Is the time dimension really important in research into contracting out?

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ABSTRACT. In a recent study into the literature, Bel and Fageda (2007) highlighted the lack of the time dimension in research dealing with explanatory factors in the decision to contract out municipal services. In this paper we attempt to evaluate if the argument of Bel and Fageda is true. We do this by means of two methodological contrasts in the designing of variables from a dataset containing 744 municipalities in Southern Spain. From our empirical analysis, we conclude that the consideration of the time dimension does contribute to a better specification of the model, and not considering it could lead to a misunderstanding of the motivation behind the decision.

KEYWORDS: Water utilities; contracting out; privatization; public services; local government

1. INTRODUCTION

In a recent survey Bel and Fageda (2007) question the research that uses cross section data in order to analyze the explanatory causes of local government decisions regarding the contracting out of municipal services. The cross section data has important limitations in terms of explaining those decisions, mainly when dealing with a long period of time. The value that the explanatory variables take at the moment *x* could be very different to the value at *x-n* in which the local government contracted out its service. Therefore, explanatory variables of the decision could not capture general

conditions at the moment the decision was made, thus contradicting the hypothesis of the analysis.

In their paper, Bel and Fageda point out that this could be the reason for the lack of explanatory power in the research that attempts to analyze the decision to contract out. This reason could additionally explain why is it so difficult to find cause-effect relationships that could be of general application and empirically contrasted. Therefore, it is very difficult to infer general patterns of behavior when studying the explanatory causes of the decision to contract out of local governments.

The argument of those authors is certainly plausible. Theoretically, the most appropriate method would be to include the value of explaining variables considering the moment when the local government decided to change the management of the municipal service. Taking this into account, the questions that we pose in this paper are the following: Is the consideration of timing in the data relevant for research? What repercussions could the lack of inclusion of the time dimension have in the interpretation of the results?

We intend to show this by means of an example about the importance of the manner of introducing the data in this kind of analysis. We do so by using data referring to the urban water service in 744 municipalities in Andalusia, an autonomous region in Southern Spain. The data was gathered for each year over the period 1986-2006. In order to capture the effect proposed by Bel and Fageda, the data are introduced in two different ways: One is by taking into account the time dimension and the other one is by disregarding it. The analysis made is a test, therefore its conclusions are not directly extrapolable to different situations. However, it could give some insights into what can be expected in other situations as well as providing a reference point for future research.

Obtaining significant differences between the two methods would provide an additional argument to support the thesis of Bel and Fageda. This would suggest the need to treat the conclusions of previous work with caution, even to review those conclusions if possible, by introducing the data in the way that Bel and Fageda suggest.

The results of this work could be of additional interest in research that applies two stage techniques of analysis. For instance, Ohlsson (2003) performs a comparative analysis of cost efficiency between public and private companies in the urban waste disposal service sector. The author incorporates the results obtained in the first stage, concluding that private companies do not randomly choose to take responsibility for the service privatized by the local administration, but instead they take responsibility for this service only in favorable scenarios which allow them to make profits. Other examples include Carpentier et al. (2006) and Martínez-Espiñeira et al. (2009), who conclude that the price of the water in cities is higher on average when the management of the municipal water service is private. This is partly because in a complex environment the local government are more willing to delegate the water service.

This paper provides empirical evidence about the best way of introducing data in research that aims to analyze the decision to contract out adopted by local governments. This contributes to a better understanding of the actions of the local government. The remainder of the paper is organized as follows. In Section 2 we examine the methodological inconsistency established by Bel and Fageda in the concrete case of water services in Southern Spain. Section 3 is devoted to describing the methodology and the dataset, respectively. Section 4 presents and discusses the empirical results. The final section summarizes and highlights some concluding remarks.

2. METHODOLOGICAL CONSISTENCY IN WATER SERVICES IN ANDALUSIA

This study focuses on Andalusia, an autonomous region in Southern Spain. The surface area of Andalusia occupies around 17 per cent of Spanish territory, and is the most populated region in the country, with approximately 8 million inhabitants. Its tourist activity is well known outside the region: The good climate, the wide variety of hotels and leisure activities are found mainly in the 1,101 kilometers of coastline. Monuments such as the Alhambra attract annually around 30 million tourists.

Spanish legislation establishes that the urban water service is a municipal responsibility. However, it is currently not obligatory for the local council to undertake its management, as this can be delegated to an external company. Many local governments in Andalusia opted for this formula, thanks to the changes established by the Law 7/1985, 2nd of April which such privatizations.

This research is made from data over the period 1986-2006, including 744 municipalities. This database refers to more than 96 per cent of the total of municipalities in Andalusia. Only 29 municipalities could not be included, therefore this dataset is almost censal information[1].

By 2006 about 40 per cent of the municipalities had contracted out their water services. More than 20 years after the establishment of Law 7/1985, we wonder why some governments have opted for external contracting out, while others have preferred direct management.

According to Bel and Fageda research into this subject normally uses cross section data. However, this way of introducing the data is not the most accurate in order to explain the real situation. In Figure 1 we show how the decision to contract out

[1] For the gathering of information about the year in which the service was contracted out, if this decision was taken, we did the following: First, an e-mail was sent to all local councils. If no reply was obtained, a letter was sent through the traditional post. Finally, if we obtained no results from these methods, a telephone call was made.

municipal services in Andalusia have been distributed over time. This information illustrates the theory of Bel and Fageda. Taking cross section data for any year in the series could not allow us to capture all of the explanatory factors in contracting out. For example, if we took cross section data from the last year of the series, we would be considering variables from data from 2006 to explain the contracting out made in 42 municipalities that took the decision between 1986 and 1990.

How important is it to take into account this dynamic in the decision-making of local governments? In the following sections we explain the methodology, the variables and the differences of data timing consideration in order to assess the methodological inconsistency proposed by Bel and Fageda.

INSERT FIGURE 1 ABOUT HERE

3. METHODOLOGY AND VARIABLES

3.1. The method

As argued before, the problem in the research of local decisions normally lies in cross section data. When the problem consists of describing why the local government took the decision to contract out water management, discrete choice models are often used (Ménard and Saussier; 2000; Bel and Miralles, 2003; Dijkgraaf, Gradus, and Melenberg, 2003; Walls, Macauley and Anderson, 2005; and Tavares and Camöes, 2007). Those models are common in this kind of literature, and their complexity depends on the number of alternatives. Therefore, if there are only two alternatives, the researchers could choose either binary probit or binary logit, and if there are more than two, the research will then apply either multinomial probit or multinomial logit[1]. In the following lines we briefly present the specification of the binary discrete choice model

that is applied for estimation. Some more complete information about this model can be found in any advanced econometric text, such as Greene (2008) and Wooldridge (2001).

The model that we wish to estimate takes the following specification:

$$y_i = x_i'\beta + \varepsilon_i, \quad (1)$$

where $i = 1,....,N$, $y_i = 1$ o $y_i = 0$, x_i' is the vector of characteristics of the observation *i*, β is the vector of parameters that we want to estimate, and ε_i is the error term.

Given the dichotomous character of the dependent variable, and depending on the nature of the problem described above, model (1) is estimated as a probabilistic model. Therefore, assuming that the critical values follow a normal distribution:

$$u_i \sim N(0,\ \sigma^2),\ \ y_i^* \sim N(x'\beta,\ \sigma^2), \quad (2)$$

if $y_i^* \geq 0$ then $y_i = 1$,

if $y_i^* < 0$ then $y_i = 0$;

we could use the probit model expression, defined as:

$$\text{Prob}\ (y = 1) = \Phi(x'\beta) \quad (3)$$

$$\text{Prob}\ (x'\beta) = \int_{-\infty}^{x'\beta} \frac{1}{\sqrt{2\pi\sigma^2}} \exp\frac{-\theta^2}{2} d\theta = \Phi(x'\beta), \quad (4)$$

where the expression in the inside of the integral corresponds to the normal distribution function. If we assume a logistic function, we have the probit model, and its expression is:

$$\text{Prob}\ (x'\beta) = \frac{\exp(x'\beta)}{1+\exp(x'\beta)} \quad (5)$$

Taking into consideration the choice of which distribution to use, we have to take into account that both distributions are similar except for the tails. Therefore, for

intermediate values of $x'\beta$ the probabilities of both distributions are similar. However, the logistic distribution gives greater probabilities for y=0 when the values of $x'\beta$ are small and lower probabilities when the values are high. Both functions are also symmetrical. In this work we use the probit model, but both models give similar results.

In order to estimate the parameters, a likelihood function is maximized. Therefore, assuming the specification of formula (1) and after operating, the function to maximize can be written as:

$$\ln L = \sum_{i=1}^{n} \left\{ y_i \ln F(x_i'\beta) + (1 - y_i) \ln[1 - F(x_i'\beta)] \right\}, \qquad (6)$$

where F corresponds to the chosen distribution function. Therefore, the partial derivatives $\partial \ln L / \beta$ are calculated, and equaling zero we solve the parameters. If we face the problem of choosing between several models, the maximum value of this function should indicate the best model to choose. As the aim of this paper is to check which is the best model obtained, if we change the design of the explanatory variables, this indicator would be extremely helpful in our analysis.

The goodness of fit of the models can be a useful indicator to determine the best model. We can compare the pseudo-R^2 in the estimation results or calculate the table of hits and misses. In this table the values of 0 and 1 of the dependent variable are compared to the values predicted by the model. A high pseudo-R^2 and a high percentage of observations correctly classified indicates a good fit of the model.

3.2 The variables and the hypothesis

Considering the chosen variables for the estimation, the explanatory variables introduced in this analysis are those traditionally used in research. This will allow us to estimate our model according to the estimations performed in the literature. The

variables try to capture the search of greater efficiency, the ideological and political motivations, the institutional factors and the financial limitations in the local administration (Hirsch, 1995a, 1995b; Domberger and Jensen, 1997; Boyne, 1998; Jensen and Stonecash, 2005; Bel and Fageda, 2007).

To check the importance of timing in the research, we introduce the variables in two different ways. In both cases, the dependent variable is a dummy variable that takes value 1 if local government has contracted out the water services during 1986 and 2006, and 0 in the contrary case. As for the explanatory variables, we introduce the data in a cross section format taking, as is usual in the literature, the latest data within the period of research. We have called this way Method 1.

In what we have called Method 2 we follow the recommendation of Bel and Fageda, taking into consideration the time dimension. If during the 1986-2006 period the local government has opted to contract out, we introduced the data of explanatory variables with a delay in time. Therefore we take into account the existing situation at the moment in which the local government took the decision. In case the local government does not contract out within the period, the explanatory variable takes the average value within the period. We take the average value because it captures the overall existing situation much better than taking the data of 2006. There are several explanatory variables that undergo no variation according to the method of measurement: these are urban agglomeration, coast, Guadalquivir, Guadiana and South. In Table 1 we show the relation of variables that are taken into account in this study and more details regarding the way in which the variables have been introduced.

INSERT TABLE 1 ABOUT HERE

Additionally, these variables have been considered according to several hypotheses, motivated by the previous studies cited above and the characteristics of the region where data was gathered. A first hypothesis to be contrasted is whether the local government is more likely to contract out in search of greater levels of efficiency. In the industry considered, the decision is linked to the local scenario. In more complex scenarios, it is desirable to have a more professionalized and specialized management (Ménard and Saussier, 2000; Carpentier et al., 2006). In order to take into account the complexity of the environment, we have introduced two variables related to the population and the coast. When the management is carried out by the local council it is common for the personnel in charge of the water service to also be responsible for other areas at the same time. For instance, when gathering the data we discovered that in a small village, the person in charge of the municipal service was also responsible for the plumbing when there were leaks in the water distribution network. It is less surprising, but more frequent, for the bureaucrat in charge of management and administration of the water service to share this activity with others at the Town Hall. Contracting out could lead to specialization in water management.

In order to obtain greater efficiency, municipalities can join forces with others (Warner and Hebdon, 2001; Warner and Hefetz, 2003; Warner, 2006; Bel, Hebdon and Warner, 2007). Therefore, it is possible to obtain the economies of scale that are recognized in this sector (Kim and Lee, 1998; Ashton, 2003; Torres and Morrison Paul, 2006; Garcia, Moreaux and Reynaud, 2007; Filippini, Hrovatin and Zorić, 2008)[2]. This strategy makes particular sense in a country such as Spain that has an important rural population spread out in small population nuclei. In order to foster this possibility, local governments and administrations have promoted the creation of consortiums. This institutional figure can unite the interests of small municipalities that can share the high

fixed costs in the industry. For instance, it is more efficient to have a common water treatment plant that can cover the demands of several small municipalities rather than a single plant for each municipality.

In other cases, a company manages the water service of several cities as a consequence of the growth of these cities. In the more dynamic areas, urban agglomerations have been created, in which the borderlines between municipalities are easily confused. In these cases, a big city with common shared interests is created. Sometimes the growth strategy of the original company means that only one company ends up managing the water service of the urban area. Another reason for this is that a certain municipality observes the success of externalization in a neighboring municipality and opts for the same decision.

Contracting out may be a measure taken by local governments as a reaction to a bad financial situation. Privatization can be interpreted as a short term situation to ease the pursuit of additional funding to undertake the necessary investment for maintenance and renovation of infrastructure (Harris et al. 1997; Kodrzycki, 1998; Bakker, 2002; Soler, 2003; Dijkgraaf, Gradus and Melenberg, 2003; Fitch, 2007). It is common for the company that wins the tender for water management makes a commitment to trying to invest in improving and maintenance of water networks. Therefore, the private sector takes the responsibility for competences that the local government could not maintain with its own financial means.

The political tendency of the local government can influence the decision to contract out municipal services. One might expect right-wing parties to be more devoted to privatization (Bel and Fageda, 2007). On the other hand, left-wing parties have rejected privatization with the aim of guaranteeing jobs and working conditions as well as the guarantee of a universal and high quality service. Regarding the dynamics of

politics, it has been argued that stability in political power can affect the decision to contract out. According to Miranda (1994), those mayors who are longest in office tend to be more conservative and therefore less willing to undertake this reform.

These are the variables and the hypotheses used in this research, according to the existing literature. These hypotheses will be explored in the next section. More importantly, we will address the main hypothesis of this study: To check if the time dimension of the data considered plays an important role in the analysis.

4. RESULTS

In this section we evaluate the importance of considering the time factor in research that aims to analyze the decisions adopted by local governments. Descriptive statistics of the data are introduced in Table 2. For the quantitative variables we introduce the mean, and for the qualitative variables we introduce the percentage of cases that equals one.

INSERT TABLE 2 ABOUT HERE

Table 3 incorporates the probit analysis[3]. Two estimations are considered, one for each procedure for introducing the data. We include the estimated coefficients and the standard errors in brackets. According to those results, the best estimation is the one performed with type 2 variables. This is due to several reasons. Firstly, the value of the log likelihood is greater. Secondly, the pseudo R^2 is higher, as the independent variables account for 64.6 per cent of the probability of contracting out. The explanatory power using Method 1 is very limited, only 15.1 per cent. Thirdly, the table of observed and predicted observations of the dependent variables also indicates that method 2 predicts

much better than Method 1. The percentage of hits, as reported in table 4 is much higher using Method 2 than using Method 1 for each class. Therefore, goodness of fit results clearly indicates that Method 2 is better than Method 1, as Bel and Fageda suggest.

INSERT TABLE 3 ABOUT HERE

INSERT TABLE 4 ABOUT HERE

The differences between Method 2 and Method 1 are quite considerable in terms of significance. If we compare the signs of the significant variables between the two estimations, they undergo no changes, but there are differences in magnitudes. Therefore, there are no contradictions in the sign in which each variable affects the probability of contracting out. The signs of the coefficients are consistent with our hypothesis. However, the differences in magnitude and significance could be misleading for local policy.

As for temporality, we do not find important differences between both methods for the estimated coefficients of the variables that remain constant, independent of the method of measuring: urban agglomeration, coast, Guadalquivir and Guadiana. This makes completely sense, and the reverse could induce us to think that there is some influence of a certain changing variable on these elements. However, the coefficients that do change between both methods are referred to the variables that change within time: population, population squared, ideology, power switching and financial burden. These results support the importance of considering the time dimension in this analysis.

Therefore, the time dimension is important, as it affects the interpretation of the coefficients. This interpretation is highly relevant because it conditions the actions and

the decisions of local governments and policy makers. Let us start with those variables related to population: Method 1 reports coefficients that are higher in magnitude and have a higher significance. Therefore, Method 1 is overestimating the population effect and its economies of scale. Concerning variables related to the political tendency of the government, the weaker method disregards them as it considers them non-significant. On the contrary, Method 2 considers them statistically significant and with a negative and positive effect respectively. Finally, using Method 1 the effect of financial burden is non-significant, but using Method 2 it is highly significant as expected.

A researcher who deals with the estimation of a similar model could ask himself/herself the following question: Would I be misspecifying my model depending on the data I use? In line with the theories defended by Bel and Fageda, the answer could be 'yes'. As Bel and Fageda conclude, the existing literature has shortcomings when analyzing the dynamics of local externalization. This has not only created difficulties in obtaining systematic results from this literature, but could also create misleading results. Our example shows that the differences are not so important in terms of the positive or negative signs of the coefficients*;* but they could be so in terms of magnitude and significance. If we had chosen Method 1 for estimation, wrong results would be produced for local governments, with the consequent negative impact on policy formulation. Important variables such as the ideology of the local service and the financial burden would be disregarded, and others such as population and its economies of scale would be overemphasized.

5. SUMMARY AND CONCLUSION

In this paper we set out to prove the methodological inconsistency recently presented by Bel and Fageda. According to both authors, taking out the time dimension

is not the best option to analyze contracting-out decisions. This practice could explain the low explanatory power of the research on the subject and the diversity of results analyzing the causality direction of the relationship of the variables.

With the aim of contributing to a better understanding and practice in local government, this research gives evidence to the thesis put forward by Bel and Fageda, orienting future studies which examine decisions related to the contracting out of municipal services by local governments. We have achieved this by introducing the data in two different ways, one with the time dimension and the other one ignoring this dimension. The dataset refers to the water service in 744 municipalities in Southern Spain over the period 1986-2006.

We pose the following question: Is the time dimension really important in research into local decisions about contracting out? According to the results, we have to answer that question affirmatively. Taking into account the value of the variables in the moment in which local governments take the decision gives a better estimation than given when ignoring this time dimension. In the two estimations performed the significance of the variables that change over time and the magnitude of its coefficients are different. However, the significance and the magnitude of coefficients do not vary between the two methods for those variables that are constant in time. Therefore, estimating the effect of several variables in the decision to contract out can lead to misleading results if we choose to disregard the time dimension. In our example, if we ignore the timing of the data, important variables are nonsignificant, such as those concerning ideology and the financial burden of the local government.

In future research we recommend introducing data taking into account the value of the variables when the decision was taken. Not doing so means that the description of

the situation is not complete, and this problem will be greater if we consider a wider period of analysis.

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Figure 1.- *Contracting out of water services in Andalusia: 1986-2006*

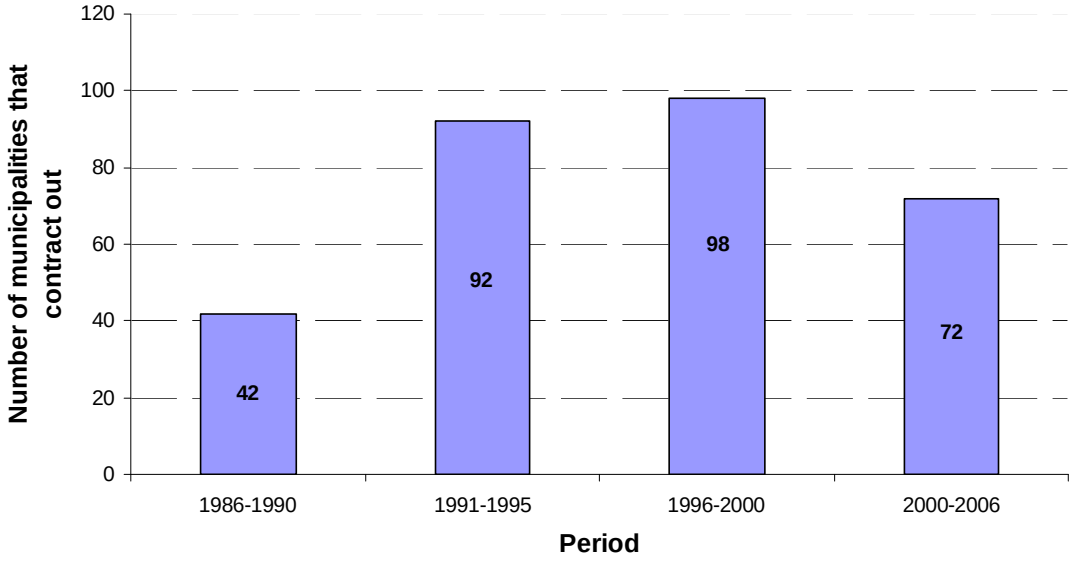

Table 1.- *Variables Description*

Variable	Type	Units-Description Method I	Units-Description Method II	Source
Contracting-out	D	1: If at the end of the period the council contracts out the water management 0: If the council controls the water management.	1: If at the end of the period the council contracts out water management 0: If the council controls water management.	Councils and private companies.
Population	C	Population in thousand of inhabitants. Value in 2006.	Population in thousand of inhabitants. If the municipality contracts out, it takes the value from the previous year. If not, it takes the average value of the period.	Municipal census, National Institute of Statistics
Ideology	D	1: Right-wing ideology of the local government. 0: Left-wing ideology. Value in 2006.	1: If the municipality contracts out and its ideology was right-wing. If the municipality did not contract out and if the party that was most time in power was right-wing. 0: If the municipality contracts out and its ideology was left-wing. If the municipality did not contract out and if the party that was most time in power was left-wing.	Census, Ministry of Public Administration.
Power switching	D	1: Switch in the ideology of the local government in the last two electoral periods from 2006. 0: No switch in the ideology in the last two electoral periods from 2006.	1: If the municipality contracts out and the decision is taken by a recently elected government. If it did not contract out and if there has been a change of government during the period considered. 0: If the municipality contracts out and the decision is taken by a government that has stayed in power. If it did not contract out and there has been no change of government during the period considered.	Census, Ministry of Public Administration.
Financial burden	C	Debt costs divided by current income. We consider the mean in the two years before 2006.	If it contracted out it is the mean within the two years before the election. In the contrary case, it is the mean within all the period.	Budget of Local Corporation, Ministry of Economics.

Consortium	D	1: If the municipality belongs to a consortium whose regulations allow them to manage to water services. 0: If the municipality does not belong to any consortium. Value in 2006.	In case of contracting out equals 1 if the municipality belong to a consortium the year before and 0 if not In the contrary case, 1 if the municipality belong to a consortium in the middle of the period and 0 if not.	Ministry of Public Administration.
Urban Agglomeration	*D*	0: If the municipality does not belong to an urban agglomeration 1: If the municipality belongs to an urban agglomeration	0: If the municipality does not belong to an urban agglomeration 1: If the municipality belongs to an urban agglomeration	Andalusian Regional Government.
Coast	D	1: If the municipality is on the coast. 0: If it is not on the coast.	1: If the municipality has a coastline 0: If the municipality does not have a coastline	Municipal census, National Institute of Statistics
Guadalquivir	D	1: If the municipality belongs to the Guadalquivir Basin 0: if not.	1: If the municipality belongs to the Guadalquivir Basin. 0: If not.	Hydrographic Confederation of the River Guadalquivir
Guadiana	D	1: If the municipality belongs to the Guadiana Basin 0: if not.	1: If the municipality belongs to the Guadiana Basin. 0: If not.	Hydrographic Confederation of the River Guadiana
South	D	1: If the municipality belongs to the South Basin 0: if not.	1: If the municipality belongs to the South Basin. 0: If not.	Hydrographic Confederation of the South

C stands for continuous specification of each covariate, and D stands for discrete specification.

Table 2.- *Descriptive statistics*

Variables	Method 1	Method 2
contracting-out	40.9%	40.9%
population	8.4	7.4
population squared	819.7	661.5
ideology	19.8%	14.2%
power switching	12.6%	45.6%
financial burden	1.9	3.7
consortium	37.2%	28.8%
urban agglomeration	22.2%	22.2%
Coast	8.1%	8.1%
Guadalquivir	55.2%	55.2%
Guadiana	9.0%	9.0%
South	34.7%	34.7%

We include the frequency for the qualitative variables and the mean for the quantitative ones.

Table 3.- *Binary probit estimation*

Variables	Type 1	Type 2
Constant	-1.112756*** (0.1412592)	-2.781134*** (0.2414836)
Population	0.0312567*** (0.0061652)	0.0197403* (0.010401)
population squared	-0.0000529*** (0.0000125)	-0.0000296 (0.0000239)
ideology	-0.1418249 (0.1515886)	-0.7531412*** (0.2276333)
power switching	0.1758824 (0.166414)	2.757034*** (0.1630153)
financial burden	0.0443905 (0.0327701)	0.1149666*** (0.0298364)
Consortium	0.5712721*** (0.1139623)	0.5342746*** (0.1658539)
urban agglomeration	0.4622894*** (0.1389085)	0.5127475*** (0.1961989)
Coast	0.231196 (0.2429364)	0.1178598 (0.3149916)
Guadalquivir	0.4962663*** (0.1317315)	0.4954657*** (0.1767412)
Guadiana	-0.0023607 (0.206226)	-0.134087 (0.276896)

Log-likelihood	-387.30554	-176.93224
Pseudo R^2	0.1519	0.6456

Estimated coefficients are presented, and standard errors between brackets.

South is the omitted variable to avoid perfect multicollineality.

*, ** and *** denote statistical significance at 10 per cent, 5 per cent and 1 per cent levels respectively.

Table 4.- *Classification table of correctly predicted and observed values of the dependent variable*

	Model 1				Model 2			
		Predicted				Predicted		
		0	1	Total		0	1	Total
Observed	0	310	130	440	0	388	52	440
	1	136	168	304	1	21	283	304
Total		446	298	744		409	335	744
Hits		69,5%	56,4%			94,9%	84,5%	

Under the label hits, we include the percentage of observed and correctly predicted 0s and 1s over the total of the predicted 0s and 1s.

[1] There are still more complex techniques in discrete choice models with cross section data, such as ordered probit (or logit), mixed probit (or logit) or nested probit (or logit). The description of those lies outside the scope of this paper. More information about these techniques can be obtained in Cameron and Trivedi (2005).

[2] A review of research into economies of scale in this industry can be found in González-Gómez and García-Rubio (2008).

[3] South is taken out from the estimation in order to avoid perfect multicollineality.