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A DURATION MODEL ANALYSIS OF PRIVATIZATION OF MUNICIPAL WATER SERVICES*

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I apply a duration model to the study of factors determining the privatization of local water services. I assess how the influence of these factors changes as time goes by. I use a sample of municipalities from the Spanish region of Catalonia during the six terms of office that ran between 1980 and 2002. I hypothesize a dynamic neighboring effect, which is not rejected by the data: in a first phase (early eighties), water privatization is more likely in regions where there is no previous privatization; in a second phase (nineties), the opposite happens. The way other factors influence the privatization decision also evolves during the two decades under study, from a priority to fix old infrastructures to a concern about service efficiency. Budgetary shortfalls seem to encourage privatization only in times of huge economic struggle. The political sign of the government may influence the mode-of-production decision if there is no consensus about the most efficient one.

Key words: privatization, water utilities, duration model.

JEL codes: C41, H11, H42.

Since 1980, local service reform, usually in some form of privatization, has spread throughout Spanish municipalities. In Catalonia, water service privatization has grown intensively. At the beginning of 1980, 21.97% of municipalities had a privatized service. In October 2002, this percentage had increased to 58.33%[1].

Determining the factors that have influenced the privatization decision over time is paramount if one wants to unbiasedly estimate the effects of such a policy. An example is Miralles (2008), where it is shown that ignoring these factors leads to greatly misleading conclusions. The aim of this paper is to provide empirical evidence on how and when several factors are influencing this policy decision. I

(*) I thank the municipalities that responded to our survey. The Statistical Institute of Catalonia and the Audit Commission of Catalonia have provided additional useful information. Contributions and institutional support from the "Public Policy and Economic Regulation" Research Unit at the University of Barcelona are gratefully recognized. The Spanish Ministry of Education and Science (BEC2003-01679, SEJ2006-04985) has financially supported the research for this paper. The author is also grateful to Germà Bel for his support and advice.

(1) Source: Local Service Production Survey (2002).

study the 1980-2002 time range. My object of study is water privatization in Catalan municipalities. I use a duration model approach, a novelty in the privatization literature.

Among the influencing factors, the dynamics of the privatization spread across municipalities are interesting and crucial. Based on the neighboring effect evidence found in Christoffersen and Paldam (2003) and Bel and Miralles (2003), I hypothesize and test a new dynamic neighboring effect. Under these hypotheses, there are two phases in the spread of privatization across local authorities. In the first phase, service privatization is relatively more likely in regions where there is no (or scarce) privatization experience. This is due to concessionaire firms' long-term strategic planning. In a second phase, privatization is more likely wherever there are more municipalities having done so. In this phase, demand elements are more important: decision-makers benefit from geographical scale economies and from reductions in uncertainty. Data do not reject this new hypothesis.

Along with this result, estimates obtained from the data suggest that the factors influencing privatization evolve according to the predominant political agenda, from a lack-of-infrastructure problem at the beginning of the eighties to efficiency considerations during the nineties.

Literature on local service privatization in Spain has not been as wide as literature about national firms' privatization. The former issue has been discussed in much greater depth in other countries. In the United States, mid-seventies tax revolts, plus the demand for higher quality in local services and harder budget constraints were determinant towards searching for efficiency-improving policies [Savas (1998)]. In the United Kingdom, pro-privatization reform was conducted by the conservative central government during the mid and late eighties [Ascher (1987)]. This finally yielded the 1988 Local Government Act, which established periodical compulsory lowest-price competitive tendering for most local services. In recent years, however, this law has been softenened in the search for values other than the lowest price.

During the eighties and the nineties, in both these countries, as in others such as Canada, Australia and New Zealand, studies on privatization efficiency performance proliferated. Despite a high variety of results, there was some consensus that privatization induces cost savings as compared to traditional public production. Nevertheless, other alternative policies were acknowledged to offer cost savings as well [Domberger, Meadowcroft and Thompson (1994), Hodge (2000)]. After having checked the relative goodness of privatization, American economists started wondering why, if privatization was that good, it was not becoming a dominant mode of local service production. Some economists looked for motivations connected to political benefits and costs of privatization [López-de-Silanes, Schleifer and Vishny (1997)]. Others tried to find motivations linked to a transaction costs perspective, and some among them pointed out that the public service reform is much more complex than the simple public-private dilemma [Kodrzycki (1998), Warner and Hebdon (2001)]. In this paper, I include hypotheses from both approaches.

From the econometric side, I present the novelty of a duration model in the privatization literature. Previous studies on the local service privatization decision are commonly based on a cross-sectional discrete choice analysis [López-de-

Silanes, Schleifer and Vishny (1997), Kodrzycki (1998), Ménard and Saussier (2000), Warner and Hebdon (2001), Christoffersen and Paldam (2003), Dijgraaf, Gradus and Melenberg (2003), Tavares and Camöes (2007)]. A duration model offers a better answer to the question of the factors that influence the privatization decision. The drawback, of course, is that panel data collection is required. I explain more about this in Section 2.

Section 1 presents the empirical model, hypotheses, data and estimation procedure. Section 2 depicts the estimation results. Section 3 concludes. An Appendix contains complementary estimations, a technical discussion and descriptive statistics.

1. The model

I split this section into four subsections. In the first, I explain the choice of a duration model. In the second, I present the hypotheses. The next subsection presents variables and data sources. The fourth subsection summarizes the estimation strategy.

Why a duration model?

As previously commented in the introduction, a cross-sectional study faces trouble when trying to explain a decision. One could wonder whether the estimates reflect exactly what they try to or not, that is, whether they identify the factors that encourage the municipal politician to privatize.

If one takes a sample of municipalities and just observes whether the service was privatized or not in some precise period *t*, then he will only be answering the question "Why do some municipalities have the service privatized at that moment of time and others do not?", but not answering "Why do some municipalities decide to privatize around some period *t* and others do not?". One would be providing an answer to both questions only if it were assumed that the politician's decision is reversible, as if he were constantly taking a decision between public or private production. Also, one would be answering the same question if it were assumed that the explanatory variables are time-invariant. But both assumptions are rarely accomplished. This is due to the fact that factors pushing politicians towards service privatization are different from the ones that make politicians maintain the service privatized. Once privatization has been undertaken, there might not be scope for reversion, or this possibility could be too costly. This hypothesis, which is continuously confirmed by evidence [see this paper, Christoffersen and Paldam (2003) and Ménard and Saussier (2000)], is called the privatization irreversibility hypothesis[2], and discards the flexibility of the mode-of-production decision that is implicitly assumed in cross-sectional analysis.

(2) In other countries, such as the United States, one can observe the rise of a reverse privatization process, by which some local services are increasingly coming back into public hands [Hefetz and Warner (2004)]. This is not clearly observed in the sample I analyze. In any case, the reader should note that relaxing the irreversibility hypothesis will not bias my results as long as these results are interpreted as factors influencing the privatization decision instead of factors influencing the mode-of-production technique.

Applying this hypothesis, it can be seen that variables measured in t, the year the study refers to, hardly ever are related to the ones measured at $t^* \leq t$, where t^* is the year of privatization. So, if we want to explain something about the privatization decision in period t, we have to select the sample, only taking into account municipalities that have not privatized in t-1. This is done in the additional switching model presented in López-de-Silanes, Schleifer and Vishny (1997), and in the switching model of Hefetz and Warner (2004). Due to sample selection, one has to be aware that he is now answering the "conditional" question "Why do some municipalities decide to privatize the service in the period t given that they did not do so between 0 and t-1?". The researcher is then analyzing facts that are conditional on past events, so the model remains incomplete and biased if one tries to extract unconditional, not historically driven, explanations of the privatization issue.

Bel and Miralles (2003) try to explain some unconditional factors influencing local service privatization. They consider the possibility of creating a cross-sectional sample not referring to the same period of time t, but to the so-called critical period t^* ($0 < t^* \leq t$). Obviously, this moment of time differs among municipalities. The critical period is the one in which the municipal politician decides to introduce privatization into the service. That way, one answers both the question "Which factors influence the politician towards service privatization during all periods under study?" and the question "Which factors explain having the service privatized in t?".

This model has its limitations, though. On the one hand, it is possible that each period had its own causes, which are not distinguished by a cross-section around t^*. On the other hand, the following question arises: "What is the critical period for a municipality that has not privatized its service?". In the quoted paper, the authors chose the last period (t) under study, as the model starts from the same moment t for all municipalities and then searches for critical periods for the ones that have privatized. But a definitive solution is still pending.

From this discussion about previous methods used, it is clear that I need an intermediate solution that could integrate both the critical period (t^*) and the last period under study (t). In this paper, I propose the use of time series $\tau = 1,2,...,t^*$, where t^* is the critical moment or, if they have not privatized, the final period $\mathbf{t}$. I obtain a panel data model that can obtain answers, for any period τ, to the question "Why do some municipalities privatize the service in period τ given that they did not do so between periods 0 and τ-1?". In turn, the model can aggregate these conditional, path-dependent explanations to obtain the unconditional ones, answering the question "Which factors push municipal politicians towards service privatization during all periods under study?"

Hypotheses

I list and explain some hypotheses concerning the factors motivating the privatization decision. Each hypothesis refers to previous work when applicable.

Hypothesis 1: The factors influencing local water service privatization during the first years of democratic systems such as the Spanish one differ from the ones that influence water service privatization in recent years.

During the first years of the current Spanish democracy, the political agenda about water supply service in Catalonia was focused on solving the serious lack-of-infrastructure problem that was inherited from the dictatorial regime [FMQ Projectes i Estudis (1999)]. A huge amount of investment was necessary in some municipalities in order to meet increasing quality demands, above all in highly populated areas and tourist resorts. Municipalities seldom had enough financial capacity to undertake those investments and were forced to reach agreements with private companies. If my hypothesis is valid, highly populated municipalities and tourism-intensive ones will experience a higher water service privatization rate during the eighties.

In the nineties, once all standards in water provision were met, the political agenda turned its attention to efficiency issues. This could have provoked a change in the privatization patterns, so that population and tourism might not have the same influence on the explained variable as they presumably had during the eighties.

Hypothesis 2: Municipalities with highly skilled bureaucrats or politicians are more prone to implement the alternative service reforms that became popular during the nineties.

As the turn to the efficiency issue was starting, a new line of economic research in the United Kingdom and the United States started casting doubt on the irrefutability of privatization as the best available reform. Authors such as Sclar (2000) showed case studies where alternative local service reforms were performing quite well. Warner and Hebdon (2001) also argued that public service reform is much more complicated than the public-private dilemma. There are other types of reform such as municipality association and the creation of private-law, publicly-owned firms.

Yet, low-skilled politicians and bureaucrats would find diffulties in implementing these alternatives. They might just contract the service out if it is performing poorly. Thus, if my hypothesis is valid, municipalities with large populations that had not yet privatized before the nineties would now be relatively less interested in privatization. This is due to the fact that, usually, towns and cities with large populations have skilled public servants and politicians.

Hypothesis 3: Party ideology matters when there is concern about efficiency and there is no consensus about whether privatization is the optimal reform.

There is widespread consensus that ideological issues have nothing to do with the chosen mode of production. In other words, assuming that one mode of production is optimal in some circumstances, both conservative and non-conservative parties tend to use this mode of production. This is found in López-de-Silanes, Schleifer and Vishny (1997), Ménard and Saussier (2000), Bel and Miralles (2003), Chistoffersen and Paldam (2003), Dijgraaf, Gradus and Melenberg (2003)[3].

(3) See also the meta-analitical approach by Bel and Fageda (2007). Bel (2006, pp. 230-234) reports evidence against the idea that the political sign influences the privatization of local water services in Spain.

Nevertheless, I postulate a new idea that can be tested in this duration model setup. When there is concern about efficiency and there is uncertainty about what the best mode of production is, ideological issues matter[4]. Each party would tend to support the reform policy that fits best the ideology that party defends before its voters[5]. Municipalities with conservative governments would be relatively more prone to privatization in periods when the consensus is weakened, namely the nineties.

Hypothesis 4: The dynamic neighboring effect. There are two phases in the spread of privatization across local authorities. In the first phase, service privatization is relatively more likely in regions where there is no (or scarce) privatization experience. In a second phase, privatization is more likely in regions where there are more municipalities having privatized.

One of the novelties of this paper is the statement and testing of this hypothesis. Bel and Miralles (2003) and Christoffersen and Paldam (2003) depicted the so-called neighboring effect, a phenomenon that was also pointed out by Reimer (1999). They found that municipalities surrounded by others that had previously privatized the service had, in turn, a relatively higher probability of privatizing it.

There are two explanations for this. Both papers coincide in the first one, which refers to political costs. If a municipality is surrounded by municipalities that have already privatized some service, then it is able to observe its neighbors' experiences, which, in turn, reduces uncertainty about what to expect from privatization. Also, a "pro-privatization" message is less politically costly when the experience has been observed in surrounding towns and cities. A second explanation, found in Bel and Miralles (2003), is based on efficiency issues. A municipality hardly ever constitutes the optimal geographical area when producing a local service due to so-called geographical scale economies [Donahue (1989)]. A private firm is less constrained than public organizations when expanding to several municipalities. It then takes advantage of these scale economies. Therefore, a firm that is established in a municipality could make good offers to surrounding municipalities[6].

(4) Non-conservative parties could be willing to undertake reforms that enhance water service production efficiency while not renouncing public ownership. This is due to the fact that this service has a well-known lack of effective competition in the privatized market. More conservative parties could rely on privatization despite this lack of competition, following the ideas of Hart, Schleifer and Vishny (1997). These ideas are focused on the property rights approach: in a public production setup, a manager has few incentives to innovate (either reducing costs or increasing quality), as he cannot claim for the rights over this innovation.

(5) From another point of view, this uncertainty gives scope for parties to undertake hidden goals in their relations with private contractors.

(6) Bivand and Szymanski (1997, 2000) present, first in a theoretical framework and then in an empirical one, their research on English and Welsh local governments. While local governments maintain public service production, they follow surrounding municipalities' results as a comparative benchmark, given the lack of information about maximum attainable efficiency. As a result, average costs are very similar among municipalities in the same region. The same idea could perfectly be applied to the privatization of a local service when its results are not clear ex ante.

Now, let us situate time in a first phase of the privatization spreading process. Having seen that privatization will eventually spread over a region, the question is: Where is it more profitable for a municipality to privatize the service at this first stage? In regions where there is scarce (or null) privatization, or in regions with many municipalities having already privatized? The key is that, ceteris paribus, firms are willing to compete more effectively for a municipality in the former region. They already forecast future extra profits coming from becoming an incumbent and expanding to surrounding municipalities so they bid more aggressively for the contract[7].

Therefore, in the first stages of the privatization-spreading process, there are two contradictory forces and the neighboring effect may not hold. If this hypothesis is correct, the neighboring effect may only be observed in recent years, i.e. the nineties. The opposite of this static view of the neighboring effect may be observed during the eighties.

Hypothesis 5: Hard budgetary shortfalls encourage privatization.

During the economic crisis that Spain experienced between 1992 and 1994, municipalities that had been progressively indebted found that their available resources were very scarce. In this context, these municipalities were obliged to undertake hard cost-saving programs. While alternatives to privatization implied some initial investments and other expenses, privatization had the advantage of being cheap and even profitable, due to the fee that the contractor usually has to pay to the municipality[8]. I therefore check if financial difficulties increase the probability of privatization, and if so, when.

Other considerations: efficiency and population dispersion; stakeholders; and combinations of different public sector reforms

Finally, I present some ideas that are worth assessing, although I do not formulate a specific hypothesis about them. Concerning efficiency, I have taken into account the fact that municipality dispersion may imply some management difficulties. In Spain, a municipality may have several geographically separate villages, towns or cities. A disperse municipality, with a high number of towns, has, on average, more pipeline length and more volume of water in reservoirs per day than a "concentrated" one [MCRIT (1996)]. This implies a higher risk of leaks and a more complex management. Municipalities with this problem may need help from a private firm.

(7) Miralles (2004) shows that the existence of expected additional future profits coming from becoming the incumbent increases effective competition for the contract of the first municipality that privatizes the service in the area.

(8) López-de-Silanes, Schleifer and Vishny (1997) observe, for the United States case, that state laws constraining municipal debt growth capacity enhance the trend to privatization. Kodrzycki (1998) observes that an increase in the budgetary deficit positively affects the probability of privatization. Bel and Costas (2000) study the privatization of national companies in Spain and deduce that one of the factors that explains the privatization process was the necessity of obtaining cash returns in order to meet European convergence criteria.

Concerning stakeholders, it is thought (but difficult to prove) that industrial water consumers are cross-subsidizing household water consumers by means of higher water tariffs. This is explained by political interest, since households are equivalent to voters. This argument could be offset by industrial consumers' lobby activities. But, if the argument were true, industrial consumers would be interested in separating political power from water service control, therefore encouraging privatization. So, in order to assess this, it is interesting to see if municipalities with a strong industrial sector are relatively more prone to privatization, and if so, when.

Also concerning stakeholders, it could be thought that a municipality with powerful unions would deter privatization, as it is known that this policy worsens labor conditions [López-de-Silanes, Schleifer and Vishny (1997), Chistoffersen and Paldam (2003)]. Nevertheless, labor participation is not that important in water services. Roughly 80% of water service cost comes from capital maintenance and investment [Ménard and Saussier (2000)]. Hence, I have skipped this issue in my analysis, while I acknowledge its importance in other services.

A final consideration concerns the fact that different kinds of public service reform could be incompatible with each other. Or, just the opposite, they could be complements. Warner and Hebdon (2001) and Bel, Hebdon and Warner (2007) state that public service reform goes beyond the public-private dilemma. There is a wide menu of different reforms that could be undertaken. Besides, different kinds of reforms could be combined with each other. In my analysis, I have simplified the scenario by assuming the public-private dilemma, in order to obtain a tractable duration model. However, taking into consideration Warner and Hebdon's proposal, I try to assess if municipality association is related to a higher or lower use of privatization.

Municipality association could be conceived as an alternative to privatization [Bel (2006, pp. 224-227)], since it is another way to exploit geographical scale economies [Bel and Fageda (2006)]. But, in turn, municipal association reduces the political costs induced by privatization, since the distance between citizens and the decision-maker increases [Bel and Miralles (2003)]. Also, municipality association may be explained by idiosincratic management difficulties (for instance, the need to connect to an external water supply network) that may induce privatization. So it is not clear what the final effect will be.

Variables and data

My main data source is a sample of Spanish municipalities from the region of Catalonia, obtained through the Local Service Production Survey (from now on, LSPS), elaborated in 2000 and updated as of October 31st, 2002.

This Survey was designed by the "Public Policy and Economic Regulation" Research Unit, at the University of Barcelona. It was sent to the 946 Catalonian municipalities. It received a total of 133 answers, 13.3% of the surveys sent. It represented roughly 60% of the Catalonian population. Thus, results are less explanatory for low-populated municipalities. But for municipalities with more than 1,000 inhabitants, the sample is more representative. 37% of municipalities with a population between 5,000 and 10,000 inhabitants answered the survey. So did

50% of municipalities between 20,000 and 50,000 and 66% with more than 50,000 inhabitants. The sample could be considered as randomly obtained, although results should be taken with caution for municipalities with less than 1,000 inhabitants.

Each four-year term of office between elections has been taken as a time period. Usually, privatization decisions are part of an electoral program[9]. The number of periods under study is therefore six, coinciding with the number of local elections held from the establisment of Spanish democracy until 2002. These periods are: 1980-1983, 1984-1987, 1988-1991, 1992-1995, 1996-1999 and 2000-2002. For each municipality and period, the mode of production and other variables have been observed.

The explained variable, Privatization, is a binary variable. To shorten notation, it will be denoted as Y in further mathematical expressions. For each municipality and for each period under study, it takes value 1 if there was any kind of water service privatization at its end[10], and 0 otherwise. Data have been collected through the LSPS.

Population is taken from the five-year periodical census at the Statistical Institute of Catalonia (from now on, Idescat), which is the most reliable database. These are data for the years 1975, 1981, 1986, 1991, 1996 and 2000, and each of them is taken as the representative population during each of the six periods under study.

Tourism is measured as the number of hotel and camping accommodation slots that the municipality offers per 1,000 inhabitants in each of the same years as the ones listed for Population. Data are also obtained from Idescat.

Conservative, the political index, is a dummy variable that takes value 1 if a conservative party (coalition) is ruling during the period under consideration and 0 if there is a non-conservative party (coalition) in office.

It is clear that creating such a variable is somewhat delicate, so I made a special effort in constructing it. The variable has been mainly elaborated from the data found at the General Files of Catalonian Municipalities, elaborated by the Federation of Catalan Municipalities. These files contain name, political affiliation and responsibility of each municipal representative of each Local Council. The mayor's political affiliation and the affiliation of other persons in charge has allowed me to create this index[11]. Unfortunately, the first period (1980-1983) was characterized by multiple local agreements among parties of different ideological signs. The ideological identity of governing parties, coalitions and organizations was so unclear that I had to skip this variable for that term of office.

(9) They could be part of a hidden program.

(10) This includes delegation contracts as well as creation of joint-ventures that operate the water supply service.

(11) Sometimes the ruling party, coalition or organization was not clearly identified into the ideological line. The problem has been addressed by observing the identity of parties in opposition, or, in a few cases, by observing the results of the nearest National Election in this municipality (data found at Idescat).

The Neighboring variable is defined as the percentage of municipalities in the Official Territory (Àmbit Territorial)[12] the observed municipality belongs to that have already privatized the service at the beginning of the period under consideration. Data for this variable are obtained from the LSPS.

The Finance variable equals the arithmetic mean of the IFB of the two years before the period under study. IFB is the Index of Financial Burden, the percentage of municipal debt costs (interest plus amortization) on municipal current returns (taxes and fund transfers). Data are taken from the General Accounts of Local Corporations, edited by the Audit Commission of Catalonia. These General Accounts have only been compiled since 1990, so the Finance variable is only collected for the last three periods under study[13]. This Finance variable measures the difficulties a municipality faces when it tries to increase its debt.

The Dispersion variable is the number of singular population entities, which is just the number of separate towns, villages or cities that a municipality has. Data are taken from Idescat, and are available only for 2001. But this variable is quite constant over time, so its value is used in any of the six periods under study.

Industry is measured as the percentage of active population that works in the industrial sector. This proxies the relative weight of industry in the municipality. Data are collected from Idescat, and are available for 1986, 1991 and 1996. I have used 1986 data for the first two periods, 1991 data for the next two and 1996 data for the last two periods.

Municipality Association is a dummy variable that takes value 1 if the municipality was part of a water supply municipality association in the period under consideration, and 0 otherwise[14]. Data are collected from the LSPS.

Estimation strategy

A decision-maker (or representative politician) in a municipality where some local service has been so far produced in-house has to decide whether or not to privatize the service. If he does so, he expects an utility increase of the following form:

$$\Delta U_{it} = X_{it}B_t + \varepsilon_{it}$$

X_{it} is a row vector that contains a one plus the explanatory variables for municipality i during period t. $B_t \equiv (\beta_{0t},\ldots,\beta_{kt})$ is a column coefficient vector, where k is the number of explanatory variables. Notice that we allow for coefficient variabi-

(12) At the time of the first version of this paper, Catalonia had 6 Official Territories. Nowadays there is a seventh one, due to the split of one Territory into two.

(13) Besides, there were no data for some municipalities, so the sample loses observations whenever this variable is used.

(14) I have adopted a wide concept of water supply municipality association. There are few cases of "strict" associations, understood as the delegation of the service to a supra-municipal public organization. But there are also "indirect" associations, produced by supply network sharing among several municipalities due to urban continuity. Sharing the network implies that organizational decisions must be taken by consensus, leading to an indirect form of association. Additionally, there are so-called "implicit" associations, which arise when a municipality contracts out the water service to another municipality. All these cases are considered as municipality water supply associations in this paper.

lity across different periods. $\varepsilon_{it} \equiv \upsilon_{it} + \nu_i$ is a random perturbation including features not proxied by explanatory variables, with a component (ν_i) that collects time-invariant (or low-time-variant) unobservables.

Thus, the politician takes into account current values of explanatory variables when taking a decision about the mode of production. He does not take into account expected future values of these variables. This myopia is supported by the fact that politicians' preference-for-the-present rate is so high (i.e. zero discount factor) that events that would take place after the next election are ignored.

If that assumption were not applied, and given some substantial costs of privatization reversal, the politician would have to make cumbersome forecasts before taking the privatization decision. He should take into account expected future benefits from privatization, including future factors unobserved by the econometrician. The model would become quite complex from an econometric point of view. Fortunately, a zero-discount-factor assumption makes sense in the political context and substantially simplifies the model[15].

The politician at municipality i chooses to privatize the service in t, given that he did not do so in t-1, if and only if

$$\Delta U_{it} \geq 0$$

Otherwise, he keeps in-house production. I now introduce the irreversibility assumption. That is, going back to public production is not possible once privatization has been undertaken. Recovering total public control over local service production becomes too costly. This assumption has been observed in the literature [see Christoffersen and Paldam (2003)], and also in my sample[16]. Under this assumption, a municipality that privatizes in some period is removed from the sample in further periods, as the probability of having the service privatized given that it was privatized in the past equals one.

Let Y_{it} be a binary variable that takes value 1 if municipality i has the service under study privatized at the end of period t, and 0 if, on the contrary, the municipality keeps it in-house during that period. Then:

$$\begin{aligned}\Pr(Y_{it} = 1 \mid Y_{it-1} = 0, X_{it}, \nu_i) &= \Pr(\Delta U_{it} \geq 0 \mid X_{it}, \nu_i) \\ &= \Pr(-\upsilon_{it} \leq X_{it}B_t + \nu_i) = F(X_{it}B_t + \nu_i)\end{aligned}$$

and

$$\Pr(Y_{it} = 1 \mid Y_{it-1} = 1, X_{it}, \nu_i) = 1$$

where F is the distribution function of the (negative) random perturbation that is not time-invariant or individual-specific. This component is i.i.d. across ob-

(15) I would like to thank a referee for pointing out the complications that could arise in the model if a privatization decision were irreversible and the policymaker cared about future terms of office.

(16) There are only two exceptions. In one municipality, a joint venture is expected to be taken over by the municipality by 2030. In a second municipality, the service came back to public hands just after the privatization process, so it is difficult to say if this was already a consistent privatization decision. The latter municipality has been dropped from the sample.

servations. I interpret it as a random shock in favor of keeping in-house production[17].

This way, the contribution of municipality *i* to the likelihood function follows as[18]

$$\begin{aligned} L_i(t_i \mid X_{i1},...,X_{it_i},v_i) = \\ &= \Pr(T_i = t_i \mid X_{i1},...,X_{it_i},v_i) \\ &= \prod_{t=1}^{t_i}[\Pr(Y_{it}=0 \mid Y_{it-1}=0, X_{it}, v_i)^{1-Y_{it}} \cdot \Pr(Y_{it}=1 \mid Y_{it-1}=0, X_{it}, v_i)^{Y_{it}}] \\ &= \prod_{t=1}^{t_i}[(1-F(X_{it}B_t+v_i))^{1-Y_{it}} F(X_{it}B_t+v_i)^{Y_{it}}] \end{aligned}$$

where T_i is the random variable "time length municipality *i* takes to be removed from the sample", due either to privatization or to censoring, and t_i is the value that this random variable takes. As there are six periods (terms of office) under study, the variable may take values between 1 and 6. Subscript *t* is also constrained to values between 1 and 6[19].

Since v_i collects features that were possibly not observable, I cannot maximize the likelihood function unless I integrate that component out:

$$\begin{aligned} L_i(t_i \mid X_{i1},...,X_{it_i}) = \\ &= E_v(I_{t_i}(t_i \mid X_{i1},...,X_{it_i},v_i)) \\ &= \int_{-\infty}^{\infty} I_{t_i}(t_i \mid X_{i1},...,X_{it_i},v_i) dG(v) \qquad \text{(Model 1)} \\ &= \int_{-\infty}^{\infty} g(v) \cdot \prod_{t=1}^{t_i}[(1-F(X_{it}B_t+v))^{1-Y_{it}} \cdot F(X_{it}B_t+v)^{Y_{it}}] dv \end{aligned}$$

where E_v is the expectation following the distribution function of the individual unobservable, *G* is this (differentiable) distribution function and *g* is the associated density function. The log-likelihood function is obtained as the sum of the logarithm of each individual contribution.

(17) The politician could be afraid of losing control over local service production once it is privatized. This explains why the politician still maintains a tough, inefficient supervision over the production techniques used in the privatized services [Bailey and Davidson (1999)], in order to avoid politically costly service performance shortfalls. Analogously, this fear could explain the existence of this shock against privatization.

(18) Firth and Payne (1999) follow a very similar model, suggested by Jenkins (1995). In fact, they deal with the heterogeneity problem in a very similar way. They try Heckman and Singer's estimation too, and they do not succeed, as in the present research.

(19) Thus, this is a discrete duration model. A continuous duration model is used in González and Guardiola (2008). The version I propose estimates how the effects evolve over time nonparametrically, at the cost of time discretization. There are arguments in favor of both approaches.

I assume that the random shock against privatization follows a complementary log-log distribution

$$F(x) = 1 - exp(-exp(x))$$

The complementary log-log distribution is adequate here as compared to other more commonly used distributions such as the normal (Probit model) and the logistic (Logit model). The latter ones are symmetric, hence assuming a priori a certain balance between 0's and 1's in the endogenous variable in each period. This does not correspond to the data of my sample. Instead, the complementary log-log distribution suits the data better, since it is asymmetric in favor of value 0[20].

I assume that the time-invariant unobservable is distributed as a normal $N(0,\sigma_v^2)$[21]. If the distribution of the time-invariant unobservable v_i is assumed to collapse to 0 (that is, $\sigma_v^2 \approx 0$), the estimation improves in simplicity extraordinarily. It makes specification tests more flexible and higher computational precision is guaranteed[22]. Therefore, I propose the following simple log-likelihood function, which ignores the individual-specific effect:

$$\ln L = \sum_{t-1}^{6} \sum_{i \in N_t} \ln[(1 - F(X_{it}B_t))^{1-Y_{it}} F(X_{it}B_t)^{Y_{it}}] \qquad \text{(Model 2)}$$

where N_t is the set of all municipalities than are in the sample at time t. The good news about this formula is that maximizing the global likelihood is equivalent to maximizing the associated partial period-specific log-likelihoods one by one. Nevertheless, it is convenient to aggregate periods (assuming constant coefficients in each aggregation) whenever possible, so that finite sample problems are avoided.

I turn my attention to coefficient variability among periods. Letting a coefficient be flexibly time-variant is correct in my 22-year range under study, but imposing some stickiness is also quite convenient. The good properties of maximum likelihood estimation are asymptotic. Hence, increasing the number of observations per estimated coefficient could be of paramount importance. Constraining coefficients to be equal between period 1 and period 2 could provoke a slight bias due to lack of flexibility but, in turn, it almost doubles the number of observations per coefficient. Throughout the estimations, I divide the time range under study into either two three-period or three two-period blocks.

(20) Dijgraaf, Gradus and Melenberg (2003) have compared his logit model to a non-parametric model. They find that the symmetric logit model is incorrect when predicting probabilities, although estimated coefficients are qualitatively similar to the non-parametric ones.

(21) An interesting alternative at this point could have been to proxy this distribution function by a discrete distribution with a finite number of mass points, hence estimating these points, their associated probabilities and the proper number of mass points. This approach was suggested by Heckman and Singer (1984). Nevertheless, applying Heckman and Singer's approach dramatically increases model complexity. I was eventually forced to use the parametric approach.

(22) The Gauss-Hermitte quadrature would have to be used if the time-invariant unobservable could not be ignored.

First of all, I test the null hypothesis that Model 2 is consistent. The way I proceed is: 1) estimate Model 1, 2) obtain an estimate for $\rho = \sigma_{\varpi}^2/(\sigma_{\varpi}^2+\sigma_{\upsilon}^2)$, and 3) test the null that $\rho = 0$. I obtain the following results:

Table 1: TESTING THE NULL HYPOTHESIS THAT $\sigma_{\upsilon}^2 = 0$

Estimation of...	χ^2	p-value
Whole time range divided into two blocks	0.02	0.446
Whole time range divided into three blocks	1.50	0.110
First three periods in a single block	0.31	0.287
Last three periods in a single block	0.02	0.439
First two periods in a single block	0.24	0.312
Periods 3 and 4 in a single block	1.71	0.095
Last two periods in a single block	$4 \cdot 10^{-3}$	0.474

Source: Own elaboration.

Estimations are carried out using the explanatory variables that are available in all periods of the considered time length[23]. Overall, none of the tests but one reject the null that the time invariant unobservable can be safely ignored. The estimation for periods 3 and 4 is already unsatisfactory (see table 2), so it is not surprising that individual effects play a role there. Besides, the constant-coefficients hypothesis is rejected by the data in that block (see below). The relatively low p-value in the second estimation is, in part, due to the weak estimates in that block. I conclude that the null hypothesis is not rejected, but special care has to be taken in the block that includes periods 3 and 4.

Hereafter, I just report results from the estimation of Model 2. At first, I tried to estimate the sample divided into two three-period blocks. However, the likelihood ratio test rejects the stability of the model within the second block. Its chi-squared statistic is 32.857 with 16 degrees of freedom, while the 95% percentile is 26.30 and the 99% percentile is 32.00.

So I divide the six periods under study into three blocks with two periods in each: 1980-1987, 1988-1995 and 1996-2002. Likelihood ratio stability tests yield the following respective results: 4.163 (6), 14.641 (7) and 9.321 (8). Numbers in parentheses are the degrees of freedom. Coefficient stability is not rejected either in the first or in the third blocks. For the second block, there are still stability problems since the 95% percentile of the relevant chi-squared distribution is 14.07.

I present the results for each of these three blocks. I additionally present and discuss a period-by-period estimation of the second block in the Appendix.

(23) The quadrature in the first two estimations uses 195 points (the maximum allowed in Stata 9.2). For the other estimations, with fewer observations, it uses 100 support points.

2. Empirical results

Pooled data maximum likelihood estimates of the coefficients in Model 2 with individual clustering are presented in Table 2.

Table 2: Factors influencing water supply service privatization in Catalonia (Spain). Complementary log-log model with pooled data and individual clustering

Variables \ Blocks	1980-1987	1988-1995	1996-2002
Population	0.0000328 (3.155)****	$-8.07 \cdot 10^{-6}$ (-0.463)	-0.000048 (-1.908)*
Dispersion	-0.0398277 (-0.717)	0.0112122 (0.167)	0.0230515 (0.597)
Association	–	1.230749 (1.254)	-0.9889664 (-0.699)
Conservative	–	0.2610911 (0.328)	0.8824532 (1.791)*
Finance	–	–	-0.0044086 (-0.206)
Tourism	0.000637 (2.426)***	-0.0000569 (-0.368)	0.0000944 (0.833)
Industry	0.0114551 (0.429)	-0.0000512 (-0.002)	0.0399798 (2.684)****
Neighboring	-0.0432482 (-1.751)*	0.0281871 (1.058)	0.0339084 (3.125)****
Constant	2.941201 (-3.241)****	-4.017493 (-3.283)****	-4.460909 (-5.040)****
Wald test overall significance	13.31 {5} [0.0206]***	6.78 {7} [0.4522]	27.81 {8} [0.0005]****
Number of municipalities	103	92	79
Number of observations	200	177	136
ln *L*	-38.030545	-36.14809	-55.679699

Notes: In parentheses, the z-statistic (standard normal) values for the hypothesis that the coefficient is not significantly different from zero. In brackets, the probability that the statistic is not significantly different from zero. In braces, the number of degrees of freedom. Significance levels: * 10%, ** 5%, *** 2.5%, **** 1%.
Source: Own elaboration.

The variables Finance and Conservative have not been included in the blocks where there were no data available. The variable Association has been skipped in the first block estimation due to perfect collinearity with the endogenous variable. All observations with value 1 for this variable had value 0 for the endogenous one.

It can immediately be seen that the second-block estimates are not significant overall. This second block is understood as an impasse between two ways of conceiving the privatization decision. A separate estimation for each period of this block is shown and discussed in the Appendix (see Table 4). As can be seen there, the only significant result obtained for this block consists of some weak evidence in favor of Hypothesis 5.

The Appendix includes additional estimations (Table 3) showing that the variation of the coefficients across blocks is not due to the omission or inclusion of variables[24].

In the first and third blocks, the model is significant overall. Results are favorable to Hypothesis 1, and give (weak) support to Hypothesis 2. The signs of the Population and Tourism coefficients are positive and significant in the first block (early eighties), while Tourism has no significant effect afterwards and Population even has a negative and significant effect at the 10% level in the third block (late nineties). Hence, a municipality with a large population, with highly skilled politicians and public servants and that has not privatized the water service during the eighties, now tends (on average) to carry out other kinds of service production reform while keeping total public control over it.

Concerning Hypothesis 3, results do not reject the idea that ideological differences start mattering during the nineties. Although information about it cannot be extracted from the first block, it can be extracted from the second block. In the second block, the Conservative variable has no significant effect at all. In the third block, on the contrary, there is a weakly significant and positive effect of ideological issues on the privatization trend[25]. This supports the idea of the importance of ideology when both efficiency issues and uncertainty about the best production method enter the municipal political agenda.

With respect to Hypothesis 4, results suggest that the existence of a dynamic neighboring effect cannot be rejected. The coefficient of Neighboring in the 1980-1987 block is negative and significant at the 10% level. It has a positive sign afterwards, and this sign is significant at the 1% level in the 1996-2002 block. In a first phase of the privatization spreading process, one observes a higher propensity to privatization in zones where it is a rare practice. In later stages, privatization spreads over the zones where it is already a usual procedure. This fits the dynamic neighboring effect hypothesis that is proposed in this paper.

(24) I thank a referee for his advice on this point.

(25) It may be argued that this coefficient is significant because of interaction with the Industry variable. Usually, industrial municipalities are ruled by leftist parties. So I tested the null that the coefficient of Conservative is zero by the LR method. The statistic is 3.335 (chi-square with one degree of freedom under the null), with p-value 0.068. At the 10% level once again, non significance of the Conservative effect is rejected.

More comments on Hypothesis 5 are presented in the Appendix. The Dispersion variable coefficient is never significant, and this casts doubt on the role that population dispersion plays in the privatization process. Apparently, the complexity-by-dispersion argument justifying the inclusion of this variable does not work. The Association variable sign is never significant either. Thus, results are in line with the offsetting effects I postulated in the previous section.

Finally, it can be seen that the variable Industry has a positive and significant (at 1% level) coefficient only in the third block, that is, between 1996 and 2002. It loses significance in other periods. To find out why this coefficient is significant only in recent years, that is, why industrial stakeholders push for privatization only in recent years, I focus on the regulatory reforms that the water sector experienced in 1999 and 2000. In the former year, the Catalonian Water Agency was created in order to meet increasing quality standards in all features of the water cycle, which were to be regulated by the European Union. The new European regulation was summarized in the 2000 Water Framework Directive. Accomplishment of new regulated standards implied higher prices for polluting water uses (mostly industrial). This price pressure could lead water-intensive industrial sectors to lobby for better tariffs in all parts of the water bill. One strategy that, in the light of my results, was put into practice consisted of separating water supply services from political control in order to reduce the cross-subsidization of household consumption[26].

3. Conclusions

In this paper, I present and estimate a duration model in order to study factors that determine the privatization process in municipal water supply services in Spain during its democratic period (1979-2002). As far as I know, this is the first time that a duration model has been used in the study of local service privatization.

This model allows me to identify the evolving pattern of these factors, and to observe that local service privatization does not always respond to the same causes in any given period of time. Results do not reject the general idea that, in the Spanish region of Catalonia in the first years of democracy, investment in infrastructures was a fundamental aim of water services. These infrastructures were in bad condition as an inheritance from the previous dictatorial regime. Water service privatization during those years was a way to obtain resources to undertake the necessary investments. In the nineties, however, once infrastructures were satisfactorily working, privatization was designed as a way to improve operational efficiency. In turn, other ways to improve service performance started gaining popularity, and municipalities with highly skilled politicians and bureaucrats were relatively more prone (on average) to undertake these alternative reforms.

During the nineties as well, there was room for party differentiation in local water service reform. The variety of different ways to improve efficiency and the

(26) Miralles (2008) provides empirical evidence that this cross-subsidization was in fact reduced.

uncertainty around the goodness of privatization explain this result. On average, conservative governments still relied on privatization as the best way to improve efficiency. Non-conservative governments tried alternative ways to achieve the same objective. Apart from this policy differentiation, these factors (variety and uncertainty) could have permitted parties to discursively justify the search for (hidden) aims in their relations with private firms. Altogether, this result seldom coincides with the literature on privatization. I break the consensus about the lack of party differentiation concerning the mode of production of local services. In my paper, I state that there are certain periods in which the public-private dilemma forms a real (not only a discursive) part of the political arena in local politics.

As a main feature of this paper, I find what I call the dynamic neighboring effect, which is an extension of the neighboring effect of Bel and Miralles (2003) and Christoffersen and Paldam (2003). In recent years, I find that the privatization decision is more frequent in municipalities that are surrounded by others that have previously privatized the service. But, in previous stages of the privatization spreading process, the privatization decision does not meet this condition. Even the opposite is not rejected: privatizations become slightly more frequent in areas where almost all municipalities were producing the service in-house.

Other things being equal, a municipality in an area without (many) previous privatization experiences may receive better offers from private firms than a similar municipality in an area where an incumbent is already installed. Due to geographical scale economies, an incumbent has a cost advantage. Once there is one, effective competition for further contracts in the area diminishes. But if no incumbent is present, competition among firms may be quite strong.

Weak evidence has been found in favor of municipal budget and indebtment constraints as a factor positively influencing the privatization decision at the local level. For my sample, indebtment capacity constraints only mattered when Spain faced the hard 1992-1994 economic crisis. Only in harsh periods of the economic cycle budget shortfalls are influential in the privatization decision at the local level.

In this paper, I also try to assess to what extent different public sector reforms are interrelated, either by incompatibility or by complementarity. In particular, I try to see the effects of municipality association on the tendency to privatize the water supply. I find that, on average, these methods are not generally interrelated. In cases they are incompatible, as municipality association could be viewed as an alternative way to exploit geographical scale economies. In some other cases, they are complements because municipality association implies that privatization decision becomes less politically costly due to the increase in the distance between citizens (voters) and decision-takers. Municipality association may also account for unobservable complexity that may induce privatization.

Finally, I find that stakeholders may have an influence in the privatization decision in some periods. Particularly for the Catalonian municipality sample, recent regulations have increased the cost of a polluting use of water. The industrial consumers were encouraged to look for better water purchase conditions. One strategy consisted of pushing politicians towards privatization in order to separate the water service from the public control, with the aim of reducing possible household cross-subsidizations.

All these findings were possible because I was able to collect panel data. These allowed me to shed more light on local service privatization as an evolving process than previous static, cross-sectional discrete choice analyses found in the literature.

The study of other factors influencing local service privatization will be addressed in further research. For instance, it would be interesting to test Biais and Perotti's (2002) prediction that ideology (and other parties' interests) is more influential on the mode-of-production decision when there is low re-election risk.

Appendix

Complementary estimations

Table 3: Factors determining water supply service privatization in Catalonia (Spain). Complementary estimations to table 2

Variables \ Periods	1988-1995	1996-2002	1996-2002(bis)
Population	$-5.32 \cdot 10^{-6}$ (-0.35)	-0.0000471 (-2.47)***	-0.0000397 (-1.98)**
Dispersion	0.007172 (0.13)	0.028218 (0.74)	0.0258835 (0.65)
Association	-	-	-0.9023659 (-0.66)
Conservative	-	-	0.8998555 (1.78)*
Tourism	-0.000057 (-0.37)	0.0000619 (0.46)I	0.0000386 (0.29)
Industry	0.0035698 (0.21)	0.0293185 (1.88)*	0.0423192 (2.77)****
Neighboring	0.0312487 (1.21)	0.0271753 (2.25)***	0.0336909 (3.06)****
Constant	-3.933438 (-3.241)****	-3.500574 (-5.78)****	-4.751155 (-5.44)****
Wald test overall significance	4.81 {5} [0.4398]	16.64 {5} [0.0052]****	25.27 {7} [0.0007]****
Number of municipalities	92	82	82
Number of observations	177	151	151
ln *L*	-36.866014	-61.906391	-59.099229

Notes: In parentheses, the z-statistic (standard normal) values for the hypothesis that the coefficient is not significantly different from zero. In brackets, the probability that the statistic is not significantly different from zero. In braces, the number of degrees of freedom. Significance levels: * 10%, ** 5%, *** 2.5%, **** 1%.
Source: Own elaboration.

Separate estimation for periods 1988-1991 and 1992-1995

I proceed to present the results that I obtain for the block 1988-1995, having split it into two periods, the 1988-1991 and the 1992-1995 terms of office. I use a complementary log-log model with robust variance-covariance matrix estimation.

Table 4: FACTORS DETERMINING WATER SUPPLY SERVICE PRIVATIZATION IN CATALONIA (SPAIN). 1988-1991 AND 1992-1995 PERIODS. COMPLEMENTARY LOG-LOG MODEL WITH ROBUST STANDARD ERRORS

Variables \ Periods	1988-1991	1992-1995	1992-1995(bis)
Population	-0.0000316 (-0.944)	0.0000123 (1.089)	0.0000245 (2.519)***
Dispersion	-0.2129977 (-1.804)*	0.0770639 (2.214)**	0.1261368 (2.214)**
Association	2.516838 (2.495)***	-	-
Conservative	1.910593 (2.010)**	-1.937924 (-2.090)**	-1.62218 (-1.100)
Finance	-	0.107026 (1.757)*	-
Tourism	0.0000478 (-0.116)	0.0002943 (-1.727)*	-0.0001051 (-0.220)
Industry	0.0163431 (-0.608)	0.0682209 (0.661)	0.029286 (0.597)
Neighboring	0.1077624 (1.766)*	0.088493 (1.209)	0.0439952 (-1.454)
Constant	6.249649 (-2.357)***	-5.909557 (-1.281)	3.696226 (-1.881)*
Wald test overall significance	15.30 {7} [0.0324]**	25.90 {7} [0.0005]****	36.01 {6} [0.0000]****
Number of municipalities	92	69	85
Number of privatizations	7	3	3

Notes: In parentheses, the z-statistic (standard normal) values for the hypothesis that the coefficient is not significantly different from zero. In brackets, the probability that the statistic is not significantly different from zero. In braces, the number of degrees of freedom. Significance levels: * 10%, ** 5%, *** 2.5%, **** 1%.
Source: Own elaboration.

The Finance variable is not included in the 1988-1991 period because, as explained before, data on this variable are only available from 1990 on. Association has been dropped from the 1992-1995 estimation because of collinearity problems. None of the three privatizing municipalities during this period were using municipality association.

It can be seen that period-by-period estimation has problems most probably related to maximum likelihood estimation in small samples. We see the high instability of results. Coefficient signs change from one period to another in many cases, so these variable results must be taken with skepticism. Only the sign of the coefficient of Tourism does not change between periods. But, as its negative sign sounds quite unintuitive, I have investigated multicollinearity problems that might give rise to this sign. I find that Tourism is highly correlated with Finance in the 1992-1995 period (0.45 correlation coefficient).

Hence, I have run a new estimation (1992-1995bis) without Finance, in order to see what happens with the Tourism coefficient. It is found that it loses significance, so I ignore it. Concerning the Association coefficient, one can see that its sign is positive and significant at the 1% level during the 1988-1991 period. However, there was a perfect negative correlation between Association and the endogenous variable in the 1992-1995 period. Both results could be explained again by typical small sample instability problems. Besides, joint estimation of both periods (see Table 2) revealed no significance for the coefficient of this variable. Due to this confusion, I decide to ignore this variable as well.

Consequently, I just comment on the Finance variable coefficient, which is the remaining coefficient that is significant in the period where data were available. It cannot be seen whether this significant positive sign is stable or not given the lack of data for the 1988-1991 period. Nevertheless, the likelihood ratio test rejects that the coefficient on Finance is not significant. The chi-squared test statistic, with one degree of freedom, is equal to 5.19444, while the 97.5% percentile of this distribution is 5.02. So there is weak evidence in favor of Hypothesis 5.

Technical discussion

Some technical concerns may arise with respect to the estimation procedure performed and shown in Table 2. These considerations have to do with the following issues: functional form, heterogeneity and sample selection, heteroskedasticity and endogeneity[27].

Functional form

I argued in a previous section that the complementary log-log distribution is more convenient than the symmetric distributions usually utilized in these models like the normal and the logistic. This is supported by the fact that, for each period under analysis, there are many more zeros than ones. A usual way to compare non-nested models is the Akaike Information Criterion (AIC). The AIC is equal to

(27) I am grateful to a referee for bringing these points to my attention.

two times the number of parameters minus two times the log-likelihood. The model with the lowest value is the best one. I compute the values for all three models and report them in Table 5.

Table 5: AIC COMPARISON AMONG DIFFERENT FUNCTIONAL FORMS IN TABLE 2 ESTIMATIONS

Model \ Period	1980-1987	1988-1995	1996-2002
Comp. log-log	88.06	88.28	129.35
Logit	88.20	88.30	129.52
Probit	88.00	88.40	129.49

Source: Own elaboration.

In general, one can conclude that the differences between the three models are rather tiny. However, the complementary log-log model is better in five out of six comparisons. Therefore, the model chosen in this work is the appropriate one, although the usual symmetric models perform reasonably well. Also, results are qualitatively identical no matter what model is chosen.

Heterogeneity and sample selection

This work has dealt with heterogeneity in the form of individual-specific unobservables that are normally distributed. However, it would be worth taking a new approach to heterogeneity due to sample selection problems. Since the sample used here is less representative of low-populated municipalities, the distribution of municipality populations conditional on being in the sample varies with respect to the original distribution. The unobservable may be independent of population in the universe under study, but the unobservable conditional on being in the sample may not. The Gamma distribution takes into account the differences in population distributions. Consider the following slight change in my model:

$$\Pr(Y_{it} = 1 \mid Y_{it\text{-}1} = 0, X_{it}, \nu_i) = F(X_{it}B_t + \log \nu_i)$$

F is still the complementary log-log distribution function. v_i is assumed to follow a Gamma distribution with mean 1 and variance ω. If the variance were zero, the model would be equivalent to the one estimated and shown in Table 2. I have then proceeded to the estimation of this "frailty model" for each block, using the Stata algorithm pgmhaz designed by Jenkins, S.P., based on Prentice and Gloeckler (1978) and on Meyer (1990).

Convergence problems were present in all but the first block. In this first block, the estimated variance is 6.4844, and the associated z-statistic is 1.0656 (non-significant). Moreover, the LR test of the null that this variance is zero yields 1.2420, and

the p-value is 0.2651. In the second block, after many failed convergence attempts due to non-concavities and discontinuities, the program reached the following result: 1) the estimated variance is $3.036 \cdot 10^{-7}$, with a z-statistic equal to 0.0003, 2) despite that, the LR test of the null gives 47.2022, with p-value $6.403 \cdot 10^{-12}$, 3) coefficients do not change much with respect to what is shown in Table 2, with the exception of the Dispersion one, which becomes significant at the 10% level. Finally, the third-block estimation has not achieved convergence. The last iteration reported a log-likelihood of -35.1974 (the LR test would give a clear rejection of the null) but the estimated variance was exp{-14.4029}, clearly close to zero.

With these (incomplete) results at hand, one may think that the simple complementary log-log distribution performs reasonably well, compared to a model incorporating heterogeneity. I am aware that these results are not conclusive. In any case, the alternative hypothesis of Gamma-distributed unobserved heterogeneity does not yield good results.

Heteroskedasticity

It is likely, then, that the variance of the error term varies with the municipal population. Small municipalities may have different unobserved factors that explain the mode-of-production decision than the highly populated municipalities. If this is true, heteroskedasticity may imply inconsistency in this kind of discrete choice models. An easy way to test for this comes from the fact that the Probit model fits the data reasonably well. Since the estimation of a heteroskedastic probit model is straightforward, we can compare the heteroskedastic model to the homoskedastic one by means of a Likelihood Ratio test. Statistics are reported in Table 6. It is clear from them that heteroskedasticity is not present.

Table 6: LR TESTS OF HETEROSKEDASTICITY WITH RESPECT TO POPULATION

1980-1987	1988-1995	1996-2002
0.07	0.79	0.07
[0.7939]	[0.3750]	[0.7845]

Notes: The test statistic, distributed as a chi-square with one degree of freedom, compares a homoskedastic probit to a heteroskedastic one. In brackets, the p-values.
Source: Own elaboration.

Endogeneity

Finally, I pay attention to endogeneity issues. A variable which is crucially important in my research is the Neighboring variable. For each period, this variable reports events that happened before the current yes-no privatization decision. There does not appear to be a double causality problem here. However, one may understand that Neighboring is controlling for some form of spatial correlation among municipalities. If a municipality in some area privatized the water service in period t-1, another municipality in the area may become more likely to priva-

tize in some period among t, t+1, ... Neighboring may be incidentally correlated to the error term if it does not control for all forms of positive spatial correlation.

In order to construct an easy test for endogeneity[28], I have again used the fact that the Probit model is apparently not too misspecified. Let the exogenous explanatory variables be denoted as X, the (probably) endogenous variable be denoted as Z, and the corresponding set of instruments be W. Let υ be the vector of unobservables in the privatization decision and let e be the vector of residuals in a linear regression of Z on W. Assume that, for any municipality i[29], e_i is distributed as i.i.d normal and that υ_i is also i.i.d. normal. If both perturbations are jointly normal, then it is true that $\upsilon_i = \pi e_i + d_i$, where $e_i \perp d_i$ and, therefore, $Z_i \perp d_i$. π is the ratio between the covariance of e and υ and the variance on υ. Therefore, conditional on d_i being a normal random variable, the privatization decision can be consistently estimated as a function of X, Z and estimated e. The test for endogeneity is simply the z-test for significance of the coefficient of e.

I use a time trend and the population density in the Official Territory the municipality belongs to as instruments for Neighboring. The adjusted R^2 of the instrumental regression lies above .70. Results are presented in Table 7, along with endogeneity-corrected Neighboring coefficients.

Table 7: ENDOGENEITY TESTS FOR NEIGHBORING

1980-1987	1988-1995	1996-2002
1.57	-1.69+	-0.88
-0.0287258	0.0204604*	0.02698****

Notes: The test values are Z-statistics. The null hypothesis is the exogeneity of the variable. Rejection symbols are: + 10%, ++ 5%, +++ 2.5%, ++++ 1%. Below, the modified coefficients of the variable of interest, once I control for possible endogeneity. Significance symbols. * 10%, ** 5%, *** 2,5%, **** 1%.
Source: Own elaboration.

The null hypothesis of no endogeneity is not rejected in blocks 1 and 3. It is rejected at the 10% level in block 2, and the coefficient becomes significant at the 10% level. However, the reader can check that the trend in the endogeneity-corrected coefficient over time is qualitatively equal to what is observed in Table 2. My hypotheses still hold. Also, although not shown here, the other coefficients remain quantitatively similar to what is shown in Table 2.

Another variable of concern is the municipality association, Association. It may not be clear whether some unobservables may simultaneously affect the pri-

(28) The test is based on Rivers and Vuong (1988).

(29) I skip time subscripts for notational convenience.

vatization decision and the association decision. Municipality association is, to some extent, related with county (comarca) characteristics, since the geographical extension of these associations is quite limited. This time, though, I have not found variables at the county level that could perform as good instruments for Association. So, unlike in the Neighboring case, I could not perform reliable endogeneity tests.

However, I shall argue that double causality problems between the privatization decision and the Association variable should not be important. As a matter of fact, the incentives to municipality association remain the same in most cases whether privatization is present or not. Privatization does not affect intermunicipal network sharing, since pipe network sharing depends only on demographic characteristics. And intermunicipal network sharing, here called indirect association, is the main form of observed municipality association of water services in my sample[30]. Besides, at the political interest level, while one could think of association as a way to reduce the political costs of privatization, privatization cannot be thought of as a way to reduce the political costs of municipality association. The reason is that municipality association is not thought to be as politically costly as privatization.

Descriptive statistics

Table 8: Evolution of sample failure over the time period

Periods	Uncensored	Failures	Survivals
Before 1980	132	29	103
1980-1983	103	6	97
1984-1987	97	5	92
1988-1991	92	7	85
1992-1995	85	3	82
1996-1999	82	13	69
2000-2002	69	14	55

Note: One municipality has been dropped from the sample since the information provided was not reliable. A privatization process took place there but the contracted firm had not even initiated its tasks when the privatization was reversed.
Source: Own elaboration.

(30) Six municipalities of my estimation sample belong or have belonged to a municipality association of water services. Three of them are involved in indirect association. Two have implicit association (they contract out the services from another municipality). And the remaining one is the only case of strict association (water services are delegated to an intermunicipal organization).

Table 9: EXPLANATORY VARIABLES FOR THE 103 MUNICIPALITIES FINALLY USED IN THE REGRESSIONS

Variable	Obs.	Mean	Std. Dev.	Min.	Quartile1	Median	Quartile3	Max.	Mean 1980-1991	Mean 1992-2002
Population	528	7562.409	15993.21	54	455	1794.5	6549.5	104659	7477.486	7667.483
Dispersion	528	5.412879	5.758253	1	1	4	7	38	5.434932	5.385593
Association	527	0.0512334	0.2206829	0	0	0	0	1	0.0549828	0.0466102
Conservative	425	0.6376471	0.4812465	0	0	1	1	1	0.6666667	0.6144068
Finance	205	11.37724	12.2408	0	4.245	8.09	13.78	103.508	--	11.37724
Tourism	528	303.9324	1089.398	0	0	6.11	60.4295	9621.177	225.059	401.5216
Industry	528	31.88331	15.92346	0	20.87	29.5	44.08	72.61	32.4063	31.23623
Neighboring	528	25.77372	18.64455	0	11.765	22.581	43.1685	77.273	21.08167	31.57914

Source: Own elaboration.

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RESUMEN

En este trabajo se utiliza un modelo de duración para estudiar los factores determinantes de la privatización del servicio de aguas. Se cuantifica cómo la influencia de estos factores cambia con el paso del tiempo, usando una muestra de municipios catalanes en las seis legislaturas locales acontecidas durante el período 1980-2002. Se presenta la hipótesis del efecto proximidad dinámico, la cual no es refutada por los datos: en una primera fase (primeros años 80), la privatización del servicio es más probable en ámbitos territoriales donde no hay experiencias previas de privatización; en una segunda fase (los 90), sucede lo contrario. La manera que otros factores influyen en la decisión de privatizar también evoluciona durante estas dos décadas, desde la priorización de la reparación de infraestructuras descapitalizadas hasta una mayor preocupación por la eficiencia del servicio. Los problemas presupuestarios al parecer sólo incitan a privatizar en períodos de grave crisis económica. El signo político del gobierno municipal puede influir en la decisión sobre el modo de producción del servicio si no existe consenso sobre cuál es el más eficiente.

Palabras clave: privatización, servicio de aguas, modelos de duración.

Códigos JEL: C41, H11, H42.