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SOCIAL POLICY, REGULATION AND PRIVATE SECTOR WATER SUPPLY: THE CASE OF COLOMBIA

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Abstract

This paper investigates the impact of PSP on the poor in the Colombian water sector in terms of access, continuity of service and affordability. Overall, the results indicate that PSP in the Colombian water sector has had a strong and positive impact on the poor as far as continuity of service is concerned; which is crucial for effective water supply to the poor. We also find a positive effect on sewerage connection rates among the poor. The evidence is less robust for piped water connection rates, where PSP either had a positive or neutral effect on connection rates among the poor. As regards affordability of service there is no statistically significant effect of PSP. This last result may be associated with the particular water subsidy scheme used in Colombia. In turn, this points to the importance of complementary social policies as a way to mitigate the impact of reform on the poor.

Keywords: social policies, privatisation, water supply and sanitation, Latin America, Colombia

Resumen

Este trabajo analiza el impacto sobre los pobres en cuanto al acceso, continuidad de servicio y gasto, de la participación del sector privado (PSP) en el sector de agua potable en Colombia. Los resultados indican que la PSP en el sector de agua potable ha tenido un efecto positivo y significativo en la continuidad de servicio para los pobres, lo cual es crucial para el acceso efectivo a agua potable por parte de este segmento de la población. También se encuentra un efecto positivo en la tasa de conexión a la red de alcantarillado por parte de los pobres. La evidencia es menos clara para el caso de conexiones a la red de agua potable, donde los resultados indican un efecto positivo o neutro de la PSP sobre el acceso. En cuanto al gasto en agua potable, no existe evidencia que la PSP haya aumentado la cuenta que por este servicio pagan los hogares pobres. Este último resultado podría estar asociado al subsidio de agua potable existente en Colombia. A su vez, esto último apunta a la importancia del uso de políticas sociales complementarias para mitigar los impactos negativos de las reformas sobre los pobres.

Social Policy, Regulation and Private Sector water supply: the case of Colombia[1]

Andrés Gómez-Lobo[a] and Marcela Meléndez[b]

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1. INTRODUCTION

Private sector participation (PSP) in the water sector is a contentious issue, especially in Latin America. PSP in water led to riots in Cochabamba, Bolivia, in 2000, social protests that led to the failure of the concession contract in Tucuman, Argentina, in the late 90's, and strong social opposition forcing a round turn to planned concessions in Lima, Peru, as well as in Rio de Janeiro, Brazil. Due to its special characteristic as a basic life giving necessity, discussions surrounding water issues —including PSP— are arguably the most emotionally charged among those relating to public utility sectors.

In spite of the passionate debate concerning PSP in the water sector, there is scant evidence regarding the social and distributive impacts of PSP in this sector. Most of the literature on the impact of privatization has focused on firm level performance of operators.[2] There are also studies on the impact of water subsidies on poverty and income distribution (Gómez-Lobo and Contreras, 2004; Komives, Foster, Halpern and Wodon, 2005) as well as several studies emphasizing policy recommendations in order to make reforms more beneficial to the poor (Estache, Foster and Wodon, 2002). However, there is a scarcity of rigorous empirical evidence on the impacts of privatization on the poor in the water sector that can be used to confirm or reject claims made by critics or apologist of these reforms.

Nellis and Birdsall (2005) contain case studies of the distributive impacts of privatization in six Latin American countries (Argentina, Bolivia, Nicaragua, México, Brazil and Peru) plus China, Russia, Sri Lanka and Ukraine.[3] However, with the exception of one concession contract in La Paz and El Alto in Bolivia (Baya, McKenzie and Urquiola, 2005) and to a lesser extent the Buenos Aires concession in Argentina, the water sector is not widely treated. This is also the case of another group of studies contained in Ugaz and Waddams-price (2003).

Another strand in the literature is to use General Equilibrium Models to estimate the welfare impacts of reforms, including PSP in the water sector. This was done by Chisari, Estache and Romero (1999) for Argentina, and more recently by Boccanfuso, Estache and Savard (2005) for water reform in Senegal. However, CGE modeling is useful to simulate effects of future policy reforms but may not be the best methodological approach to identify the impacts of past reforms.

The most widely cited study on the social effects of water sector reform is Galiani, Gertler and Schargrodsky (2005) who assess the impact on child mortality of the private sector participation in municipal water companies in Argentina. Clarke, Kosec and Wallsten (2004) use household level data to analyze the effects of PSP on water and sewerage coverage rates in Bolivia, Brazil and Argentina.

The evidence to date, besides being scarce, is inconclusive. Baya, McKenzie and Urquiola, (2005) find a positive effect of PSP on coverage rates for La Paz and el Alto. They also find that prices rose by less in this area than in other cities of Bolivia. Coverage rates also increased in Buenos Aires, while tariff rates fell. However, in Mexico, privatization was associated with rising tariffs (Birdsall and Nellis, 2002). In Argentina, Galiani, et al (2005) find a significant reduction on child mortality (relate to water borne diseases) in areas where the water service was privatized. For Bolivia, Brazil and Argentina, Clarke, Kosec and Wallsten (2004) find that coverage rates improved both in areas with and without private participation, thus increasing access does not seem to be related to private participation, although at least the poor were not hurt by PSP. Boccanfuso, Estache and Savard (2005) find regressive impacts of water reform in Senegal.

In this paper, we use two waves of the Living Standards Households surveys (1997 and 2003), and econometric techniques from the modern policy evaluation literature, to identify the impacts of private sector participation (PSP) in the Colombian water sector on access, continuity of service and affordability. Overall, the results indicate that PSP in the Colombian water sector has had a strong and positive impact on the poor as far as continuity of service in concerned. We also find a positive effect of PSP on sewerage connection rates among the poor. The evidence is less robust for piped water connection rates, where PSP either had a positive or neutral effect on connection rates among the poor. As regards affordability of service, measured by the proportion of poor households that pay more than 3% of their monthly income on water bills, there is no statistically significant effect of PSP. There is some evidence that this last result is associated with the particular water subsidy scheme used in Colombia. In turn, this points to the importance of complementary social policies as a way to mitigate the impact of reform on the poor.

This paper expands the existing literature in four dimensions. First, it presents another case study of the impacts of PSP in water sector on the poor in a country not covered by the existing literature. As mentioned above, there is scarcity of studies that deal with the impact of PSP on the poor in the water sector. Recognizing the importance of adequate water supply and sanitation for the alleviation of poverty and the need for substantial further investment in most development countries to meet the Millennium Development Goals, it is probable that PSP in the water sector will remain in the agenda together with the controversies that it generates. Thus, this paper provides additional evidence in order to make informed judgments on this highly controversial issue.

Second, existing studies have generally examined the issue of coverage and prices (affordability). To our knowledge ours is the only study that examines continuity of service (24 hours, 7 days a week) of service. This is an important issue given that effective water supply for the poor depends both on having access to the network (connection) and on the service being forthcoming (continuity

of service). In Colombia, the lack of continuity of service seems to be just as important as lack of access for the well being of poor households. Our results indicate that PSP has had its clearest and strongest impact in this dimension. Thus previous studies that ignore this effect are probably omitting one of the most important beneficial impacts on the poor of private water provision.

Third, our results on affordability are quite surprising. Although the data does not allow us to make conclusive judgements as to the role of social policies in making PSP amiable to the poor, the evidence does suggests that the particular subsidy scheme used in Colombia to reduce the financial burden of utility bills on poorer households may have been a contributing factor. Thus, perhaps the important issue relating to poverty and water sector reform may not be so much the ownership of providers (public versus private) but the complementary social policies that are implemented.

Finally, in this paper we use several econometric techniques from the social policy evaluation literature to overcome potential selectivity biases and other statistical problems related with our data. Our methodological approach may be useful for other researchers working with similar data as ours.

This paper is organized as follows. Section 2 describes the different PSP experiences in the Colombian water sector. In Section 3, we present the data and discuss the econometric issues and estimation techniques used in the analysis. In Section 4 we present the results. The paper concludes with a discussion of the findings, especially as relates to the water subsidy scheme used in Colombia to make water affordable to the poor.

2. PSP IN THE COLOMBIAN WATER SECTOR[4]

There are two clearly defined stages in the PSP in the water and sanitation sector in Colombia. The first stage, between 1991 and 1997 consisted in individual Municipalities autonomously awarding contracts to private operators or the formation of mixed public-private companies to administer, operate and invest in their respective water companies. The second stage, between 1997 and the present, involved a more structured approach with the central government playing a vital role in structuring and funding these processes. The first stage was initiated by the city of Barranquilla, which in 1991 created a public share company to operate its water and sanitation infrastructure. In this company, private investors owned 11% of shares, while the Municipality owned the rest. Later the ownership share of private investors increased to 50%. Other cities adopted a similar model of PSP, including Montería, Florencia, and Santa Marta.

Cartagena incorporated a private operator into its mixed property company in 1994. In Chipichape a completely private company was established in 1994 to operate and administer the water and

sewerage services in that locality. This company charges customers for water and sewerage services and then pays EMCALI, owner of the infrastructure, a transport fee for using the water and sewerage mains and for the disposing of waste water.

Table 1 presents a summary of the main PSP experiences during this first stage of PSP in the water sector. This first stage was characterized by a rather haphazard and individual approach to PSP. A review by CONPES (1997) identified several problems with the way PSP was being undertaken by different Municipalities during this period.

As a reaction to the problems encountered with the above experiences, in 1997 the national authorities developed what was called the Management Modernization Program (Programa de Modernización Empresarial, or PME). This program was aimed at promoting PSP in the water sector but on a more technically sound basis.

Table 1: Main PSP experiences before 1997

Municipality	Population 1995	Type of PSP	Year
Tunja	113,454	Concession	1996
Palmira	255,303	Municipal/ Private partnership	NA
Neiva	289,516	Municipal/ Private partnership	1996
Cartagena	780,527	Municipal/ Private partnership	1995
Santa Marta	329,556	NA	NA
Montería	303,468	Minority share ownership	1994
Florencia	112,737	Minority share ownership	1991
Barranquilla	1,126,729	Minority share ownership	1991

Source: CONPES (1997), National Planning Department and DANE.

Under PME, a municipality receives technical advice and co-financing for the hiring of consultants in order to structure a reform process in which tariff levels, investment commitments and coverage targets are mutually consistent. The central government also offers to partially fund priority investments for municipalities that take part in the PME program. Specific targets for the improvement of services to low-income households are a central feature of the reforms structured under PME.

Some other features of the PME program include the creation of autonomous operating companies in participating municipalities —in many cases services were ran by a special unit within the local government administration— and a commercial orientation of management and services. In addition, under PME the central authorities explicitly promote the association of neighbouring

municipalities in a given reform process. The objective is to exploit economies of scope and scale in the operation of services by tendering contracts over a more aggregate geographical area than just a municipality.

Contracts are competitively tendered and last between 10 to 30 years. The tendering variable is either the price bidders are willing to pay for each share of the company or the tariff offered to users. Since its creation in 1997 until early 2003, 19 contracts have been tendered under the PME framework.[5] Given that some contracts cover more than one municipality, the number of municipalities involved is larger. A summary of these contracts is presented in Appendix 1. In practice almost all contracts tendered to date have mixed public/private investment commitments with US$152 million of the US$355 million total projected investment being funded by the private sector and benefiting 1.8 million individuals. The rest of the investment program is funded from national government funds or Municipal funds.

Table 2 presents the information available from the National Planning Department (DNP) regarding the institutional structure and ownership of water providers up to 2005. From this table we can see that 89 providers —close to 10% of the total— have some form of PSP, including those companies that have a concession or contract under the PME framework. Since some contracts cover more than one municipality, the number of municipalities with some form of private provision is higher. According to Fernández (2004)) by 2003 there were over 100 municipalities with private participation in the water sector, accounting for 15% of the urban population.

Table 2: Types of water providers in Colombia, 2005

Type of organization	Number	Percentage
Private company	62	7.3%
Mixed property company	27	3.2%
Municipal company	1	0.1%
State owned company	196	22.9%
Organization within Municipality	188	22.0%
Share company wholly owned by public sector	12	1.4%
Other (authorized organizations and others)	369	43.2%
Total	855	100.0%

Source: National Planning Department (DNP) of Colombia.

From this information we can conclude that there are at least three types of PSP schemes in operation in Colombia. First, a municipality may have tendered a contract under the PME framework. We know for certain that these contracts were tendered after 1997.[6] Second, a

municipality may have followed an independent process to incorporate a private operator within its coverage area. To make matter more complex, there are municipalities with more than one operator, some with PSP and others without.

3. ESTIMATING THE IMPACT OF PSP ON POVERTY RELATED ISSUES

(a) Data

In the empirical estimation we use the last two waves of the Living Standards Measurement Survey (ECV 1997 and 2003). This household-level survey includes several questions regarding household connections to water supply, sewerage connections, expenditure on water and sewerage, and water supply quality. The 2003 survey was much larger and covered more localities than the 1997 survey.[7] In addition, these surveys were not designed to be statistically representative at the municipal level, only at the regional and rural/urban segmentations. Thus, some households from a given municipality were surveyed in 1997, but the corresponding municipality may not have been covered in 2003 and vice versa. In addition, even when there is an overlap of the municipalities surveyed in both waves, the households in each case are not representative of those municipalities and therefore municipal level averages cannot be constructed.

As discussed further below, the nature of the data imposes certain statistical difficulties to correctly identify the effects of private participation on the variables of interest. Therefore, several different methodological approaches are used to test the robustness of the results. The variables of interest in this paper are: (a) whether a household has a connection to piped water supply, (b) whether the household has a connection to a sewerage network, (c) whether the monthly water bill (excluding sewerage) is above 3% of monthly household expenditure, and (d) whether the households receives a continuous (24 hours, 7 days a week) water supply or not.[8] In all four cases the variable of interest is discrete, taking a value of one if the condition is met for a certain observation and zero otherwise.

Our affordability measure deserves some comments. First, only expenditure on water services is used. Although sewerage expenditure is also available for some observations, the sample size is reduced considerably if we use expenditure on both water and sewerage since the number of missing observations for sewerage expenditure is large. Second, although usually a 5% limit of expenditure (or income) is used as rule of thumb for the affordability of services, this figure generally considers both water and sewerage. Since we only consider expenditure on water services, we use a 3% affordability threshold.

Since the main interest of our research is the impact of PSP on low-income households, observations were ranked according to expenditure per capita deciles.[9] We consider households in the first four deciles as poor and the main object of our research.

Table 3 presents some summary statistics regarding the variables of interest. At the national level there has been an important increase in the percentage of households connected to piped water and sewerage networks. Although this increase in coverage has benefited households across the whole income distribution, it has been strongest among the lowest deciles. However, lack of access is still an important issue among the poor.

Continuity of service seems to be just as important an obstacle for effective water supply to poor households. More than a third of connected households in the first two deciles of the expenditure distribution receive continuous service.[10] The situation is not much better among households in the third and fourth decile. Moreover, continuity of service seems to have deteriorated between 1997 and 2003 for poor households.

Affordability is also an important issue given that households in the lowest expenditure decile pay more than 3% of the monthly total expenditure on water.

Table 3: Summary statistics by expenditure per capita deciles

Decile	Proportion of households with a water Connection		Continuity of service among connected households (24 hours, 7 days a week)		Expenditure on water as a proportion of total household expenditure		Proportion of households with a sewerage connection	
	1997	2003	1997	2003	1997	2003	1997	2003
1	0.54	0.62	0.68	0.63	0.049	0.048	0.26	0.32
2	0.69	0.74	0.63	0.61	0.027	0.029	0.44	0.47
3	0.78	0.82	0.69	0.64	0.021	0.025	0.57	0.59
4	0.87	0.87	0.71	0.70	0.020	0.024	0.67	0.71
5	0.91	0.89	0.68	0.72	0.017	0.022	0.73	0.75
6	0.91	0.92	0.76	0.76	0.017	0.020	0.80	0.82
7	0.94	0.95	0.75	0.78	0.017	0.019	0.84	0.87
8	0.96	0.96	0.78	0.78	0.014	0.016	0.89	0.88
9	0.98	0.95	0.83	0.79	0.014	0.014	0.93	0.88
10	0.99	0.98	0.85	0.87	0.012	0.012	0.94	0.95

Notes: All statistics are the average of each variable in each equivalent expenditure decile. Survey weights were used to estimate averages in each case.
Source: ECV 1997 and 2003, Departamento Nacional de Estadística, DANE.

(b) Methodology

In order to identify the varying effects that private versus public ownership may have had on connection rates, affordability and continuity of service we apply several econometric techniques. This is done to evaluate the robustness of the results to different comparison groups and estimation methods.[11]

The first method used is a simple regression using the 2003 survey data and including a dummy indicator of PSP as an explanatory variable:

$$y_i = \alpha + \beta \cdot D_i^{PSP} + \gamma' \cdot X_i + \varepsilon_i \qquad (1)$$

where y represent our variable of interest, X is a vector of socioeconomic and dwelling characteristics and γ is conformable vector of parameters.[12]

One reason to estimate a model using the 2003 data only is that we know in which Municipalities there are companies with PSP in 2003 (either under the PME framework or as an independent process). Thus we can clearly identify whether a household is treated or not treated.[13] As mentioned above, we lack information on the staring date of the non-PME processes and therefore we are unsure whether the observations in 1997 where treated or not.

However, there are major problems with using just one cross-section to identify the effects of PSP. First, it may be that the areas with PSP and without PSP differ with respect to the observable socioeconomic and dwelling characteristics contained in the vector X. For example, it may be that the average income of households surveyed in municipalities with PSP is different from those in municipalities without PSP. If the effects of PSP are different depending on the level of X, then the above model is not well specified. As an illustration, it may be that the impact of PSP on coverage rates will be lower for higher income municipalities that already have high coverage rates. The above model assumes that the impact of PSP is the same for all levels of the variables X, the so-called homogenous effects assumption (see Blundell and Costa-Dias, 2002).

The second problem is that the occurrence of PSP may not be random but instead may be related to some factor of each locality that is not controlled for in the X vector. For example, perhaps PSP

was undertaken in those areas where the water distribution systems were initially in very bad shape or coverage levels were very low. If we now compare areas with and without PSP, the first will have lower coverage rates but this may be due to the fact that PSP was brought in precisely because these areas lagged behind in this respect.

The last problem can be tackled using two or more cross-sections of data. If we are willing to make the homogenous effects assumption, as in our first model, we can then estimate the model using a Difference in Difference (DID) approach suing both waves of the survey:

$$y_{it} = \alpha + \beta \cdot D_{it}^{PSP} + \delta \cdot D_{it}^{year} + \varphi \cdot (D_{it}^{PSP} \cdot D_{it}^{year}) + \gamma' \cdot X_{it} + \varepsilon_{it}. \quad (2)$$

In this model, the dummy variable indicating that the provider for observation i in year t has private participation and the dummy indicator of the year are interacted. Assuming for illustration purposes that there are no X regressors, then it is easy to show that the parameter associated with this interacted variable measures:

$$\hat{\varphi} = \left(\bar{y}_{2003}^{T} - \bar{y}_{1997}^{T}\right) - \left(\bar{y}_{2003}^{NT} - \bar{y}_{1997}^{NT}\right)$$

where the superscript denotes the group of observations with PSP (T: treated) or without (NT: not treated) in each year. This estimator compares the change between both years in the average value of the y variable over treated and non-treated observations. In essence, this estimator uses the change in the average value of the y variable of non-treated observations as a control benchmark to evaluate the change in the treated group.

Since we are unsure when the non-PME private participation experiences began we implement two DID estimators. The first assumes that only those Municipalities identified in Table 2 had PSP in 1997.[14] We know this may wrongly classifies some municipalities as not having PSP in 1997 when they really did have private participation by that date. The second DID estimator excludes all observations from municipalities that were identified as having non-PME type private participation at some date. What this second estimator does is to compare observations from PME municipalities with observations from municipalities that never had private participation.

One of the assumptions of both methods presented above is that the treatment effect is homogeneous. That is, PSP affects all observations in the same magnitude irrespective of their individual characteristics, or X values. In some general sense, the problem with heterogeneous effects is that we are not comparing 'like with like' in the above regressions. That is, the control groups are not properly defined.

We tackle the above problem by following two strategies. The first is to apply each of the above models using different subsets of the data. In the first case we use all observations available. In the second case, we drop all observations from the three principal cities (Bogotá, Cali and Medellin) under the assumption that owing to their size and political importance these cities are not comparable to the rest of the municipalities of Colombia. Finally, we drop all observations that belong to the largest municipality in each Department, thus leaving observations from the relatively smaller municipalities in each region. The idea is that by selecting a subset of the data we are making the database more homogenous, thus making the treatment and control groups more comparable. By analyzing how results vary across each subset of the data we can evaluate the robustness of the results. In addition, this strategy controls for possible endogeneity problems associated with the PSP variable.

The second strategy is to use a propensity-score matching estimator. What a matching estimator does is to compare the outcome of one household that was treated with one (or several) untreated 'similar' households. Similarity in this context refers to having common X characteristics. It is a more refined method for determining a control group. With a matching estimator, observations without common support —that is treated observations that do not have a counterpart in a non-treated observation— are not considered in the analysis. We estimate a propensity-score matching estimator using the data from 2003.

In summary, we estimate four models (linear regression with 2003 data, two DID estimators using 1997 and 2003 data, and a matching score estimator using 2003 data). Each of these models was estimated on three different sub-samples of the data (full sample, sample excluding observations from the three largest cities, and sample excluding all observations from the largest municipalities in each Department). Each estimation method and sample definition is controlling for different statistical problems that may characterize our data. Therefore, if the empirical results are consistent among the different methods and samples used, we can be quite confident that they are not spurious.

5. RESULTS

We present the results for each of the four variables in turn.[15] Since our main interest is the effect of PSP on the poor, the estimations were undertaken using both all households as well as the subset of households in the first four deciles of the income distribution. For each model we only present the estimated parameter relating to the presence of PSP. However, each regression included the following control variables in the X vector: dummy variables for each region (this a more aggregate classification than Department, there are 9 regions in the country), number of persons in the household, income (in pesos of 2003), and dummy variables indicating an electricity connection, telephone, different types of dwelling wall material, garden in dwelling and garage. These were all the household variables available for both years of the survey. In addition to household level controls, we also included some municipal level variables for each observation. These included the population density and a poverty index, both calculated for each municipality.[16] The poverty index is a measure of the 'unsatisfied basic needs' of the population and is crucial to control for different socioeconomic conditions in treated and untreated municipalities. The population density variable is also important to control for differences in service costs among municipalities.

The matching estimator used the five nearest neighbor matching for each treated observation. Standard errors were obtained by bootstrapping 100 times.[17]

The number of observations and the adjusted R2 statistic (were relevant) is presented for each estimated model in Appendix 2.

(a) Water connections

Table 4 presents the results for the water connection variable. Rows 1 and 2 present the estimated coefficients using the simple linear model with 2003 data, on the full sample and then on the sample including only households in the first four deciles of the income distribution. Each column presents the results using different sub-samples of municipalities. The parameter in the first row and second column of the table indicates that across the full sample of observations, the water connection rate of households in municipalities with PSP is about 0.05 percentage points higher than in non-PSP municipalities. This coefficient is statistically significant at a 1% confidence level. If we consider only poor households, the estimated coefficient is almost identical and is also statistically significant. If we exclude the three largest municipalities from the data (Bogotá, Cali and Medellin) the coefficient using the full sample increases slightly and remains statistically significant. If we further exclude all of the principal municipalities of each Department, the coefficient is even larger and also highly significant statistically.

Table 4: Estimation results for the water connection variable

		All Municipalities in the data	All Municipalities except Cali, Medellin and Bogota	All Municipalities excluding largest in each Department
Simple regression using 2003 data only	Decile 1-10	0.0542 ***	0.0616 ***	0.0773 ***
	Decile 1-4	0.0543 ***	0.0681 ***	0.1010 ***
Difference in difference estimator using 1997 and 2003 data	Decile 1-10	- 0.0021	- 0.0068	0.0520 ***
	Decile 1-4	0.0350	0.0217	0.0604 **
Difference in difference dropping Municipalities with PSP but not PME	Decile 1-10	0.0839 **	0.0972 **	0.0961 **
	Decile 1-4	0.0503	0.0725 *	0.0735 *
Propensity score matching using 2003 data	Decile 1-10	0.1216 **	0.1028 **	0.1276 **
	Decile 1-4	0.1300 **	0.0120	0.0300

Notes: All regression, except for propensity score matching, use survey weights for each observations.

Propensity score matching used 5 nearest neighbours and standard errors were estimated by bootstrapping 100 times.

* significant at a 10% confidence level

** significant at a 5% confidence level

*** significant at a 1% confidence level

The results of the first model seem to indicate a strong and positive effect of PSP on water coverage, which in the case of poorer households is between 0.05 to 0.10 percentage points, depending on the sub-sample used. These results may be biased if there are systematic differences among treated and non-treated municipalities which we do not control for in the regression or if the impacts of PSP are not homogenous among different types of municipalities or households.

Therefore, a first step to check the robustness of these initial results is to compare them to results using the difference in difference estimator. We can see that in this case PSP does not have a statistically significant effect on water coverage except when we restrict the sample to the relatively smaller municipalities. In this last case there is a positive and significant effect of 0.06 percentage points among poor households.

If we apply the DID estimator but dropping all municipalities that had non-PME PSP at some date, the estimated impacts are positive and significant, although for the case of poor households in one of the three samples the coefficient is not statistically significant. Finally, the propensity-score estimator indicates a positive and significant effect of PSP, although when the sample is restricted to poor households in two of the three cases there is no statistically significant effect.

The above results for water connections can be summarized as follows. In general, there seems to be a positive and significant impact of PSP on coverage rates, although for poorer households the evidence is weak and in many cases there is no discernible effect on connection rates for this group. What is clear, however, is that there are no cases in which PSP had a significantly negative effect on water coverage rates. Therefore, at least in can be stated unambiguously that PSP did not hurt the poor as far as water connections are concerned, while they possibly benefited in some areas particularly in smaller municipalities.

(b) Sewerage connections

Table 5: Estimation results for the sewerage connection variable

		All Municipalities in the data		All Municipalities except Cali, Medellin and Bogota		All Municipalities excluding largest in each Department	
Simple regression using 2003 data only	Decile 1-10	0.1072	***	0.1258	***	0.1216	***
	Decile 1-4	0.0664	***	0.0959	***	0.1160	***
Difference in difference estimator using 1997 and 2003 data	Decile 1-10	- 0.0051		- 0.0144		0.1088	***
	Decile 1-4	0.1183	**	0.0944	**	0.1104	**
Difference in difference dropping Municipalities with PSP but not PME	Decile 1-10	0.2201	***	0.2538	***	0.2553	***
	Decile 1-4	0.1816	***	0.2382	***	0.2409	***
Propensity score matching using 2003 data	Decile 1-10	0.1961	***	0.1412	**	0.2052	***
	Decile 1-4	0.1168	**	0.0496		0.0794	**

Notes: All regression, except for propensity score matching, use survey weights for each observations.

Propensity score matching used 5 nearest neighbours and standard errors were estimated by bootstrapping 100 times.

* significant at a 10% confidence level

** significant at a 5% confidence level

*** significant at a 1% confidence level

Table 5 presents the results with respect to sewerage connections. In general the estimated effects are in almost all cases positive and statistically significant, especially among poorer households. In addition, the absolute level of the estimated parameters are higher than in the case of water connections, indicating that the effects of PSP, if any, are stronger with respect to sewerage connections than to water connections. This may be reasonable considering that there was a larger initial deficit in sewerage connections in relation to water connections (see Table 3). The only case in which the PSP variable was not statistically significant among the poor is with the propensity score matching estimator when the three largest urban centers are dropped from the sample. If we give more credibility to the DID estimators we find that the impacts of PSP increases sewerage

connections between 0.09 and 0.11 points among the poor and even more if PME municipalities are compared to non-PSP municipalities.

(c) Affordability

Table 6 presents the results for the affordability variable. The results in this case are mixed. The results for the simple regression using 2003 data and the first DID estimator show a positive and significant impact of PSP on affordability when all households are included. This implies that in municipalities that had PSP a larger fraction of households paid water bills above 3% of monthly household expenditure. However, it is interesting to note that when the sample is restricted to poor households, this effect disappears with no statistically significant effect of PSP on affordability. This last result is probably due to the contribution of the subsidy scheme used in Colombia to protect poor households from high utility service bills. Although PSP brings about higher bills as a proportion of expenditure, households in the lower deciles receive a subsidy that helps to neutralize this effect. We will come back to this issue in the conclusions.

Table 6: Estimation results for the affordability variable

		All Municipalities in the data	All Municipalities except Cali, Medellin and Bogota	All Municipalities excluding largest in each Department
Simple regression using 2003 data only	Decile 1-10	0.0474 **	0.0446 ***	0.0041
	Decile 1-4	0.0341	0.0333	- 0.0336
Difference in difference estimator using 1997 and 2003 data	Decile 1-10	0.0689 **	0.0565 **	0.0380 *
	Decile 1-4	0.0433	0.0450	0.0090
Difference in difference dropping Municipalities with PSP but not PME	Decile 1-10	- 0.1416 **	- 0.1262 **	- 0.1231 **
	Decile 1-4	- 0.1405 **	- 0.1196 **	- 0.1157 **
Propensity score matching using 2003 data	Decile 1-10	0.0061	- 0.0950 **	- 0.1095 **
	Decile 1-4	- 0.0357	- 0.0569	- 0.0471

Notes: All regression, except for propensity score matching, use survey weights for each observations.
Propensity score matching used 5 nearest neighbours and standard errors were estimated by bootstrapping 100 times.

* significant at a 10% confidence level

** significant at a 5% confidence level

*** significant at a 1% confidence level

Furthermore, if only PME municipalities are compared with non-PSP municipalities, the impact of PSP is negative and statistically significant, both for all households as well as for poor households. This implies that PME municipalities were associated with lower water bills to total expenditure than municipalities that never had private sector participation. However, with the propensity-score matching estimator the PSP variable in general had no effect on affordability for poorer households.

Once again we find that in no case is there a measurable negative effect on poor households. Therefore, in the worse case, poorer households were unaffected by PSP as far as affordability is concerned.

(d) Continuity of service

Table 7 presents the results for continuity of water supply. In this case the results are quite consistent across estimation methods and sub-samples used. Except for some negative results with the first DID estimator, all the other parameter estimates are positive and statistically significant. Moreover, among poor households the results show that PSP had a strong significant effect on the continuity of service compared to non-PSP municipalities in all cases and sub-samples. The estimated effects for the poor imply that continuity of service was between 0.13 to 0.33 percentage points higher due to PSP among this group.

Table 7: Estimation results for the continuity of service variable

		All Municipalities in the data	All Municipalities except Cali, Medellin and Bogota	All Municipalities excluding largest in each Department
Simple regression using 2003 data only	Decile 1-10	0.1787 ***	0.1921 ***	0.1945 ***
	Decile 1-4	0.2173 ***	0.2293 ***	0.2252 ***
Difference in difference estimator using 1997 and 2003 data	Decile 1-10	- 0.0896 ***	- 0.0858 **	0.1796 ***
	Decile 1-4	0.1369 **	0.1486 **	0.2118 ***
Difference in difference dropping Municipalities with PSP but not PME	Decile 1-10	0.3616 ***	0.3829 ***	0.3953 ***
	Decile 1-4	0.2892 ***	0.3126 ***	0.3210 ***
Propensity score matching using 2003 data	Decile 1-10	0.1915 ***	0.1789 ***	0.1946 **
	Decile 1-4	0.1936 **	0.2202 ***	0.2634 ***

Notes: All regression, except for propensity score matching, use survey weights for each observations.
Propensity score matching used 5 nearest neighbours and standard errors were estimated by bootstrapping 100 times.
* significant at a 10% confidence level
** significant at a 5% confidence level
*** significant at a 1% confidence level

7. CONCLUSIONS

In this paper we analyze the impacts that private sector participation in the water sector in Colombia had over four variables: piped water connections, sewerage connections, affordability, and continuity of service.

Overall the results indicate that PSP has had a strong and positive impact on the poor as far as continuity of service is concerned. There has also been a positive effect on sewerage connection rates among the poor. The evidence is less robust for the piped water connection rates, where PSP either had a positive or neutral effect on connection rates among the poor. As regards affordability of service, as measured by the proportion of poor households that pay more than 3% of their monthly income on water bills, there is no statistically significant effect of PSP.

The strong and robust results relating to continuity of service are interesting since much of the literature has been mute on this point. However, they are not really that surprising. Private operators have expertise in improving the operation and maintenance of water and sewerage systems while connection rates depend more on investment levels. In turn, the investment that can be funded in a given reform will depend, among other things, on the level of tariffs and in the case of Colombia the capacity of the municipality to mobilize matching investment funds. In many PSP experiences, municipal authorities were unwilling to increase tariffs thus limiting the investment capacity of operators. In fact, many of these contracts can be characterized more as operational and management contracts rather than concessions.

Furthermore, our results are consistent with Galiani et. al (2005) who find positive health effects of PSP in Argentina. These health effects can also be considered, together with continuity of service, as another dimension of quality of service.

Another surprising result is the absence of an effect of PSP on affordability. However, the results are interesting because in some of our estimations using the full sample of data, PSP does seem to have an impact on affordability. However, when only poor households are included, this effect disappears. Therefore, it seems that there is some factor that is mitigating the impacts of PSP on water bills for poor households. Naturally, an obvious candidate for this mitigating effect is the unique subsidy scheme for public services applied in Colombia. This scheme is a formal cross subsidy mechanism, enshrined in law, whereby lower income households (as identified a socioeconomic stratification system based on dwelling characteristics) receive a subsidy on their water, electricity and local telecommunication bills, while higher income households pay a surcharge. This scheme is further described and evaluated in Gómez-Lobo and Contreras (2004) and Cardenas and Melendez (2004).

From the perspective of the present paper, these findings would seem to suggest that the heated discussions surrounding PSP in the water sector may be misleading. More than ownership, what may really matter for the poor are the social policy instruments used to mitigate high water bills. These schemes can operate perfectly well with private as well as public providers as shown by the Colombian and Chilean experience (Gómez-Lobo and Contreras, 2004).

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APPENDIX 1: Summary of contracts tendered until 2003 under the PME framework

Contract[1]	Population (x1,000)	PSP type	Start date	Investments (US$ millions)[2]			
				Total	National	Municipal	Private
ASOAGUA (La Guajira): Barrancas, Distracción, El Molino, Villanueva	42.7	Operation with investment (12 years)	Nov. 2000	0.8	0.3	0.3	0.2
ASOSASA (Atlántico): Sabana grande y Santo Tomás	44.0	Operation with investment (10 years)	Jun. 2002	4.6	0.8	3.4	0.4
Buenaventura (Valle del Cauca)	350.0	Management and operation (20 years)	Jan. 2002	62.0	15.0	19.0	28.0
Cumaral (Meta)	9.2	Construction-operation (10 years)	Jan. 2002	1.5	0.7	0.5	0.3
El Charco (Nariño)	5.3	Management and operation	Jan. 2002	1.6	0.7	0.6	0.3
Guapi (Cauca)	14.0	Management and operation (20 years)	Jan. 2002	1.0	0.2	0.4	0.4
Istmina (Chocó)	13.5	Management and operation (12 years)	Oct. 2001	1.7	0.1	0.1	1.5
Maicao (Guajira)	100.0	Concession (30 years)	Jan. 2001	51.3	6.8	16.5	28.0
Montería (Córdoba)	320.0	Concession (20 years)	Jan. 2000	70.0	4.0	28.0	38.0
Nátaga (Huila)	1.8	Construction-operation (10 years)	Apr. 2001	2.8	2.2	0.6	---
Pondera (Atlántico)	9.1	Construction-operation (10 years)	Aug. 2002	1.2	0.6	0.7	0.0
Puerto Carreño (Vichada)	7.5	Management and operation (20 years)	Jan. 2002	2.2	0.3	1.5	0.4
Riohacha (Guajira)	90.0	Management and operation (20 years)	Nov. 2000	36.1	4.4	7.5	24.2
San Juan Nepomuceno (Bolívar)	27.0	Management and operation (10 years)	Dec. 2001	3.0	0.4	2.6	0.0
San Marcos (Sucre)	32.75	Operation with investment (15 years)	Jul. 2002	4.1	1.0	2.9	0.2
Soledad (Atlántico)	360.0	Concesión (20 years)	Dec. 2001	43.2	2.0	28.0	13.2
Tadó (Chocó)	9.1	Management and operation (12 years)	Oct. 2001	0.6	0.1	0.0	0.4
Sincelejo-Corozal (Sucre)	280.5	Operation with investment (20 years)	Dec. 2002	61.0	1.9	6.1	17.0
El Banco (Magdalena)	51.7	Operation with investment (16 years)	May 2003	6.4	1.8	4.5	0.05
Total	1,768.2			355.0	43.4	123.1	152.5

Source: CONPES (2003) and Ministry of Environment, Housing and Territorial Development (MAVDT).

Notes: [1] Name of contract is followed by Department (in parenthesis) and by the municipalities involved. [2] Investment figures are for the level committed by the national government, municipal government and the private sector. Figures are planned investments not effective investments.

APPENDIX 2: Summary statistics of econometric results

		All Municipalities in the data	All Municipalities except Cali, Medellin and Bogota	All Municipalities excluding largest in each Department
Simple regression using 2003 data only	Decile 1-10	n=7292; R2 adj.=0.31	n=6324; R2 adj.=0.30	n=5181; R2 adj.=0.30
	Decile 1-4	n=3785; R2 adj.=0.30	n=3488; R2 adj.=0.28	n=3202; R2 adj.=0.28
Difference in difference estimator using 1997 and 2003 data	Decile 1-10	n=13671; R2 adj.=0.30	n=11794; R2 adj.=0.29	n=9679; R2 adj.=0.29
	Decile 1-4	n=7026; R2 adj.=0.28	n=6534; R2 adj.=0.27	n=5948; R2 adj.=0.26
Difference in difference dropping Municipalities with PSP but not PME	Decile 1-10	n=11358; R2 adj.=0.30	n=9481; R2 adj.=0.28	n=8472; R2 adj.=0.27
	Decile 1-4	n=6061; R2 adj.=0.28	n=5569; R2 adj.=0.26	n=5391; R2 adj.=0.25
Propensity score matching using 2003 data	Decile 1-10	n=4743	n=4146	n=3421
	Decile 1-4	n=2373	n=2233	n=1985

Table A2.1: Water connection variable (number of observations and adjusted R^2)

Table A2.2: Sewerage connection variable (number of observations and adjusted R^2)

Table A2.3: Affordability variable (number of observations and adjusted R^2)

		All Municipalities in the data	All Municipalities except Cali, Medellin and Bogota	All Municipalities excluding largest in each Department
Simple regression using 2003 data only	Decile 1-10	n=7292; R2 adj.=0.46	n=6324; R2 adj.=0.45	n=5181; R2 adj.=0.44
	Decile 1-4	n=3785; R2 adj.=0.44	n=3488; R2 adj.=0.41	n=3202; R2 adj.=0.41
Difference in difference estimator using 1997 and 2003 data	Decile 1-10	n=13761; R2 adj.=0.44	n=11794; R2 adj.=0.42	n=9679; R2 adj.=0.40
	Decile 1-4	n=7026; R2 adj.=0.41	n=6534; R2 adj.=0.36	n=5948; R2 adj.=0.35
Difference in difference dropping Municipalities with PSP but not PME	Decile 1-10	n=11358; R2 adj.=0.45	n=9481; R2 adj.=0.39	n=8472; R2 adj.=0.38
	Decile 1-4	n=6061; R2 adj.=0.40	n=5569; R2 adj.=0.34	n=5391; R2 adj.=0.33
Propensity score matching using 2003 data	Decile 1-10	n=4743	n=4146	n=3421
	Decile 1-4	n=2373	n=2233	n=1985

		All Municipalities in the data	All Municipalities except Cali, Medellin and Bogota	All Municipalities excluding largest in each Department
Simple regression using 2003 data only	Decile 1-10	n=7292; R2 adj.=0.15	n=6324; R2 adj.=0.16	n=5181; R2 adj.=0.16
	Decile 1-4	n=3785; R2 adj.=0.13	n=3488; R2 adj.=0.13	n=3202; R2 adj.=0.13
Difference in difference estimator using 1997 and 2003 data	Decile 1-10	n=13671; R2 adj.=0.13	n=11794; R2 adj.=0.13	n=9679; R2 adj.=0.14
	Decile 1-4	n=7026; R2 adj.=0.09	n=6534; R2 adj.=0.10	n=5948; R2 adj.=0.10
Difference in difference dropping Municipalities with PSP but not PME	Decile 1-10	n=11358; R2 adj.=0.14	n=9481; R2 adj.=0.15	n=8472; R2 adj.=0.15
	Decile 1-4	n=6061; R2 adj.=0.11	n=5569; R2 adj.=0.11	n=5391; R2 adj.=0.11
Propensity score matching using 2003 data	Decile 1-10	n=4743	n=4146	n=3421
	Decile 1-4	n=2373	n=2233	n=1985

Table A2.4: Continuity variable (number of observations and adjusted R^2)

		All Municipalities in the data	All Municipalities except Cali, Medellin and Bogota	All Municipalities excluding largest in each Department
Simple regression using 2003 data only	Decile 1-10	n=5520; R2 adj.=0.27	n=4570; R2 adj.=0.23	n=3818; R2 adj.=0.23
	Decile 1-4	n=2634; R2 adj.=0.24	n=2344; R2 adj.=0.21	n=2141; R2 adj.=0.23
Difference in difference estimator using 1997 and 2003 data	Decile 1-10	n=10181; R2 adj.=0.23	n=8323; R2 adj.=0.19	n=6865; R2 adj.=0.18
	Decile 1-4	n=4648; R2 adj.=0.21	n=4165; R2 adj.=0.18	n=3717; R2 adj.=0.19
Difference in difference dropping Municipalities with PSP but not PME	Decile 1-10	n=8173; R2 adj.=0.25	n=6315; R2 adj.=0.18	n=5854; R2 adj.=0.17
	Decile 1-4	n=3926; R2 adj.=0.21	n=3443; R2 adj.=0.18	n=3316; R2 adj.=0.18
Propensity score matching using 2003 data	Decile 1-10	n=3727	n=3160	n=2488
	Decile 1-4	n=1612	n=1479	n=1286

NOTES

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2. Surveys of some of this literature and evidence are provided by Megginson and Netter (2001) and Parker and Kirkpatrick (2005).

3. Four of the Latin American case studies are summarized by McKenzie and Mookherjee (2003), while a summary of all studies can be found in Birdsall and Nellis (2002). See also a review of the evidence provided by Estache, Gómez-Lobo, and Liepziger (2001).

4. This section is based on CONPES (1995), CONPES (1997) and CONPES (2003).

5. Four more contracts as well as two extensions to existing contracts have been signed since 2003 to date within the PME framework.

6. There is one exception, the city of Cartagena. It had a contract with a private operator since 1995. However it later extended this contract under the PME framework.

7. The database for 1997 has 9,121 observations from 100 municipalities, while the 2003 survey has 22,949 observations from 110 municipalities. For the most part there is not much overlap of the municipalities surveyed in each wave.

8. The 2003 survey has more information on the quality of water supply. However, in order to compare with the 1997 survey data only continuity of service is used, which is available in both years.

9. Households without expenditure information were dropped from the database. To calculate expenditure per capita equivalent scales were used. Household members 18 years or older had a weight of one and the rest a weight of 0.5.

10. Unfortunately we do not have information on the severity of service discontinuity.

11. Further details of the econometric techniques can be found in Gómez-Lobo and Melendez (2007). See also Blundell and Costa-Dias (2002) for a review of the policy evaluation problem in applied microeconomics of which there is now a vast literature.

12. Since our variables of interest are discrete, a Probit or Logit model may seem more appropriate rather than the linear probability model we use. However, we prefer the linear specification in order to compare results with the matching score estimator described further below. In any case, Probit estimators gave almost identical results in terms of coefficient sign and significance.

13. In the largest Municipalities there are multiple operators, only a fraction of which may have PSP. We define D_i^{PSP} as a taking a value of one if at least one operator has private participation under PME or an independent mechanism.

14. All Municipalities with PME experiences that began after 1997 but prior to 2003 are identified in Appendix 1. The PSP experiences that began before 1997 are presented in Table 2. There were seven other municipalities that introduced PSP but not under the PME framework. These were Marinilla, Puerto Berrío, Turbo, Chigordó, Sonsón, Mutatá and Santa Fé de Antioquia. We assume these experiences began after 1997.

15. As mentioned earlier the qualitative results presented in these sections are unchanged if we use a probit model instead of the linear probability model.

16. The population density and poverty index by Municipality were obtained from the National Statistics Department of Colombia (DANE), and are based on calculations using the 1993 census data.

17. All the estimations, with the exception of the matching estimator, were estimated using survey frequency weights. The matching estimator was implemented through the psmatch2 command in STATA written by Leuven and Sianesi (2003).