatize across municipalities and time depends only on fixed characteristics and wide-ranging political variables, or whether it depends on shocks to socioeconomic variables that may also affect the mortality rates.

[4] Specifically, the government measures the poverty of a municipality using an index based on data from the 1991 Census. This index measures the percentage of households with Unmet Basic Needs (UBN) in the municipality. When we split the sample into 3 groups: non-poor municipalities where less than 25 percent of households have UBN, poor municipalities where between 25 and 50 percent have UBN, and extremely poor municipalities where more than 50 percent have UBN, we found that the EDS does not include any extremely poor municipalities and only includes a few semi-poor municipalities.

4.1. Methods

We estimate a discrete time hazard model of the probability of transiting from public to private water service provision in period t = 1…T (Prentice and Gloeckler 1978; Jenkins, 1995). All municipalities i = 1…N are in the public provision state at the beginning of the sample period, i.e. at t = 0. The instantaneous hazard rate function for municipality i at time t > 0 is assumed to take the proportional hazard form:

$$\lambda_{it} = \lambda_0(t)\exp(\mathbf{x}_{it}'\beta) \qquad (1)$$

where $\lambda_0(t)$ is the baseline hazard function, β is a vector of parameters to be estimated, and $\mathbf{x}_{it}$ is a vector of covariates corresponding to municipality i at period t. The associated continuous-time survivor function is given by:

$$S(t;\mathbf{X}_{it}) = \exp\left[-\sum_{t=1}^{T}\exp[\mathbf{x}_{it}'\beta+\gamma_t]\right], \quad \text{where } \gamma_t = \int_{t-1}^{t}\lambda_o(\tau)\,d\tau \qquad (2)$$

where $\mathbf{X_{it}}$ is a matrix that represents the path of the covariate vector x_{it} between times 0 and t. This stochastic process allows for duration dependence, i.e. the probability of transition varies with the time spent in the origin state.

However, the underlying continuous durations are only observed in disjoint time intervals of unit length. Assume that any time-dependent covariates only vary between duration intervals but not within them (i.e. they follow a piece-wise constant path over time). Then, the probability that water supply is privatized in any period for municipality i is:

$$\Pr(T \in [t-1,t)) = S(t-1,\mathbf{X}_{it\text{-}1}) - S(t,\mathbf{X}_{it\text{-}1}) \qquad (3)$$

and the survivor function at the start of period t-1 is given by:

$$\Pr(T > t-1) = S(t-1,\mathbf{X}_{it\text{-}1}) \qquad (4)$$

Municipalities are recorded as either having private or public provision of water. The former group, contributing completed spell data, are identified using the censoring indicator c_i =

1. For the latter group, contributing right-censored spell data, $c_i = 0$. Then, the sample log-likelihood can be written as follows:

$$\log L(\beta) = \sum_{i=1}^{N} \{c_i \log[S(t_i - 1; \mathbf{X}_{it_i - 1}) - S(t_i; \mathbf{X}_{it_i})] - (1 - c_i) \log S(t_i; \mathbf{X}_{it_i})\} \quad (5)$$

4.2 Results

Recall that our purpose in this exercise is to test whether the likelihood of privatization in a municipality is related to time-varying factors that may also affect mortality rates. We model the probability that the water system in a given municipality and period of time is privatized as a function of a set of municipality time-invariant and time-varying covariates. The descriptive statistics for these variables are reported in the first column of table 6. The time-invariant covariates include the mean income, mean income inequality, mean unemployment and mean child mortality during the period of analysis, and a set of municipality characteristics from the 1991 Census.

The time-varying variables are divided into political variables indicating whether the privatization decision was taken by the federal government or by a provincial government of a particular political affiliation, and one-year lagged shocks to the observable socioeconomic variables (income, inequality, and unemployment) and to the child mortality rates. We use lagged shocks for two reasons. First, the privatization itself may have affected these time-varying variables (income, inequality, unemployment, and mortality rates), and, second, the long length of time required by privatization processes suggests that the privatization decisions could not have been a response to contemporaneous shocks.

We estimate the model with two different samples. The models reported in columns (2) and (3) of table 6 exclude municipalities where cooperatives managed the water systems since none of them were ever privatized. Nevertheless, these municipalities still could be good measures of the counterfactual evolution of child mortality for the municipalities that eventually

privatized. Therefore, in Columns (4) and (5) we report results for models that also include cooperative municipalities.

There are a number of important results. First, there are no important differences across the models reported in Table 6. Second, the likelihood of privatization is higher when the federal government administers the public company and lower when the Radical party governs the province relative to the Peronist or provincial (the baseline case) parties. This is consistent with the fact that the federal government launched the privatization wave of all SOEs, when the Peronists were the party in power and the radicals were loyal opposition. Third, the fixed baseline municipality characteristics are individually and jointly significantly different from zero, and explain a good portion of the decision to privatize. Fourth, we used a fifth order polynomial to control for duration dependence, which shows that the likelihood of privatization increased over time. This is consistent with the sequencing of the overall privatization program where the transfer of water systems to private operation occurred later in the decade. Finally, neither of the socioeconomic time-varying shocks nor the shocks to mortality rates are statistically significant. Thus, the probability that the water system is privatized in a given municipality and period of time does not depend on shocks to socioeconomic variables that may also affect mortality rates or shocks in mortality rates themselves.

5. THE EFFECT OF PRIVATIZATION ON CHILD MORTALITY

In this section, we estimate the impact of the privatization of water services on the mortality of children under five. We focus on young children because they are particularly vulnerable to water-related diseases due to weak body defenses, higher susceptibility, and greater exposure from inadequate knowledge of how to avoid risks; and because these water related diseases can easily be prevented through access to clean drinking water, better hygiene and better sanitation (WHO, 2000).

Based on our earlier discussion, there are a number of potential pathways by which the privatization of water systems might have affected child mortality. First is that the privatization fostered the network expansion providing access to service to households that were not previously connected to water and sewage. Most of these new customers were in the lower-middle and low-income groups at higher risk of mortality than the middle and upper income groups. Second is the improvement in service quality in terms of reduced water and sewage spillage, faster repair rates, fewer shortages, and better water pressure and sewage treatment. All of these quality enhancements improve the epidemiological environment (WHO, 2002b). Finally, prices may have changed and the enforcement of service payment cutoffs may have tightened, potentially reducing the access to service by low-income population. In this section, we evaluate empirically the impact of the privatization of the provision of water and sanitation services on child mortality.

5.1. Mortality

The Ministry of Health compiles mortality data from vital statistic registries. The data are aggregated to the municipality level on an annual basis for 20 pathology groups. Of the 20 pathology groups, the main category of death-causes that should be affected by water and sanitation provision is "Infectious and Parasitic Diseases". However, deaths resulting from water-related causes can also be registered under "Perinatal Diseases", which is not actually a pathology but an indication that the death occurred during the first 28 days of life regardless of its cause.

We divide the number of deaths by the number of children of that age to obtain Mortality Rates, the dependent variable of our analysis. Our database includes the 165,542 child deaths occurred from 1990 through 1999.[5] Child mortality rates have been falling in Argentina over

[5] We exclude from the analysis 5,042 child deaths for which the municipality is unspecified. The mortality data is not available at the municipality level before 1990.

time (as well as in the rest of Latin America and throughout the world). Mortality rates, measured as hazard rates, have fallen from 72 over 1,000 live births in 1960 to 22 in 1999.[6]

Our main result is evident in Figure 4, which depicts the evolution of the mortality rates for privatized and non-privatized water companies. Until 1995, the mortality rates of the municipalities that privatized their water systems decreased at the same rate as the mortality rates of the municipalities that did not privatize. However, after 1995 the mortality rates of the municipalities that privatized decreased faster than the mortality rates of those that did not privatize. This timing is commensurate with the timing of privatization. Before 1995 only a few municipalities had privatized; the bulk of privatizations occurred after 1995.

The fact that the trends in mortality rates in both groups of municipalities were the same previous to 1995 is also important. This behavior in the mortality rates in treatment and control groups in the "pre-treatment" period validates our difference-in-differences identification strategy (Heckman and Hotz, 1989).

5.2. Methods

Our objective is to identify the average effect of privatization on child mortality rates in the municipalities where the water supply system has been privatized (i.e. the average impact of treatment on the treated). To cast the discussion in formal terms, we write potential outcomes, the child mortality rates y_1 and y_0, as a function of observable variables $\mathbf{x}$ and unobservable variables u_1 and u_0:

$$y_{1t} = g_1(\mathbf{x}) + u_{1t} \qquad \text{and} \qquad y_{0t} = g_0(\mathbf{x}) + u_{0t} \tag{6}$$

[6] We define our dependent variable as the ratio of the number of deaths of children below 5 years of age to the total number of children of that age. Alternatively, international health organizations typically report child mortality rates for children below 5 as the number of deaths of children below 5 years of age divided by live births of that year. Thus, they report a proxy of a hazard rate, the probability that a child born alive dies before the age of 5. Instead, we consider the probability that one child born alive (of age below 5) dies during that year. Our results in this section do not change when we redefine our variable as a hazard rate. In that case, the estimated coefficients are equal to five times ours.

where y_{1t} is the mortality rate in a given municipality in period t if the water system had been privatized, and y_{0t} is the mortality rate in that municipality in the same period if it had not been privatized.

Formally, we estimate the influence of privatization on child mortality for a group of municipalities i = 1…N observed over the sample horizon t = 1…T. Let dI_{it} be a zero-one indicator that equals unity if municipality i's water system was private during period t. Further, let D be a zero-one indicator that equals unity if the water system is privatized at any $t \in T$, and equals zero otherwise. Then, assuming that g_1 and g_0 are nonstochastic functions, the parameter we are interested in is given by:

$$\varphi = E(y_{1t} - y_{0t} \mid \mathbf{x}, D = 1) = E(\Delta \mid \mathbf{x}, D = 1) = g_1(\mathbf{x}) - g_0(\mathbf{x}) + E(u_{1t} - u_{0t} \mid \mathbf{x}, D = 1) \quad (7)$$

The parameter φ may be time varying, and in that case, our parameter of interest may be defined by applying the expectations operator over time as well as over possible realizations of $u_1 - u_0$. Let t' be any pretreatment period and k > t' be the treatment period. Then, it is worth noting that (7) can be written as

$$E(\Delta \mid \mathbf{x}, D = 1) = E((y_{1t} - y_{0t'}) - (y_{0t} - y_{0t'}) \mid \mathbf{x}, D = 1) \text{ for any } t \geq k. \quad (7')$$

However, $E(y_{0t} \mid \mathbf{x}, D = 1)$ is not observed and must be estimated using data gathered from municipalities where privatization has not been adopted. A major concern, though, is that municipalities that chose to privatize could be different from the municipalities that chose not to privatize, and that these differences may be correlated with mortality. For example, wealthier more urban areas where mortality rates were decreasing faster may have been the ones to privatize. In this case, the correlation between privatization and mortality would be confounded with the wealth effect. in principle, the types of unobservables that may confound identification are those that are fixed characteristics over time and those that are time varying municipality idiosyncratic shocks. However, the analysis in section 6 provided evidence consistent with the

notion that privatization is driven by fixed characteristics and not by the time varying idiosyncratic shocks.

A common method of controlling for time invariant unobserved heterogeneity is to use panel data and estimate difference in differences models. The general difference-in-differences estimator is given by:

$$\hat{\varphi} = \mathrm{E}(\mathrm{y}_{1\mathrm{t}} - \mathrm{y}_{1,\mathrm{t}'} \mid \mathbf{x}, \mathrm{D} = 1) - \mathrm{E}(\mathrm{y}_{0\mathrm{t}} - \mathrm{y}_{0,\mathrm{t}'} \mid \mathbf{x}, \mathrm{D} = 0) \tag{8}$$

This general difference-in-differences model reduces to the following two-way fixed effect model if the expected conditional mortality rates only differ by a constant α:[7]

$$\mathrm{y}_{\mathrm{it}} = \alpha\, \mathrm{dI}_{\mathrm{it}} + \boldsymbol{\beta}\, \boldsymbol{x}_{\mathrm{it}} + \lambda_{\mathrm{t}} + \mu_{\mathrm{i}} + \varepsilon_{\mathrm{it}} \tag{9}$$

where $\boldsymbol{x}_{\mathrm{it}}$ is the vector of the subset of control variables in the vector $\mathbf{x}$ that vary both across units and time, μ_i is a time-invariant effect unique to municipality i, λ_t is a time effect common to all municipalities in period t, and ε_{it} is a municipality time-varying error distributed independently across municipalities and time and independently of all μ_i and λ_t (see Chamberlain, 1984; and Heckman and Robb, 1985).

The difference in difference estimator in (9) is the most widely used estimator in the evaluation literature (see, among others, Angrist, 1995; and Heckman et al., 2000). The model assumes that the impact of privatization on child mortality rates is homogenous across municipalities. However, when the impact of treatment on the treated is not homogenous across municipalities, difference in difference estimates may suffer from two sources of bias (Heckman et al., 1997, and Heckman et al., 1998a). The first of these biases may arise because for some municipalities where privatization has taken place there are no comparable municipalities for

[7] That is, the case in which $g_1(\mathbf{x}) = \alpha + g_0(\mathbf{x})$ and $u_{1t} = u_{0t}$, and therefore $E(\Delta| \mathbf{x}, D = 1) = \alpha$.

which privatization did not occur and vice versa. The second bias may arise from different distributions of **x** within the two groups of municipalities.[8]

Matching methods eliminate these two potential sources of bias by pairing privatized municipalities (treatments) with non-privatized municipalities (controls) that have similar observed attributes. Using observations in the treatment and control groups over the region of common support in the distribution of **x** eliminates the first source of concern, while the bias due to different distribution of **x** between treated and untreated municipalities within this common support is eliminated by reweighting the control group observations.

In general, conventional matching methods assume that, conditional on the observed variables **x**, the counterfactual outcome distribution of the treated units is the same as the observed outcome distribution of the units in the control group. This assumes that there is no selection into treatment on the basis of unobservables. To avoid the necessity of this assumption, we follow Heckman et al (1998b) who propose a generalized difference in differences matching estimator that extends conventional matching methods to longitudinal data. By conditioning on fixed-effects, the generalized difference-in-differences estimator identifies the parameter of interest without ruling out selection into treatment on the basis of time-invariant unobservables.

The objective, then, is to construct a control group by finding controls that have similar observed **x**'s as the treatments. Rosenbaum and Rubin (1983) show that to match treated and untreated units on the basis of **x** is equivalent to match them using a balancing score B(**x**). The coarsest balancing score is the propensity score which gives the conditional probability of receiving treatment given the pre-treatment values of the vector **x,** i.e. P(**x**) = Pr(D = 1 | **x**). Then, the method of matching assumes that conditional on P(**x**), the counterfactual outcome distribution of the treated units is the same as the observed outcome distribution of the controls. This result is

[8] Heckman et al. (1997) suggests that, in practice, the first of these two sources of bias is likely to be the most severe.

very important in practice since it reduces the potential problem of matching on a high dimensional **x** to matching on a scalar.

We estimate propensity scores from a logit model of the probability that a municipal water system that was public in 1990 was privatized sometime before the year 2000 as a function of the pre-intervention characteristics used in Column 3 of Table 6. These models are then used to predict the propensity (probability) that a municipality will privatize.

We identify control and treatment observations on a common support as follows. We exclude all control observations whose propensity score are less than the propensity score of the treatment municipality at the first percentile of the treatment propensity score distribution, and exclude all treatment observations whose propensity score is greater than the propensity score of the control observation at the 99th percentile of the control distribution. Our second set of estimates is obtained as difference-in-differences on the observations that lie on this common support.

We use a kernel density weighting procedure to obtain the generalized difference-in-differences matching estimators (see Heckman et al., 1997). Let $A_c = \{1,\ldots,N_c\}$ be the set of untreated municipalities whose propensity scores are over the region of common support in the distribution of $P(\mathbf{x})$ and let $A_T = \{1,\ldots,N_T\}$ be the set of treated municipalities whose propensity scores also lie in that region**.** The counterfactual outcome for any treated municipality i using the kernel matching estimator is given by a weighted average of the entire comparison sample $A_c = \{1,\ldots,N_c\}$, where the weight of each control municipality in A_c is given by:

$$\varpi(i,s)=\frac{K(P(\mathbf{x})_i - P(\mathbf{x})_s)}{\sum_{s=1}^{N_c} K(P(\mathbf{x})_i - P(\mathbf{x})_s)}, \quad s = 1..., N_c$$

where K(.) is a kernel function given by the standard normal density function.

The generalized difference in differences matching estimator then uses the simple matching estimator idea. For any $t \geq k$, the before-after change in child mortality is given by:

$$y_{1,i,t} - \sum_{j=1}^{k-1} W(i,j)\, y_{0,i,j} \quad (10)$$

where $\sum_{j=1}^{k-1} W(i,j) = 1$. We adopt the simplest case where W(.) is constant. For each treated municipality i in A_T and for each period $t \geq k$, we then form the difference-in-difference Δ_{it} in the child mortality rates with the comparison group i':

$$\Delta_{it} = \left[y_{1,i,t} - \sum_{j=1}^{k-1} W(i,j) y_{0,i,j} \right] - \left[y_{0,i',t} - \sum_{j=1}^{k-1} W(i',j) y_{0,i',j} \right] \quad (11)$$

where $y_{0,i'}$ is the counterfactual outcome given the kernel matching weighting procedure, and where W(i,j) = W(i',j) for all i, i' and j. This transforms the comparison group to be conformable with the treatment group. Finally, we estimate the average treatment effect as the sample average of Δ_{it} over all treated localities i and estimate the standard errors by bootstrap.

5.3. Main Results

We present the estimated impacts of the privatization of water services on child mortality from all causes of death in table 7. The first column reports the mean municipality mortality rate at the beginning of the decade. Each cell in the remaining four columns reports the estimated impact from a separate model. The estimates in columns (2) and (3) are from the simple difference in difference models as specified in (9) without and with controls, respectively. The estimates in column (4) are from difference in differences models with controls using the control and treatment observations that lie on the common support (i.e. overlapping propensity scores). Finally, the estimated reported in column (5) are from the generalized difference in difference model using kernel weighted matching as specific in equation (11).

The results, regardless of method, show a statistically significant negative association between privatization and child mortality. The estimated impact varies from 4.8% to 6.7% of baseline mortality. There are some differences by methods. The addition of time-varying

controls in column (3) does not change either point estimate or precision of the estimate from the simple difference in difference estimate in column (1). However, conditioning on control and treatment observations that have common support, column (4), increases the point estimate by over one-third and improves the precision. This is consistent with the results in Heckman et al, (1998a) where they evaluated matching estimates results from a controlled randomized experiment. Finally, the generalized difference in difference point estimate with kernel matches in column (5) is about 10 percent higher and more precisely estimated than the simple difference in difference estimate. Overall, the results are consistent and very similar across methods.

5.4 Results by Cause of Death

One concern with the analysis so far is that there may have been some other unobserved changes in the municipalities that privatized at the time of privatization that are correlated with mortality in general. For example, there may have been enhancements in the health care system or increases in public welfare programs possibly driven by an improved local budgetary position from the privatization of water services. It is also possible that mortality rates had been, in general, decreasing faster in the treated municipalities than in the untreated municipalities, or that there were different migratory trends among treated and untreated municipalities correlated with water privatizations.

In order to rule out unobserved changes correlated with privatization, we examine the impact of privatization on mortality by cause of death. The mortality data is disaggregated for 20 specific pathology groups. The privatization of water provision on child mortality should mainly operate by affecting deaths from Infectious and Parasitic Diseases. However, recall that the Perinatal Disease category indicates that the death occurred during the first 28 days of life, regardless of the cause of death. Thus, even if the death occurred from an infectious or parasitic disease in the first 28 of life it is assigned to Perinatal Diseases and not to the Infectious and Parasitic Diseases category. Therefore, if the observed reduction in child mortality is operating

through improved access and quality of water, then we should see significant negative effects on deaths in the Perinatal Diseases and Infectious and Parasitic Diseases categories, and negligible effects on deaths from other causes such as accidents, cardiovascular diseases, and cancer.

We estimate the difference in difference models using municipalities with common support for mortality rates for each cause of death.[9] The results are reported in Table 8. As predicted, we find a statistically significant effect on mortality from infectious and parasitic diseases (and perinatal diseases), but no statistically significant effect on mortality from any other cause.

The importance of this result cannot be overemphasized. It rules out the presence of almost any other plausible explanation of our main results and leads us to believe in their causal interpretation. For example, it rules out the possibility that mortality rates had been, in general, decreasing faster in the treated municipalities than in the untreated municipalities. It also rules out the possibility that there were different migratory trends among treated and untreated municipalities correlated with water privatization. Finally, it rules out the concern that the decrease in mortality rates had been induced by the use of revenues generated from the privatization to finance welfare programs or to increase health expenditures.

5.5. Impact By Socioeconomic Status

If the privatization of water systems increased access and improved service, privatization should show a higher impact on child mortality in poor municipalities than in wealthier ones. Middle and high-income groups already had a high rate of connection to the water network prior to privatization. Even when they were not connected or when service quality was unsatisfactory, these income groups enjoyed better access to substitutes such as pumped wells, septic tanks, or

[9] As we are analyzing child mortality, we exclude from this exercise the analysis of deaths from suicides; homicides; other violent deaths; and pregnancy, labor, delivery and puerperial diseases. We also exclude the residual category of undefined causes.

bottled water than poor sectors. The main beneficiaries of network expansions and service enhancements, therefore, were low-income households that, at the same time, are the groups more sensitive to child mortality.

In Table 9 we report the result of estimating the impact of water privatization on child mortality at three different ranges of poverty at the municipality level. To estimate these heterogeneous impacts of privatization on child mortality, we interact the treatment dummy variable with a poverty indicator function from the 1991 Census. We construct three ranges of poverty: municipalities with a percent of households suffering from Unmet Basic Needs (UBN) lower to 25%, municipalities with UBN between 25 and 50%, and municipalities with UBN higher than 50%.

We find that the privatization of water systems does not affect those localities with low levels of poverty (UBN lower than 25%). The effect on the remaining treated municipalities is increasing in the level of poverty and highly significant. In fact, the privatization of water systems is associated with a 24 percent reduction in child mortality in municipalities with high levels of poverty (UBN greater than 50%). This result is coincident with the predictions of our causal model. The effect of privatization on child mortality should be stronger for the groups that are more vulnerable to water related diseases.

6. CONCLUSIONS

During the 1990s Argentina launched a massive privatization program as part of a large plan of structural reforms. The program included the privatization of several local water companies providing service to approximately 30 percent of the municipalities of the country. Available information from a number of case studies demonstrates that the newly privatized water firms were more efficient, invested more in physical infrastructure, and provided better service quality than their previous public incarnations. Indeed, our evidence on access to service shows that the network connections increased significantly in the areas that privatized. We hypothesized that

increased access to the water and sanitation network, and potential changes in service quality and costs paid by customers may have affected health outcomes among young children, the age group that is more fragile to water and sanitation conditions.

The results from our adoption models show that the main determinants of the decision to privatize water services were location specific fixed factors and political variables, rather than time varying factors that could be correlated with mortality changes. This validates our use of the exogenous variation across time and space in the ownership of the water companies to evaluate the causal impact of privatization on health outcomes. Using a combination of methods, we find that child mortality fell by approximately 5 to 7 percent or about 375 lives per year in the areas where water systems were privatized. This drop in child mortality emerges from a reduction in the number of deaths caused by infectious and parasitic disease, and not from deaths due to causes unrelated to water conditions.

The previous literature that analyzes the effect of privatization compares the relative performance of private versus public firms on several company indicators. Although these studies show that privatization raises firms' productivity and profitability, the evidence is insufficient to address the ultimate question of whether social welfare increases with privatizations. Evaluations of welfare effects that rely on rough estimates of consumer and producer surpluses are also insufficient. Instead, we analyzed the effect of transfers to private operation on a direct, tangible welfare indicator: the impact of water system privatization on child mortality. The evidence suggests that the deterioration in performance of water systems in Argentina under public management was so large that allowed for a privatization that generated private profits, attracted investments, expanded service, and reduced child mortality.

Our results also shed light on two important policy debates. One concern, that has postponed privatization of water systems around the world, is the fear that private operators would fail to take into account the significant health externalities that are present in this industry, and therefore under-invest and supply suboptimal service quality. Contrary to this concern, we

find that the effect of privatization on health outcomes has been positive. Private operators have accomplished the network expansion and quality requirements specified in the privatization contracts or, at least, their level of attainment has been superior to the performance under public management. While the private sector maybe providing suboptimal services, they are doing a much better job than either the public sector or the non-profit cooperative sector.

Second, there is a growing public perception that privatization hurts the poor. This perception is driven by the belief that privatized companies raise prices, enforce service payment, and invest only in lucrative high-income areas. Instead, we find that the poorest population experienced the largest gains from privatization in terms of reduction in child mortality. Privatization appears to have had a progressive effect reducing health inequality.

Data appendix: Definitions and Sources

Variable	Definition	Source
Child Deaths$_{it}$	Number of deaths of children below 5 years of age for municipality *i* in year *t* (split by cause of death when necessary).	Ministerio de Salud de la República Argentina
Child Population$_{it}$	Number of children below 5 years of age for municipality *i* in year *t*, obtained by extrapolating the number of children of that age from the 1991 Census using INDEC estimates of the evolution of the total population at the municipality level for 1990-2000.	INDEC, Censo Nacional de Población y Vivienda 1991. INDEC, Proyecciones de Población por Localidad 1990-2000.
Child Mortality Rate$_{it}$	= *Child Deaths*$_{it}$ / *Child Population*$_{it}$ (split by cause of death when necessary).	
Private$_{it}$	Dummy variable that equals 1 if the largest fraction of the population in municipality *i* in year *t* that has water provision is supplied by a private company, and 0 otherwise.	SPIDES (Sistema Permanente de Información de Saneamiento), ENOHSA (Ente Nacional de Obras Hídricas de Saneamiento), www.enohsa.gov.ar
Unemployment$_{it}$	Unemployment rate (May and October average) in period *t* in the surveyed cities of the province in which municipality *i* is located (population weighted average if data is available for more than one city in the province). Not available for the 12 municipalities of the province of Río Negro as none of its cities are surveyed. Not available for 15 municipalities of the province of Chubut for 1990 as none of its cities were surveyed.	Permanent Household Survey (EPH), INDEC
Income$_{it}$	Per capita household income (May and October average in constant 1995 pesos) in period *t* for households with positive income in the surveyed cities of the province in which municipality *i* is located (population weighted average if data is available for more than one city in the province). Not available for the 12 municipalities of the province of Río Negro as none of its cities are surveyed. Not available for 15 municipalities of the province of Chubut for 1990 as none of its cities were surveyed.	See *Unemployment*
Inequality$_{it}$	Ratio of top 10% to bottom 10% per capita household income (May and October average) in period *t* for households with positive income in the surveyed cities of the province in which municipality *i* is located (population weighted average if data is available for more than one city in the province). Not available for the 12 municipalities of the province of Río Negro as none of its cities are surveyed. Not available for 15 municipalities of the province of Chubut for 1990 as none of its cities were surveyed.	See *Unemployment*
Population$_{i}$	Total population for municipality *i* in 1991 Census recoded in a set of dummy variables into the	INDEC, Censo Nacional de Población y Vivienda 1991.

	following categories: below 5000, 5000 to 25000, 25000 to 50000, 50000 to 100000, 100000 to 250000, and above 250000.	
$Overcrowding_i$	Fraction of households with an average of more than three people per room for municipality *i* in 1991 Census.	See *Population*.
$NFEvac_i$	Fraction of households with no faecal evacuation system for municipality *i* in 1991 Census.	See *Population*.
$BadHouse_i$	Fraction of households living in precarious houses and with at least one child in school age not attending school for municipality *i* in 1991 Census.	See *Population*.
$Below\ Subsistence_i$	Fraction of households with 4 or more members per working member and low household-head education for municipality *i* in 1991 Census.	See *Population*.
UBN_i	Fraction of households with Unmet Basic Needs (Overcrowding, NFEvac, Bad House, and Below Subsistence simultaneously) for municipality *i* in 1991 Census.	See *Population*.
$Population\ Age_i$	Mean age of the household head for municipality *i* in 1991 Census recoded in a set of dummy variables into the following categories: below 45, between 45 and 52, and above 52.	See *Population*.
$No\ Sewage_i$	Dummy variable that equals 1 if sewage was not provided in municipality *i* in 1991 Census, and 0 otherwise.	See *Population.*
$Unemployment\ 1991_i$	Unemployment rate for municipality *i* in 1991 Census.	See *Population*.
$>High\ School_i$	Fraction of households where the educational level of the household head is above high school for municipality *i* in 1991 Census.	See *Population*.
$Federal_{it}$	Dummy variable that equals 1 if the company providing water services in municipality *i* in period *t* belongs to the federal government, and 0 otherwise.	ENOHSA
$Peronist_{it}$	Dummy variable that equals 1 if the Peronist party governs province *i* in period *t*, and 0 otherwise.	Jones et al (2000)
UCR_{it}	Dummy variable that equals 1 if the Union Civica Radical party governs province *i* in period *t*, and 0 otherwise.	See *Peronist*.

References

Abdala, M. (1997): "Welfare Effects of Buenos Aires' Water and Sewerage Service Privatization", Anales de la XXXII Reunion Anual de la Asociación Argentina de Economia Política, www.aaep.org.ar.

Abdala, M. and P. Spiller (1999): "Agua y Saneamiento", in Instituciones, contractos y regulación en Argentina, TEMAS.

Angrist, J. (1995): "Introduction to the JBES Symposium on Program and Policy Evaluation", *Journal of Business and Economic Statistics* 13, pp. 249-88.

Armstrong, M., S. Cowan, and J. Vickers (1994): Regulatory Reform: Economic Analysis and British Experience, Cambridge, MIT Press.

Artana, D., F. Navajas and S. Urbiztondo (2000): "Governance and Regulation in Argentina", in Spilled Water, Savedoff, W. and P. Spiller, (eds.), IDB Press.

Barberis N., M. Boycko, A. Shleifer and N. Tsukanova (1996): "How Does Privatization Work? Evidence from the Russian Shops", *Journal of Political Economy* 104 (4), pp. 764-90.

Behrman, J. and B. Wolfe (1987): "How Does Mother's Schooling Affect Family Health, Nutrition, Medical Care Usage and Household Sanitation?", *Journal of Econometrics* 36, pp. 185-204.

Cebu Team (1991): "Underlying and Proximate Determinants of Child Health: The Cebu Longitudinal Health and Nutrition Survey", *American Journal of Epidemiology* 33 (2), pp. 185-201.

CEP (1998): "Privatizaciones: Un Balance Cuantitativo", Buenos Aires, Ministerio de Economía, www.mecon.gov.ar/index/cep/notas/notas8/nota3.htm.

Chamberlain, G. (1984): "Panel Data", in Griliches, Z. and M. Intriligator (eds.), Handbook of Econometrics, Volume 2, North-Holland.

Chisari, O., A. Estache, and C. Romero (1999): "Winners and Losers from the Privatization and Regulation of Utilities: Lessons from a General Equilibrium Model of Argentina", *World Bank Economic Review*, 13 (2), pp. 357-78.

Esrey, S. A., J. B. Potash, L. Roberts, et al (1991): "Effects of Improved Water Supply and Sanitation on Ascariasis, Diarrhea, Dracunculiasis, Hookworm Infection, Schistosomiasis and Trachoma", *Bulletin of the World Health Organization*, 69(5), 609-21.

Estache, A. , A. Gomez-Lobo, and D. Leipziger (2001): "Utilities Privatization and the Poor: Lessons and Evidence from Latin America", *World Development*, 29(7), pp 1179-98.

Foster, V. (1999): "Literature Review for Regional Studies Project on Privatization and Infraestructure Services of the Urban Poor", mimeo, World Bank.

Frydman, R., C. Gray, M. Hessel, and A. Rapaczynsku (1999): "When Does Privatization Work? The Impact of Private Ownership on Corporate Performance in the Transition Economies", *Quarterly Journal of Economics* 114 (4), pp. 1153-91.

Galiani, S. and D. Petrecolla (1996): "The Changing Role of the Public Sector: An Ex-post View of the Privatization Process in Argentina", *Quarterly Review of Economics and Finance* 36 (2), pp. 131-52.

Galiani, S., P. Gertler, E. Schargrodsky and F. Sturzenegger (2002): "The Benefits and Costs of Privatization in Argentina: A Microeconomic Analysis", *Forthcoming* in The Benefits and Costs of Privatizations, Chong, A. and F. Lopez-de-Silanes (eds.).

Gerchunoff, P., editor (1992): Las privatizaciones en Argentina - Primera etapa, Instituto Torcuato Di Tella, Buenos Aires

Heckman, J., and V. J. Hotz (1989): "Choosing among Alternative Non-experimental Methods for Estimating the Impact of Social Programs: The Case of Manpower Training", *Journal of the American Statistical Association* 84 (408), pp. 862-74.

Heckman, J., H. Ichimura and P. Todd (1997): "Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Program", *Review of Economic Studies* 64 (4), pp. 605-54.

Heckman, J. H. Ichimura, J. Smith and P. Todd (1998a): "Characterizing Selection Bias using Experimental Data", *Econometrica* 66 (5), pp. 1017-98.

Heckman, J., H. Ichimura and P. Todd (1998b): "Matching as an Econometric Evaluation Estimator", *Review of Economic Studies* 65 (2), pp. 261-94.

Heckman, J., R. LaLonde and J. Smith (2000): "The Economics and Econometrics of Active Labor Market Programs", in The Handbook of Labor Economics, Volume 3A, Ashenfelter, O. and D. Card (eds.), North-Holland.

Heckman, J. and R. Robb Jr. (1985): "Alternative Methods for Evaluating the Impact of Interventions: An Overview", *Journal of Econometrics* 30 (1-2), pp. 239-67.

Heymann, D and B. Kosacoff (2000): La Argentina de los Noventa. Desempeño Económico en un Entorno de Reformas, EUDEBA, Buenos Aires.

Heymann, D. and F. Navajas (1989): "Conflicto Distributivo y Déficit Fiscal. Notas sobre la Experiencia Argentina, 1970-1987", *Desarrollo Económico* 29 (115), pp. 309-29.

IADB (2002): "The Future of Reforms", Latin American Economic Policies vol. 17.

Jenkins, S. (1995): "Easy Estimation Methods for Discrete-time Duration Models", *Oxford Bulletin of Economics and Statistics* 57 (1), pp. 129-138.

Jones, M., P. Sanguinetti and M. Tommasi (2000): "Voters as Fiscal Liberals", mimeo, Centro de Estudios para el Desarrollo Institucional (CEDI).

La Porta, R. and F. Lopez-De-Silanes (1999): "The Benefits of Privatization: Evidence from Mexico", *Quarterly Journal of Economics* 114(4), pp. 1193-1242.

Lavy, V., J. Strauss, D. Thomas, and P. de Vreyer (1996): "Quality of Health Care, Survival and Health outcomes in Ghana", *Journal of Health Economics* 15, pp. 333-57.

Lee, L., M. R. Rosenzweig, and M. M. Pitt (1997): "The Effects of Improved Nutrition, Sanitation, and Water Quality on Child Health in High-Mortality Populations", *Journal of Econometrics* 77, pp. 209-35.

Megginson, W. L., R. C. Nash, and M. van Randenborgh (1994): "The Financial and Operating Performance of Newly Privatized Firms: An Interpretational Empirical Analysis", *Journal of Finance* 49 (2), pp. 403-52.

Merrick, T. W. (1985): "The Effect of Piped Water on Early Childhood Mortality in Urban Brazil, 1970 to 1976", *Demography* 22 (1), pp. 1-24.

Ministerio de Economía (2000): "El Proceso de Privatizaciones en la Argentina desde una Perspectiva del Balance de Pagos", Buenos Aires, Ministerio de Economía.

Ministerio de Salud (1999): "Programa Nacional de Estadísticas de Salud, Defunciones de Menores de 5 Años, Argentina 1997".

Noll R., M. Shirley and S. Cowan (2000): "Reforming Urban Waster Systems in Developing Countries" in A. Krueger (ed.) Economic Policy Reform: The Second Stage, Chicago: University of Chicago Press.

Prentice, R. and L. Gloeckler (1978): "Regression Analysis of Grouped Survival Data with Application to Breast Cancer Data", *Biometrics* 34, pp. 57-67.

Rosenbaum, P. and D. Rubin (1983): "The Central Role of the Propensity Score in Observational Studies for Causal Effects", *Biometrika* 70, pp. 41-55.

Shirley, M. (2000): "Reforming Urban Water Systems: A Tale of Four Cities" in L. Manzetti (ed.) Regulatory Policy in Latin America: Post Privatization Realities, North-South Center Press.

Shleifer, A., and R. Vishny (1994): "Politicians and Firms", *Quarterly Journal of Economics* 109 (4), pp. 995-1025.

Shleifer, A. (1998): "State versus Private Ownership", *Journal of Economics Perspectives* 12 (4), pp. 133-50.

Spiller, P. and W. Savedoff (2000): Spilled Water (eds.), IDB Press.

UNICEF (2001): Estado Mundial de la Infancia.

Water World Vision (2000): "Informe Nacional sobre la Gestión del Agua en Argentina", mimeo.

WHO (2000): Global Water Supply and Sanitation Assessment 2000 Report, World Health Organization and Unicef.

WHO (2002a): Children's Health and Environment: A Review of Evidence, World Health Organization and European Environment Agency.

WHO (2002b): Water and Health, EEA and WHO, Regional Office for Europe, Copenhagen.

World Bank (2002): "Water - The Essence of Life", Development News, May 17.

Table 1: Privatization of Federal Argentine SOEs

Sector Privatized	Total Sale Income (Millions of US$)	Dates Privatized
Oil and Gas Production	7,594	1990 to 1999
Electricity	3,908	1992 to 1998
Communications	2,982	1990 to 1992
Gas Transport and Distribution	2,950	1992 to 1998
Transportation (Airlines, Rail, Ships)	756	1990 to 1994
Petrochemical and Oil Derivatives	554	1991 to 1995
Banks and Finance	394	1994 to 1999
Steel	158	1992 to 1992
Other	126	1991 to 1999
Railways	Concession	1991 to 1995
Highways	Concession	1990 to 1993
Ports	Concession	1990 to 1994
Airports	Concession	1998
Radio and TV	Concession	1990 to 1991
Water and Sewage	Concession	1993
Mail Service	Concession	1997
Total Privatization Revenue [(a)]	19,422	

Notes: (a) The total revenue from privatization does not include royalty payments from companies privatized through concessions or revenues from the privatization of provincial and municipal SOEs. Source: Ministerio de Economía (2000).

Table 2: Change in Ownership of Water Systems 1990-1999

Ownership [(a)]	Number of Municipalities
Always Public or Cooperative	338
From Public to Private	138
Always Private	1
No Service or Missing Information	18
Total	495

Notes: (a) In municipalities where more than one company provides water services, we defined the ownership status of the municipality as the ownership of the company supplying the largest fraction of the population. Source: SPIDES, ENOHSA.

Table 3: OSN vs. Aguas Argentinas (1980-1999)

	OSN [a] (Before Privatization)	Aguas Argentinas [b] (After Privatization)	Δ After Privatization
Water Production (1) (Millions of cubic meters per day)	3.56	3.89	9.3%
Spilled Water (2) (Millions of cubic meters per day)	1.49[c]	1.27	-14.8%
Water Supply (1- 2) (Millions of cubic meters per day)	2.07[c]	2.62	26.6%
Sewage Drainage Volume (Millions of cubic meters per day)	2.18	2.45	12.4%
Water Network Extension (Km of network)	10,148	13,287	30.9%
Sewage Network Extension (Km of network)	6,875	8,312	20.9%
Average Delay in Attending Repair Requests (Days)	180[d]	32[e]	-82.2%
Water Leakages repaired per year	42,000[c]	96,383	129.5%
Sewage Blockages repaired per year	100,000[c]	148,500	48.5%
Usage Fee Index [f]	100	84	-16%
Employees	9300	4000	-57%
Percentage of Clients With Appropriate Water Pressure	17 [c]	54 [g]	217.6%

Notes: (a) Average for the period 1980-1992. (b) Average for the period 1994-1999. (c) 1993 only. (d) 1992 only. (e) Average excludes 1994. (f) Corresponds to the "K" tariff factor. (g) 1996 only. Source: UADE-CEER.

Table 4: Network Expansion by Income Group in Greater Buenos Aires (1993-2000)

Income level	New Connections	Percent of Total
High & Upper Middle Income	90,200	15.4%
Lower Middle Income	282,250	48.3%
Low Income	211,800	36.3%
Total	584,250	100.0%

Source: Subsecretaria de Recursos Hidricos, from Abdala and Spiller (1999).

Table 5: Difference-in-Differences Estimates of the Impact of Privatization on the Proportion of Households Connected to the Water Network, 1991-1997

	All municipalities	Excluding Buenos Aires
Municipalities that were not privatized:		
Proportion of households connected in 1991 $\left(p_{91}^{public}\right)$	0.866	0.866
Proportion of households connected in 1997 $\left(p_{97}^{public}\right)$	0.898	0.898
Difference 1997 – 1991 $\left(p_{97}^{public} - p_{91}^{public}\right)$	0.032	0.032
Municipalities that were privatized:		
Proportion of households connected in 1991 $\left(p_{91}^{private}\right)$	0.730	0.640
Proportion of households connected in 1997 $\left(p_{97}^{private}\right)$	0.780	0.714
Difference 1997 – 1991 $\left(p_{97}^{private} - p_{91}^{private}\right)$	0.050	0.074
Difference-in-Differences $\left(p_{97}^{private} - p_{91}^{private}\right) - \left(p_{97}^{public} - p_{91}^{public}\right)$	0.018	0.042
Z-test for Difference-in-Differences Estimate [(a), (b)]	2.83 ***	5.78 ***

Notes:

(a) The statistic of contrast is $z = \frac{(p_{97}^{private} - p_{91}^{private}) - (p_{97}^{public} - p_{91}^{public})}{\sqrt{\frac{p_{97}^{private}(1-p_{97}^{private})}{n_{97}^{public}} + \frac{p_{97}^{public}(1-p_{97}^{public})}{n_{97}^{public}}}}$, where p_t is the proportion of households with access to water connection in year t in a municipality where water has been privatized (private) or in a municipality where water has not been privatized (public), and n is the number of observations. Note that there is no sample variability when we estimate p for 1991 since these statistics are estimated from Census data.

(b) *** Statistically different from zero at the 0.01 level of significance.

Table 6: Discrete Time Hazard Estimate of the Probability of Being Privatized

	Means (Standard Dev.) (1)	Excluding Cooperatives (2)	Excluding Cooperatives (3)	Including Cooperatives (4)	Including Cooperatives (5)
Time varying covariates:					
Federal Government (=1)	0.008 (0.090)	14.07 *** (2.39)	14.08 *** (2.38)	13.36 *** (2.23)	13.33*** (2.23)
Municipality Governed by Radical Party (=1)	0.155 (0.362)	- 2.68 ** (1.07)	- 2.70 ** (1.07)	- 2.81 *** (1.06)	- 2.92 *** (1.064)
Municipality Governed by Peronist Party (=1)	0.691 (0.462)	0.63 (0.43)	0.58 (0.44)	0.54 (0.38)	0.44 (0.39)
Δ Provincial Mean Income$_{t-1}$	11.987 (27.236)	- 0.00 (0.01)	- 0.00 (0.01)	- 0.01 (0.01)	- 0.01 (0.01)
Δ Provincial Unemployment $_{t-1}$	0.006 (0.029)	- 4.18 (5.9`)	- 4.39 (5.94)	- 3.92 (5.63)	- 4.32 (5.70)
Δ Provincial Inequality $_{t-1}$	0.213 (0.753)	- 0.26 (0.20)	- 0.27 (0.20)	- 0.19 (0.18)	- 0.21 (0.18)
Δ Municipal Child Mortality Rates$_{t-1}$	-0.254 (3.094)		0.03 (0.04)		0.02 (0.04)
Time invariant covariates:					
Mean Provincial Income	268.212 (56.694)	- 0.0` *** (0.00)	- 0.01 *** (0.00)	- 0.01 ** (0.00)	- 0.01 * (0.00)
Mean Provincial Unemployment	0.104 (0.025)	20.37 *** (5.45)	19.83 *** (5.49)	12.63 ** (5.02)	11.34 ** (5.03)
Mean Provincial Inequality	8.478 (0.841)	- 0.44 ** (0.19)	- 0.43 ** (0.20)	- 0.02 (0.17)	- 0.00 (0.18)
Mean Municipal Child Mortality Rates	5.107 (2.752)		0.04 (0.05)		0.11 ** (0.05)
Pretreatment Characteristics [(a)]					
Municipal Population is 5000 to 25000 (=1)	0.471 (0.499)	0.14 (0.47)	0.24 (0.50)	0.22 (0.48)	0.47 (0.52)
Municipal Population is 25000 to 50000 (=1)	0.196 (0397)	0.03 (0.54)	0.13 (0.56)	0.24 (0.53)	0.49 (0.57)
Municipal Population is 50000 to 100000 (=1)	0.106 (0308)	-0.74 (0.63)	-0.62 (0.65)	-0.37 (0.61)	-0.09 (0.65)
Municipal Population is 100000 to 250000 (=1)	0.075 (0.264)	0.67 (0.61)	0.76 (0.63)	0.62 (0.61)	0.89 (0.65)
Municipal Population is More than 250000 (=1)	0.039 (0.194)	1.34 ** (0.64)	1.47 ** (0.67)	1.51 ** (0.64)	1.81 *** (0.69)
Proportion of Population with Unmet Basic Needs	0.257 (0.154)	-12.04 * (6.17)	-13.72 ** (6.47)	-17.75 *** (6.09)	-20.88 *** (6.28)
Proportion of Population in Overcrowded Houses	0.101 (0.619)	16.26 ** (6.71)	17.06 ** (6.82)	16.64 *** (6.26)	18.09 *** (6.37)

Table 6: Discrete Time Hazard Estimate of the Probability of Being Privatized (Continued)

	Means (Standard Dev.) (1)	Excluding Cooperatives (2)	Excluding Cooperatives (3)	Including Cooperatives (4)	Including Cooperatives (5)
Proportion of Population living in Bad Houses	0.058 (0.046)	0.75 (3.67)	1.56 (3.69)	6.70 * (6.64)	7.84 ** (3.61)
NFEvac	0.104 (0.122)	10.06 ** (4.53)	11.39 ** (4.81)	15.33 *** (4.47)	17.79 *** (4.64)
Proportion of Population living Below Subsistence	0.038 (0.022)	5.30 (7.12)	6.17 (7.01)	4.51 (7.26)	6.70 (7.14)
Proportion of Families With Head > High School	0.024 (0.012)	-31.75 *** (11.44)	-33.36*** (11.65)	-29.24 *** (11.03)	-32.06 *** (11.13)
Family Head Mean Age between 45 and 52 (=1)	0.661 (0.474)	-0.15 (0.37)	-0.09 (0.37)	0.25 (0.37)	0.34 (0.38)
Family Head Mean Age above 52 (=1)	0.142 (0.349)	-0.07 (0.49)	0.00 (0.50)	0.46 (0.48)	0.60 (0.49)
Unemployment Rate in 1991	0.042 (0.022)	10.57 ** (5.26)	10.93 ** (5.30)	14.95 *** (5.02)	15.92 *** (5.07)
Proportion of Households With No Sewage	0.379 (0.485)	-0.54 * (0.32)	-0.57 * (0.32)	-0.83 *** (0.31)	-0.85 *** (0.31)
Duration Dependence [(b)]		Yes	Yes	Yes	Yes
Number of Observations		2,281	2,281	3,392	3,392

Notes: (a) Pre-Treatment Characteristics are from the 1991 Census aggregated to the municipality level. See Data Appendix for specific definitions. (b) We include a fifth order polynomial in time to control for duration dependence, and each coefficient in the polynomial is statistically different from zero at the 0.01 level in all specifications. (c) Standard errors are in parentheses. *** Statistically different from zero at the 0.01 level. ** Statistically different from zero at the 0.05 level. * Statistically different from zero at the 0.1 level.

Table 7: Estimates of the Impact of Water Services Privatization on Child Mortality [(a)]

Dependent Variable: Mortality Rate of Children 0 to 4 years old (all causes)	1990 Mean Child 0-4 Mortality Per 100 [(b)]	Simple Difference-in-Difference With No Controls	Simple Difference-in-Difference Controlling for Income, Unemployment & Inequality	Difference-in-Difference Using Control and Treatment Municipalities With Common Support	Generalized Difference-in-Difference (Kernel Weighted Matches) [©]
	(1)	(2)	(3)	(4)	(5)
Coefficient (Standard Deviation)	6.250	- 0.300 * (0.166)	- 0.310 * (0.165)	- 0.420 ** (0.175)	- 0.323 ** (0.159)
% Δ in Mortality Rate		- 4.8 %	- 5.0 %	- 6.7%	- 5.2 %
Number of Observations		4625	4625	3873	3873

Notes:

a. Each cell in columns 2-5 is the estimated coefficient and standard error on the privatization dummy variable from a separate model. All of the regressions include year and municipality fixed effects. *** Statistically different from zero at the 0.01 level of significance. ** Statistically different from zero at the 0.05 level of significance. * Statistically different from zero at the 0.1 level of significance.

b. The 1990 mean mortality rates are for the control and treatment municipalities with common support (i.e. overlapping propensity scores).

c. The standard errors for the Generalized Difference-in-Differences Estimator are bootstrapped estimates using 100 replications.

Table 8: The Impact of Privatization on Child Mortality by Cause of Death

	1990 Mean Mortality Rate ‰	Difference-in-Differences Estimates With Common Support	% Δ in Mortality Rate
	(1)	(2)	(3)
Infectious and Parasitic Diseases	0.581	-0.096** (0.049)	- 16.5 %
Perinatal Diseases	2.355	-0.237** (0.105)	- 10.1 %
Accidents	0.395	0.002 (0.052)	…..
Congenital Anomalies	0.729	-0.020 (0.054)	…..
Skin and Soft Tissues Diseases	0.000	-0.000 (0.001)	…..
Blood and Hematologic Diseases	0.025	0.008 (0.008)	…..
Nervous System Disorders	0.163	0.012 (0.027)	…..
Cardiovascular Diseases	0.263	0.001 (0.031)	…..
Gastrointestinal Tract Disorders	0.058	0.002 (0.012)	…..
Genital and Urinary Diseases	0.020	-0.005 (0.007)	…..
Osteoarticular and Connective Tissue Diseases	0.003	-0.001 (0.001)	…..
Respiratory Diseases	0.534	-0.003 (0.049)	…..
Immuno-deficiencies and Endocrine and Nutrition System Diseases	0.394	-0.010 (0.034)	…..
Mental Disorders	0.002	0.001 (0.001)	…..
Tumors	0.069	-0.004 (0.015)	…..
Number of observations		3873	

Notes:

a. Each cell in column (2) reports the estimated coefficient (and standard error) on the privatization dummy variable from a different regression. All of the regressions also include year and municipality fixed effects, and income, unemployment, and inequality as time varying control variables (see Data Appendix).

b. *** Statistically different from zero at the 0.01 level of significance. ** Statistically different from zero at the 0.05 level of significance. * Statistically different from zero at the 0.1 level of significance.

Table 9: Estimated Impact of Privatization on Child Mortality by Poverty Level

	1990 Mean Mortality Rate ‰	Difference-in-Differences Estimates With Common Support [(b)]	% Δ in Mortality Rate
Non-poor Municipalities [(a)]	5.15	0.105 (0.229)	.....
Poor Municipalities	7.18	-0.767 *** (0.277)	- 10.7%
Extremely Poor Municipalities	9.46	-2.214 *** (0.544)	- 23.4%

Notes:

a. Municipalities are allocated in poverty groups using the government's index of Unmet Basic Needs (UBN) using data from the 1990 Census. The index identifies a family as poor if they live in an overcrowded and poor quality house without access to water and sewage, and have an income below the subsistence level. Non-poor municipalities are defined as those in which less than 25% of households have Unmet Basic Needs. Poor municipalities are defined as those in which 25% to 50 % of households have Unmet Basic Needs. Extremely poor municipalities are defined as those in which more than 5o% of households have Unmet Basic Needs.

b. The coefficients reported are the interaction of Private and UBN (recoded in a set of dummy variables in the following categories: below 25%, between 25% and 50%, and above 50%) in a difference in difference regression using only the control and treatment observations that have common support and controlling for Income, Unemployment, and Inequality. All of the regressions include year and municipality fixed effects. Standard errors are reported in parentheses. *** Statistically different from zero at the 0.01 level of significance. ** Statistically different from zero at the 0.05 level of significance. * Statistically different from zero at the 0.1 level of significance.

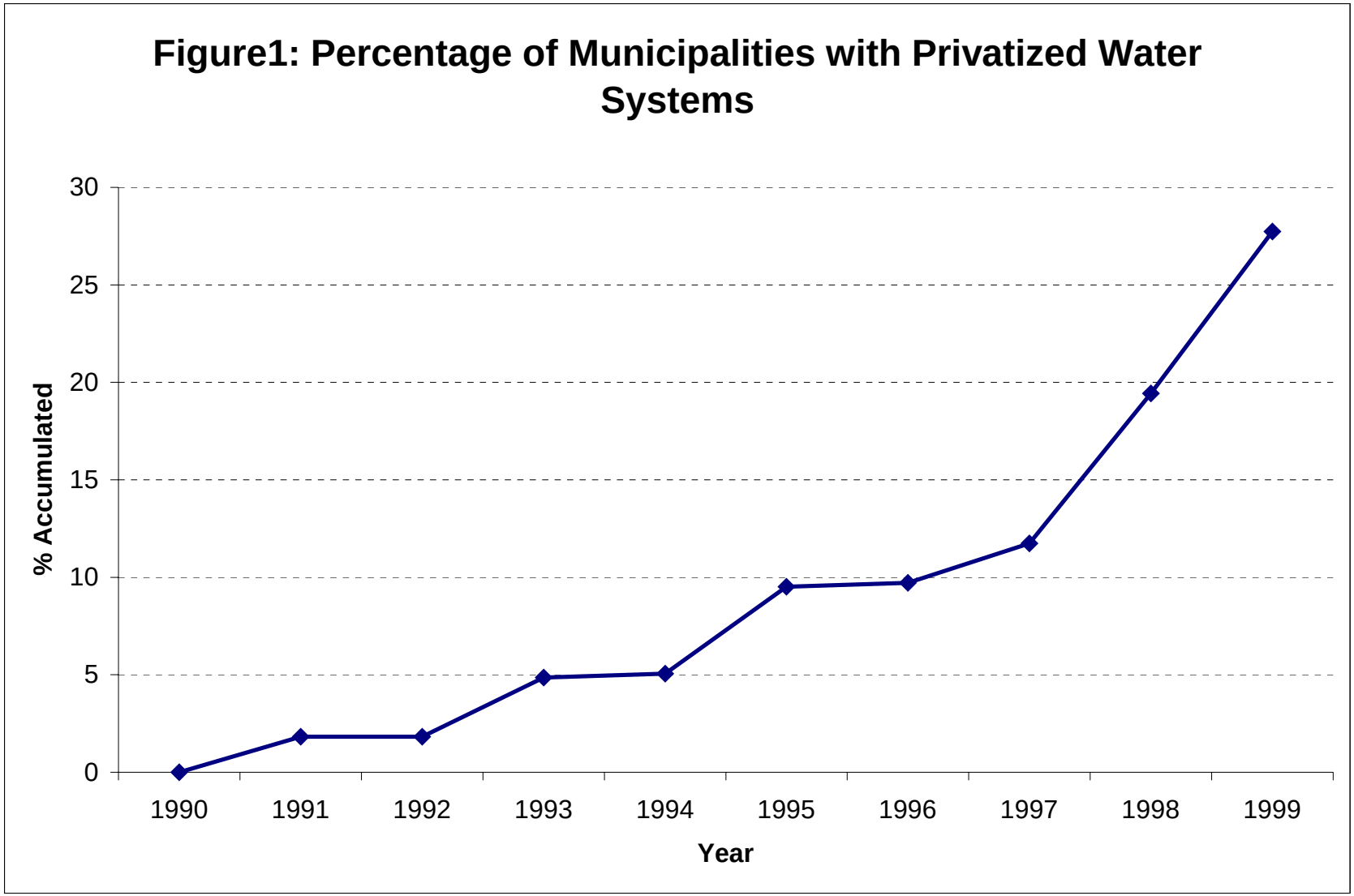
Figure1: Percentage of Municipalities with Privatized Water Systems
% Accumulated
30
25
20
15
10
5
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Year

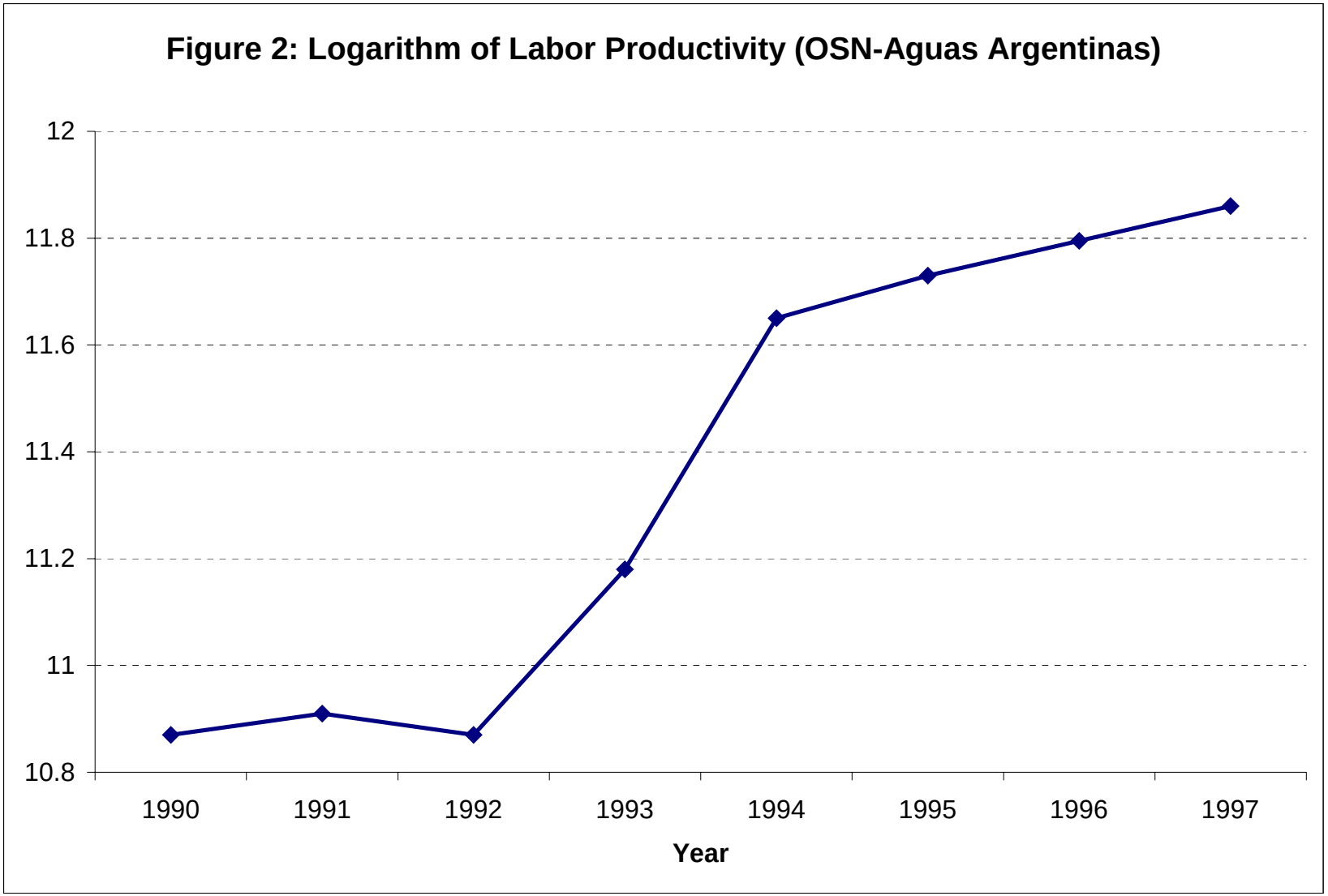
Figure 2: Logarithm of Labor Productivity (OSN-Aguas Argentinas)
12
11.8
11.6
11.4
11.2
11
10.8
1990
1991
1992
1993
1994
1995
1996
1997
Year

Figure 3: Logarithm of Population Connected to OSN-Aguas Argentinas Network

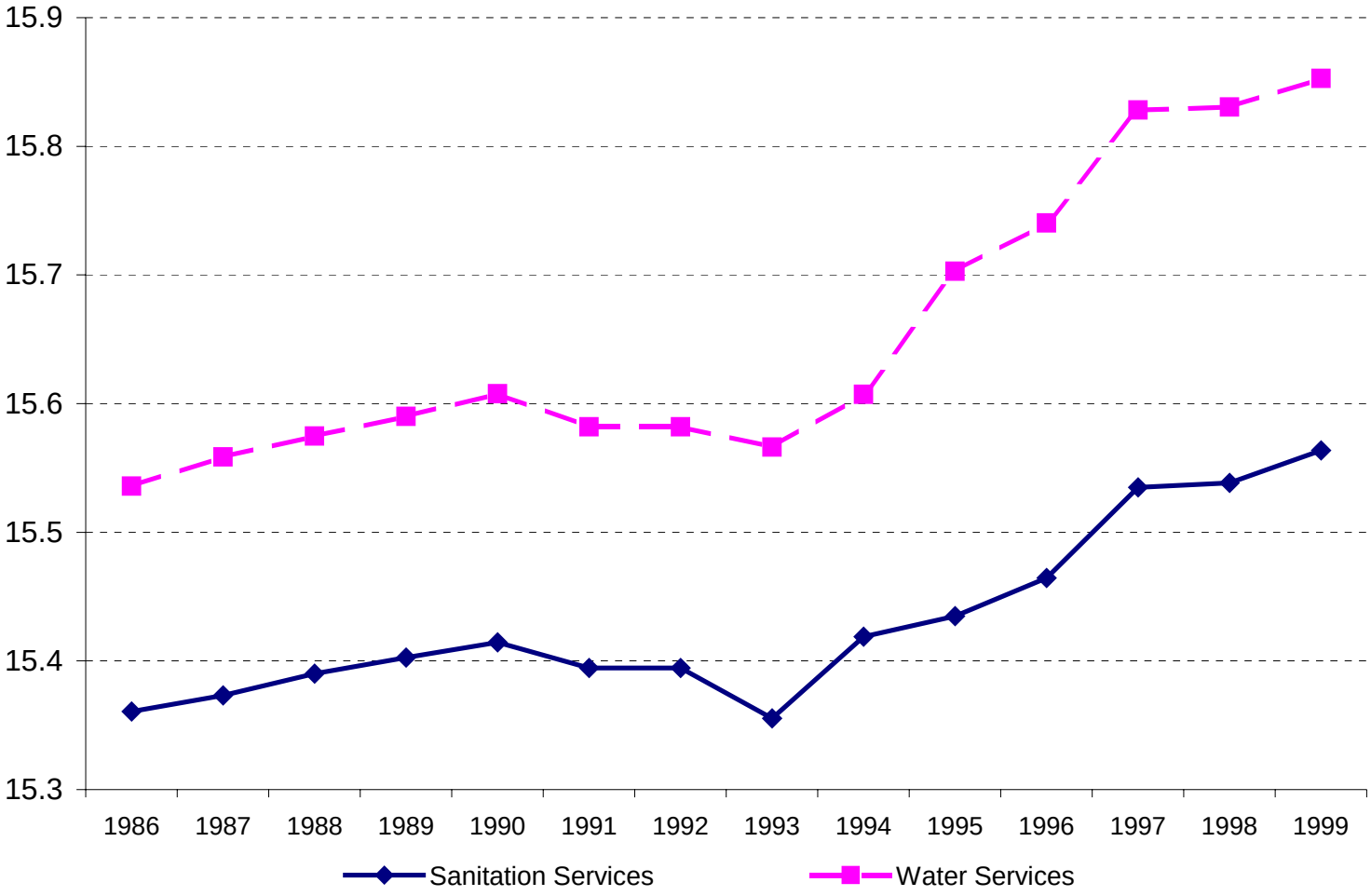

Figure 4: Evolution of Mortality Rates for Municipalities with Privatized vs. Non-Privatized Water Services