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"Privatization, cooperation and costs of solid waste services in small towns"

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Abstract

This paper analyzes the cost implications of privatization and cooperation in the provision of solid waste services for a sample of small municipalities. In conducting this empirical analysis, a survey is first designed and administered to municipalities in the Spanish region of Aragon, and then an estimation of the determinants of service costs is undertaken, considering the possible endogeneity of delivery choices. Our findings indicate that cooperation is more effective than privatization in saving costs. Both production forms can enable small municipalities to cut costs by exploiting scale economies. However, the fact that inter-municipal cooperation involves lower transaction costs and is less likely to be affected by competition problems would seem to account for the fact that it is a more effective way of reducing costs..

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1. Introduction

Decisions regarding how solid waste services are to be provided can be constrained by the fact that the size of a municipality does not coincide with the optimal geographical scale in terms of production. One means of reorganizing services in order to obtain returns to scale is via the consolidation of the territory. Such a process involves the merging of multiple jurisdictions, so that services are provided in an aggregate and joint form. However, this formula has met with little success in general, although it has been adopted in countries such as Holland (Bel, Dijkgraaf, Fageda and Gradus, 2010) and Switzerland (Soguel, 2007). Contrary to a number of *a priori* expectations, empirical evidence of the economic effects suggests that consolidation is often accompanied by cost increases.

Alternatively, many municipalities with a suboptimal size for the production of local services resort to outsourcing in order to exploit economies of scale (Donahue, 1989). Outsourcing can ensure cost savings because an optimal scale of production can be achieved by aggregating the production of multiple municipalities. Yet, according to recently published reviews of the empirical evidence, the results of privatization have not, in general, been as satisfactory as expected (Bel and Warner, 2008a, 2008b; Bel, Fageda and Warner, 2010).

Specifically, in the case of small municipalities, the transaction costs associated with the privatization of services may be greater than any benefits it might provide (Bel and Miralles, 2003). Furthermore, as the availability of private providers is not as high, the likelihood of privatization occurring is lower (Lamothe, Lamothe and Feiock, 2008). Thus, in the least populated municipalities the frequency of privatization is lower than it is in their more heavily populated counterparts, as has been described by Bel and Miralles (2003) and Bel (2006a) for Spain, and Warner (2006) for the U.S.

In various European countries, local authorities have opted to work with their neighboring municipalities in inter-municipal cooperation schemes that aggregate the production of services in a number of different municipalities. This has been the case in France, the Netherlands and Spain, where inter-municipal cooperation today is widespread. In England, however, there are few examples of horizontal cooperation among local authorities reflecting a range of historical and political factors (Kelly, 2007). Inter-municipal cooperation can be an alternative to privatization (Bel and Costas, 2006; Bel and Fageda, 2008), allowing the aggregation of the service at the local level and offering the possibility of realizing economies of scale with lower transaction costs. In

Spain, however, inter-municipal cooperation has also been compatible with the privatization of the services (Bel, 2006a; Bel and Fageda, 2008), and the transaction costs associated with the privatization contract have been shared by the cooperating municipalities.

Today, local service operations, in general, and the solid waste service, in particular, are scheduled within a restrictive budget. Thus, it has become increasingly important to know how municipalities manage their local services. Empirical evidence is widely available at the local level, but very few studies have analyzed this problem for small municipalities, which typify the Spanish region of Aragon.

The aim of this study is to analyze the determinants of the costs of providing solid waste services for a sample of small municipalities, with particular attention to the impact that privatization and inter-municipal cooperation might have on these costs.

Several studies have analyzed the impact of privatization on the provision costs of solid waste services, but the literature on the impact of inter-municipal cooperation on costs is scarce. Thus, one of the main contributions of this paper is to examine separately the role that privatization and cooperation have on the costs of solid waste services. This allows us to explicitly address the question as to which reform of the service - privatization or cooperation - is more effective at reducing costs[1].

A further contribution of the empirical analysis is to take into account the simultaneous determination of costs and of the decision regarding the production form. The previous literature has tended to focus on just one of the issues (either determinants of costs or production form). No earlier study has provided an estimation using instrumental variables that takes into account the possible endogeneity of the explanatory variables related to privatization and cooperation in the cost equation. To the extent that decisions regarding these policies may be motivated by the desire to reduce costs, any statistical bias in identifying the effect of the production form will be important bearing in mind the possible endogeneity[2].

[1] Bel and Costas (2006) analyze the impact of privatization and cooperation on the costs of providing solid waste services in the same regression.
[2] Dubin and Navarro (1988) develop an empirical model for the United States that addresses issues related both to the determinants of the production form and to the determinants of costs, but regressions are carried out independently and do not take into account the possible statistical bias derived from the simultaneous decision taken by local governments to reduce production costs and to opt for a given production form.

To carry out the empirical analysis, a survey was designed and conducted among municipalities with over 1,000 inhabitants in the Spanish region of Aragon, which is characterized by the small number of inhabitants in most of its municipalities.

The rest of our paper is structured as follows. In the first section, we review previous research examining the relationship between privatization, cooperation and costs in the provision of local services. In the second section, a more extensive review of empirical studies analyzes the relationship between production costs and delivery choices of the solid waste service. In the following section, we describe the equations that are to be estimated and provide details regarding the data and information sources that underpin our empirical analysis. This is followed by an explanation of the estimation results. The final section looks at the conclusions that can be drawn from the empirical work.

2. Privatization, cooperation and costs

Many publicly provided goods are characterized by the existence of economies of scale, which poses a problem regarding the optimal geographical scale for the service. The analysis of a municipality's optimal size for the provision of local services has had a certain significance in the economic literature since the early seventies (Oates, 1972; Mirrless, 1972; Dixit, 1973).

On occasions, as Donahue (1989) points out, the size of the municipality is not optimal in terms of production. Therefore, it is technically more efficient to reduce the number of companies operating in that market or even, in extreme cases where economies of scale are of great importance, to have just one company provide the entire service. In this way, the fixed costs are shared by several municipalities.

Hence, one of the main motives for privatizing a local service could be the reduction achieved in costs through economies of scale. As the size of the smallest municipalities is not optimal for the production of certain services, outsourcing can allow an optimal scale of production to be achieved. Given that the external producer is not limited to operating in a single city, the production of several municipalities can be summed together and, as a result, cost savings can be made.

For these reasons, the realization of economies of scale through outsourcing can potentially create high welfare gains[3]. Two factors largely determine the desirability of privatization policies aimed at improving social welfare: the real conditions of competition for the contract and the magnitude of transaction costs. In the first case, the introduction of competition through public tender introduces pressure to minimize costs. Moreover, if the contract winner is able to aggregate the production of several municipalities then its average costs will also be lower. However, in some cases, problems of competition arise in the designation of the contract or, in other others, there is a trend towards the concentration of private producers (Bel and Costas, 2011) which may result in local service privatization failing to achieve economies of scale.

It should be borne in mind, however, that the transaction costs derived from privatization (comprising administrative costs and those incurred from incomplete contracts) are relevant (Brown and Potoski, 2003, 2005) and can, on occasions, even exceed the cost savings associated with the exploitation of scale economies. These costs may be particularly significant in smaller municipalities because, on the one hand, as pointed out by Bel and Miralles (2003), transaction costs may outweigh the potential benefits of privatization and, on the other, because with a more restricted availability of private providers, the probability of privatization is also lower.

The aggregation of solid waste services through inter-municipal cooperation also facilitates the exploitation of economies of scale, by either public or private production. In Spain, cooperation is compatible with privatization (Bel, 2006a; Bel and Fageda, 2008). In other countries such as Netherlands (Bel, Dijkgraaf, Fageda and Gradus, 2010) and Norway (Sörensen, 2007), cooperation takes place in a situation of public production.

Nevertheless, inter-municipal cooperation is not exempt from problems. Sörensen (2007), in the case of Norway, and Garrone, Grilli and Rousseau (2010), in the case of Italy, have studied inter-municipal cooperation in providing solid waste services from the point of view of agency theory and economic policy. In these countries, the organizations responsible for managing municipal cooperation are multi-governmental agencies that risk aggravating principal-agent problems by increasing the distance between local government and the executive in charge of production. In addition, they weaken the incentive for the agent to oversee the system because of the dispersion of ownership, resulting in a reduction in the efficiency of production.

[3] The lack of competition in public production results in average costs that suffer from inefficiency. The introduction of competition through auction encourages a minimization of costs, resulting in technical efficiency. Inter-municipal economies of scale also lead to lower average costs for the overall market winner.

Likewise, Garrone, Grilli and Rousseau's (2010) results show that the main source of inefficiency originates from the discretional nature of management. More specifically, cost efficiency is positively related to the entry of external directors on to the board, and to the concentration in municipal ownership. From a political standpoint, their results indicate the importance of governance issues in the restructuring of public services.

3. Delivery choices and costs: Empirical evidence on the solid waste service

Since Hirsch's (1965) pioneering econometric analysis, the relationship between the costs of solid waste services and the production form has been discussed in numerous articles. However, the limitations imposed by the availability of data and the econometric techniques employed meant that these early studies provided only very preliminary conclusions.

Thus, the results regarding different modes of production are contradictory. Estimates provided by Kemper and Quigley (1976) and Collins and Downes (1977) indicate that private production is more expensive than municipal production. However, under public production, Hirsch (1965) and Collins and Downes (1977) find no significant differences between the service costs of private production and those of municipal production[4].

By contrast, Kitchen (1976) and Kemper and Quigley (1976) associate outsourcing with lower costs than those incurred in local municipal production. In addition to the modes of production, these authors use other explanatory variables – including, output (measured by population served or number of waste collection units), the frequency of collection, population density and distance to the garbage dump, among others – to analyze service costs. Pommerehne and Frey (1977), employing more robust techniques, conclude, in line with Reeves and Barrow (2000), that service costs are higher in municipalities with public production, regardless of the existence of competition.

Elsewhere, Domberger, Meadowcroft and Thompson (1986) and Szymanski and Wilkins (1993) conclude that competitive bidding makes no difference to public and private costs; while Szymanski (1996) reports lower private costs with competitive bidding because the benefits of competitive contracting diminish over time for all types of ownership; but the rate of degradation is

[4] In this review we focus exclusively on econometric studies that conduct multivariate analyses and employ control variables.

slower in the case of contracts won by private firms and more rapid in the case of units won by their public counterparts. Finally, in these studies, increases in the amount of waste and the frequency of collection, higher wage costs and a location in a metropolitan area or big city raise costs, while a shorter distance to the refuse site reduces them.

More recently, with the application of more advanced statistical techniques, a number of studies have been published that primarily estimate total service costs, but they are conducted for very different environments. With the exception of Callan and Thomas (2001) for the U.S., which uses a linear functional form of the cost equation, the models of Dijkgraaf and Gradus (2003, 2007) for Netherlands, Bel (2006b), Bel and Costas (2006) and Bel and Mur (2009) for Spain, and Ohlsson (2003) for Sweden, consider a log-log form.

Service costs do not vary significantly between public and private modes of production. In general, these models serve to reinforce the argument that competition for the production of the service is more important than ownership[5]. Only in Ohlsson's model (2003) is private production more costly than public. Moreover, costs rise as the following factors increase – the volume of waste generated, the amount of waste recycled, the number of collection points, wage costs, the frequency of collection and the distance to the refuse site[6]. By contrast, the existence of a garbage dump in the municipality reduces costs.

Finally, Bel and Costas (2006) and Bel and Mur (2009) extend their analyses to a study of inter-municipal cooperation. The outcomes reported in Bel and Costas (2006) indicate that municipal cooperation reduces costs[7] and support the hypothesis of Kodrzycki (1994) and Ballard and Warner (2000) that cost savings derived from outsourcing tend to diminish over time, and that the earlier the first recruitment experience in a municipality, the greater the competition will be and the more marked the effect on lowering service costs. Bel and Mur's (2009) results point to the existence of lower costs in the presence of cooperation, especially among smaller municipalities (less than 5,000 inhabitants). Overall, the average cost in the cooperating municipalities is 25% less than the average costs in municipalities that do not cooperate.

[5] Based on a meta-analysis of empirical studies of solid waste services, Bel and Warner (2008a) suggest that the absence of competition could explain why in some cases no evidence of a positive effect of outsourcing is found.

[6] In the case of selective waste collection, only Dijkgraaf and Gradus (2003) report that a high amount of selective organic waste reduces costs.

[7] Interestingly, the outcomes reported by Bel and Costas (2006) show that cooperation is negatively related to costs for estimates of the aggregate equation and estimates that sum municipalities with populations up to 10,000 and 20,000 inhabitants. By contrast, this variable is not significantly different from zero in the estimate for municipalities with a larger population (over 20,000 inhabitants).

In short, based on this review of the most recently published literature we find no significant differences between the modes of production. The amount of waste and, alternatively, the size of the population served as a proxy of output, service frequency, distance to the place of dumping and higher wage costs increase municipal service costs. By contrast, the existence of a garbage dump in the municipality and inter-municipal cooperation lower costs. Finally, a number of questions including the existence of scale economies present ambiguous evidence.

4. The empirical model

Based on our review of the previous literature, the basic function for the municipal costs of providing a solid waste service takes the following form:

$$CTE = f(PROD, COOP, POP, DISP, DEN, FREQ, EQUIP) \quad (1)$$

To the extent that the decision to cooperate or privatize are alternative forms (though not mutually exclusive) available to municipalities in order to reduce costs, we analyze the impact that privatization and cooperation have on the costs of providing the solid waste service separately. This should allow us to identify the most effective way (privatization or cooperation) to organize the provision of this service so as to maximize cost savings. Thus, we estimate two equations of the determinants of the costs for the provision of solid waste services. In equation (2), private production is included as the explanatory variable, while in equation (3), cooperation is included as the explanatory variable. Thus, we estimate the following equations:

$$CTEi = \beta 0 + \beta 1PRODi + \beta 2POPi + \beta 3DISPi + \beta 4DENi + \beta 5FREQi + \beta 5EQUIPi + \varepsilon i \quad (2)$$

$$CTEi = \beta 0 + \beta 1COOPi + \beta 2POPi + \beta 3DISPi + \beta 4DENi + \beta 5FREQi + \beta 5EQUIPi + \varepsilon i \quad (3)$$

The dependent variable in this cost equation, which we shall refer to as *CTE*, represents the cost paid for solid waste services in the municipalities of Aragon, and includes expenditure covering collection, transport, disposal/self-disposal and treatment. Total costs are determined by the population of the municipality (*POP*), a variable that reflects the quality of the service such as the frequency of collection (*FREQ*), and a number of service conditions (defined below) affecting input requirements (*EQUIP, DEN, DISP, PROD, COOP*).

Next, we define the variables included in our model of the determinants of costs and describe the expected effects of each.

a) Population of the municipality, *POP*. As a proxy for output we take the population of the municipality, according to the 2008 municipal register of inhabitants. A positive relationship is expected between population (*POP*) and total costs.

b) Frequency of collection, *FREQ*. This variable is the number of days waste is collected each week. In theory, a higher frequency of collection should lead to higher costs. Note that in our sample there is not much variation in the frequency of collection among the different municipalities. Thus, it is not easy to determine the real effect of this variable accurately.

c) Existence of a landfill in the municipality, *EQUIP*. To capture the fact that transport costs will be higher, we introduced a *dummy* variable to capture the existence of the municipal waste dump. This variable takes the value 1 if the municipality has a landfill and the value 0 otherwise. Thus, we expect a negative coefficient for the relationship between the landfill and the costs of the service.

d) Municipal density, *DEN*. Previous empirical studies frequently use the number of dwellings in relation to the area of the municipality as an explanatory variable. However, the lack of up to date figures for this variable in Aragon means we have used the number of inhabitants per square kilometer as our indicator of “population density". On the one hand, increasing population density leads to a rise in the amount of waste collected at each stop, which in principle should reduce collection costs. However, on the other hand, a higher concentration of population leads to more traffic congestion and so increased travel time could cause costs to rise. Therefore, the final effect of the DEN variable is a priori undetermined.

e) Municipal dispersion, *DISP*. A large number of villages within a municipal area may increase service costs because of the greater distances involved in providing the service. Therefore, the *DISP* is expected to have a positive effect on costs.

f) Private production, *PROD*. To capture the influence that the mode of providing the service (private or public) has on costs, we have constructed a *dummy* variable that takes the value 1 if the service is produced by a private company and the value 0 in case of public production (direct municipal management and public company). In the most recent and most robust empirical studies no differences between the two forms of ownership have been found. Thus, the expected effect of this variable is undetermined.

g) Municipal Cooperation, *COOP*. This variable is represented by a *dummy* that takes the value 1 if the service is provided at a supra-municipal level, i.e. via an area or commonwealth of municipalities, and 0 otherwise. The empirical literature suggests, as discussed above, that inter-municipal cooperation may be an alternative to privatization for smaller municipalities with fewer potential external contractors (Warner and Hefetz, 2003; Bel and Costas 2006). Municipalities are expected to cooperate in order to reduce costs, therefore, *a priori*, the expected effect of this variable on costs is negative[8].

On the other hand, there is a general consensus in the literature that the decision to privatize (or cooperate) is motivated by the interests of local governments to reduce costs. Thus, it may be necessary to take into account the possible endogeneity of the variables related to the means of production (privatization or cooperation) in the estimation of the determinants of costs. In line with the previous literature on factors affecting the form of production of solid waste services (Bel and Fageda, 2007, 2009), we use the following variables as instruments of privatization and cooperation:

1) *Index of financial burden (CFCRA).* A municipality's financial difficulties may constitute a decisive factor in the privatizing of local services, especially in small municipalities. We built this variable as the ratio of debt costs (interest plus amortization) and current revenue[9] (Chapter I to V of income).

2*) Ideology of local politics (POL).* The local government's decision concerning the means of production may be influenced by ideological criteria. This variable is, therefore, a qualitative variable that takes the value 1 if the mayor is from a right-wing party and 0 if he or she is of a left-wing ideology[10].

In the annex, we present the estimation results of the determinants of privatization and cooperation, which is not in fact the main focus of this study. However, it should be borne in mind that the results of the estimation of these equations show that costs significantly influence the decision as to which means of providing the service is eventually adopted[11].

[8] According to the literature (Bel and Costas, 2006), the effect of this variable should not be significant for large municipalities.
[9] In accordance with the *Ley Reguladora de las Haciendas Locales*, which states that the sum of depreciation plus interest on debt cannot exceed 25 per cent of the Autonomous Community's current revenues.
[10] Thus, we consider a mayor's party ideology to be left-wing if he belongs to the Spanish Socialist Party (PSOE), Izquierda Unida (IU) or Chunta Aragonesista and right-wing if he belongs to the Democratic Centre Union (UCD), Partido Popular (PP, formerly People's Alliance) or Partido Aragonés (PAR).
[11] Note that in the case of the equations of the determinants of privatization and cooperation, the cost per capita (*CTEcapita*) is included as an explanatory variable rather than the total cost. The latter is closely correlated to the population (a coefficient of over 90%), which is why by using the per capita cost we are

In Table 1 we summarize the variables that are used in our study together with their expected sign.

Table 1 Description of the variables used in the analysis of cost determinants

	Dependent Variable	
CTE	Total costs incurred by the municipality for its municipal solid waste service, including expenditure on collection, transportation to the disposal center, self-disposal and treatment.	
	Independent Variables	**Expected impact**
POP	Number of inhabitants in the 2008 population census.	+
DISP	Municipal dispersion: number of population centers within the municipality (2008).	+
FREQ	Number of times a week waste is collected.	+
EQUIP	Existence of waste disposal facilities in the municipality. *Dummy* variable: = 1 if the municipality has a landfill in the municipality. = 0 if the municipality has no landfill in the municipality.	-
DEN	Population density: number of inhabitants per square kilometer in the municipality in 2008.	Undetermined
PROD	Form of production of the urban solid waste service. *Dummy* variable: = 1 if the municipality has contracted the production of the service to a private company during the period under review (1979-2008). = 0 if the municipality maintains the production throughout all the period (direct municipal management plus public enterprise).	Undetermined
COOP	Cooperation in the service of municipal solid waste. *Dummy variable*: = 1 if the municipality has chosen to cooperate during the period (1979-2008). = 0 if the municipality does not cooperate at all during the period (1979-2008).	-

Source: authors' own

5. Data

To carry out this empirical analysis, a survey was designed and administered to municipalities with more than 1,000 inhabitants in the Spanish region of Aragon. The data refer to the year 2008, the latest available at the time of the survey. Information regarding costs was obtained from this survey, as was that related to the means of production, ownership of the service, frequency of

able to identify more precisely the effect that population has on the decision to cooperate or to privatize once the effect of population in terms of scale economies has been discounted.

collection and the availability of a landfill in the municipality. Complete information was obtained from 79 municipalities. An analysis of the representativeness of this sample shows that the coverage is around 80% of all the municipalities with more than 1000 inhabitants in Aragon.

Information regarding population and municipal size was provided by the National Institute of Statistics (http://www.ine.es). Information on local dispersion is published on the website of the Aragonese Institute of Statistics (http://portal.aragon.es). Labor cost estimates at the provincial level were derived from information reported in Alcaide and Alcaide (2010).

Table 2 shows the descriptive statistics for the model's variables, while Table 3 shows the correlation matrix of the variables used in the empirical analysis. There does not appear to be a problem of multicollinearity since there are no high correlations between the explanatory variables, while the majority of the explanatory variables (in particular, population) show a relatively high correlation with the costs variable.

Table 2. Descriptive statistics of the model's variables

Continuous Variables	**Average**	**Standard Deviation**	**Minimum**	**Maximum**	**N**
CTE	167736.2	305873.5	14800	1991663	79
CTEcapita	29.2	12.01	6.3	63.8	79
POP	4729.9	7564.8	917	51117	79
DISP	3.5	5.3	1	33	79
CFCRA	0.5	0.12	0.0006	0.61	79
DEN	61.6	105.4	6.2	719.5	79
FREQ	5.6	1.2	2	7	79
Discrete variables		**Number observations 1**	**Number observations 0**	**N**	
PROD (Production private=1;public=0)		50	29	79	
COOP (Municipal cooperation=1; no cooperation=0)		69	10	79	
POL (Right-wing=1; left-wing= 0)		38	41	79	
EQUIP (Landfill = 1; no landfill=0)		11	68	79	

Source: authors' own

Table 3. Correlation matrix of the model's variables

	POP	*DEN*	*DISP*	*COOP*	*PROD*	*EQUIP*	*FREQ*	*CTE*	CTE_C	*CFCRA*	*POL*
POP	1	0.27	0.36	-0.25	-0.26	0.63	0.41	0.94	0.15	-0.05	-0.02
DEN		1	-0.02	0.08	0.07	0.07	0.21	0.33	0.18	-0.05	-0.02
DISP			1	-0.26	-0.15	0.23	0.34	0.49	0.46	-0.03	-0.10
COOP				1	-0.05	-0.17	-0.09	-0.35	-0.18	0.03	-0.24
PROD					1	-0.22	0.10	-0.21	-0.20	0.10	0.10
EQUIP						1	0.36	0.56	0.08	-0.04	0.05
FREQ							1	0.40	-0.09	-0.06	-0.09
CTE								1	0.38	-0.04	0.04
CTE_C									1	0.07	-0.10
CFCRA										1	-0.10
POL											1

Table 4 shows the characteristics of the sample of municipalities indicating whether they cooperate or not, and whether production is public or private. Note, first and foremost, that the levels of outsourcing and cooperation in solid waste services in Aragon are very high. At the same time, it also appears that in the municipalities that do not cooperate the population is much higher, even though per capita costs are also higher in these municipalities. By contrast, the population is higher in those municipalities with public production than it is in those with private production, while per capita costs are higher in municipalities with public means of production.

Table 4. Characteristics of the sample of municipalities according to the form of production and provision

	Cooperation		**Form of production**	
	Municipalities that cooperate (N=69)	**Municipalities that do not cooperate (N =10)**	**Municipalities with private production (N=50)**	**Municipalities with public production (N=29)**
Continuous variables (Average values)				
Costs	126545.2	451954	117631.9	254123
Costs per capita	28.4	34.9	27.4	32.4
Population	4005.8	9725.4	3259.2	7104.3
Density of population	64.3	39.8	67.2	51.8
Dispersion	3.0	7.2	2.9	4.6
Financial burden	0.55	0.17	0.76	0.08
Frequency	5.6	5.9	5.7	5.4
Discrete variables (Number of municipalities with value 1)				
Right-wing mayor	30	8	26	12
Cooperation	-	-	43	26
Private production	43	7	-	-
Percentage of municipalities with a landfill	8	3	4	7

Note: Data for all the variables refer to 2008.

6. Estimation and results

Tables 5a and 5b show the results of the estimated cost determinants including as explanatory variables the decision to privatize and to cooperate, respectively. The estimation was undertaken using the two-stage least squares estimator given that the variables related to the privatization or cooperation decision may potentially be endogenous. As instruments of these variables, we included the financial burden of municipalities and the mayor's political affiliation. Standard deviations were robust to any problem of heteroscedasticity and clusters were applied at the provincial level (NUTS 3) in order to take into account the possible correlation between observations for municipalities in the same province.

As expected, total costs increase as the population rises, and this is true whether privatization or cooperation is included as the explanatory variable. In both cases, the coefficient associated with the population variable is positive and statistically significant at the 1% level.

On the other hand, total costs also increase as the population becomes more dispersed. The coefficient associated with this variable is positive and statistically significant at the 5% level whether privatization or cooperation is included as the explanatory variable and statistically significant elasticities are obtained at the 1% level. We also obtain some evidence that total costs are higher as the population density rises. However, the coefficient associated with this variable is not statistically significant, and the coefficient associated with this variable is only statistically significant at the 10% level in the equation that considers cooperation as an explanatory variable.

Contrary to expectations, the coefficient associated with the frequency of collection has a negative sign and is statistically significant at the 10% level in the equation that considers privatization as an explanatory variable. The fact that there is little variability in the frequency of collection might explain why we are unable to identify with any degree of accuracy the effect of this variable on the costs of providing solid waste services. Moreover, the cooperative provision of the service is generally associated with an equal rate of frequency in all the municipalities cooperating in a given area, regardless of population size. Hence, given the high frequency of cooperation (87% of the municipalities in the sample), the association between frequency and costs has to be called into question.

Finally, we should highlight the results for the variables related to the decision to privatize or cooperate. The coefficient associated with the privatization variable is positive and statistically significant at the 10% level. In terms of elasticities, the positive impact of privatization on costs is 1% and the value of this elasticity is 0.53. Therefore, it seems that privatization not only fails to reduce costs, but may even involve an increase in the cost of providing the solid waste service.

By contrast, the coefficient associated with the variable of cooperation is negative and statistically significant at the 10% level. The effect in terms of elasticities is important because these elasticities are above 1 and statistically significant at the 1% level. Therefore, it would appear that the decision to cooperate has a substantial influence on the costs of providing the solid waste service.

In conclusion, it seems that local governments in small municipalities may obtain further cost savings if they decide to co-operate with other municipalities in the provision of this service, while the decision to privatize the service or maintain public production seems less relevant in terms of costs.

In municipalities with small populations, there are two factors that may serve to explain why cost savings with privatization are merely modest. First, these municipalities may face difficulties in meeting the high transaction costs derived from the design and supervision of contracts with private companies. Second, it is likely that competition for the contract is not strong given the small number of companies that tender for such contracts. In fact, in many cases local monopolies may be consolidated in local municipalities or where populations are low (Bel and Fageda, 2011).

The other factor that can have a real impact on the potential cost savings of privatization is the exploitation of scale economies. Indeed, private companies can aggregate the output generated by several municipalities, while the output of the municipality itself (where the population is modest) may not be sufficient to minimize costs. However, our results indicate that inter-municipal cooperation, which also allows the exploitation of scale economies through the aggregation of the output of different municipalities, seems a more effective alternative than privatization to reduce costs. The fact that inter-municipal cooperation involves lower transaction costs and is less likely to be affected by competition problems may account for this result.

Table 5a. Empirical results of the estimation of the determinants of costs (two-stage least squares) – Privatization

	Coefficient	Elasticities
Constant	-954.5 (54022.7)	
PROD	90014.6 (32506.6)*	0.53 (0.17)***
POP	36.8 (2.12)***	1.03 (0.03)***
DISP	12816.2 (1651.11)**	0.27 (0.04)***
DEN	261.04 (141.6)	0.09 (0.05)*
EQUIP	-7572.7 (42545.7)	-0.04 (0.55)
FREQ	-21849.1 (6469.4)*	-0.7 (0.19)***
R^2	0.91	
Test-F	186.74***	
N	79	

Note 1: *** indicates significance at 1% level; ** indicates significance at 5% level; * indicates significance at 10% level.
Note 2: In parentheses, standard errors robust to heteroscedasticity.
Source: authors' own

Table 5b. Empirical results of the estimation of the determinants of costs (two-stage least squares) – Cooperation

	Coefficient	Elasticities
Constant	160735.4 (64857.8)	
COOP	-180405 (49403.9)*	-1.07 (0.25)***
POP	33.41 (3.29)***	0.94 (0.12)***
DISP	9655.9 (1407.4)**	0.20 (0.03)***
DEN	375.3 (106.6)*	0.13 (0.03)***
EQUIP	-26491.8 (43504.1)	-0.15 (0.26)
FREQ	-8385.2 (4624.07)	-0.28 (0.15)*
R^2	0.93	
Test-F	89.23***	
N	79	

Note 1: *** indicates significance at 1% level; ** indicates significance at 5% level; * indicates significance at 10% level.
Note 2: In parentheses, standard errors robust to heteroscedasticity.
Source: authors' own

7. Conclusions

In this article we have analyzed the cost determinants of providing solid waste services by including the decision to privatize and the decision to cooperate, respectively, as explanatory variables. To the extent that these two decisions might be considered alternative (though not exclusive) ways for municipalities to reduce their costs, we have analyzed separately the impact that privatization and cooperation can have. In this way, we have been able to identify the most efficient way of organizing the provision of the service so as to achieve the greatest cost savings.

It should be borne in mind that while there is an extensive empirical literature analyzing the impact of privatization on cost savings, few previous studies have analyzed the impact that inter-municipal cooperation can have on the costs of providing solid waste services. In addition, this study undertakes a combined estimation of the determinants of costs and the modes of organizing production (privatization and cooperation). In this way, we are able to account for the possible endogeneity of the variables related to these forms of organizing production in our estimation of the cost determinants. Here, it is worth noting that there is a consensus in the literature that one of the factors behind the decision to privatize (and to cooperate) is the concern expressed by local governments to reduce costs. Therefore, local government decisions regarding the modes of production and cost savings may be taken simultaneously.

Our estimations of the cost determinants show that total costs increase as populations increase and as the population becomes more dispersed in the municipality. This holds true when both privatization and cooperation are included as the explanatory variable. However, we have obtained some evidence that total costs are higher when population densities are high. This might be explained by the higher transport costs resulting from congestion in more densely populated urban areas.

To summarize our findings, therefore, the coefficient associated with privatization is positive and statistically significant. This suggests that privatization will reduce the costs of providing solid waste services. By contrast, the coefficient associated with cooperation is negative and statistically significant. The effect in terms of elasticities is clearly significant as the elasticities are above 1, suggesting that the decision to cooperate has a substantial influence on the costs of providing solid waste services. In conclusion, it would seem that local governments in small municipalities can obtain greater cost savings by opting to cooperate with other municipalities in the provision of the service. However, the decision as to whether to outsource the service or to maintain public production seems less relevant in terms of costs.

The other factor that might have an impact on the potential cost savings of privatization is the exploitation of scale economies. Here, private companies can aggregate the output generated by several municipalities, while the municipal output (where a population is only modest) may not be sufficient to minimize costs. However, our results show that inter-municipal cooperation, which similarly allows scale economies to be exploited by grouping the output of different municipalities, appears to be a more effective alternative to that of privatization for reducing costs. The explanation for this seems to lie in the fact that inter-municipal cooperation incurs lower transaction costs and is less likely to be affected by competition.

These results have obvious implications for public policy. The most compelling of these is, undoubtedly, the potential that inter-municipal cooperation appears to offer in realizing economies of scale and, thus, in reducing costs. Yet, this potential is not unconditional. Local services need to characterized by the existence of scale economies while the municipalities that cooperate need to have fairly small population thresholds, since larger municipalities already tend to be operating at an optimal scale. In this context, if there are economies of scale to be exploited and if municipalities are of the appropriate size, cooperation can be well worth promoting.

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ANNEX

Table A1. Empirical results of the estimation of the determinants of cooperation and privatization (probit with instrumental variables)

	Cooperation	Privatization
	Coefficient	
Constant	-1,73 (0,52)***	-1,98 (0,64)***
CTEcapita	0,09 (0,008)***	0,08 (0,02)***
POP	-5,32e-06 (0,000017)	-0,000021 (0,00004)
DISP	-0,10 (0,02)***	-0,09 (0,03)***
CFCRA	-1,04 (1,02)	1,05 (2,66)
POL	-0,40 (0,27)	-0,15 (0,27)
Test χ^2	123,33***	81,20***
Log-pseudolikelihood	-316,60	-335,55
N	79	79

Note 1: *** indicates significance at 1% level; ** indicates significance at 5% level; * indicates significance at 10% level.
Note 2: In parentheses, standard errors robust to heteroscedasticity.
Source: authors' own

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