Water Reforms, Decentralization and Child Mortality in Colombia, 1990–2005

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Summary. — This paper attempts to determine the municipal level impact of the 1994 Law 142 water and sewerage services reforms on child mortality and service coverage. The objective of these reforms was to transfer service provision from the municipalities to specialized companies. These reforms were undertaken within the 1990s decentralization process which established that the provision of water and sewerage services was the responsibility of local governments. The results obtained indicate that municipalities that reformed exhibit a slower reduction of child mortality rates and lower increases in water coverage than the ones that did not reform.
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Key words — child mortality, water reforms, decentralization

1. INTRODUCTION

High quality provision of water and sewerage services is fundamental to overcome poverty and to improve quality of life. In particular, access to potable water and basic sanitation facilities is strongly related to the prevention of gastrointestinal diseases in children and adults [1] (Esrey, Potash, Roberts, & Shiff, 1991). The World Health Organization estimates that 1.8 million people die every year from diseases related to an inadequate provision of water and sanitation; 90% of them are children under five (OMS, 2004). As part of the Millennium Goals, Colombia committed to reduce mortality in children under five from 37 to 17 deaths per 1,000 live births. Achieving such an objective inherently entails improved provision of water and sanitation services.

By the late 1980s, Colombia had already begun to reform water and sanitation service provision through two strategies. First, the central government sought to enhance service provision by gradually transferring it to the local governments. Second, the government also transformed the regulation of the service provision sector in order to allow for the participation of specialized private or mixed firms. The final stage of the latter strategy was the enactment of Law 142 of 1994 which established a new institutional framework for the provision the services. One key aspect of the Law was to authorize the participation of private capital in the provision of those services. In this regard, the Law facilitated the creation of companies specialized in the provision of water and sewerage services as a way to stimulate coverage expansion and quality improvement. The entrance of specialized companies would lead eventually to the gradual elimination of local governments as direct providers of those services. To date, however, local governments remain the principal providers, as specialized companies mainly operate in municipalities with more than 20,000 subscribers (Roda, 2004). The reform was implemented more than 15 years ago, yet as of now its impact is not completely known.

The objective of this paper is to empirically evaluate the impact of the reforms on water and sewerage service provision, as well as on child mortality from 1990 to 2004. We find that the municipalities that chose to reform by incorporating specialized providers experience less progress in their indicators of child mortality and water coverage than municipalities in which local governments continued providing services. Thus,

the incentives that a private maximizing specialized firm experiences do not lead by themselves to more coverage or better quality of water and hence to lower child mortality. It may be, in fact, that the incentives that a local politician has—accountability, reelection, etc.—may bring about better water and sewerage services, which in turn may lead to better indicators of child mortality.

Almost at the same time that Law 142 was enacted, Law 60 of 1993 determined the complete decentralization of the provision of water and sewerage services. More specifically, Law 60 established that municipalities were obligated to assure service provision either as direct providers or in association with other public, private, or communal entities. Thus, when specialized public, private, or mixed firms began to operate, it was within a decentralized environment As a consequence, local governments have had full autonomy to choose either to contract the specialized providers or to remain service providers themselves.

The paper consists of eight sections, including the introduction. Section 2 presents a short review of the literature on international water and sanitation sector reforms. Section 3 describes the water sector reform process prompted by Law 142 in relation to public utilities provision by private parties. Section 4 presents descriptive statistics on water and sewerage coverage and child mortality. Sections 5 and 6 present the methodology of estimation and the econometric results for child mortality. Section 7 analyzes the effect of the reform on service coverage, and its relation to child mortality. Finally, Section 8 summarizes results and presents concluding considerations.

2. LITERATURE ON THE IMPACT OF WATER AND SANITATION REFORMS: INCONCLUSIVE EVIDENCE

The relationship between the availability of potable water and sewerage and a population's quality of life is well

established in the literature (Abou-Ali, 2002; Esrey et al., 1991; Fajardo, 2004; Jalan & Ravallion, 2003; Lavy, Strauss, Thomas, & Vreyer, 1996). Specifically, a lack of potable water and sewerage systems is strongly related to an increased incidence of infectious and transmissible diseases, including diarrhea and cholera. While children are especially vulnerable to such diseases, previous research suggests other factors, including parental education level, hygienic practices, and proper medical care, may also contribute to the prevalence of these diseases in children (Payment & Hunter, 2001). Most studies show that the availability of potable water and sewerage services reduces the child mortality rate by 5–27%, reduces overall disease incidence by about 20% (Galdo & Briceño, 2005 [1]), and reduces disease duration by 29% (Jalan & Ravallion, 2003). The provision of water and sewerage services is undertaken within different institutional setups—public, private, and mixed providers—each of which may affect differently the coverage and the quality of the service according to the set of incentives the providers experience. This paper attempts to explain those issues in the case of Colombia.

Since the late 1980s, a process of reforms on the provision of public utility services including water and sanitation, electricity and telecommunications began in many developing countries. One of the cornerstones of the reforms was the involvement of private providers using diverse participation models. As described below, evaluations employing diverse methodologies and approaches have been carried out in the 20 years since the reforms began. In the cases of electricity and telecommunications, evidence concurs that private participation yields positive effect on service efficiency and coverage. However, in the case of water and sanitation the impact of private sector involvement remains controversial as evaluation of the reforms have not shown conclusive results as shown below.

Arguments in favor of private sector provision of water and sewerage services can be summarized by stating that the most important incentive to increase efficiency is the possibility of financial profits (De Alessi, 1980). Public provision of services lacks this incentive and hence exhibits low levels of efficiency and quality. On the other hand, opponents of reforms that increase private provision claim that water and sanitation services should be public goods because they generate environmental and health externalities. Under this premise it is not possible to reach a socially optimal level of private sector service provision because of the difficulty in efficiently internalizing and regulating those externalities (Noll, Shirley, & Cowan, 2002). Moreover, researchers have identified several limiting factors related to the private provision of water and sewerage services, including its characteristic of natural monopoly, the low elasticity of demand and the high risk of nonfee payment among lower-income sectors (for discussion see Galiani, Gertler, & Schargrodsky, 2005). The reforms implemented in Colombia fall between these two extremes for and against private service provision. These reforms recognize the government's responsibility—particularly the local governments' responsibility—to ensure the universal provision of quality services. At the same time, however, they promote private involvement in the water and sewerage sector while still demanding good performance and positive outcomes no matter the type of service provider.

Regardless of the discussion on its potential benefits, private involvement in the provision of water and sanitation services took place in 140 countries from 1990 to 2003 (Prasad, 2006). These reforms considered different models for the participation of private capital such as sales of equity of state-owned companies, concession contracts, and Build, Operate, Manage, Transfer contracts (BOMT). According to Prasad

(2006), the literature on the implementation of water and sanitation reforms has focused on the performance of provider companies from a microeconomic point of view, analyzing efficiency and productivity indicators although the results are not conclusive in the case of private capital involvement. Moreover, the impact of those indicators on the population quality of life and on the decrease of poverty levels has not been studied in-depth.

De Allesi's (1980) hypothesis that the maximization of profits drives increased efficiency of private water provision firms has been empirically tested in studies across multiple countries. Bhattacharya, Elliot, and Raffie (1994) show that public companies in the US exhibit higher efficiency in the use of production materials and have better technical capacity, though the dispersion of results for public companies is higher than for private companies. Estache and Rossi (2002) analyze the performance of 50 Asian water companies to demonstrate that private companies are not more efficient than public ones. Coelho, Da Silva, and Moreira (2005) find that private water companies in Brazil are only marginally more efficient that public companies. The African case presented by Kirkpatrick, Parker, and Zhang (2006) finds no evidence of superior performance of private companies over public companies. Clarke, Menard, and Zuluaga (2000) use household surveys from Brazil, Argentina, and Bolivia to show that there is no correlation between private participation and the coverage achieved by water and sewerage systems. Clarke et al. (2000) and Shirley, Xu, and Zuluaga (2000) examine the private provision of water and sanitation in Conakry and Santiago de Chile and find that reforms benefited consumers, local governments, and private investors. In sum, these studies indicate that there is no clear evidence of greater efficiency or coverage in regions or countries with private sector participation. When outcomes are widened to consider quality of life, Galiani et al. (2005) find that in Argentina, private participation is associated with a 9% decrease in child mortality, with stronger effects on municipalities with higher poverty levels.

In the Colombian case, Silva and Andia (2006) analyze the relationship between resources transferred to municipalities and water and sewerage service coverage during 1998–2002, as well as the link between the latter and under five child mortality. The authors find that the relationship between the allocated resources and the change in coverage is weak, which indicates the existence of sharp spending inefficiencies. There is a similarly weak relationship between the latter and under five child mortality. [2] Barrera and Olivera (2007) find private participation on coverage has a positive effect on service quality, particularly in urban areas, [3] yet the authors find only inconclusive evidence on the link between private participation and the incidence of diarrhea in children. Giraldo and Rosales (2004) analyze the effect of access to electricity and potable water on the productivity of households in Colombia; they find that the productivity differential explained by the access to these services is equivalent to 10.5% of the monthly minimum legal wage. Arevalo and Schippener (2002) explore the experience of private sector participation in the administration and operation of water and sanitation services in the department of Antioquia. Specifically, the authors analyze the evolution and performance of 11 small and medium-sized providers serving 38 municipalities, and evaluate users' satisfaction. Their results indicate that the highest satisfaction is found under mixed management strategies, as they combine the joint interests and efforts of both the public and private sectors (Arevalo & Schippener, 2002). Finally, Krause (2007) finds that quality of governance such as strong civil society, control of corruption, and low activity of illegal armed groups favor

efficiency of specialized providers and widen population's service access.

The wide range of approaches to analyze water and sanitation reforms across national settings, as well as the results obtained, clearly show that the debate on the impact of such reforms is ongoing. The Colombia context is particularly complicated because water and sewerage service decentralization were carried out in parallel to regulatory reforms, creating the need for a more nuanced analysis of the impact of the latter. Central to this analysis is consideration for the relationship between local governments and service providers. This paper proposes an empirical measurement of the impact the regulatory reforms on child mortality, within the context of the 1990s decentralization reforms that characterized the Colombian case.

3. REFORMS TO THE PROVISION OF WATER AND SEWERAGE IN COLOMBIA

(a) The decentralization reforms

Since 1950 decentralization has been a key policy for the provision of drinking water in Colombia. Since this time, there has been an ongoing shift of responsibility for water and sanitation services management to local governments (Faguet & Sánchez, 2008; Maldonado & Vargas, 2001). Nonetheless, the water and sanitation investments necessary to increase service coverage have been influenced by political and electoral interference, much as in other countries in the region that decentralized during this period, given the potential for electoral gains represented by the provision of such essential services.[4]

More specifically, until 1950 central government resources for water and sewerage systems were managed by the *Fondo de Fomento Municipal* (Municipal Development Fund, or FFM). Decentralization in this sector began when the *Instituto de Fomento Municipal* (Municipal Development Institute, or INSFOPAL) was put in charge of designing, operating, maintaining, managing, and financing water and sewerage services at the municipal level (Maldonado & Vargas, 2001). In 1968, the creation of the *Junta Nacional de Tarifas* (National Board of Pricing, hereafter the Board) addressed the need to "lower the political interference on the pricing process" of water and sewerage systems. The Board ranked the service use and the payment capacity of the user-households, commerce, industry, and government. Based on these rankings, both rates and subsidies were defined. At this time, the Board and INSFOPAL actions actually excluded the municipalities from service provision, and the system shifted briefly toward centralized management. However, this trend reversed in 1975 when service management control was transferred to *Empresas de Obras Sanitarias* (Sanitary Work Companies, or EMPOS), and *Sociedades de Acueductos y Alcantarillados* (Departmental Water Supply and Sewerage Companies, or ACUAS), INSFOPAL entities at the department and municipal levels (Domínguez & Uribe, 2005).

By the late 1980s the services management resembled what Spiller and Savedoff (2000) have called a "low-level equilibrium" in which tariffs were low and did not match the costs of coverage expansions and quality improvement. Additionally, the system lacked a pricing mechanism that would allow for the rationalization of consumption. System reform was needed, and it was then undertaken within the broader framework of decentralization. The foundation for these service reforms was the enactment of Law 11 of 1986, which authorized municipalities to deliver water and sewerage services without interference from the central government. In 1987, Decree 77 liquidated INSFOPAL as the final step toward service decentralization. The central government bailed out EMPOS and ACUAS, and their equity was transferred to municipalities (Domínguez et al., 2005). Despite these steps, the INSFOPAL's legacy after 40 years of centralized management was one of low coverage and bad service quality (Maldonado & Vargas, 2001).

The municipalities in the worst situation at the time of decentralization were those with populations from 2,500 to 100,000 individuals that had been served directly by INSFOPAL, and hence faced greatest change in the face of the reforms (Maldonado & Vargas, 2001). The reforms transferred to the municipalities both the related public works and the operation and management of the service. Simultaneously, central government resources that had been allocated to municipalities were increased in order to support their new responsibilities. Thus, under this new institutional framework, municipalities became autonomous although the central government remained the main source of funds to finance sector-specific investments. With the 1993 enactment of Law 60, municipalities started to receive transfers specifically allocated for water and sewerage services. In 2001, Law 715 which modified Law 60, maintained transfers destined for water and sewerage services for the poorest and less populated municipalities.[5] Those transfers were to be spent either in infrastructure building or to subsidize a portion of the water and sewerage service fees paid by the poorest households. Thus, the Colombian user fees system takes a cross-subsidization approach, with residential users from low socio-economic strata (1–3) receiving fee discounts that are in turn covered by higher fees for high socio-economic strata (5 and 6[6]) and commercial and industrial users. Since the implementation of this scheme, most municipalities run deficits that are partially covered by central government transfers. The remaining resources cover a portion of the investments needed to provide the services, either through direct subsidies to the provider (including the municipality itself),or through the delivery of physical infrastructure (Silva, 2007).

(b) The regulatory reforms under Law 142 of 1994 and the business transformation of the providers

The Colombian Constitution of 1991 provided for the possibility of service provision by nongovernmental agents, as well as the creation mechanisms to facilitate user participation in the management and oversight of service providers. In 1994, these Constitutional provisions were regulated further by Law 142, *Régimen de Servicios Públicos Domiciliarios* (the Household Public Utilities Regime). Specifically, this law introduced a new institutional framework for household public utilities provision with the creation of regulatory boards for the telecommunications, energy and gas, and potable water and sanitation and the Superintendence of Household Public Services (SSPD) sectors. Under this new framework, the central government was made responsible for the planning, regulation, oversight, and control of services while service provision was to be carried out by one of the following by providers: (1) public service companies incorporated as public limited liability companies (ESP S.A.), (2) municipalities as direct providers, (3) *Empresas Comerciales e Industriales del Estado* (government-managed industrial and commercial companies, or EICE), (4) marginal or independent producers, or (5) organizations authorized to provide service in rural areas or specific urban areas.[7]

The process of drafting Law 142 assumed that *empresas de servicios públicos* (companies of public utilities, or ESP) should be in charge of service provision, as the adoption of a business-like model was considered the best way to reach high levels of efficiency. [8] It was then expected that the existing municipal or regional entities that provided public services would transform themselves into ESPs. Though service provision through ESPs was intended to be the main mean of service delivery, municipalities could also be direct providers when setting up an ESP was not possible. Nonetheless municipalities were obligated—so as to improve efficiency—to comply all the regulations and obligations determined by Law 142. [9] In the case of decentralized entities, the Law's Article 17 offered the option of setting up an EICE. [10]

The adoption of business-like management model for water and sewerage service provisions by the municipalities has been rather sluggish. In fact, municipalities still represent nearly 51% of direct providers (Silva, 2007). Law 142 incentivizes the replacement of the municipalities as direct providers with public utility companies, which is intended to improve service coverage and quality, in turn engendering increases in measured quality of life. However, as our review of the literature suggests, there is not conclusive evidence of this occurring.

This paper seeks to determine whether water and sewerage service provision reform, specifically service provision by an entity other than the municipal government, may lead to better quality of life. The indicators to be examined in this paper will be the total mortality rate for children under five, and the mortality rate of children under five from infectious and transmissible diseases in each municipality. These indicators were selected based on the established, close relationship between child mortality and access to water supply and sewerage services.

(c) Trends of the reforms of water and sewerage services

Water supply and/or sewerage service provider data was collected from the Super Intendancy of Public Utilities (SSPD). At the time of collection (March 2007), there were 780 registered companies, including 422 that provided both services, 345 that provided only water services, and 13 that provided only sewerage services. Table 1 contains the distribution of companies according to provider type as defined by Law 142.

The number of municipalities served according to provider type is also summarized in Table 1. The 780 companies registered before the SSPD operated in 623 municipalities. The providers included in Table 1 are either those companies operating as EICE, or ESP S.A. or the municipality as direct provider. Authorized organizations and marginal producers were excluded because they could not be incorporated. Thus, the total sample consists of 550 municipalities, including both those that underwent service provision reform during 1994–2004 and those in which service provision remained with the local government.

The analysis of water service provision covers 545 municipalities, while analysis of sewerage service provision covers 484 municipalities. The period under examination is from 1990 to 2004, with an emphasis on the period after the 1994 enactment of the Law 142 which allowed municipalities to reform service provision. The year of the reform of each service in a municipality was simply the year in which new companies (EICE or ESP) began operating. Thus, the variable *water reform* is equal to one in a given year if during that year the service was delivered by an EICE or ESP previously incorporated. If the service was delivered by the municipality, the variable reforms take value zero. The sewerage reform variable was built in a similar fashion. Figure 1 illustrates the percentage of municipalities that undertook service provision reform for each year from 1994 to 2004.

The number of municipalities in which water and sewerage services were provided by the local government dropped from 416 to 220 from 1993 to 2004. For sewerage services only, the reduction was from 367 to 191. Thus, 47% of municipalities undertook service provision reform, including 194 that reformed water provision and 174 that reformed sewerage provision. Larger municipalities were more attractive to provider companies, and as a result, this group experienced more reforms than other groups. Out of the reformed municipalities, 87% is served by companies with more than 2,500 subscribers.

As shown in Table 2, the majority of municipalities (57%) that implemented a service provision reform set up an EICE while the remaining (43%) established an ESP. Private participation (total or partial) in service provision took place in 80 out of the 84 municipalities that reformed by setting up of an ESP. S.A. (Company of Public Utilities, Inc). Thus, only four (5%) municipalities created an ESP. SA with exclusively public funds. As Table 2 summarizes, around half of the sampled municipalities implemented water and/or sewerage service provision reform during 1994–2004, while complete private investment occurred in only about 35% (69) of the reformed municipalities, or close to 11% of the of total sample (623).

4. CHILD MORTALITY AND ACCESS TO WATER AND SEWERAGE SERVICES

The relationship between potable water and sanitation service provision and public health indicators is widely acknowledged in the related literature (Esrey *et al.*, 1991). Specifically, the lack of access to water and sewerage services is associated with an increased incidence of infectious and transmissible diseases because the absence of these services increases the possibility an individual will ingest contaminants in unclean water, as well as suffer from poor personal hygiene (Payment & Hunter, 2001). Trends across of water and sewerage service coverage and the evolution of child mortality rates in the 550

Table 1. *Number of companies registered before the SSPD and municipalities served by type of provider in 2007 Source: SSPD, own calculations*

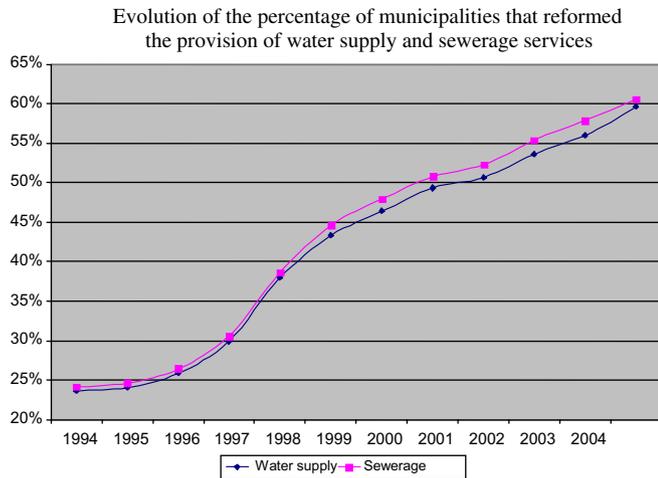| Type of provider	Registered companies			Municipalities served	
	Water and sewerage	Only water supply	Only sewerage system	Water supply	Sewerage system
EICE	142	14	2	169	154
Municipality	190	21	7	213	188
Authorized organization	32	292	0	329	32
Marginal Producer	3	11	0	14	3
Sociedades (ESP)	55	7	4	163	142

Figure 1. *Evolution of the percentage of municipalities that reformed the provision of water supply and sewerage services.*

Figure 2. *Evolution of coverage of water supply and sewerage services 1993–2005.*

municipalities included in the study are presented and described below.

(a) Evolution of coverage of water supply and sewerage services

Figure 2 presents the percentage of households with water and sewerage services calculated from census data for the years 1993 and 2005. The percentages only measure access to services, but do not account for quality of services. Coverage of water and sewerage services in the analyzed municipalities increased by 7.8 and 9.8 percentage points respectively, during 1993–2005. During that period, water service coverage rose from 64.8% to 72.6% and sewerage coverage rose from 42.5% to 52.3%. Figure 2 shows coverage differences among municipalities according to the implementation of service provision reforms. Although in 1993 reforms had not been yet implemented, "municipalities with reform" represents municipalities in which service provision reform occurred after 1994.

As shown in Figure 2, municipalities that continued to directly provide water services increased coverage by 3.4 percentage points, in contrast to municipalities that implemented service provision reform, in which the increase was only 0.52 percentage points. An opposite trend is observed for sewerage services; coverage in the former group of municipalities only increased by 0.47 percentage points, but in the reformed group, the increase was 4.24 percentage points. Differences in coverage increase may be influenced by starting levels (i.e., it is more difficult to increase coverage if it is already at relatively high levels), and in fact these levels were lower in unreformed municipalities. However, the methodology used in Section 6 allows us to capture the effect of the reform on service coverage by controlling for socio-economic characteristics and fixed effects.
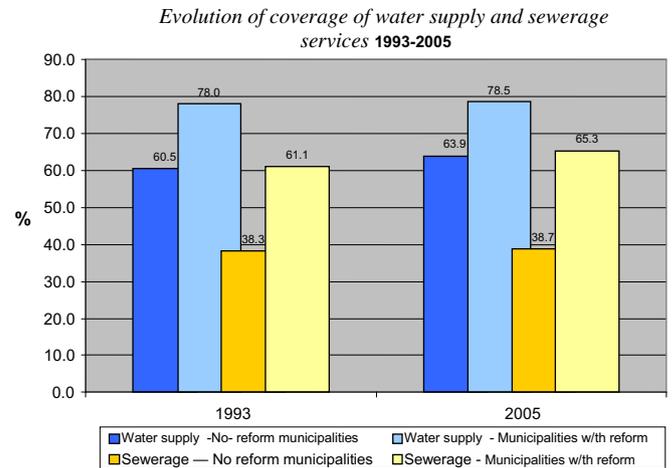
(b) Evolution of child mortality rates

The mortality rate was constructed based on the number of deaths of children under the age of five registered in the sampled municipalities during 1990–2004. Data included 184,007 deaths sorted by cause of death, according to List 6/67 of International Classification of Diseases, ICD-10 used in the Vital Statistics. The child mortality rate was calculated for each year as the ratio between the number of deaths registered in a municipality and its overall population between 0 and 4 years old. [11] From 1990 to 2004 the deaths of children under five dropped from 13,382 to 10,381, a 19% decrease. However, the decline in the infectious and transmissible diseases child mortality rate was much more significant, falling from 1.27% in 1990 to 0.20% in 2004. In 1990, 8.4% of child deaths was caused by infectious and transmissible diseases, and by 2004, the percentage was down to 4.4%.

For analysis purposes, we constructed two child mortality variables. The first one covered all registered deaths, except those classified as "deaths from external cause" ($n = 12.947$).The second variable only included the reported 23,595 deaths from infectious and transmissible diseases, as these diseases are directly associated with a lack of water and sewerage services. During the time period under study the sample municipalities demonstrated a decrease in the child mortality rate from nonexternal causes from 1.16% to 0.15%, while the mortality rate from infectious and transmissible diseases declined from 0.15% to 0.03%. However, there were salient differences in the behavior of child mortality rate between *r* municipalities that reformed and those that did not reform water and/or sewerage services provision, as shown in Figures 3 and 4.

In 1990, municipalities that would continue to provide services directly exhibited an average higher mortality rate than

Table 2. *Type of provider set up by municipalities that reformed service provision in 2007 Source: SSPD, own calculation*

Tipo de prestador	Servicio			Total	%
	Water supply and sewerage	Only water supply	Only sewerage		
EICE	101	9	2	112	57
Incorporated companies (ESP)	71	13		84	43
Official	4			4	5
Private	58	11		69	82
Mixed	9	2		11	13

those in which a company would become the service provider. However, this pattern changed, and in 2004 direct service provider municipalities (i.e., municipalities that did not reform) exhibited lower child mortality rates than reformed municipalities.

Figures 3 and 4 present the descriptive evidence of the apparent response of child mortality rates to the implementation of reforms in water and sewerage services provision. In order to obtain a more precise estimate of the impact of the reforms on child mortality rates, we employ an econometric approximation that incorporates the particular characteristics of each municipality, the overall tendencies of child mortality and an exact measurement of the year the reforms were introduced in each municipality. Section 6 describes the methodology used and the results obtained.

5. THE DECISION TO REFORM THE PROVISION OF WATER AND SEWERAGE SERVICES

Law 142 stipulated that a municipality could continue as the direct provider of water and sewerage services if: (i) no company was interested in providing the service; (ii) the municipality, the department, or other entities were not interested in creating a public utility company; or (iii) if companies were willing to provide the service, but the costs of direct provision would be lower than those the willing company reported.[12] Given these restrictions, it is likely that a greater number of ESPs would be created either in the largest municipalities or in municipalities grouping themselves so as to have a single low cost providing company. Indeed, as mentioned above, in the sample under analysis, 87% of reforms were implemented in municipalities served by companies with more than 2,500 subscribers.

Thus, it is necessary to determine the set of variables linked to the reform decision. Conceptually the decision may be associated, on the one hand, with the socio-economic characteristics of municipalities and to its evolution in time and, on the other hand, with a particular political juncture in the municipality that promotes or facilitates the participation of a company in water and sewage services provision. Taking into account these two sets of variables we estimate a xtlogit probability model of the municipality's decision to reform service provision through the creation of a company. As shown in Table 3,[13] two models were estimated. In the first, the socio-economic characteristics of the municipality (Unmet Basic Needs—UBN, rurality rate, land distribution, tax revenue,
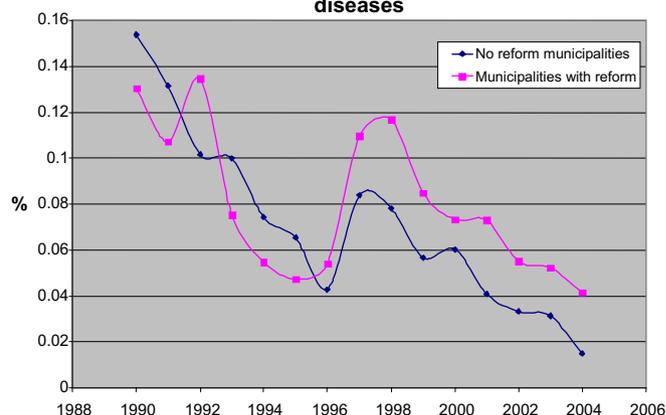

Figure 4. *Evolution of child mortality rate from infectious and transmissible diseases.*

and child mortality rate) vary through time. In the second one, we use the 1993 values of these variables and the lagged first difference of land distribution, tax revenues, and child mortality. The inclusion of these three lagged variables seeks to determine if the decision to reform is related to changes of municipality's socio-economic indicators.

Both models include service coverage, percentage of dwellings sheltering more than four households, and percentage of population with a complete high-school level education in 1993. Additionally, two variables were included as indicators of the municipality political circumstances: electoral turnout in local elections, and effective number of political parties (ENP) with representation in the city council. Finally, as time dependency or duration variable we use the number of years until the reform is implemented (fixing 1995 as equal to one). It is expected that as time goes on the likelihood of engaging in reform increases.

Results in Table 3 indicate that probability of reform exhibits a positive dependency on duration. For the two services and in both models, initial coverage is significant and positively affects the probability of reforming. This result does not support the objective of the Law that attempted to promote access to these services through the creation of public utility companies in the municipalities with lower coverage. This result is also consistent with the negative impact of the percentage of rural population in both models for the case of water service reform. In other words, a municipality with a high rate of rural residents would have low water coverage and be less likely to implement reform. In regard to the political variables, higher electoral turnout is negatively related to reform implementation. If turnout represents the population's greater awareness of and participation in public issues, this result suggests it may be more difficult to convince citizens or win their support for changing the traditional water provider. By contrast, when the local political process exhibits more competition (more effective number of parties), it is more likely to reform. This result may suggest that the cost of the decision to reform would fall not on a few political groups, but rather on the many groups active in the municipality, and thus no one political party would be electorally punished (i.e., bear the cost) for the reform decision.

Finally, neither the child mortality rate nor its change is correlated with the decision to reform service provision in any of the models estimated. This result would allow us to establish a causal relation between service provision reform and mortality rate without having an endogeneity problem.
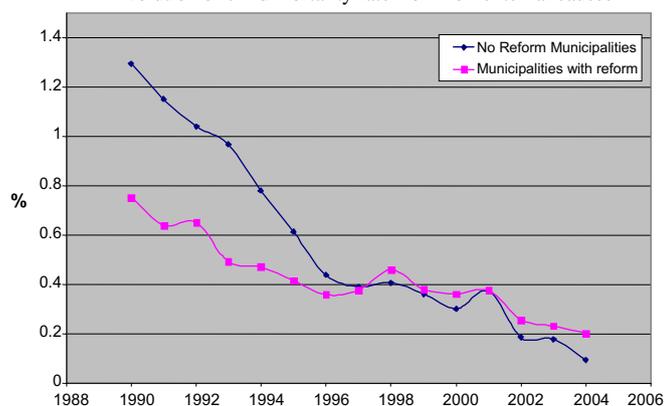

Figure 3. *Evolution of child mortality rate from nonexternal causes.*

Table 3. *XTLogit models of the likelihood of reforming service provision*

	Descriptive statistics	Water		Sewerage	
		(1)	(2)	(3)	(7)
Log time	1.242	1.906**	2.231*	1.996**	2.351*
	(0.72)	(0.913)	(1.204)	(0.926)	(1.250)
	Municipal Characteristics 1993				
Coverage	59.4	0.0163**	0.0182*	0.0167**	0.0187*
	(22.1)	(0.00813)	(0.00987)	(0.00838)	(0.0103)
% of Home with more than four household	0.346	0.274	0.445	0.282	0.453
	(0.67)	(0.251)	(0.284)	(0.259)	(0.296)
% of Population With High School	6.37	−0.00345	0.00861	−0.00316	0.00923
	(4.08)	(0.0462)	(0.0526)	(0.0479)	(0.0548)
Poverty rate	49.7		0.0126		0.0130
	(16.1)		(0.0125)		(0.0130)
% Rural	60.2		−0.0161		−0.0165
	(24.3)		(0.0118)		(0.0124)
Gini of land	0.69		0.417		0.395
	(0.1)		(1.375)		(1.422)
Tax revenue (millions of $ COL)	0.018		3.530		3.953
	(0.023)		(6.003)		(6.229)
Infant mortality rate (per thousand)	1.12		−0.143		−0.149
	(1.16)		(0.129)		(0.134)
	Variables that change over time				
Electoral participation	0 .55	−2.452**	−2.651**	−2.603**	−2.808**
	(0.13)	(1.023)	(1.131)	(1.031)	(1.157)
Mayor's proportion of votes	0.51	0.592	0.572		
	(0.12)	(0.862)	(0.913)		
Change in Gini (−1)	−0.00038		18.85		19.22
	(0.004)		(31.91)		(33.30)
Change in tax revenue (−1)	0.002		−1.369		−1.445
	(0.026)		(3.528)		(3.581)
Change in mortality rate (−1)	−0.106		−0.203		−0.208
	(0.97)		(0.191)		(0.195)
Effective numbers of parties	2.07	0.330**	0.342**	0.330**	0.344**
	(1.01)	(0.133)	(0.148)	(0.131)	(0.149)
Poverty rate	46.3	0.00594		0.00594	
	(16.1)	(0.00974)		(0.0100)	
Rurality rate	58.7	−0.0170*		−0.0172*	
	(24.1)	(0.00984)		(0.0102)	
Tax revenue	0.029	3.945		4.089	
	(0.044)	(2.486)		(2.531)	
Gini of land	0.69	0.703		0.708	
	(0.10)	(1.236)		(1.264)	
Infant mortality rate	0 .569	−0.0381		−0.0483	
	(0.73)	(0.244)		(0.250)	
Constant		−6.183***	−6.894**	−5.972**	−6.754**
		(2.366)	(3.003)	(2.325)	(3.041)
Observations		2018	2018	2018	2018
Number of municipalities		318	318	318	318

Standard errors in parentheses.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

6. EFFECTS OF REFORMS ON CHILD MORTALITY

Due to the strong relationship between lack of water and sewerage services and infectious and transmissible diseases, child mortality caused by these diseases is the variable used to evaluate the effect of service provision reform on population quality of life. We seek to estimate the difference in child mortality between the reformed and unreformed municipalities, namely those that continue providing services directly. It is necessary to note, however, that child mortality may be affected by nonobserved variables, which in turn may have affected the decision to reform service provision. These nonobserved variables may be typical of each municipality but constant through time, or may be shared by all municipalities and change over time. In order to determine the reform impact controlling for nonobserved variables, we estimate a difference-in-difference panel data model with the following specification:

$$m_{it} = \alpha_0 + \alpha_1 * Before94 + \alpha_2 * Reform_{it} + \alpha_3 * Reform$$
$$* Dummy2500_{it} + \alpha_4 * Reform * Private_{it} + \alpha_3$$
$$* Reform * Private * Dummy2500_{it} + \sigma * x_i + \gamma_t + \delta_i$$
$$+ \varepsilon_{it} \tag{1}$$

Where m_{it} is the child mortality rate in the municipality i in year t,[14] $Before94$ indicates whether the municipality already had a specialized provider before 1994, $Reform_{it}$ t is a categorical variable of reform constructed as described in Section 3(b), $Reform*Dummy2500_{it}$ indicates if the reformed municipality has more than 2,500 subscribers,[15] $Reform*Private_{it}$ denotes whether the provider is completely private, $Reform*Private*Dummy2500_{it}$ is the interaction of a private provider with the dummy of more than 2,500 subscribers, x_{it} is a vector of characteristics that change in different municipalities and through time, γ_t is a temporal effect common to all municipalities, δ_i is a municipality fixed effect that controls for the non-observed time invariant characteristics, and ε_{it} is the error term. Coefficient α_2 is the difference-in-difference estimator which indicates the average effect of the reform on child mortality rate. The other α's coefficients stand for heterogeneous effects of the reform.

Although terms γ_t and δ_i in (1) capture the effect of nonobserved variables, the estimation entails an additional problem which arises from the heterogeneous distribution of variables that influence the decision to implement a reform of the reformed and unreformed municipalities. As a result of this heterogeneity, comparing municipalities that reformed water provision with others that did not would be a source of bias as the latter municipalities may not be comparable to the reformed ones. In order to single out the noncomparable municipalities and find a common support that allows the comparison, we follow Rosenbaum and Rubin's (1983) methodology. Accordingly, we estimate the probability of provision reform using as regressors a set of observed variables from e o year previous to the reform implementation. Thus, we estimate a probit model of the variable "Reform in 2004" using the 1994 local socio-economic and political characteristics as independent variables. The estimated probability based on the coefficients of Eqn. (2) is known as the "Propensity Score" (PS) and allows for identification of the noncomparable municipalities, thereby establishing the common support.

$$PS_i = p(X_i) \equiv P\langle R = 1 X_i \rangle \tag{2}$$

According to estimated PSs, two groups of municipalities were excluded from the sample: (1) unreformed municipalities with a PS lower than the minimum (0.07) of the municipalities that reform, and (2) reformed municipalities that have a PS higher than the maximum (0.95) of the unreformed municipalities. As observed in Table 4 more that 20% of the municipalities did not fall in the common support and hence were excluded in the common support regression.

The models shown in Table 4 were estimated for mortality rate from nonexternal causes and from infectious and transmissible diseases as dependent variables.[16] For the latter case, the regression was restricted to nonzero values because in many municipalities there were no records of deaths caused specifically by infectious or transmissible diseases for one or more years. In both cases, estimation was performed with the total sample and with the restricted sample, according to PSs of municipalities.[17]

There are several variables that seek to determine the impact of the reform. The dummy variable $Reform\ before\ 1994$ was used to control for municipalities where service provision was already in the hands of a company prior to Law 142. A dummy variable was created for all the municipalities that reformed after 1994, with various interactions that capture whether the providing company involved private capital and whether the latter is located in a municipality with more than 2,500 subscribers. These variables help determine if within the municipalities that reformed, the effect on mortality is different if the provider company is private or mixed, or if it offers the service to relatively large number of subscribers (2,500 subscribers or more).

Results in Columns 1 and 2 of Table 4 show that reform after 1994 did not significantly affect the mortality rate from nonexternal causes. Nonetheless, if the municipality reformed but private capital was involved in services provision, the mortality rate in fact decreases in 0.22, though this effect is offset in the municipalities with private providers and more than 2,500 subscribers. Moreover, in the latter municipalities and with private capital involved in reform implementation, there may be a slower drop in infant mortality compared to the rest of the municipalities (see Table 4).

According to estimations of the model for the mortality rate based on infectious and transmissible diseases (Columns 3 and 4 in Table 4), reform is associated with a decrease of 0.073 percentage points in the mortality rate and a decrease of 0.046 percentage points when the common support sample is used. The interactions indicate that the effect of private capital is not significant, but the impact of the reform in municipalities with more than 2,500 subscribers is indeed positive (0.14) and statistically significant. These results demonstrate that the municipalities that use public utility companies (EICE or ESP) as providers experienced an additional fall in mortality rate from infectious and transmissible diseases of around 0.05 percentage points as compared with the unreformed municipalities. However, such impact may have occurred only in the small municipalities; according to the results, mortality rates from infectious and transmissible diseases in reformed municipalities with more than 2,500 subscribers is 0.14 percentage points higher than rates in reformed municipalities with less than 2,500 subscribers.

Finally, the coverage rates of the subsidized health regime (government-financed health insurance for the poor) is strongly associated with lower child mortality rates—both the total and infectious diseases-based rates—and its impact is negative in both the complete and the common support samples.

7. EFFECT OF REFORMS ON WATER AND SEWERAGE COVERAGES

The impact of reform on child mortality explained in the preceding section could occur through different mechanisms, in particular service coverage and improvements (or deteriorations) in water quality and hours of service. In this section, we will attempt to determine the effect of the reform on water and sewerage coverage. We will use data of water and sewerage systems coverage from the 1993 and 2005 censuses. A model of difference-in-difference with a panel data from two time periods was estimated following the specification:

$$Cov_{it} = \beta_0 + \beta_1 * Year2005 + \beta_2 * Reform_{it} + + \beta_2$$
$$* Reform * Dummy2500_{it} + \beta_2 * Reform * Private_{it}$$
$$+ \delta_i + \varepsilon_{it} \tag{3}$$

In this case, the independent variable, Cov_{it} is the coverage of service (water or sewerage system) of municipality i in year t. The estimator of difference-in-difference α establishes the

Table 4. *Impact of reform on child mortality rates*

	Descriptive statistics	Infant mortality rate		Infant mortality for infectious diseases	
		Total sample	Common support	Total sample	Common support
Reform	0.3	−0.0570	−0.0164	−0.0733***	−0.0463*
	(0.48)	(0.0525)	(0.0534)	(0.0224)	(0.0265)
Reform before 1994	0.06	−0.384***	−0.359***	−0.0718***	−0.0758***
	(0.24)	(0.0436)	(0.0506)	(0.0159)	(0.0227)
Reform* private or mixed	0.07	−0.225**	−0.221**	−0.0308	−0.0307
	(0.25)	(0.0985)	(0.0992)	(0.0394)	(0.0458)
Reform*more than 2500	0.29	0.264***	0.257***	0.142***	0.142***
	(0.45)	(0.0739)	(0.0800)	(0.0272)	(0.0342)
Reform *more than 2500* private or mixed	0.05	0.305**	0.245*	0.0484	0.0434
	(0.22)	(0.127)	(0.142)	(0.0464)	(0.0609)
Proportion of poor with health insurance	0.25	−0.419***	−0.400***	−0.211***	−0.184***
	(0.26)	(0.0710)	(0.0846)	(0.0380)	(0.0495)
Tax revenue	0.031	1.037***	1.287***	0.308	0.257
	(0.04)	(0.402)	(0.436)	(0.205)	(0.288)
Gini of land	0.70	−1.042**	−1.068**	−0.208	−0.0726
	(0.10)	(0.449)	(0.504)	(0.176)	(0.266)
Poverty rate	43.1	0.00517*	0.000763	0.00181	0.000385
	(17.8)	(0.00275)	(0.00298)	(0.00136)	(0.00174)
Log population	9.73	0.280***	0.0562	−0.0407	−0.119**
	(1.13)	(0.0864)	(0.0956)	(0.0395)	(0.0524)
Rurality rate	53.6	−0.000717	−0.00155	0.00200*	0.00173
	(25.2)	(0.00298)	(0.00331)	(0.00111)	(0.00149)
Constant		−0.997	1.540*	0.712*	1.497***
		(0.867)	(0.929)	(0.418)	(0.526)
Observations		7725	6435	3332	2386
Fixed effect of year		Yes	Yes	Yes	Yes
R-squared		0.198	0.222	0.163	0.182
Number of municipalities		515	429	380	307

Standard errors in parentheses.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

change in coverage in municipalities that reformed provision *vis a vis* those that did not. Variable *Year_2005* summarizes the change in coverage common to all municipalities. Two interactions of variables *R* (Reform) were included: the first one is the interaction with *More_than_2500* and the second with *Private_Mixed*. The first equals one if the company providing the service in the municipality serves more than 2,500 subscribers, and the second equals one if the company partially or totally involves private capital. These terms of interaction allow for the determination of differences in coverage changes related both to the number of subscribers served and to the public and private character of the Company of Public Utilities among the municipalities that implemented reforms. Finally, δ_i is a vector with other time invariant characteristics of the municipality.

The econometric results are shown in Table 5. Inter census water coverage increased in average by 11 percentage points (column 1) and sewerage coverage by nine (column 2). Reform only has a significant impact on sewerage coverage; Municipalities that reformed increased sewerage coverage by an additional 4.0 percentage points.

Table 5 also demonstrates that in municipalities that undertook reform and had more than 2,500 subscribers, the increase in water supply coverage was 6 percentage points lower (Column 2) than the municipalities that did not reform. Sewerage service difference is positive and statistically significant, particularly for the municipalities with more than 2,500 subscribers.

These results are consistent with the ones obtained for the impact of the reform on child mortality (Table 4). It was found that reformed municipalities with more utility companies with more than 2,500 subscribers experienced a lower reduction of child mortality rates. Additionally, municipalities that reformed and contracted new mixed- or public capital-based providers demonstrated 2004 water coverage that was 4.5 percentage points lower than those that did not reform. Thus, the econometric results for coverage in 2005 suggest that one likely mechanism of the lower reduction in child mortality in the reformed municipalities may have been the smaller increase in water coverage.

8. CONCLUSIONS

This paper has attempted to evaluate impact of the water and sewerage services reforms of *at municipal level* established in Colombia by the Law 142 of 1994 on child mortality. The timing of these reforms coincided with the strengthening of the national decentralization process that began in 1993. In fact, the municipalities' burgeoning autonomy in relation to water and sewerage provision allowed them to decide whether to reform or not. The results obtained indicate that municipalities that reformed with more than 2,500 subscribers and with some degree of private participation in providing company provision experience a lower reduction of child mortality rates

Table 5. *Impact of reforms on service coverage*

	Water						Sewerage					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Reform before 1994	18.97***		6.454***		6.475***		23.55***		9.577***		9.592***	
	(1.780)		(2.086)		(2.084)		(2.085)		(2.421)		(2.421)	
Dummy Year 2005	11.49***	11.67***	11.56***	11.67***	11.56***	11.67***	9.387***	9.186***	9.501***	9.186***	9.501***	9.186***
	(1.325)	(1.340)	(1.307)	(1.324)	(1.301)	(1.319)	(1.310)	(1.318)	(1.310)	(1.319)	(1.309)	(1.320)
Reform Dummy	−4.798***	−4.766***	0.148	0.950	0.998	1.901	3.026*	3.395**	3.246	4.292*	3.666	4.627*
	(1.691)	(1.707)	(2.311)	(2.382)	(2.332)	(2.413)	(1.671)	(1.679)	(2.327)	(2.372)	(2.360)	(2.414)
More than 2500			19.83***		19.84***				22.24***		22.24***	
			(1.988)		(1.986)				(2.326)		(2.326)	
Reform*more 2500			−6.955***	−7.928***	−6.563***	−7.460***			−0.458	−1.244	−0.258	−1.079
			(2.226)	(2.331)	(2.225)	(2.332)			(2.254)	(2.322)	(2.261)	(2.333)
Reform*mixed or private					−4.504**	−5.230**					−2.255	−1.844
					(2.034)	(2.427)					(2.138)	(2.428)
Constant	53.16***	64.76***	51.43***	64.75***	51.43***	64.76***	29.36***	43.75***	27.39***	43.75***	27.39***	43.76***
	(1.394)	(0.593)	(1.316)	(0.586)	(1.315)	(0.584)	(1.630)	(0.583)	(1.519)	(0.584)	(1.519)	(0.584)
Fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	932	932	932	932	932	932	932	932	932	932	932	932
R-squared	0.194	0.210	0.301	0.230	0.302	0.238	0.278	0.080	0.391	0.073	0.392	0.073
Number of municipalities	484	484	484	484	484	484	484	484	484	484	484	484

Standard errors in parentheses.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Table 6. *Sources information*

Variable	Source
Child Mortality	Vital Statistics for 1990–2005. National Statistical Office (DANE)
Coverage of water and sewerage	National Censuses of 1993 and 2005. National Statistical Office (DANE)
Effective number of political parties	Electoral Results in Local Elections. National Electoral Office. (Registraduria)
Electoral participation	Electoral Results in Local Elections. National Electoral Office. (Registraduria)
Gini of Land	Economic Development Research Center (CEDE)—Universidad de los Andes
Health Insurance for the Poor	National Planning Department (DNP)
Local tax revenue	Statistics of Local Finances. National Planning Department (DNP)
Population	National Censuses of 1993 and 2005 and Population Porjections. National Statistical Office (DANE)
Porcentage of population with secondary education	National Censuses of 1993 and 2005. National Statistical Office (DANE) and Economic Development Research Center (CEDE)—Universidad de los Andes
Poverty rate	National Censuses of 1993 and 2005. National Statistical Office (DANE) and Economic Development Research Center (CEDE)—Universidad de los Andes
Rurality Rates	National Censuses of 1993 and 2005. National Statistical Office (DANE) and Economic Development Research Center (CEDE)—Universidad de los Andes
Type of water and sewerage provider	Superintendence of Public Utilities
Year of Reform	Superintendence of Public Utilities

than the municipalities that did not reform. Child mortality from infectious and transmissible diseases in the municipalities that reformed and had more than 2,500 subscribers also exhibited as a smaller drop than the rates observed in municipalities that maintained service provision in the hands of the local government. The estimated difference was 0.096 mortality rate points (approximately 19% of the mean mortality rate for 1990). Private sector participation in the provision of water and sewerage services in the reformed municipalities was not related to child mortality from infectious and transmissible diseases.

As for the expansion of service coverage the results are mixed. The reform had a positive impact on sewerage coverage. Municipalities that reformed sewerage increased coverage levels by 4 percentage points compared to municipalities that did not reform. The number of subscribers or the mixed or private nature of the providing company had no impact on sewerage coverage. In the case of water service, however, the opposite effect took place. Municipalities with mixed or private capital and more than 2,500 subscribers experienced a lower coverage increase than those that did not reform the provision. In this case, the estimated difference is 6 percentage points (or 12 percentage points in the municipalities that exhibited both features).

Evidence found suggests the direct provision of water and sewerage services by local governments may yield better results both in terms of child mortality and water coverage than the ones achieved when specialized companies are in charge of such services. For future analysis, sector policies and incentives for municipal providers should be examined to determine what may bring about such undesirable outcomes.

NOTES

1.　These figures correspond to results found by Galdo and Briceño (2005 in a literature review of numerous studies from different countries.

2.　Silva and Andia (2006) conclude institutional adjustments that it is needed to promote of efficient administration of resources in the municipalities as well as to improve the coordination between health policies and the basic sanitation.

3.　Barrera and Olivera (2007) find moreover that there was no difference in coverage in municipalities with private providers as compared to those with public providers exhibiting high technical capacity. According to the authors, these results suggest that municipal governments are able "to compete" with private companies in the provision of the service.

4.　Faguet (2012) provides an extensive discussion of the political economy of the provision of water and other basic services.

5.　The Law 715 of 2001 was supported on the so-called General System of Revenue Sharing (Sistema General de Participaciones) established in the 2000 Constitutional reform and determined the criteria to distribute the transfers going to the departmental and municipal governments. For a more detailed description of SGP's resources, see Silva and Rozo (2005).

6.　Level 4 does not receive subsidy or pay contribution, that is to say, the service corresponds to the service provision cost.

7.　Law 142 of 1994, Article 15. Other changes introduced by Law 142 were: (a) the definition of a pricing regime based on the cost of providing the service, (b) the creation of a control mechanisms of the provider performance enforced by citizens, (c) establishment of a regime of free enterprise which constitutes the base for the entry of the private sector to as a provider and, (d) for the implementation of management control and internal control systems within the provider companies.

8.　Statement of Motivations, Regime of Household Public Utilities (Exposición de Motivos, Régimen de Servicios Públicos Domiciliarios)— Draft Law.

9.　Law 142 states clearly on Article 6.4 that direct provision by municipalities is subject to the same terms and conditions as any other kind of entity, such as Public Utility Companies (ESPs).

10.　Law 286 of 1996 ordered that all decentralized entities and companies that provided services, including Empresas Industriales y Comerciales del Estado EICE (Government-owned industrial and commercial companies) formed after 1994 should be transformed into empresas de servicios públicos, ESP (public utilities companies). For the purposes of this paper, the transformation process was accomplished with the initial setting up of an EICE, and not with the subsequent change in legal status to become an ESP.

11.　In this document, we will use this definition of child mortality rate. However, in the literature, child mortality rate is defined as the number of deaths of children between 0 and 1 per 1,000 born live.

12.　Law 142 of 1994, Article 6.

13.　In the Table 6 Definition of Variables, a detailed description of each one of the variables used and its corresponding source is included.

14.　As Miller and Piedad (2010) pointed out the vital statistics from the National Statistical Office (DANE) may underestimate the infant mortality figures which may lead to bias the estimators especially if the reforming municipalities exhibit better recording of child mortality. We believe that the collection of infant mortality should not improve or worsen after adopting a reform. In other words, there is no reason to expect any correlation between the water reforms and better information of infant mortality which mean that existing biases are likely to remain after the water reforms. Besides, the below econometric exercises control for municipality fixed effect which contribute to reduce the biases originated from sub reporting. Moreover, we also perform regressions with common support that further helps to reduce the mentioned biases.

15.　2,500 subscribers is the threshold established by the Colombia's Superintendence of Public Utilities to determine whether a provider is a "big" one. These providers have the obligation to report regularly to the Superintendence information on their finances, operation, and fees.

16.　In Table 6: we provide the sources of information for the different variables used in the present paper.

17.　Estimations were made using data for the reform in water service, as in most municipalities, both services of water and sewerage are delivered. Results are the same when the model was estimated using only data of sewerage service.

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