DIRECT MANAGEMENT OR INTER-MUNICIPAL COOPERATION IN SMALLER MUNICIPALITIES? EXPLORING COST EFFICIENCY AND INSTALLED CAPACITY IN DRINKING WATER SUPPLY

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Abstract: The aim of this study is to examine whether drinking water services are supplied more efficiently, in small municipalities, under direct public provision or through inter-municipal cooperation. This analysis focuses on the use made of installed capacity, examining whether similar-sized municipalities have optimised their fixed infrastructure and/or physical inputs. A sample of 750 Spanish municipalities, each with fewer than 5000 inhabitants, was analysed, with data for the period 2014-2016, using a new order-m directional method with data panel and calculating the technological gap ratio, to evaluate the impact of different management forms on the efficiency obtained, thus measuring the use made of installed capacity. The main results obtained show that municipal direct management is the most cost efficient but that inter-municipal cooperation makes the best use of installed capacity. However, in similar-sized municipalities there are no significant differences in the latter respect according to the management form adopted, and therefore the differences observed in cost efficiency between the two management forms are associated with variable costs.

Key words: Cost efficiency, Direct provision; Inter-municipal cooperation; Drinking water supply.

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1 Introduction

A major research question in the field of municipal government is that of which forms of management provide the most efficient delivery of public services. In this respect, studies have traditionally focused on whether private delivery is more efficient than direct public management. However, not all local entities are able to privatise their public services, seeking thereby to improve efficiency; for example, smaller municipalities that wish to do so often have difficulty in finding available suppliers (Johnston and Girth 2012, Molinos-Senante and Maziotis 2019, 2020), as the limited scale of their services is sub-optimal and makes them less attractive to private providers (Bel and Fageda 2006).

Accordingly, most such local governments have tended to manage their public services directly. With respect to the drinking water supply service, however, the use of this management form, either directly or through public companies, has been criticised as being incapable of improving the quality of service or of expanding its coverage (Lo Storto 2014), due to the high maintenance costs of the service (Sauer and Frohberg 2007) and to the considerable financial investment needed to expand the network (González-Gómez et al. 2013). In view of these problems and with the option of privatisation ruled out, many local authorities have turned to inter-municipal cooperation, which provides an interesting alternative route towards greater efficiency, enabling partners to increase the size of their service delivery, and hence generating economies of scale (Bel and Mur 2009).

In the present study, we first analyse the management options of municipal direct vs. inter-municipal cooperation to determine which is more efficient for drinking water supply services in smaller municipalities, what has not been empiricaly studied in previous literature. To do so, we examined a sample of 750 Spanish municipalities, each with fewer than 5,000 inhabitants, for the period 2014-2016, basing our analysis on the magnitude of effective cost. We applied a newly-devised order-m method, which incorporates directional functions and makes use of panel data, such that the output obtained from fixed inputs can be determined from the differences between distances. Although few studies used separately directional distance functions and order-m panel data (see for instance Suárez-Varela et al. 2017 or Garrido-Rodríguez et al. 2018) to evaluate public services, the method here proposed combines for the first time, to best of our knowledge, their advantages. Firstly, it allows to differentiate among fixed and variables cost when calculating the efficiency scores, what is especially relevant in a sector with important fixed costs not adjustable in the short term. Secondly, it is very robust to the existence of extreme or anormal observations since is based on a panel data re-sampling procedure. Under this approach, local frontiers are calculated for each management form and the meta-frontier corresponding to the two management options is determined. Thus, we obtain the technological gap ratio (TGR), which is more useful than the transversal estimates obtained in previous research. After that we analysed the impact that capacity utilization has over the efficiency of the municipal drinking water management. This is an important issue, since this is an activity where low capacity utilization could lead to a relevant source of inefficiency. For this reason, from a municipal point of view, a relevant question is whether the inter-municipal cooperation could increase the efficiency through a better capacity utilization. This question has been omitted in previous studies (Suárez-Valera et al. 2016; Benito et al. 2018a,b). Consequently, the contribution of this work is twofold. First, it proposes a method of measuring efficiency not previously used. Secondly, it analyzes the impact that capacity utilization has on the drinking water management efficiency and whether it depends on the form of management adopted: direct or inter-municipal cooperation

Our results show that direct management is more cost efficient than inter-municipal cooperation for municipalities with fewer than 5,000 inhabitants. On the other hand, better use is made of installed capacity, i.e. the fixed structure, with inter-municipal cooperation. However, control-group analysis, with similar-sized municipalities employing either direct management or cooperation, revealed no differences in the use of installed capacity. This suggests that the greater cost efficiency observed with direct management arises from the greater variable costs incurred with inter-municipal cooperation.

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The rest of this paper is structured as follows: section 2 reviews the previous literature on service-delivery efficiency and the management forms that may influence it. Section 3 then describes the method applied to address this research question, after which we present the data analysed and the results thus obtained. The final section summarises the main conclusions drawn.

2 Service-delivery efficiency in small municipalities. Direct public provision vs. inter-municipal cooperation: a theoretical framework.

One of the fundamental goals of public managers, especially at the local level, is to identify and apply the management form of service delivery that maximises efficiency whilst maintaining acceptable levels of quality (García-Sánchez 2006, 2007). In this context, the privatisation of services – which has been considered under various theoretical approaches, including the theory of public choice and the theory of property rights (Bel and Fageda 2006; Jacobsen et al. 2013; Zafra-Gómez et al. 2013; Pérez-López et al. 2016), together with the theory of new public management (Osborne and Gaebler 1992; Andrews and Van de Walle 2013; Alonso et al. 2015) – has been widely used to achieve cost savings. This approach is often preferred by public managers, many of whom consider traditional direct management to be inefficient (Roy and Yvrande-Billon 2007), being strongly associated with political goals that may be contrary to service efficiency (Saal and Parker 2001). Moreover, direct management can be inflexible, which further hinders efficient service delivery (Donahue and Zeckhauser 2011).

Nevertheless, public managers in smaller municipalities are often unable to outsource their public services because their limited size means that economies of scale cannot be generated, unit costs cannot be reduced and the service is unprofitable (Bel and Fageda 2006; Mohr et al. 2010; Zafra-Gómez et al. 2013). As a result, in these municipalities the provision of public services is not usually attractive to private suppliers (González-Gómez et al. 2011; Pérez-López et al. 2016).

Therefore, small municipalities are often obliged to provide services themselves, either directly or through a subsidiary public company. However, in recent years alternatives to direct management have proliferated for this type of municipality, offering economies of scale, enhanced technical capacities, more efficient management (Deller and Rudnicki 1992) and decreased fiscal stress (Kim and Warner 2016).

In this respect, many experts consider that inter-municipal cooperation may provide the best alternative to privatisation for small municipalities (Warner and Hebdon 2001; Bel and Fageda 2006; Carr et al. 2009; Mohr et al. 2010; Zafra-Gómez et al. 2013; Silvestre et al. 2018). This management formula can be defined as the union of several municipal entities, or their agreement to create a supra-local agency, in order to jointly provide public services and thus enhance service efficiency and quality, while overcoming the problems arising from the territorial environment in which they operate (Citroni et al. 2013; Bel and Warner 2015). This formula enables cost savings in the provision of public services, via economies of scale obtained from increased demand and production (Bel and Fageda 2006; Carvalho and Marques 2014a, b). Accordingly, the more municipalities included in such cooperation agreements, the greater the savings achieved (Warner and Hebdon 2001).

For local authorities, it is of crucial importance to determine which form of management maximises the efficiency of service delivery, in view of the substantial costs involved. This is especially so for smaller municipalities, which have fewer resources with which to meet their obligations (González-Gómez et al. 2013). With respect to municipal drinking water supply, a significant proportion of delivery costs corresponds to the fixed structure that must be installed to provide this service. Even in municipalities with small populations, large distribution networks may be required, according to the local geography and characteristics (Sauer and Frohberg 2007), while the demand by the local population is relatively low. In these cases, in which the service capacity, i.e. the maximum level of production that can be achieved (Nelson 1989), exceeds the normal level of demand, inefficiencies can appear (Bhattacharyya et al. 1995).

In this context, when analysing the cost efficiency of the drinking water supply service in small municipalities, it is necessary to examine how much of their inefficiency may be due to the presence of excess capacity. In addition, it should be taken into account that cost efficiency and the use made of installed capacity may be determined or influenced by the form of service management adopted. Given the nature of inter-municipal cooperation, it might be argued that this form of management would make better use of installed capacity and thus increase cost efficiency. In the following sections of the paper, we consider these questions by means of a new directional order-m method, based on panel data.

3 Method

In the present study, we evaluate municipal efficiency in drinking water supply using a new order-m non-parametric model (Cazals et al. 2002), incorporating a meta-frontier (O'Donnell et al., 2008), a directional distance function (Luenberger 1992; Färe and Grosskopf 2000; Beltran-Esteve et al. 2019) and panel data (Surroca et al. 2016). For the meta-frontier, local frontiers were defined according to the two forms of management considered: municipal direct or inter-municipal cooperation. The following specific outcomes were calculated: a) the municipal efficiency results, according to inputs, in order to determine the potential decrease achievable in each of the input variables; b) the technological gap ratio (TGR), to quantify the impact produced on efficiency by the management form adopted. In the temporal analysis, a non-parametric panel data approach was used to evaluate the average behaviour of each unit with respect to the reference technological frontier obtained from the total observations available during the study period. Directional distance functions (DDF) offer great flexibility, allowing us to choose the direction in which to expand the outputs and/or reduce the inputs in order to reach the efficient production frontier. For the purposes of our study, this property is especially useful, requiring us to consider not only outputs but also inputs, although in practice only the latter are subject to reduction.

Assume that *J* municipalities employ the vector $x^{k,t} = (x_f^{k,t}, x_v^{k,t}) \in \mathbb{R}^{F+V}$ of fixed and variable inputs in the production of $y^{k,t} \in \mathbb{R}^M$ outputs in the drinking water supply service during year $t = 1 \ldots T$ and under management form $k = \{k_1\ , k_2\ \}$, where k_1 is municipal direct and k_2 is inter-municipal cooperation. Then, the possible production set for management form *k* in year *t* is defined as:

$$T^{k,t} = \{(x_f^{k,t}, x_v^{k,t}, y^{k,t}) \mid (x_f^{k,t}, x_v^{k,t})\ can\ produce\ y^{k,t}\} \tag{1}$$

The production set $T^{k,t}$must meet the usual axioms established in production theory (see, for example, Färe et al., 2007 or Shephard 1970). The efficient production frontier or enveloping frontier of $T^{k,t}$ can be defined from the following DDF (Luenberger 1992; Oh 2010; Sueyoshi and Goto 2010):

$$\vec{D}^{k,t}[(x_f^{k,t}, x_v^{k,t}), y^{k,t}; g] =$$
$$max(\beta \mid [(x_f^{k,t} - \beta g_f\ , x_v^{k,t} - \beta g_f\ ), y^{k,t} + \beta g_y\ ] \in\ T^{k,t}) \tag{2}$$

where $g = (g_f, g_v, g_y)$ is the directional vector that determines the direction of approach in which any unit will be projected to place it on the efficient frontier and $\vec{D}^{k,t}$ indicates the proportion by which the outputs/inputs must be expanded/contracted to reach the frontier. Consequently, if β = 0, neither its inputs nor its output can be expanded without their ceasing to belong to T _ ^ (k, t) and therefore the unit is considered to be efficient. A unit is considered to be inefficient when β> 0; the higher its value, the higher the level of inefficiency.

$\vec{D}^{k,t}[\cdot]$ can be calculated under various approaches. As mentioned above, we opted for an order-m model with panel data, similar to that used in Garrido-Rodríguez et al. (2018). The main advantage of this model is its low sensitivity to the presence of outliers when measuring efficiency, in contrast to non-parametric models. The order-m model presents the following characteristics: a) it assumes the non-convexity of the efficient frontier; b) it is based on partial frontiers. The first characteristic means that its basic formulation is that of a free disposal hull (FDH) model (Vanden Eeckaut et al. 1993). The second means that it is estimated by a resampling process with replacement of size *m* performed *B* times. The directional formulation of the FDH model with panel data to calculate the efficiency of the unit or to determine whether it belongs to management form *k* is given by the following linear expression:

$$\vec{D}^{k}\left[\left(x_f^{k,t}, x_v^{k,t}\right), y^{k,t}; g\right] = \max \beta$$

$$s.a. \sum_{j=1}^{J} \sum_{t=1}^{T} \lambda_j^{k,t} x_f^{k,t} \leq \bar{x}_{fo} - \beta \quad g_f \quad f = 1 \ldots F$$

$$\sum_{j=1}^{J}\sum_{t=1}^{T}\lambda_j^{k,t}x_v^{k,t} \leq \bar{x}_{vo} - \beta \quad g_v \quad v = 1 \dots V$$

$$\sum_{j=1}^{J}\sum_{t=1}^{T}\lambda_j^{k,t}y^{k,t} \geq \bar{y}_{mo} + \beta \quad g_y \quad m = 1 \dots M$$

$$\lambda_j^{k,t} \in \{0,1\}, \beta \in \mathbb{R}$$

(3)

where $\bar{x}_{fo}, \bar{x}_{vo,}\bar{y}_{mo}$ represents the average value during the study period of the fixed inputs, the variable inputs and the output, respectively, of the unit *o* being evaluated. The directional vector can be defined according to the needs in question, but it is often defined in the form $g = \left(\bar{x}_{fo}, \bar{x}_{vo,}\bar{y}_{mo}\right)$, which enables β to be interpreted straightforwardly as the maximum proportional reduction/increase that can be achieved simultaneously in all inputs/outputs.

The directional order-m panel data model is obtained from model (3), in accordance with the following procedure proposed by Daraio and Simar (2007):

1. Choose a random sample with replacement of size m from the units (municipalities) that fulfil $\bar{y}_{mo} \leq y^{k,t}$;
2. Resolve model (3) using the units selected in step 1, thus obtaining β^m;
3. Repeat steps 1 and 2 during *B*, thus obtaining $\beta_2^m, \dots \beta_B^m$ efficiency coefficients for the unit being evaluated;

4. Calculate the average efficiency coefficient of the unit being analysed as $\beta = \left({}^{1}/_{B}\right) \sum_{b=1}^{B} \beta_b^m$.

From the above procedure, we obtain β efficiency coefficients located outside the frontier (super-efficient units), considering the partial frontiers derived by resampling. An important property of this is that when m → ∞, the efficiency coefficient obtained with the order-m model will converge with that obtained in (3). Consequently, the higher the value of *m*, the smaller the number of units located outside the efficient frontier, and *m* can take values higher than the number of units evaluated, according to the percentage of super-efficient units required. Therefore, the value assigned to *m* is an important decision in this type of model. Previous studies have suggested assigning a value such that super-efficient units comprise about 10% of the observations (Bonaccorsi et al. 2006; Felder and Tauchmann 2013). In our study, the same criterion is applied, and so the value assigned to *m* represents 7-10% of the total of the sample, at each of the local frontiers, and also at the meta-frontier. Although for most applications a value for *B* of 200 is considered sufficient (Balaguer-Coll et al. 2013), we prefer to use *B* = 2000, as suggested by De Witte and Geys (2013).

Our empirical application has two main objectives: first, to calculate the potential reduction in variable inputs, by determining the impact of each form of management; secondly, to calculate the use made of installed capacity.

To address the first of these goals, we estimate each unit's level of efficiency with respect to the same group by management form, resolving the order-m model with the directional vector $(0, \bar{x}_{vo,} 0)$. Then, following the proposal of O'Donnell, Rao and Battese (2008), its TGR is determined as follows:

$$TGR_o = \frac{1 - D^{k_1 \cup k_2}[\cdot]}{1 - D^k[\cdot]}$$

(4)

Thus, TGR_o is defined by the quotient between the variation achievable in the inputs, considering all of the units in the sample (meta-frontier), and the variation achievable considering only the units that belong to the same management form (local frontier) as the unit *o* being evaluated. The closer the value of TGR_o to one, the closer the local frontier to the meta-frontier and, therefore, the weaker the impact of this management form on the efficiency obtained.

With respect to the second of our objectives, to determine the level of installed capacity used (CU), we follow the proposal of Ferrier, Leleu and Valdmanis (2009):

$$CU_o = \frac{\vec{D}^k\left[\left(x_f^{k,t}, x_v^{k,t}\right), y^{k,t}; g_{fv}\right] + 1}{\vec{D}^k\left[\left(x_f^{k,t}\right), y^{k,t}; g_f\right] + 1}$$

(5)

where $g_{fv} = (0,0, \bar{y}_{mo})$ and $g_f = (0, \bar{y}_{mo})$.

If $CU_o = 1$, the unit is making maximum use of its capacity; if this value is smaller, it indicates the proportion of output achieved with respect to the maximum.

4 Variables and data

To obtain the raw material for analysis, information on service costs was obtained from municipalities with fewer than 5,000 inhabitants, according to the statistics on the effective cost of public services published by the Ministry of Finance and Public Administration. These data comprised the inputs for our analysis. The same source supplied the data related to management forms. The resulting sample consisted of 721 municipalities that provided the drinking water supply service directly and another 29 that provided it through inter-municipal cooperation. This disproportion clearly reflects these smaller municipalities' predilection for direct management[3]. The output data, including the quality variable, were obtained by consulting the Survey of Infrastructure and Local Equipment, the results of which are published by the Ministry of Finance and Public Administration[4].

The study variables were selected taking into account previous work in this field, such as Romano and Guerrini (2011) and Berg and Marques (2011). Table 1 shows the variables taken as inputs and outputs in our analysis of service efficiency.

[Insert Table 1]

As stated above, the aim of this study is to analyse the efficiency of the drinking water supply service provided in smaller municipalities. To do so, we calculate the TGR (defined in the Method section for estimating cost efficiency) using the value m = 388. The level of installed capacity used (CU) was calculated assuming m = 1046. These values

[3] Following the publication of Order HAP/2075/2014, of 6 November, information is now available for the effective cost of Spanish municipalities for the period 2014-2016, and is updated annually.
[4] The large difference between the two samples is one of the reasons why the non-parametric technique is used. Suarez-Valera et al. (2016) used small sample sizes in a similar approach.

were sufficient to ensure that superefficient units represented 7-10% of the total (Feder and Tauchmann 2013).

5 Results

The results of our analysis are shown in Table 2. However, given the large differences in sample sizes, between municipal direct management and inter-municipal cooperation, efficiency values were calculated, on the one hand, for a municipal direct management group, and on the other, for an inter-municipal cooperation group, in both cases with similar levels of population, thus ensuring greater robustness of the results obtained.

Each of the results tables presents the cost efficiency measured by the mean TGR, together with its constituent elements, the value of the meta-frontier and that of the local frontier (that is, for each of the management forms analysed). The TGR measures the distance between the two frontiers, which enables us to determine which of the two management forms is technologically more efficient. The TGR value that is closer to one (i.e., when the local border is closer to the meta-border) represents the management form that is more technologically efficient in terms of mean costs. TGR values greater than one indicate that this management form is super-efficient in providing the service in question. The CU is then calculated in the same way as the TGR.

Traditionally, in order to test whether two distributions are significantly different, the value used is either the t-value for related parametric samples or the Wilcoxon value for unrelated non-parametric samples. However, there exists an alternative, based on mean values and referring to the notion of global distance, or closeness, between two densities f(x) and g(x), via their integrated square error (Pagan and Ullah 1999). This approach, following Pastor and Tortosa-Ausina (2008) and Balaguer-Coll et al. (2010), is based on Li's test (Li, 1996), which measures the distance between two density functions using their integrated square error (Zafra-Gómez and Muñiz 2010:621). Accordingly, in our study, the Li test was applied to determine whether the GRTs obtained for the two management forms differed significantly.

The results of the Li test and for the density functions (see Figure I) show that for cost efficiency and CU the hypothesis of equality of distribution of efficiency between the two management forms is rejected, with the results obtained being significantly different. From the mean values for the management forms, it can be seen that the average TGR for municipal direct management is 27% higher than that for inter-municipal cooperation. Thus, for municipalities with fewer than 5,000 inhabitants we conclude that direct management obtains better levels of cost efficiency (see Figure 1).

[Insert Table 2]

These results contrast with the empirical evidence reported in previous studies of waste collection services (Bel and Mur 2009; Pérez-López et al. 2016), which measured higher levels of efficiency with inter-municipal cooperation for this type of municipality.

The analysis of installed capacity shows that inter-municipal cooperation makes better use than municipal direct management of resources (51.31% vs. 41.29%, respectively) (see the Li test results and density functions in Figure 1).

As stated above, for greater robustness of the analysis, the study method was applied to a specific sample of the municipalities applying the municipal direct management form, thus forming a control group with municipalities similar to those of the inter-municipal cooperation group. The resulting sample was composed of 58 municipalities, 29 for each management form. The results of this analysis are shown in Table 3. The independence of the samples was examined by applying the Li test, which revealed significant differences in cost efficiency, leading us to reject the hypothesis of equality in this respect (see the Li test results -table 4- and Figure 1 density functions) at a significance of 1%. Thus, the municipal direct management form obtained a better mean TGR than inter-municipal cooperation (0.96 vs. 0.70, respectively), which corroborates the results obtained for the whole sample.

[Insert Table 3]

On the other hand, for the same control group our analysis of the use of installed capacity, via the Li test, indicates that the hypothesis of equality cannot be rejected, as there were no significant differences in this respect between the two management forms (see Li test table 4 and Figure 1). These results for the control group show that for a given municipal size there are no differences by management form in the use made of installed capacity, and therefore the existence of significant differences in cost efficiency in this group arises from the fact that inter-municipal cooperation incurs higher variable costs than municipal direct management.

[Insert Table 4]

[Insert Figure 1]

6 Conclusions

Numerous studies have sought to identify the management form that maximises cost efficiency in the provision of a basic service, such as drinking water (see Silvestre et al. 2018), due to the major role played by this parameter in the proper functioning of public entities, which are often subject to considerable inefficiency in the provision of essential services. These problems are accentuated in small municipalities, where public managers wish to adopt a suitable management form for the service in question, but only have access to certain formulas in this respect.

These considerations underscore the need to analyse the efficiency of providing this service, considering the special circumstances facing smaller municipalities, in order to identify the best option for service delivery form. Accordingly, in the present study we consider the two forms of management that have been shown to be most suitable for the provision of public services in small municipalities, namely direct management and inter-municipal cooperation. The results obtained extend our understanding of how this public service may best be managed.

To address these study goals, we employed a new approach, estimating order-m panel data through directional functions. This method determines the efficiency obtained, in terms of service delivery costs, and enables us to compare these costs according to the management form employed, by means of local and meta-frontiers. It also reveals the level of use made of fixed installations (in the case in question, the distribution network for municipal drinking water supply), by determining the differences between distances, an aspect that has not been considered in the previous literature on management forms for the drinking water supply service, based on panel data models.

However, although most experts agree that inter-municipal cooperation is, in principle, the most appropriate management form for this type of municipality (Warner and Hebdon 2001; Bel and Fageda 2006; Carr et al. 2009; Mohr et al. 2010; Zafra-Gómez et al. 2013; Silvestre et al. 2018), our results suggest that in smaller municipalities, direct management obtains higher levels of cost efficiency.

On the other hand, municipalities that opt for inter-municipal cooperation make greater use of installed capacity (fixed service inputs), thus reducing the inefficiencies that can arise from excess capacity. These differences between our conclusions and previously-reported findings may be explained by the different nature of the services analysed. In fact, the drinking water supply service requires a very high level of fixed inputs, which clearly distinguishes it from other services, such as public transport or waste collection, that have been analysed in previous research. Moreover, our results cannot be compared directly with previous work in the field of drinking water supply because our analysis presents the novel aspect of evaluating the service efficiency achieved by inter-municipal cooperation.

These considerations highlight the need to clarify the question of what measures public managers should take to improve the efficiency of public services when they are provided through inter-municipal cooperation. Our analysis, based on the inclusion of a control group composed of municipalities with comparable socioeconomic and population characteristics, shows that the use of installed capacity does not differ according to the way in which service provision is managed, and therefore the inefficiency associated with inter-municipal cooperation is due to the presence of higher variable costs. These results provide public managers with useful information, helping them improve the cost efficiency of services provided via this management form.

Finally, we show that both management forms for the provision of the public drinking water supply service are subject to inefficiencies, due to an excess capacity of fixed installations. This inefficiency could be eliminated if better use were made of the infrastructure. This understanding might account for the growing tendency of public managers to adopt the form of inter-municipal cooperation for the provision of essential public services, thus optimising their scale of operation.

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Conflicts of interest The authors declare no conflicts of interest.

Availability of data and material Some or all data, models, or code that support the findings of this study are available from the corresponding author upon reasonable request.

Code availability Not applicable.

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Table 1 Descriptive statistics of inputs and outputs

	Variable	N	Mean	Std. Dev.	Min.	Max.
INPUT	Current expenses (euros/year)	750	46348.37	68771.14	913.9	671257.6
	Personnel (euros/year)	750	21610.66	23409.31	2636.24	207621.2
	Network length input (m)	750	19872.76	25383.15	450	185000
OUTPUT	Mean consumption (m^3/day)	750	435.5583	503.9393	50	6332
	Mean consumption *Quality[i] (m^3/day)	750	617.7669	805.0712	50	6332

[i] Mean water consumption, in m^3/day, corrected by the index of service quality, an internal measure based on the quality of water purification treatment, the volume of water flow and the pressure of domestic water supply.

Table 2 Levels of efficiency, by management form

Management form / Efficiency	Cost Efficiency **			Mean use of installed capacity (Fixed input) ***
	Mean meta-frontier value	Mean local frontier value	Mean TGR	
Municipal direct	0.499	0.508	0.981	0.412
Inter-municipal cooperation	0.600	0.774	0.770	0.513
Overall	0.503	0.518	0.973	0.416

*Note: *** Irrespective of management form adopted at 99% significance according to Li's test.*

*** Irrespective of management form adopted at 95% significance according to Li's test.*

Table 3 Levels of efficiency, by management form, for the control group

Management form / Efficiency	Cost Efficiency **			Mean use of installed capacity (Fixed input) ***
	Mean meta-frontier value	Mean local frontier value	Mean TGR	
Municipal direct	0.536	0.553	0.964	0.443
Inter-municipal cooperation	0.600	0.774	0.770	0.513

*Note: *** Irrespective of management form adopted at 99% significance according to Li's test..*

Table 4 Results of the Li test

	Total cases (Cooperation/Direct)		Control group (Cooperation/Direct)	
	P value	T	P value	t
Cost efficiency	0.02815881	1.90857	0.000105545	3.705361
Use of capacity	1.576098e-07	5.114112	0.5637249	-0.1604201

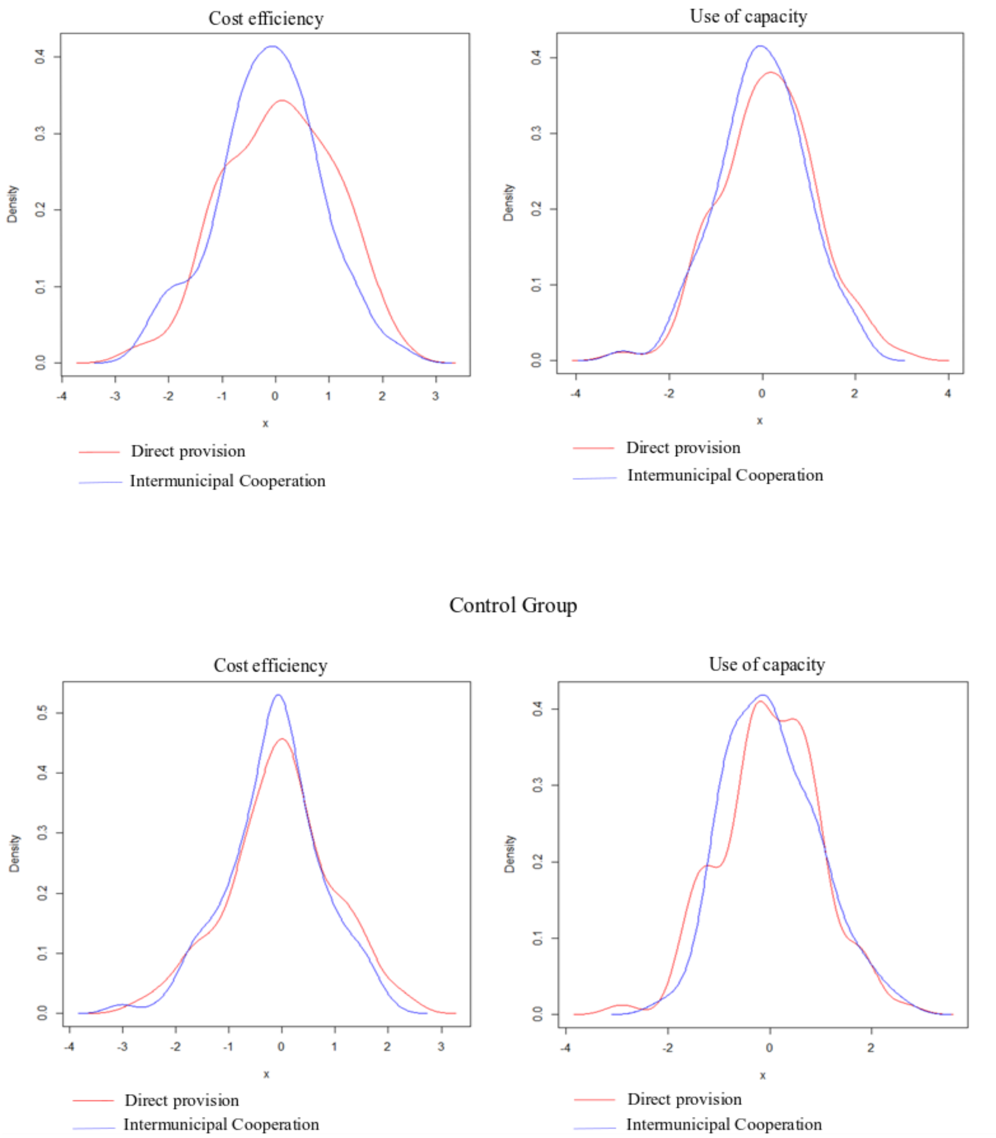

Fig. 1 Density, according to management form