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Water Expansions in Shantytowns: Health and Savings

by

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Abstract[1]

This paper examines the effects of the expansion of the water network in urban shantytowns in Argentina. We find large reductions in the presence, frequency, and severity of diarrhea episodes among children in the households reached by network expansions relative to the control group. Moreover, expanded water connections induce savings, as these families are able to substitute piped water for more expensive and distant sources of water. These health and savings effects are also important for households that previously had clandestine self-connections to the water network, which were free but of low quality.

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1. Introduction

Even though water is one of the most crucial elements for life, more than 20 percent of the world's population does not have access to safe drinking water (WHO and UNICEF, 2004). Those who are not connected to the water system often resort to purchasing water from independent providers, and those who cannot afford it consume unsafe polluted water. This lack of access to safe drinking water is a serious threat to the health of disadvantaged populations, especially children.

At the 2000 Millennium Summit, the member countries of the United Nations unanimously agreed on a set of eight goals to reduce poverty by 2015, including reducing child mortality by two-thirds and halving the number of households that do not have access to safe water. These two goals are interrelated because 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; Esrey et al., 1991; Lavy et al., 1996; Lee, Rosenzweig, and Pitt, 1997; and Jalan and Ravallion, 2003).

Galiani et al. (2005) document large improvements in access to water and water quality as a result of the privatization of water companies in Argentina during the 1990s. In addition, they find that privatization led to a reduction in child mortality in poor and extremely poor regions. In spite of these improvements, however, a large fraction of the Argentine population, mainly poor, still lacks access to the water network, and there is concern about whether private companies have any incentives to serve extremely poor households.

This paper examines the effects of a program of expansion of the water network in urban shantytowns undertaken by a privatized water company in Argentina. Relative to the control group, we find large reductions in the presence, severity, and duration of diarrhea episodes among children in the treated population, as well as reductions in water-related expenses. It turns out that unserved households need to rely on alternative sources of water that require greater monetary expenditures and higher transportation costs than households that have network connections. We also show that these health and savings effects are important for households

that previously had clandestine self-connections to the water network, which were free but of low quality.

The rest of the paper is organized as follows. The next section discusses the privatization of the Buenos Aires water company, while. Section 3 describes a program of water expansion in shantytown neighborhoods. Section 4 presents the sampling design, Section 5 the estimation strategy, and Section 6 the empirical results. Section 7 concludes.

2. Water Privatization: The Case of Aguas Argentinas

Argentina undertook a broad privatization program during the 1990s, which included the provision of water and sanitation services. In 1990, before privatization, public companies provided water service to two-thirds of the country's municipalities, while not-for-profit cooperatives provided service to the remaining one-third. Between 1991 and 1999, about half of the public water companies, serving 28 percent of the country's municipalities and almost 60 percent of the country's population, were transferred to private for-profit control. The largest water company privatization was that of the federal company Obras Sanitarias de la Nación (OSN), which provided service in the Buenos Aires metropolitan area.

In May 1993 Aguas Argentinas, a private consortium led by the French company Lyonnaise des Eaux, won a 35-year concession to provide water service previously provided by OSN.[2] The terms of the concession established service quality and waste-treatment standards. The terms also stipulated construction plans to expand the water network to 100 percent of households and the sewage network to 95 percent of households in metropolitan Buenos Aires by the end of the 35-year period.

Privatization increased efficiency, productivity, and investments (Artana, Navajas, and Urbiztondo, 2000; Alcazar, Abdala, and Shirley, 2002; Galiani et al., 2005). Several case studies show 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 and cleanliness improved. These service improvements were accompanied by an almost 50 percent reduction in the number of Aguas Argentinas' employees. The employment reduction, together with the increase in coverage and production, resulted in large productivity

[2] Concessions, rather than the sale of assets to the private firms, are the most common method of privatizing water services worldwide (Noll, Shirley, and Cowan, 2000).

increases. Investments were particularly important in terms of increased access to the network. More than 2 million people in metropolitan Buenos Aires gained access to the water service, and about 1.24 million people gained access to the sewage network. In spite of this significant network expansion, however, more than 15 percent of the population is still not connected to the water network, and more than 40 percent still lacks access to the sewage network. This large unconnected fraction of the population is located in the poorest neighborhoods of metropolitan Buenos Aires.

Although water privatization brought significant progress, if not universal connection, it was not popular in the opinion polls.[3] This was neither a particular characteristic of the water privatization nor particular to Argentina. Opinion polls and press articles report widespread discontent with privatization in general in Latin America (IDB, 2002; McKenzie and Mookherjee, 2003). The Argentine macroeconomic crisis of 2001-02 increased political tensions. The government did not allow the tariff increases stipulated in the contracts, and the private companies interrupted investments. The conflict between Aguas Argentinas and the government escalated until the water concession was cancelled in March 2006, and water provision was transferred to the newly created public company AySA.[4] However, the particular program of water expansion in shantytowns analyzed in this paper took place entirely before this renationalization.

3. Expansion of Water in Shantytown Neighborhoods

After 10 years of concession, several shantytown neighborhoods were still not connected to the water and sewage networks. A main regulatory problem for the expansion of the water network in shantytowns is that these areas are not formally urbanized and parcelized. This means that

[3] The Buenos Aires water privatization did not imply a significant price increase. Indeed, water-use fees in Buenos Aires were initially lowered by 26.9 percent as a result of the privatization bid. However, 13 months after privatization, the regulator authorized a 13.5 percent increase in the usage fee, and a significant increase in connection fees. In response to protests, this high connection fee was later lowered to about one-tenth of the previous level, and a fixed charge was added to the water-use bills for all clients as a cross-subsidy. Some customers also suffered fee increases through property reclassifications (for most customers, fees are based on property characteristics, not on metered use). Indeed, the Buenos Aires water concession has been criticized for its frequent tariff renegotiations. For a general discussion on the evolution of tariffs under privatization in Latin America, see McKenzie and Mookherjee (2003); for the Argentine case, see Alcazar, Abdala, and Shirley (2002); Gerchunoff, Greco, and Bondorevsky (2003); and Clarke, Kosec, and Wallsten (2003).

[4] Although only a few of the companies privatized during the 1990s have returned to public hands, Aguas Argentinas was not the only case. Other examples include the mail service, the water company of the Province of Buenos Aires (which returned to provincial administration after Enron's bankruptcy), the public purchase of a fraction of the shares of the national airline company, and the creation of a new public energy company.

Aguas Argentinas was not licensed to provide service to them. In order to address the specific problem of water development in shantytowns, Aguas Argentinas created a department in 1999 called Development of the Community (*Desarrollo de la Comunidad*) with the objective of designing a methodology to provide water and sewage services to shantytowns. Three years later, at the beginning of 2002, this department launched a specific expansion program, the *Modelo Participativo de Gestión* (MPG, or Participative Expansion Program), in collaboration with neighborhood communities, municipal governments, and the regulatory agency Ente Tripartito de Obras y Servicios Sanitarios (ETOSS).

The program operated as follows. First, a poor neighborhood community had to ask Aguas Argentinas for provision of the service. Second, the firm evaluated the technical feasibility of the extension of water and/or sewage services to that area. The program did not include the extension of the primary water network, but only secondary connections. Thus, a technical condition was that the neighborhoods had to be less than two blocks away from a covered area. Third, if the provision of the service was technically feasible, Aguas Argentinas asked the neighborhood's municipality for approval to initiate the program in the area. If the municipality approved the project, an agreement among the municipality, Aguas Argentinas, the neighborhood, and ETOSS was signed. This agreement stipulated the role and responsibilities of each party in the program. A salient characteristic of this contract was that beneficiary households agreed to provide the labor for the execution of the construction works in the neighborhood. In return for this work, Aguas Argentinas did not charge water connection fees to any household in the neighborhood. Once connected, the households had to pay a bimonthly service fee of about five pesos (around US$ 1.7) per household.[5] Households also agreed to eliminate all alternative installations of water, including any clandestine connections that might exist.

A clandestine water connection is defined in this study as a water connection inside the house that was not provided by the water company. In our sample, about half of the households had a clandestine connection to the water network. It is worth emphasizing that this high percentage is not representative across the Buenos Aires metropolitan area, but was the result of the particular fact that the program was restricted to shantytowns less than two blocks away from

[5] The standard connection fee at that time was 138.4 pesos, and the bimonthly service fee was 11 pesos. According to Aguas Argentinas, their labor costs for these connections would have amounted to 132.5 pesos.

connected neighborhoods. Because clandestine connections cannot be carried out over long distances, they are particularly developed in close-by shantytowns, where it is also very difficult for water company personnel to get safe access to the connections to shut them down.

The MPG was an institutional arrangement in which public institutions (the water regulatory agency and the municipal government), a private firm, and the community came together to provide piped water and/or sewage services to poor neighborhoods. The program was institutionalized through a contract among Aguas Argentinas, the neighborhood, and the neighborhood's municipality. ETOSS supervised and authorized the whole process.

It is important to consider this arrangement in the context of Argentina's macroeconomic situation. During the 1990s, the country began massive market reforms. However, the performance of labor markets during that period was very disappointing. Poverty and unemployment increased and income distribution worsened (see Altimir and Beccaria, 1998). Social conditions sharply deteriorated during the 2001-02 crisis, when the Argentine GDP plummeted, unemployment exploded, and significant inflation affected the purchasing power of Argentine households. At the end of 2003, when the research for this paper began, around 6 million people—of a total population of 12.6 million in GBA—were living on less than 3 dollars per day.[6] Of those living in poverty, 44 percent were considered indigent, meaning they lived on a dollar per day or less. Although the number of people below the poverty line began to decline, it still remained very high at around 31 percent by the end of 2005, in spite of strong GDP growth—around 9 percent—in 2003, 2004, and 2005. These figures highlight the enormous magnitude of the poverty problem in Argentina.

According to Aguas Argentinas,[7] by 2002 there were 593 shantytown neighborhoods with an estimated population of 2.5 million people within the concession area. Of this total, 445 neighborhoods with an estimated population of 1.1 million people were within the limits covered by the water network but were without service because of the lack of urbanization and parcelization. The Aguas Argentinas MPG program was a partial attempt to overcome this problem by developing the provision of water and/or sewage service to shantytowns located in the concession area. The program would also improve the public image of the company by showing its concern for the poor. The conditions for participating in the program were:

[6] See INDEC (2003, 2004).
[7] See Botton, Braïlowsky, and Matthieussent (2003).

- The shantytown community had to request the service. The neighbors had to be organized and they had to elect representatives to form a community assembly to interact with the other actors in the program. The community also provided labor for construction.
- The neighborhood municipality contractually agreed to undertake certain activities: assigning a supervisor of works; ordering the opening of streets (if required); assigning, if necessary, people with assistential work plans to do the construction work in front of churches, health centers, schools, and other community buildings in the neighborhood; and distributing work tools (gloves, spades, etc.).
- Aguas Argentinas had to guarantee the technical feasibility of the project. It agreed to deliver the necessary materials (pipes, keys, etc.) and to assure the technical formation of the labor force through several training workshops on work techniques and aspects of labor security. The company was also responsible for communicating the commercial aspects of the service to the community's assembly. It additionally organized social workshops for families in the neighborhoods in order to develop a good relationship between the new clients and the firm, and to provide information about the potential health gains from water infrastructure improvements and about the benefits from responsible use of the service.

After the program's connection works were finished, the households in the neighborhood were incorporated as clients of Aguas Argentinas, and each household had to pay a bimonthly service fee of about five pesos.

In 2003, 33 MPG projects were approved by the water company and the respective municipal governments. As of October 2003, agreements had already been signed for 17 of these projects. Of these, 6 MPG projects were already finalized, 9 were ready to begin, and 2 were signed but the starting date was not yet scheduled. Agreements for the remaining 16 projects had not yet been signed (though all of the 33 MPG projects were eventually executed by the program). Table 1 shows these projects divided by location. The different progress of these projects may have been due to the different times at which the neighborhoods presented their requests (which, in turn, may reflect different organizational structures), to delays in obtaining approval and construction tools from the municipality, or to delays in obtaining technical approval, construction materials, and workshop developments from the company. The different

timing may also be related to geographic neighborhood characteristics, such as the distance to the water network or the need to open a new street.

Table 1. MPG Projects (as of October 2003)

Location	Number of Projects	Population	Number of Agreements Signed	Status of Work	
				Ready to Begin	Finalized
South Region GBA	10	18,320	5	4	1
North Region GBA	15	9,350	12	5	5
West Region GBA	4	3,445	0	0	0
Buenos Aires City	4	18,832	0	0	0
Total	33	48,947	17	9	6

Source: "Hacia un acceso universal a los servicios. El modelo participativo de gestión." "Ready to Begin" means that the contract agreement among the municipality, the neighborhood, Aguas Argentinas and ETOSS was already signed and the training workshops and social activities were scheduled but the works had not yet begun.

4. Sampling Design

In order to study the impact of these MPG projects on the health and expenditures of poor households, we conducted a before-and-after study comparing the performance in treated neighborhoods relative to a control group. Since the MPG programs began with a community's request for service connection, we selected as the control group neighborhoods that had asked Aguas Argentinas for water service, but that for administrative reasons were not included in the program. Our before-and-after strategy allows us to use household fixed effects to address the potential presence of time-invariant differences between treatment and control groups.

For the treatment group, of the 33 projects in Table 1, we only considered the 27 neighborhoods where the MPG programs were not finalized by the beginning of the first survey (mid-February 2004). Moreover, we focused on the 25 neighborhoods that had requested connection only to the water network, not the sewage network.[8] Within this group, we selected six neighborhoods to be sampled, stratifying the projects by region and choosing neighborhoods that belonged to different municipalities throughout Greater Buenos Aires.

[8] Sewage construction takes much longer, impeding comparability. Two neighborhoods were excluded for this reason.

Table 2. Neighborhoods in the Treatment Group

Region	Neighborhood	Number of Households		Date of finalization of the MPG program
		Population	Sample	
North	San Jose	107	41	July, 2004
North	Cina Cina	400	70	September, 2004
West	San Miguel	209	50	April, 2004
West	Hipólito Yrigoyen	198	40	September, 2004
South	La Tablada	360	70	April, 2004
South	10 de Enero	271	95	May, 2004
Total		1,545	366	

In addition to these six neighborhoods participating in the MPG program, we selected three neighborhoods to form a control group. These three control neighborhoods were chosen from a group of seven neighborhoods that had asked Aguas Argentinas for water service through the MPG project, but that for administrative reasons were not included in the program. Table 3 presents information on these neighborhoods.

Table 3. Neighborhoods in the Control Group

Region	Neighborhood	Number of Households	
		Population	Sample
North	Villa Lanzone	435	94
North	Villa Hidalgo	554	95
South	La Rivera	120	80
Total		1,109	269

Once all neighborhoods were defined, we conducted a systematic household survey of each neighborhood. Our pollsters had a sketch of each neighborhood and a previously defined pathway, guaranteeing that we covered the whole neighborhood. The survey included questions regarding the incidence of water-related illnesses among young children (less than 6 years old),[9] hygiene habits, trips to medical centers, medical consultations related to water-related illnesses, and household socioeconomic characteristics.

[9] The incidence was taken for the month of reference (i.e., one month before the survey was conducted).

The baseline survey was conducted in the last two weeks of February and the first week of March 2004, and the follow-up survey was conducted in the same weeks of 2005. The last column in Table 2 indicates the date of finalization of the program in each neighborhood.[10]

In October 2004, the regular Aguas Argentinas water network expansion reached the "La Rivera" neighborhood and, as a consequence, some of the sampled households in that control neighborhood gained access to water service by November of that year. Since our first survey had already been conducted in that neighborhood, we accordingly redefined the treatment and control observations, transferring the connected households from the control group to the treatment group.[11]

In order to compare the pre-treatment characteristics of the treated and control groups, Table 4 shows mean equality tests for several variables using the survey conducted in February and March 2004. Both groups share similar characteristics in terms of houses and heads of households, which made treatment and control groups comparable. There is a 20 peso difference between the per capita family income[12] of control and treatments groups. This difference is statistically significant at the 5 percent level.

[10] Before the survey, it was essential to contact some key people in each neighborhood who could guarantee the safety of the pollsters. These key people were community leaders, schoolteachers, or priests in the neighborhood. In order to have a low non-response rate, we agreed with these leaders to donate educational material to each neighborhood school.

[11] As shown in Appendix B, the results are robust to excluding from the analysis all the observations from the "La Rivera" neighborhood and they are also robust to excluding only those households that received water in that neighborhood.

[12] For those families in both groups that did not report their income during the survey, we imputed family income using the hotdeck methodology within neighborhoods using age, formal education, and gender of the head of household as stratification variables.

Table 4. Mean Equality Tests

Variable	Treatment Group	Control Group	Diff
Gender of head of household (HH)	0.778	0.804	0.026
	(0.02)	(0.029)	(0.035)
Education of HH (years)	7.347	7.284	-0.063
	(0.125)	(0.21)	(0.244)
Marital status of HH (married=1)	0.721	0.778	0.057
	(0.021)	(0.03)	(0.037)
Nationality of HH (foreigner=1)	0.134	0.093	-0.041
	(0.016)	(0.021)	(0.026)
Employment of HH (employed=1)	0.89	0.88	-0.01
	(0.017)	(0.027)	(0.031)
Unemployment of HH (unemployed=1)	0.11	0.12	0.01
	(0.017)	(0.027)	(0.031)
Age of HH	41.347	45.314	3.967**
	(0.679)	(0.895)	(1.123)
House has a bad roof	0.057	0.066	0.009
	(0.012)	(0.018)	(0.022)
House has electricity	0.973	0.985	0.012
	(0.008)	(0.009)	(0.012)
Water used for cooking is from clandestine connection	0.519	0.554	0.035
	(0.024)	(0.036)	(0.043)
Water used for personal hygiene is from clandestine connection	0.519	0.549	0.03
	(0.024)	(0.036)	(0.043)
Water used for drinking is from clandestine connection	0.482	0.477	-0.005
	(0.024)	(0.036)	(0.043)
Per capita family income	140.02	120.07	19.948**
	(8.35)	(4.86)	(9.66)

Notes: ** Significant at the 5 percent level.

5. Estimation Strategy

Our main objective is to identify the impact of the MPG water network expansion on children's health status and on the water-related expenses of these households. We are first interested in the average effect of access to the water network on water-related illnesses in young children less than six years old. In particular, we measure these water-related illnesses through the presence of diarrhea episodes in young children during the month before the surveys were conducted, the duration of those episodes, and whether those episodes included blood or parasites (as a way to assess their severity).

Given the *ex ante* poor quality of the water provision in the neighborhoods, most households bought bottled water to drink—regardless of whether they had clandestine connections to water services.[13] Thus, we are also interested in changes in water-related expenditures as a result of the MPG program. Note that this effect is very important since the potential increase in fees under privatization for those people already connected to the service provision has been frequently discussed. However, the savings for those who gained access and had been purchasing water from more expensive sources has been mainly ignored in public debates.

Assessing the impacts of access to the water network can be done by comparing the health or economic output of interest in those neighborhoods where the program has been applied with the same outcome in counterfactual neighborhoods—in other words, in the same treatment neighborhoods at the same point in time but without the application of the program. Since this counterfactual is not observed, we need to estimate it. Ideally, we would like to randomly assign access to the water system across neighborhoods. In the absence of this randomized trial we estimate the impacts of interest using the non-experimental method of difference in differences.

The difference-in-differences model can be specified as a two-way fixed effect linear regression model:

$$y_{it} = \alpha\, I_{it} + \beta\, x_{it} + \lambda_t + \mu_i + \varepsilon_{it}$$

where y_{it} is the outcome of interest—such as the presence of diarrhea episodes, duration and severity of these episodes, water-related expenses, etc.—for household (child) i in year t; I_{it} is an indicator variable that takes on a value of 1 if household (child) i received water network treatment in year t; x_{it} is a vector of control variables; λ_t is a time effect; μ_i is a household fixed effect; and ε_{it} is the error term.

6. Results

First, we study the effect on child health of gaining access to piped water through the water network. Table 5 shows very large reductions in the presence of diarrhea episodes (measured with a dummy variable), the duration of those episodes (measured in days), and their severity

[13] Bottled water comes in 5, 10, or 20 liters, and the retail price of the 10-liter bottle is around 3.60 pesos (US$1.2). In the baseline, water-related expenditures represented 5.3 percent of average household income.

(whether the episodes included blood and/or parasites). The effects are always significant at conventional levels. Controlling for changes in household income, we find that diarrhea episodes decrease by as much as 90 percent of the baseline incidence. Besides reducing the number of diarrhea episodes, access to piped water shows reductions in the duration and severity of those episodes. This evidence complements the findings of Galiani, Gertler, and Schargrodsky (2005) on child mortality. In this case, the provision of potable water has a positive effect on reducing health morbidity.

Table 5. Health Effects of the Expansion of the Water Network

Dependent variable	Presence of diarrhea episodes		Duration of diarrhea episodes.		Severity of diarrhea episodes	
	(1)	(2)	(3)	(4)	(5)	(6)
I_{it}	-0.1047**	-0.1274*	-0.9359	-1.1241	-0.0644**	-0.0814*
	(0.0525)	(0.0737)	(0.4707)	(0.6581)	(0.0320)	(0.0488)
	{0.0464}	{0.0691}	{0.5383}	{0.7938}	{0.0339}	{0.0524}
% change	-74.26	-90.35	-84.13	-101.04	-87.38	-110.45
Per capita income		-0.0001		-0.0003		0.0003
		(0.0004)		(0.0036)		(0.0004)
		{0.0004}		{0.0036}		{0.0005}
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Mean dependent variable	0.1410	0.1410	1.1125	1.1125	0.0737	0.0737
Observations	819	649	819	649	819	649
R-squared	0.53	0.56	0.50	0.52	0.46	0.47

Notes: The regressions are run at the child level for children less than six years old. Robust standard errors are in parentheses. Robust standard errors clustered at the household-period level to address potential correlation among children of the same household are in curly brackets. The percentage change is computed using the sample average of the dependent variable in the first survey as the baseline level. Statistical significance calculated using the robust standard errors in parentheses: * significant at 10 percent, ** significant at 5 percent, *** significant at 1 percent.

An important issue is that approximately half of the treated group was connected clandestinely to the water network and was receiving water, but it was of poor quality. This is

shown in Table 6, which presents reported improvements in water after the treated areas were connected to the water system.

Table 6. Changes in the Perception of Water Quality before and after Treatment

Treatment Group (in percentages)								
Quality	Color		Taste		Odor		Pressure	
	Before	After	Before	After	Before	After	Before	After
Very good	1.06	16.25	0.71	13.43	0.71	12.37	0.00	19.08
Good	52.65	74.91	53.71	72.08	55.48	73.14	36.75	59.36
Regular	30.04	7.07	28.27	11.31	26.86	11.66	15.55	7.77
Bad	12.37	1.41	13.07	2.47	13.43	2.47	32.86	5.30
Very bad	3.18	0.35	2.47	0.00	2.47	0.00	12.72	8.13
No answer	0.71	0.00	1.77	0.71	1.06	0.35	2.12	0.35

Tables 7 and 8 present the effect of access to the water network on the distance walked by household members to bring water to the house (Table 7) and on water-related expenditures by families (Table 8). Table 7 uses as dependent variable the distance (measured in 100-meter blocks) traveled by household members to the nearest hand-pumped well in order to bring water to the house. The program shows a statistically significant effect in reducing the distance traveled by household members to bring water to the house.

Table 7. Effect on the Distance Walked to Procure Water

Dependent Variable: Distance to well (in blocks)	(1)	(2)
I_{it}	-0.8303***	-0.8682***
	(0.1492)	(0.1936)
% change	-77.48	-81.02
Per capita income		0.0005
		(0.0007)
Household Fixed Effects	Yes	Yes
Period Fixed Effects	Yes	Yes
Mean dependent variable	1.0716	1.0716
Observations	934	724
R-squared	0.97	0.98

Notes: The regressions are run at the household level. Robust standard errors are in parentheses. The percentage change is computed using the sample average of the dependent variable in the first survey as the baseline level. * significant at 10 percent, ** significant at 5 percent, *** significant at 1 percent.

Finally, the program also contributed to reducing the money families allocated to water-related expenditures. Table 8 shows that, on average, families in the treatment group spent about 20 to 22 pesos per month (around US$ 7 to 7.5) less than families in the control group that bought water. This evidence implies that the provision of potable water through the MPG program reduced water-related expenditures between 85 and 95 percent with respect to the sample average of water-related expenditures at the baseline level. These savings represent around 4.5 percent of average total family income in the baseline survey for the treatment group.

Table 8. Effects on Water-Related Expenditures

Dependent variable	Water-related expenditures (in pesos)		Water-related expenditures including payment for water service after the program	
	(1)	(2)	(3)	(4)
I_{it}	-21.8678***	-19.7232**	-19.2469***	-17.1078**
	(6.3073)	(8.0001)	(6.2267)	(7.9029)
% change	-94.97	-85.65	-83.59	-74.30
Per capita income		-0.0001		0.0000
		(0.0175)		(0.0174)
Household Fixed Effects	Yes	Yes	Yes	Yes
Period Fixed Effects	Yes	Yes	Yes	Yes
Mean dependent variable	23.0266	23.0266	23.0266	23.0266
Observations	483	369	483	369
R-squared	0.85	0.88	0.85	0.88

Notes: The regressions are run at the household level. Robust standard errors are in parentheses. The percentage change is computed using the sample average of the dependent variable in the first survey as the baseline level. * significant at 10 percent, ** significant at 5 percent, *** significant at 1 percent.

Finally, Table 9 presents evidence on the allocation of this extra money by treated households. Families connected to the water network allocated most of the water savings to food consumption.

Table 9. Actual Spending of the Money Saved from Water-Related Expenditures in the Treatment Group

Expenditures on:	Percentages
Food/Beverages	67.61
Personal items	2.82
Items for children	9.86
Savings/paying public utilities	1.41
General expenses	14.08
No answer	4.23

Another important question is whether the expansion of the water network had positive or negative impacts on households in the treatment group that already had a clandestine self-connection to the water network. On the one hand, the expansion program meant that these families had to pay for something they were already receiving for free. On the other hand, these clandestine self-connections are of inadequate quality in terms of water pollution and low pressure. Table 10 differentially analyzes the effect of the MPG expansion for previously unconnected and clandestinely connected households. The results broadly show that the health and savings effects are about half for the clandestinely connected than they are for the previously unconnected, but in both cases the effects are large.

Table 10. Differential Effects for Unconnected Households and Households with Previous Clandestine Connections

Dependent variable:	Presence of diarrhea episodes	Duration of diarrhea episodes.	Severity of diarrhea episodes	Distance to well (in blocks)	Water-related expenditures
	(1)	(2)	(3)	(4)	(5)
Water for unconnected households	-0.1358**	-0.6544	-0.0802**	-1.1154***	-29.9020*
	(0.0607)	(0.4757)	(0.0398)	(0.2146)	(16.9421)
	{0.0557}	{0.4659}	{0.0452}		
% change	-96.31	-58.82	-108.82	-104.09	-129.86
Water for households with clandestine connection	-0.0686	-1.2626*	-0.0461	-0.6079***	-19.6430***
	(0.0586)	(0.7392)	(0.0339)	(0.2059)	(5.9026)
	{0.0505}	{0.9584}	{0.0336}		

Table 10., continued

Dependent variable:	Presence of diarrhea episodes	Duration of diarrhea episodes.	Severity of diarrhea episodes	Distance to well (in blocks)	Water-related expenditures
% change	-48.65	-113.49	-62.55	-56.73	-85.31
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes
Mean dependent variable	0.1410	1.1125	0.0737	1.0716	23.0266
Observations	819	819	819	934	483
R-squared	0.529	0.505	0.458	0.972	0.851

Notes: The regressions in columns (1) to (3) are run at the child level, whereas columns (4) and (5) are run at the household level. Robust standard errors are in parentheses. Robust standard errors clustered at the household-period level to address potential correlation among children of the same household are in curly brackets. The percentage change is computed using the sample average of the dependent variable in the first survey as the baseline level. These results do not change if per capita income is included as a regressor. Statistical significance calculated using the robust standard errors in parentheses: * significant at 10 percent, ** significant at 5 percent, *** significant at 1 percent.

7. Conclusions

In this paper, we study the effects of a specific program of water expansion in urban shantytowns undertaken by a privatized company in Argentina. We find large reductions in diarrhea episodes, their duration, and their severity among children in the treated population. We also record a significant reduction in water-related expenses, since piped water is cheaper than bottled water. We also show that these health and savings effects are important for households that previously had a clandestine self-connection to the water network, which was free but low quality.

Our results highlight two main findings that are important as policy lessons. First, there are significant savings from gaining access to the water network for those households that previously had to rely on alternative water sources (such as bottled water, clandestine connections, or water transported from distant wells). These savings are overlooked in traditional analyses of the privatization of water services. Second, the apparent monetary loss for those households when replacing their free clandestine self-connection with a formal water network connection may be overcome by important health improvements.

Appendices:

A. Definition of Variables

Presence of diarrhea episodes. Dummy variable adopting the value of 1 if the child (less than six years old) has had diarrhea in the reference month (one month before the survey was conducted).

Duration of episodes. Number of days the last diarrhea episode lasted.

Severity of the episode. Dummy variable adopting the value of 1 if the last diarrhea episode included blood and/or parasites.

Distance to well. Distance measured in blocks that a member of the family had to travel to bring water to the house from the nearest hand-pumped well.

Water-related expenditures. Monthly monetary expenditures on bottled water.

B. Effects of the MPG Program Excluding La Rivera Neighborhood

Dependent variable	Presence of diarrhea episodes	Duration of diarrhea episodes.	Severity of diarrhea episodes.	Distance to well (in blocks)	Water-related expenditures
	(1)	(2)	(3)	(4)	(5)
I_{it}	-0.0853	-0.8270	-0.0346	-0.7294***	-17.6393***
	(0.0523)	(0.5103)	(0.0308)	(0.1595)	(4.6200)
	{0.0460}	{0.6048}	{0.0325}		
% change	-60.16	-82.63	-66.03	-68.91	-86.30
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes
Mean dependent variable	0.1418	1.0009	0.0524	1.0585	20.4392
Observations	761	761	761	883	437
R-squared	0.57	0.54	0.52	0.98	0.92

Notes: The regressions in columns (1) to (3) are run at the child level, whereas columns (4) and (5) are run at the household level. Robust standard errors are in parentheses. Robust standard errors clustered at the household-period level to address potential correlation among children of the same household are in curly brackets. The percentage change is computed using the sample average of the dependent variable in the first survey as the baseline level. Statistical significance calculated using robust standard errors in parentheses: * significant at 10 percent, ** significant at 5 percent, *** significant at 1 percent.

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