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"Private Sector Involvement in Water Services: Theoretical Foundations and Empirical Evidence"

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Abstract

Water services management has become a key issue as urban water supply is considered a service of general interest in the European Union (EU, 2001). In this context, public-private partnerships (PPP) have emerged as a usual way of local water services provision. This paper contributes to analyze the effects and consequences of PPP in the management of water resources. First of all, we develop a theoretical framework to show the effects of water services contracting-out on water prices. Second, we estimate the model using a sample of Spanish municipal water services recently privatized. Our findings support that, in a context of limited resources, local governments are using public-private partnerships in order to get additional fundings to reduce their indebtness levels. Moreover, the fact of setting a high reservation price as a way to guarantee a minimum amount of resources has had consequences in terms of water price increases after water services privatization.

JEL-Classification: L33, L95, Q25

Keywords: water services; public-private partnerships; auctioning; game theory; water prices.

1 Introduction

Supplying public goods and services while achieving quality requirements is a challenge in both developed and developing countries. In this respect, public-private partnerships (PPPs) have strongly emerged as a way of collaboration. According to Ménard (2013), PPPs are basically a contractual approach to the delivery of infrastructures, goods and services traditionally provided by the public sector or by private operators subject to tight command-and-control regulation, such as public utilities.

In general, PPPs have been usually justified by efficiency reasons (Bel and Fageda, 2007; Bel et al., 2010). So, a key aim consists of avoiding the negative effects of a bureaucratic environment (Rodríguez and Suárez-Pandiello, 2003). Moreover, PPPs give to public administrations the possibility to create incentives that encourage private operators to invest, in order to control costs but at the same time improve quality and quantity standards. However, on top of this argument, there could be other reasons to begin a process of privatization for the management of several public services. These could be ideological (supporting a conservative idea about the need of limiting the size of the public sector) or more pragmatic (obtaining additional resources to face eventual situations of financial stress).

The management of local water services using PPP has become popular in the last decades (World Bank, 2006). Water is a merit good that has important implications in economic, social and environmental dimensions (OECD, 2003). Moreover, urban water supply is considered a service of general interest in the European Union (EU, 2001).

The literature has suggested several reasons that lead local governments to privatize water services (González-Gómez and García-Rubio, 2008). Political, financial and operational factors have influence on the privatization decision. Focusing on some of them, several studies have found that the fragile financial situation of several municipalities has also been a key factor in the decision to externalize urban water services (González-Gómez et al., 2011). Thus, privatization has been a source of significant revenue for local governments. On the other hand, local governments could try to get improvements in the management of water services, especially under complex operational environments.

Additionally, several studies have investigated some consequences of PPPs schemes in water sector, considering different dimensions, as quality (Shaoul, 1997; Lobina and Hall, 2000; Wallsten and Kosec, 2008), efficiency (González-Gómez and García-Rubio, 2008; Picazo-Tadeo et al., 2009a,b) and prices (Hall and Lobina, 2004; Lobina, 2005; Garcia et al., 2005; Chong et al., 2006; Carpentier et al., 2006; Martínez-Espiñeira et al., 2009; Ruester and Zschille, 2010; García-Valiñas et al., 2013).

However, the previous literature has neglected some characteristics of privatization processes, which can be significant key-drivers to explain price variations. This research develops a theoretical auctioning model in which reservation price set by local authorities has a significant impact on water prices. An empirical analysis has also been carried out in order to test this hypothesis. Financial stress under economic crisis has also been considered as an additional factor in this framework.

The outline of this paper is as follows. The next section describes the institutional water sector framework in Spain. In Section 3 we develop a theoretical model to explain PPPs and auctioning in the water sector, assuming profit maximization in the case of private operator, and the presence of a vote-maximizing local government. Section 4, based on a database of Spanish municipal water services recently privatized, we test the effects of PPPs on several key variables. Finally, we conclude by summarizing the most significant findings and future extensions of this research.

2 Water Sector in Spain: PPP schemes

The legal framework in Spain, Law 7/1985 on the Regulation of Local Government Terms and Conditions and Law 57/2003 on Local Government Modernization Measures, establishes that local governments are responsible for guaranteeing the urban water service, but may choose how it should be managed and the legal regime for provision. The laws mentioned above and Royal Decree 2/2000 establish the legal regimes for the provision of municipal services. The local government may choose between either managing the service in-house or outsource it to an external company. In case of externalization, management may be transferred either to a public company or privatized. In the latter case, the management of the service may be either fully privatized, contractual PPP, or partially privatised to a mixed company, institutionalised PPP. It is worth highlighting that Spanish legislation only contemplates privatizing the management of the service, as the infrastructure remains public property. Statistics show that there has been a progressive process of water services privatization from the 80s in Spain. In 2008 private companies supplied 46% of the Spanish population (AEAS, 2010). Additionally, it should be noted that the Spanish market is highly concentrated: Aqualia and Aguas de Barcelona are the two main private operators.

Contractual public-private partnerships are the most widespread form of privatizing public services in Spain. In 2008 33% of Spanish population was served by fully private companies (AEAS, 2010). Concessions take the form of contract whereby the local government entrusts an individual or corporation (legal entity) with the management, but still owns the service. They are awarded following a public tender and for a limited amount of time. In the case of water supply companies, contracts that involve building infrastructures and operating the service must be no longer than fifty years, while those that only imply running the service have a twenty-five-year limit. At the end of the contract, local governments must again decide how they wish the service to be managed for a new period.

An alternative for the private sector to participate in the management of the urban water service is the creation of institutionalized PPPs (Bel and Warner, 2008; González-Gómez et al., 2011), whereby capital is shared between the private and public sector. In such companies, local government participation is high enough to guarantee that public objectives will be accomplished successfully. In 2008, those entities served to 13% of Spanish population (AEAS, 2010). This form of management makes it possible to combine public interests such as universal access and quality standards with the industry know-how of private management. In this sense, the private partner is mainly responsible for managing these companies, while the political decisions are made by the public partner. Da Cruz and Marques (2012) have nonetheless pointed out that, in spite of the theoretical advantages of institutionalized PPPs, the empirical evidence for the case of the Portuguese water service shows that the complexity involved in their management usually leads to a poor protection of the public interest. In line with those results and using a sample of big-medium size cities in Spain, García-Valiñas et al. (2013) found that mixed companies set higher prices that other kind of entities. [What about selection bias? Carpentier]

Anyway, when local governments decide to let private initiative come into the management of water services, they might organize an auction with some requirements to operators in order to attend to the competition. Those specifications include, among others, a minimum entrance and/or annual fees, and a certain level of investment during the concession period. Private operators might submit a bid trying to improve those minimum requirements. Once offers are received, local governments choose a winner based on several criteria.

In this situation, it is clear that the minimum requirements included in the initial bidding conditions should reveal the intention of local governments when they decide to privatize. Thus, they can fix a high minimum fee and (or) investments, in order to maximize the revenues from privatization. However, if the minimum requirements are not so high, other kind of objectives could emerge. Hence, the way the auction is organized could determine the final result of privatization process, in terms of price and quality. In this paper, we analyze this hypothesis from both a theoretical and empirical point of view.

3 The Model

Consider a municipality with M agents. Each agent inelastically consumes one unit of tap water. The municipality considers whether or not to privatize the supply of tap water. The privatization occurs through a first-price sealed-bid auction.

There are N potential suppliers of tap water, indexed by i. Firm i wins the auction if her bid, b_i, is higher than the other bids and if it exceeds the municipality's reservation price r. Bidder i faces cost c_i to supply tap water. The cost c_i is private information of Firm i. The costs c_i are independently drawn from distribution with c.d.f. F. Its support is $[0, \omega]$. Function F admits a continuous density function $f \equiv F'$. The hazard rate function associated with the distribution F is defined as $\frac{F(c)}{f(c)}$, and we assume that it is increasing in c.

After the auction, the winning bidder must decide on how much to invest to improve the supply of water. This investment is denoted by I. The municipality, after observing I, decides on the unit price p that the water company is allowed to charge. We assume that $p = \phi^s(I)$, where s describes a state of nature and where ϕ^s is increasing and concave with $\phi^s(0) = 0$.[1] To avoid confusion, we consider the following sequencing of events:

1. State s is publicly observed.
2. The municipality chooses the reservation price r. Bidder i learns her cost c_i.
3. All bidders—after observing r—participate in a first-price auction.
4. The winning bidder chooses her investment level I.
5. The municipal council observes I and sets p.

As usual this game is solved by backward induction. At time 3, the winning firm faces the following problem:

$$\max_I \phi^s(I)M - I - c_i.$$

As ϕ^s is concave, there exists a unique value of I which maximizes her profits. The equilibrium investment level is calculated as

$$I = \left(\frac{d\phi^s}{dI}\right)^{-1}\left(\frac{1}{M}\right). \tag{1}$$

Obviously, I depends on whether or not the local government needs to compromise with members of the opposition. To avoid cumbersome notations, in what follows we drop the superscript s to define the equilibrium price and profit.

The equilibrium post-privatization price of water is then:

$$p = \phi(I). \tag{2}$$

[1]For example, $s \in \{\text{maj}, \text{min}\}$. If $s = \text{maj}$, the municipal government has a majority in the municipal council. If $s = \text{min}$, the municipal government must compromise with the opposition in the municipal council in order to increase the price of water.

Let $\pi(c)$ denote the equilibrium profits (excluding her bid) made by the winning firm. Formally,

$$\pi(c) = \phi(I)M - I - c,$$

where equilibrium investment level is defined in (1). We assume that $\pi(0) > 0$. This assumption is natural: If $\pi(0)$ were negative, a bidder with zero costs who won the auction after bidding zero would still face losses. No bidder would be interested to participate in such an auction.

All bidders are assumed to bid according to a symmetric, decreasing and differentiable bidding function $\beta : [0, \omega] \to \Re^{+}$. Let

$$\bar{c} \equiv \phi(I)M - I - r, \tag{3}$$

where equilibrium investment level is defined in (1). Intuitively, a bidder with cost $\bar{c}$ who pays the reservation price r gets zero profits. Any bidder with cost $c > \bar{c}$ thus drops out of the auction. Formally, any strategy which prescribes her to bid above r is dominated. Now suppose bidder i's cost c_i is less than $\bar{c}$, i.e. that $pM - I - r - c_i > 0$. Suppose there exists an equilibrium in which she is supposed to bid less than r. In this candidate equilibrium, she never wins the auction and she therefore gets zero. She can, however, profitably deviate by bidding $r + \epsilon$: With positive probability she then wins the good and receives a payoff equal to $\phi(I)M - I - r - c_i - \epsilon > 0$. Hence, in any candidate equilibrium, $\beta(\bar{c}) = r$. A unit increase in the reservation price r thus leads to a unit decrease in the types that drop out of the auction.

We assume that $p^{\text{maj}}M - I^{\text{maj}} - \omega = 0$. In words, the assumption states that if $c_i = \omega$ and if bidder i wins her tract after bidding zero, she gets zero in state $s = \text{maj}$. It is thus without loss of generality to assume that $c_i \leq \omega$: A bidder with a cost $c_i > \omega$ would never participate in the auction, not even if $r = 0$ and if $s = \text{maj}$.

Let Y_1 denote the lowest cost realization among the remaining $N - 1$ bidders. Formally, $Y_1 \equiv \min_{j \neq i}\{c_j\}$. Let $G(c) \equiv \Pr(Y_1 < c)$ denote the probability that the lowest cost of the $N - 1$ other bidders is less than c and $g(c)$ is the corresponding density function[2]. Following

[2] $G(c) = 1 - [1 - F(c)]^{N-1}$.

Krishna (2009) the proposition below summarizes equilibrium bidding strategies at time three.

Proposition 1

$$\beta(c) = \begin{cases} 0 & \text{if} \quad c > \bar{c}, \\ \frac{1}{1-G(c)} \left[\int_c^{\bar{c}} \pi(x) g(x) dx + [1 - G(\bar{c})] r \right] & \text{if} \quad c < \bar{c} \end{cases} \tag{4}$$

and $\bar{c}$ is given by (3).

We now analyze the municipality's maximization problem. Municipality chooses r to maximize its ex ante expected revenue. Our most important result, which describes the equilibrium reservation price, is summarized below.

Lemma

In equilibrium,

$$r = \frac{F}{f} \left(\phi(I) M - I - r \right). \tag{5}$$

The equilibrium reservation price is uniquely defined since the hazard rate function is increasing.

We now analyze some comparative static results of our model.

Recall, that the equilibrium quantities are defined through the following system of equations:

$$r = \frac{F}{f} \left(\max_I \phi^s(I) M - I - r \right)$$
$$p = \phi \left(\left(\frac{d\phi^s}{dI} \right)^{-1} \left(\frac{1}{M} \right) \right)$$

We make additional assumptions on function ϕ^s: for all I, $\frac{\partial \phi^s}{\partial I}$ is increasing with s. This assumption ensures that the winning firm has more incentives to invest when the state is more favorable for the local government. The assumption also implies that $\phi^{s_1}(I) < \phi^{s_2}(I)$ for $s_1 < s_2$ whenever $I > 0$. In case $s \in \{\text{maj}, \text{min}\}$ the condition translates to $\frac{\partial \phi^{min}}{\partial I} < \frac{\partial \phi^{maj}}{\partial I}$, which ensures higher investments for the winning firm when the local government does not need to compromise with the local opposition parties.

From the model we get the following results.

1. As $\frac{\partial\phi^s}{\partial I}$ increases the equilibrium price p and the reservation price r increase.
2. As $\frac{F}{f}$ increases r increases and p does not change.
3. As M increases both r and p increase.

COULD YOU WRITE HERE SOME PARAGRAPHS TO CONNECT THIS PART WITH THE EMPIRICAL PART? THE RELATIONSHIP BETWEEN P AND R, THE RELATION WITH POLITICAL VARIABLES, ETC ETC

4 Empirical evidence

In order to test some of the findings showed in the previous section, we estimate a simple model using a data base of Spanish municipalities recently privatized, with a population size lower than 50.000 inhabitants. In particular, we analyze the influence of some auction conditions and environmental factors on water prices.

4.1 Data

Data on the auctioning terms and conditions are taken from several public websites which contain all the details on the privatization process. Law 30/2007 on Public Sector Contracts compels public authorities to upload to a public website all the documents linked to the public contracting processes from April 2008. Big-medium municipalities use to have a specific link in its own webpage that contains all the information. However, information on small municipalities contracting-out is centralized in a website managed by a regional public authority. Additionally, we have got information on water infrastructure quality from a survey on local infrastructures conducted periodically by the Ministry of Public Administration. Every 5 years, municipalities smaller than 50.000 inhabitants are interviewed in order to get exhaustive information on local public assets in terms of quantity and quality. The National Institute of Statistics (INE) elaborates statistics related to population, and political and public finance variables were taken from the Ministry of Economics and Public Administration webpage.

4.2 Econometric Analysis

Hereafter, we estimate the following equation system:

$$difp = f_1(r, pop, bpipeb, majority, difv) \tag{6}$$

$$r = f_2(debtb)$$

$$difv = f_3(incbill).$$

Our dependent variable ($difv$) is showing the difference between prices before and after privatization. From an empirical point of view, the construction of this variable in relative terms is more interesting, since it is showing how privatization process leads to price variations. As independent variables, we include the population (*pop*), and two political variables, showing the presence of strong majority governments in the year of privatization ($majority$), and a variable representative of the electoral support of local government along time ($difv$). Unfortunately, it was not possible to get information on the final investment. So we finally include a water services infrastructure quality index, as a way to approach future investments (*bpipeb*).

At the same time, we consider that r is a function of the financial situation of the local incumbent (*debtb*). In this respect, we are also testing if local governments are using privatization processes to get extra-funding and pay public debt off. We also consider that the causality relationship in the case of $difv$ is not clear. That fact means that the electoral support can allow to increase prices, but that support can also be influenced by privatization outcomes. Thus, we specify an additional equation where the electoral support depends on the relative increase of water bill after water services privatization (*incbill*). Appendix B includes further details about variables that we use in our empirical analysis [variable cons is not described].

[INSERT TABLE 1 ABOUT HERE]

Tables 1 and 2 shows some summary statistics. In Table 1, the representative municipality is a small entity around 8.200 inhabitants, with financial problems and around 25% of its pipes in bad conditions. On average, the difference between monthly water bill after and before privatization represents 2.3 Euros (in average, around 30% increase on monthly water bill). Regarding political variables, we observe that majority governments during the privatization, that loose votes in the elections after privatization. Additionally, in the majority of municipalities, there are not minimum investment requirements included in the bid terms and conditions. That evidence makes easier to assume that the municipality has focused basically on the revenues (?).

Table 2 presents average figures by municipality size. The small sample size make not possible to show independent estimates. Anyway, it is interesting to observe the differences among the three groups of municipalities defined [3]. Although the relation is not linear, the most significant bill increases (higher than 2 euros) are registered in small municipalities (lower than 20,000 inhabitants). Additionally, the percentage of pipes in bad conditions is higher in the block from 5,001 to 20,000 inhabitants, which presents the higher price increases after privatization. The percentage of strong majorities during the privatization is much higher in the smaller municipalities (up to 5,000 inhabitants). In addition, it decreases substantially with municipality size. Municipalities between 20,000 and 50,000 inhabitants suffer the most important reduction in the electoral support after privatization. Finally it is in this population block where the reservation price is higher in relative terms. It represents around 57% of the local debt.

[INSERT TABLE 2 ABOUT HERE]

Table 3 presents the main results. First of all, OLS model is applied to a basic model with no political variables (m0). The remaining models (m1,m2, m3) show estimates using three stage least square econometric method (3SLS). Compared with OLS, this method allows correcting endogeneity and improves efficiency. The last three models add variables in a sequential way, in order to carry out sensitivity analysis. Model m3 presents the results for the whole equation system in (6).

[INSERT TABLE 3 ABOUT HERE]

The empirical analysis shows a positive and strongly significant relationship between the

[3] Those three groups are based on population blocks at the Spanish Law 7/1985 regulating the Basis of Local Regime

reservation price and the price increase after the privatization. Moreover, local governments with higher financial problems set higher reservation prices in the auction. Thus, local public debt is emerging as a determinant of the reservation price, assuring higher revenues to improve municipal financial situation. The setting of higher reservation prices could also lead to reduce competition at the bidding process, because only the big private operators would participate. In this respect, the competition emerge as a significant issue to improve private firms behavior (Wallsten and Kosec, 2008; Picazo-Tadeo et al., 2009a,b; García-Valiñas et al., 2013).

Water infrastructures in bad conditions require higher investments, so price increases after the privatization are higher. In bigger municipalities, price increase is lower. This finding makes sense, since municipality size is directly linked to the costs of water services (García-Valiñas et al., 2013). Regarding political variables, we have found higher price increases linked to majority governments. Controlling for endogeneity, the relationship between the price increase after privatization and the political support is slightly significant and positive. That probably means that in those cities where there is a strong political support, local governments have higher probability to accept price increases after privatization. However, it seems that water services are not the key issue which lead parties to loss/gain votes. So, political support on time depends on different factors and local management dimensions, and not exclusively on water services management.

5 Concluding remarks

A growing interest on the analysis of causes and consequences of PPP schemes in public services management can be found in economic literature along the last years. These models have been encouraged by two main reasons: Firstly, as a voluntary way to reach efficiency goals and, alternatively, as a more pragmatic manner (less orthodox) to cover financial gaps between the needs of expenditure and the current tax resources in moments of fiscal stress for local governments.

With this article we contribute to this debate. Thus, we provide some theoretical background and interesting findings in the water sector. We have presented a stylized theoretical model in order to characterize the relevant conditions of the process throughout an auction. The reservation price, the need for some minimum investment requirements, the costs or provision and the price structures are important factors to take into account. The model assumes that private operator tries to maximize their profits and considers some public choice constraints linked to the governance of the involved public administration.

Afterwards, we have tested the effects of PPPs on several key variables. We use a database of Spanish low and medium-size municipalities where water management was recently privatized. A significant contribution of this paper is related to the current public sector financial situation. Thus, our first conclusion is that local governments are using public-private partnerships in order to get additional funding to reduce their indebtness levels. Economic crisis emerges as a key-driver of water services privatization. Moreover, the fact of setting a high reservation price as a way to guarantee a minimum amount of resources has had consequences in terms of water price increases after the privatization processes. our second conclusion is that political issues are also significant, in the sense that majority governments allow private operators to set higher water prices after the privatization.

An overview of the last two results should alert us about the implications of the privatization process in terms of public choice on the future sustainability of public finances. Thus, the opportunistic use of privatization processes, from a relatively comfortable political position could lead to undesirable effects. A government supported by a large majority could decide to switch from public to private management for a long period of time, by requesting a high initial fee (reservation price). In the short term, this government could allocate the amount collected to reduce past debts or to extend or improve other services different from the privatized. However, our results suggest that this will have relevant effects on the privatized utility, without any a priori guarantee to get proportional improvements in the quality of the service (prices will tend to grow more so greater has been the reservation price, because the private operator would want recover its original investment).

Although the externalization processes occurred in Spain along the last years are yet very recent and therefore it is too early to judge their outcomes in perspective, we have provided some useful findings. Definitively, it is therefore highly important that these privatization processes are conducted with the greatest transparency. So, this contribution allows enhancing the knowledge on the management of this significant merit good.

Appendix A

Proof of Proposition 1.

Following Krishna (2009) let us assume that all firms but firm 1 follow the strategy $\beta(c) \equiv \beta$ provided in (4). We would like to show that in this case it will be optimal for firm 1 to follow β as well. We denote by z the cost for which b is the equilibrium bid, i.e., $\beta(z) = b$. Then firm 1's expected payoff from bidding $\beta(z)$ when his cost is c is calculated as follows:

$$\begin{aligned} \Pi(b,c) &= [1-G(z)]\,[\pi(c)-\beta(z)] \\ &= [1-G(z)]\,\pi(c) - \int_z^{\overline{c}} \pi(x)g(x)dx - [1-G(\overline{c})]\,\pi(\overline{c}). \end{aligned}$$

As a result of integration by parts one can get that:

$$\begin{aligned} -\int_z^{\overline{c}} \pi(x)g(x)dx &= \int_z^{\overline{c}} \pi(x)d(1-G(x)) \\ &= [1-G(x)]\,\pi(x)\,|_z^c + \int_z^{\overline{c}} [1-G(x)]\,dx. \end{aligned}$$

Therefore,

$$\begin{aligned} \Pi(b,c) &= [1-G(z)]\,[\pi(c)-\pi(z)] + \int_z^{\overline{c}} [1-G(x)]\,dx \\ &= [1-G(z)]\,[z-c] - \int_z^{\overline{c}} [1-G(x)]\,dx. \end{aligned}$$

We thus can obtain the difference in expected payoffs when firm 1 bids $\beta(c)$, where c is its true cost, as compared when it bids $b = \beta(z)$:

$$\Pi(\beta(c), c) - \Pi(\beta(z), c) = [1 - G(z)]\,(c - z) - \int_z^c [1 - G(x)]\,dx. \tag{7}$$

From the mean-value theorem:

$$\int_z^c [1 - G(x)]\,dx = [1 - G(y)]\,(c - z)\,,$$

where $y \in (z, x)$ for $x \geq z$ and $y \in (z, x)$ for $z \geq x$. Then, (7) becomes:

$$\Pi(\beta(c), c) - \Pi(\beta(z), c) = (c - z)\,[G(y) - G(z)]\,.$$

Since the cumulative distribution function G is non-decreasing the last expression is non-negative regardless of whether $z \geq x$ or $x \geq z$.

Proof of Lemma 1

As there is a one-to-one relationship between r and $\bar{c}$, it is without loss of generality to assume that she chooses $\bar{c}$ instead of r. We assume that she chooses $\bar{c}$ to maximize revenues.

The expected payment of a bidder is $\beta(c)\,[1 - G(c)]$, and from (4) it reduces to:

$$\int_c^{\bar{c}} \pi(x)g(x)dx + [1 - G(\bar{c})]\pi(\bar{c}).$$

Then a bidder's ex ante expected payoff is:

$$\int_0^{\bar{c}} \int_c^{\bar{c}} \pi(x)g(x)dxf(c)dc + \int_0^{\bar{c}} [1 - G(\bar{c})]\pi(\bar{c})f(x)dx. \tag{8}$$

Applying integration by parts one can rewrite the double integral in (8) as:

$$\int_0^{\bar{c}}\int_c^{\bar{c}} \pi(x)g(x)dxf(c)dc = \int_c^{\bar{c}} \pi(x)g(x)dxF(c)\,|_0^{\bar{c}} + \int_0^{\bar{c}} F(c)\pi(c)g(c)dc$$
$$= \int_0^{\bar{c}} F(c)\pi(c)g(c)dc.$$

Thus, (8) becomes:

$$F(\bar{c})\left[1 - G(\bar{c})\right]\pi(\bar{c}) + \int_0^{\bar{c}} F(c)\pi(c)g(c)dc.$$

Without loss of generality, we assume that if the auction fails, i.e., $c_i > \bar{c}$ for all i, the municipality obtains 0. Then, the overall expected payoff of the municipality from setting a reservation price is:

$$NF(\bar{c})\left[1 - G(\bar{c})\right]\pi(\bar{c}) + N\int_0^{\bar{c}} F(c)\pi(c)g(c)dc. \tag{9}$$

. As there is a one-to-one relationship between r and $\bar{c}$, it is without loss of generality to assume that the municipality chooses $\bar{c}$ instead of r to maximize its overall expected payoff (9).

Taking into account the fact that

$$G(x) = 1 - \left[1 - F(x)\right]^{N-1},$$

the derivative of (9) with respect to $\bar{c}$ is:

$$N\left(1 - G(\bar{c})\right)\left(\pi(\bar{c})f(\bar{c}) - F(\bar{c})\right),$$

and the result follows.

Appendix B: Variables definition

difp: Difference between total bill after and before privatization, corresponding to an average consumption of 15 cubic meter per month (in Euros per cubic meter).

r: Reservation price (in thousands of Euros).
pop: Population of the municipality in 2011 (in thousands of people).
bpipeb: Percentage of pipes in bad conditions in 2005 (in percentages).
majority: Dummy which takes value 1 if there was a majority government the year of privatization.
difv: Difference between the percentage of votes got by the party governing in the moment of privatization, after and before the privatization (in percentages).
debtb: Local debt the year before privatization (in thousands of Euros).
incbill: Total bill growth rate (in percentages).

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Table 1: Summary statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
difp	2.318	3.141	-0.820	14.632	64
r	1,603.149	1,954.972	0	8,000	64
pop	8.262	9.061	0.439	44.737	64
bpipeb	24.404	33.718	0	100	61
majority	0.688	0.467	0	1	64
difv	-2.16	10.157	-27.24	22.91	64
debtb	2,831.526	3,827.958	0	15,247	57
incbill	0.332	0.506	-0.07	2.386	64

Table 2: Statistics by municipality size

pop	difp	r	bpipeb	majority	difv	debtb	incbill
< 5,000	2.09	462.09	22.77	0.83	-1.51	908.75	0.32
5,001-20,000	2.91	2,272.41	27.67	0.57	-1.38	4,044.68	0.40
20,000-50,000	1.34	5,693.86	22.24	0.33	-8.93	14,444.67	0.16
Total	2.32	1,603.15	24.40	0.69	-2.16	2,831.53	0.33

Table 3: Estimates

	m0	m1	m2	m3
r	.001	.029***	.041***	.032***
	(.000)	(.007)	(.010)	(.008)
pop	-.197	-5.733***	-7.985***	-5.810***
	(.118)	(1.428)	(1.977)	(1.602)
bpipeb	.022	.112***	.136***	.202***
	(.013)	(.032)	(.039)	(.060)
majority			5.678*	10.160*
			(2.591)	(4.395)
difv				1.841*
				(.872)
cons	1.877**	-1.410	-7.115*	-11.325**
	(.690)	(1.337)	(2.847)	(4.152)
r				
debtb		.323***	.323***	.337***
		(.046)	(.046)	(.044)
cons		592.012**	592.012**	550.805*
		(221.036)	(221.036)	(218.195)
difv				
incbill				-2.784
				(2.545)
constant				-.981
				(1.673)
N	54	54	54	54

* p<0.05, ** p<0.01, *** p<0.001