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**Political economy of municipal water service privatization in  
Spain: a duration model analysis.**

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**Abstract:**

This empirical work applies a duration model to the study of factors determining privatization of local water services. I assess how factors determining privatization decision evolve as time goes by. A sample of 133 Spanish municipalities during the six terms of office taken place during the 1980-2002 period is analyzed. A *dynamic neighboring effect* is hypothesized and successfully tested. In a first stage, private water supply firms may try to expand to regions where there is no service privatized, in order to spread over this region after having being installed thanks to its scale advantages. Other factors influencing privatization decision evolve during the two decades under study, from the priority to fix old infrastructures to the concern about service efficiency. Some complementary results regarding political and budgetary factors are also obtained.

**Resumen:**

Este trabajo empírico utiliza un modelo de duración en el estudio de los factores determinantes de la privatización del servicio de aguas municipal. Se presta especial atención a cómo los factores determinantes de la privatización evolucionan a lo largo del tiempo. Una muestra de 133 municipios españoles durante las seis legislaturas habidas entre 1980 y 2002 es minuciosamente analizada. Se presenta y se comprueba la *hipótesis del efecto proximidad dinámico*. En los primeros años, las empresas contratistas tratan de instalarse en regiones y comarcas donde hasta la fecha el nivel de privatización había sido nulo o muy bajo, para así poder expandirse dentro de ellas sin apenas competencia gracias a sus consecuentes ventajas de escala. Otros factores influyentes en la decisión de privatizar evolucionan a lo largo de las dos décadas estudiadas, desde la inicial prioridad en la reparación de infraestructuras descapitalizadas durante el antiguo régimen hasta la más moderna preocupación por cuestiones de eficiencia en la gestión del servicio de aguas. También se obtienen resultados sobre la influencia de factores políticos y presupuestarios.

## 1. Introduction

Literature on local service privatization in Spain has not been as wide as has been the literature about national firms' privatization. Nevertheless, the former field has been discussed quite more deeply in other countries. In the United States, mid-seventies tax revolts, plus higher quality demand 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), finally yielding the 1988 Local Government Act, which established periodical compulsory lowest-price competitive tendering for most of local services. In recent years, however, this law has been smoothed in the search for other values apart from the lowest provision price.

During the eighties and the nineties, in both countries as in others as Canada, Australia and New Zealand, studies on privatization efficiency performance proliferated. Despite a high variety of results, there was some consensus on the fact 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 a dominant mode of local service production. Some economists looked for motivations connected to political profits and costs of privatization (López-de-Silanes, Schleifer and Vishny, 1997). Other economists tried to find motivations linked to a transaction costs perspective, and some of them pointed out that public service reform was something much more complex than the simple public-private dilemma (Kodrzycki, 1998; Warner and Hebdon, 2001).

The aim of this paper is merely empirical, and includes hypothesis stemming from both approaches. By means of a repetitive binomial choice model, based on a simple politician's utility function, I construct a discrete-time duration model that contributes to find the causes underlying Spanish municipalities' public service reform decisions concerning the local water supply service.

Section two justifies the motivation that induces the author to use a duration model approach, more complete than the most commonly used cross-section discrete choice models. Section three presents explanatory variables, hypothesis supporting their

inclusion, and data sources. Section four presents the model and its results. Section five concludes. An appendix with complementary estimations is included.

Local service privatization is not a new phenomenon in Spain. As in France, privatization cases are registered since the XIX century, and institutional framework is flexible regarding the mode of production that municipalities could decide concerning local services. In Spain, a privatization spreading process started at the beginning of Spanish young democracy, giving rise to interesting fields of study for economists.

## **2. Motivation and contents of this paper**

The scarce econometric studies on local service privatization decision are commonly based on a cross-section discrete choice analysis (López-de-Silanes, Schleifer and Vishny, 1997; Kodrzycki, 1998; Ménard and Saussier, 2000; Warner and Hebdon, 2001; Christoffersen and Paldam, 2003). When a study is focused on a sample of individuals referring to the same period of time, one could wonder whether estimation results reflect exactly what they tried to or not, that is, whether they identify or not the factors that push municipal politician towards taking the privatization decision. If we take a sample of municipalities and we just observe whether the service was privatized or not in some precise period  $t$ , then we are just answering to the question “Why do some municipalities have the service privatized in that moment of time and others do not?”, but not exactly to “Why some municipalities *decide* to privatize around some period  $t$  and others do not?”. We would be answering to both questions only if we assumed that politician decision is reversible, so that he is constantly taking a decision between public or private production. Also, we would be answering the same question if we assumed that explanatory variables are time-invariant. But both assumptions are from my point of view unusually accomplished. This is due to the fact that factors pushing politicians towards service privatization are different from the ones that cause politicians to maintain the service privatized. Once privatization has been undertaken, there might not be possibility of 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*, and rides out the flexibility of the mode-of-production decision that is implicitly assumed in cross-section analysis.

Applying this hypothesis, it can be seen that variables measured in  $t$ , the year our study refers to, hardly ever have to do with 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, taking into account municipalities that have not privatized in  $t-1$  only (this is done in the additional switching model presented in López-de-Silanes, Schleifer and Vishny, 1997). Given to sample selection, we have to be aware that now we are 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  $t-1$* ?”. We are analyzing then facts that are conditional to past events, so the model remains incomplete and biased if we try to extract unconditional, unhistorical explanations to 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-section 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 municipal politician decides to introduce any form of privatization in the service. That way, we answer 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 presents 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, this question arises: “What is the critical period for a municipality that has not privatized its service?”. In the quoted paper, 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 we need an intermediate solution that could be able to integrate both the critical period ( $t^*$ ) and the last period under study ( $t$ ). I propose in this paper the use of time series  $\tau = 1, 2, \dots, t^*$ , where  $t^*$  is the critical moment or, in case of not having privatized, the final period  $t$ . I obtain a panel data model that can extract explanations, for any period  $\tau$ , to the question “Why do some municipalities privatize the *service in the period  $\tau$  given that they did not do so between periods 0 and  $\tau - 1$* ?”. 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?”.

In this paper, I analyze the factors that provoke the undertaking of privatization policies in the water supply local service during the current Spanish democracy. I use a sample of Spanish municipalities from the region of Catalonia, obtained through the Local Service Production Survey (from now on, LSPS)<sup>1</sup>, elaborated in 2000 and actualized to October 31<sup>st</sup>, 2002.

Each four-year term of office between elections has been taken as a “period” unit. Usually, privatization decisions are part of an electoral program<sup>2</sup>. Besides, politician cares about in-charge mandate results much more than to future consequences of their policies. Thus, the number of periods under study is six, that is, the number of local elections taken place during the current Spanish democracy. 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.

### **3. Hypothesis, variables and data**

The explained variable,  $Y$ , is a binary variable that, for each municipality and for each period under study, takes value 1 if there was any kind of water service privatization at its end<sup>3</sup>, and takes value 0 otherwise. Data have been collected through the LSPS. Some hypotheses explaining this variable are listed below. Each hypothesis makes reference, when applicable, to other previous work on the issue, and is followed by an explanation about the proxies I use to test them.

*Hypothesis 1: Factors explaining local water service privatization during the first years of young democracies as Spanish one differ from the ones that explain water service privatization in recent years.*

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<sup>1</sup> This Survey was designed by the “Public Policy and Economic Regulation” Research Unit, at University of Barcelona. It was sent to the 946 Catalan municipalities. It received a total of 133 answers, a 13.3% of sent surveys. It represented roughly the 60% of Catalan 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% municipalities with a population between 5,000 and 10,000 inhabitants answered the survey. So did 50% municipalities between 20,000 and 50,000 and 66% more-than-50,000-inhabitant municipalities. Sample could be considered as randomly obtained, although results may be taken cautiously for municipalities with less than 1,000 inhabitants.

<sup>2</sup> Although they could be part of the hidden program.

<sup>3</sup> This includes delegation contracts as well as creation of joint-ventures that operate water supply service.

During the first years of current Spanish democracy, the political agenda concerning water supply service was centered 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 high-populated areas and tourism destinations. In turn, municipalities seldom had enough financial capacity to undertake those investments, hence having to arrive to agreements with private enterprises. If my hypothesis were valid, relatively high-populated municipalities and relatively tourism-intensive ones would be more in favor of water service privatization during the eighties. So I define the variables *POP* (population) and *TOUR* (tourism intensity). *POP* 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. *TOUR* is measured as the number of hotel and camping accommodations that the municipality has per 1,000 inhabitants in each of the same years as the ones listed for *POP*. Data are also obtained from Idescat.

In the nineties, once having met all satisfactory standards in water provision, the local politician's agenda directed its attention to efficiency issues. This could have provoked a change in the privatization patterns, so that *POP* and *TOUR* might not have the same influence on the endogenous variable as they had during the eighties.

*Hypothesis 2: During the nineties, while the political agenda was focusing on efficiency issues, a new wave of public sector reforms other than privatization started having effects on local service production. Municipalities with high-skilled bureaucrats and politicians were more prone to implement these alternative policies.*

As the turn to the efficiency issue was starting, a new line of economic research in the United Kingdom and the United States started putting into doubt the irrefutability of privatization goodness. Authors as Sclar (2000) revealed by continuous exhibition of case studies that in some municipalities there were examples of non-privatizing local service reforms that were working quite well. Warner and Hebdon (2001) also argue that public service reform is something much more complicated than the public-private dilemma. There are many other types of reform, as service-specific municipality association and creation of private-law publicly owned service-producing firms.

Yet, these kinds of alternative reforms are quite tough to be implemented by low-skilled politicians and bureaucrats, who would just contract the service out if they found that it was poorly performing. Thus, if my hypothesis is not invalid, large-populated municipalities that had not yet privatized before the nineties would be now relatively less interested in privatization. This is due to the fact that, usually, largely populated towns and cities have skilled public servants and politicians. The variable *POP* will be useful to check my point of view.

*Hypothesis 3: When there is concern about efficiency in production and there is not consensus about the goodness of privatization, given in part by the rise of alternative ways to introduce improvements, party differentiation arises in deciding which local service reform is to be undertaken.*

The major consensus about ideological matters and party differentiation concerning privatization has so far been that these issues have nothing to do with the mode of production that is chosen. In other words, assuming that one mode of production is the best one in some circumstances, both conservative and non-conservative parties tend to this mode of production. This is found in López-de-Silanes, Schleifer and Vishny (1997), Ménard and Saussier (2000), Bel and Miralles (2003) and Chistoffersen and Paldam (2003). Here, 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 the best mode of production, ideological issues matter<sup>4</sup>. Each party will tend to support the reform policy that suits best with the ideology it defends in front of its voters<sup>5</sup>. To see that, I elaborated variable *PI*, the political index, which is a dummy variable that takes value 1 if a conservative party (coalition) is governing during the period under consideration and value 0 if there is a non-conservative party (coalition) in office.

It is clear that creating such a variable is somewhat delicate, so I paid much effort in constructing it. The variable has been mainly constructed from the data of the General Files of Catalonian Municipalities, elaborated by the Municipalities Federation of

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<sup>4</sup> Non-conservative parties could be willing to undertake reforms that enhance water service production efficiency while not renouncing to public ownership. This is due by 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 reclaim the rights over this innovation.



Catalonia. These files contain name, political affiliation and charge of each municipal representative of each Local Council. Knowing mayor's political affiliation and the affiliation of other persons in charge has allowed me to create this index<sup>6</sup>. In the first period (1980-1983), however, the ideological identity of governing parties, coalitions and organizations was so unclear that I had to skip this variable for this period.

If my hypothesis is correct, this variable should have influence on the endogenous variable during the nineties, but not during the eighties.

*Hypothesis 4: The dynamic neighboring effect.*

One of the novelties of this paper is the statement and positive testing of this hypothesis. Bel and Miralles (2003) and Christoffersen and Paldam (2003) depicted the so-called *neighboring effect* in the same year, an effect that was also pointed out by Reimer (1999). They found that municipalities surrounded by other ones that had previously privatized the service had in turn a higher probability to privatize it than municipalities that were not surrounded by privatizing municipalities.

There are two explanations for this phenomenon. Both papers coincide in the first one, which refers to the political cost concept. If a municipality is surrounded by municipalities that have already privatized some service, then the former one is able to observe others' neighboring experiences, which reduces uncertainties concerning privatization performance. Also, a "pro-privatization" message is less politically costly when the experience has been observed in surrounding towns and cities. A second explanation, explained in Bel and Miralles (2003), makes reference to efficiency issues. A municipality hardly ever constitutes the optimal geographical area when producing a local service, because of so-called geographical scales economies (Donahue, 1989). A private firm is less constrained than public organizations when expanding through several municipalities, hence taking advantage of these scale economies. Therefore, a firm that is established in a municipality could make good expansion offers to surrounding municipalities<sup>7</sup>.

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<sup>5</sup> From another point of view, this uncertainty feeds discretionary search for party's hidden aims in its relations with private contractors.

<sup>6</sup> Sometimes the governing 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).

<sup>7</sup> Bivand and Szymanski (1997, 2000) present, first in a theoretical framework, and secondly in an empirical one, their research on how English and Welsh local governments, when still maintaining public service production, set surrounding municipalities' results as a comparative benchmark to follow, given the lack of information about maximum attainable efficiency. As a result, average costs are very similar

So far, this is the static version of the neighboring effect. Now, imagine that we are in the first stages of the privatization spreading process. There are zones where there is a high percentage of privatizing municipalities, while there are others where the service is publicly produced in almost every municipality. A forward-looking firm already installed in the former zone is to decide its expansion plan. It could simply take advantage of geographical scale economies and make an offer to a municipality of the former zone. Or it could take the risk and try to enter the latter zone, as he knows that there is a high probability, as discussed above, of expanding after some years to other municipalities in this “unexplored” region, hence getting more profits in the future<sup>8</sup>. Then, in the first stages of the privatization-spreading process, there are two contradictory forces and the static neighboring effect may not hold. If this hypothesis is correct, the static neighboring effect may only be observed in recent years, i.e. the nineties, while something opposite to this static view of the neighboring effect may happen during the first eighties.

The variable I use to measure the neighboring effect, which I call *NEIGH*, is defined as the percentage of municipalities of the Official Zone<sup>9</sup> the observed municipality belongs to that have already privatized the service at the beginning of the period under consideration. Following my hypothesis, its influence on the endogenous variable should be positive during the nineties, while its sign should be not clear, or even negative, during the eighties. Data for this variable are extracted from the LSPS.

*Hypothesis 5: Hard budgetary shortfalls enhance the use of privatization.*

During the economic crisis that Spain bitterly experienced between 1992 and 1994, municipalities that had been progressively getting indebted found that their available resources during those years were very scarce. In such a context, a municipality is bound 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 contractor usually has to pay to the municipality<sup>10</sup>.

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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.

<sup>8</sup> A theoretical paper by Miralles (2004), using auction theory, shows that existence of these expected future profits increases effective competition for the contract of the first municipality that privatizes the service in some region.

<sup>9</sup> Catalonia currently has 6 Official Zones.

<sup>10</sup> López-de-Silanes, Schleifer and Vishny (1997) observe, for the United States case, that state laws constraining municipal debt growth capacity enhance the tendency to privatization. Kodrzycki (1998)

To assess this idea, I have elaborated the variable *AFB*, the average financial burden. It is equal to the arithmetic mean of the IFB of the two previous years to 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 are compiled only since 1990, so the *AFB* is only collected for the last three periods under study<sup>11</sup>. The *AFB* is a good variable because it measures the difficulties that a municipality has to become more indebted.

*Other considerations: efficiency and population dispersion; groups of interest; and combinations of different kinds of public sector reform.*

Finally, I present some variables that are worth it to be assessed, although I do not formulate a precise hypothesis about their effects.

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 in 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. Following this idea, I have used the variable *SPE*, 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.

Concerning groups of interests, it is though (but difficult to prove) that industrial water consumers are cross-subsidizing household water consumers by means of paying quite high water tariffs (while underpricing household consumption). This is explained by a political interest argument, considering household consumers as voters. The argument could be outweighed by the fact that industrial consumers could offer other

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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 explain the privatization process was the necessity of obtaining cash returns in order to meet European convergence criteria.

<sup>11</sup> Besides, there were no data for some municipalities, so the sample loses observations whenever this variable is used.

types of (hidden) support to politicians. But if the former argument were true, industrial consumers would be interested in separating political power from water service control, therefore enhancing privatization. So, in order to assess this, I have used the proxy *IND*, the percentage of active population that works in the industrial sector. Data are collected from Idescat, and are available only for 1986, 1991 and 1996. I have used the 1986 data in the first two periods, the 1991 ones in the next two and the 1996 data in the last two periods.

Also concerning groups of interest, it could be thought that a municipality with powerful worker 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). But for the water service case, labor participation is quite low and unimportant. Roughly 80% 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 types of service.

A final consideration concerns the fact that different kinds of public service reform could be either incompatible with each other or just the opposite, that is, complementary. Warner and Hebdon (2001) state that public service reform is something that 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 handy duration model. But, taking into consideration Warner and Hebdon's proposal, I have included a variable that can assess the relation between privatization and other kind of public sector reform. This variable, *MASS*, municipality association, is a dummy that takes value 1 if the municipality took part in a specific water supply municipality association in the period under consideration, and 0 otherwise<sup>12</sup>. Data are collected from the LSPS.

Municipality association could be conceived as an alternative to privatization, as it is another way to exploit geographical scale economies. But, in turn, municipal association reduces political costs induced by privatization, as the distance between

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<sup>12</sup> 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 imply that organizational decisions must be taken by consensus, implying an indirect form of association. Additionally, there are so-called "implicit"

citizens and decision-taking organization increases. So it is not clear what the final effect will be.

#### 4. The model and results

The representative local politician in a municipality where some local service is so far publicly produced has an expected utility increase function derived from the fact of privatizing the service that by assumption takes the following linear form:

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

where:

$X_{it}$  is a row vector that contains a one plus the above quoted explanatory variables, for municipality  $i$  during the period  $t$ .

$B_t \equiv (\beta_{0t}, \dots, \beta_{kt})$  is a coefficient vector, where  $k$  is the number of explanatory variables. Notice that we assume that there could be variability in the coefficients among the different periods.

$\varepsilon_{it} \equiv u_{it} + v_i$  is a random perturbation including features not proxied by explanatory variables, with a component ( $v_i$ ) that collects time-invariant (or low-time-variant) unobservables.

Thus, politician takes into account current values of explanatory variables when taking a decision about the mode of production. This is similar to assuming myopia of the politician, as he does not take into account expected future values of these variables. This assumption is supported by the fact that politician's preference-for-the-present rate is so high that events that would take place after the next election are ignored.

Politician of 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, public production remains. We now introduce the *irreversibility assumption*, that is, going back is not possible once privatization has been undertaken. Recovering total public control over local service production becomes too costly. This

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associations, which arise when a municipality contracts out the water service to other municipality. All this cases are considered as municipality water supply associations in this paper.

assumption has been observed in the literature (see Christoffersen and Paldam, 2003), and also in our sample<sup>13</sup>. Its effect on our model is that a municipality that privatizes in some period gets out of the sample in further periods, as the probability of having the service privatized given that it was privatized in the past is equal to 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 maintains the service publicly produced during that period. Then:

$$P(Y_{it} = 1 | Y_{it-1} = 0, X_{it}, v_i) = P(\Delta U_{it} \geq 0) = P(-u_{it} \leq X_{it} B_t + v_i) = F(X_{it} B_t + v_i) \quad ,$$

and

$$P(Y_{it} = 1 | Y_{it-1} = 1, X_{it}, v_i) = P(Y_{it} = 1 | Y_{it-1} = 1) = 1$$

Where  $F$  is the distribution function of the (negative) random perturbation that is not time-invariant or individual-specific. This i.i.d. part of the perturbation, with its negative sign, is interpreted as a random shock in favor of keeping public production<sup>14</sup>. That way, the contribution of municipality  $i$  to the likelihood function that is to be maximized follows as<sup>15</sup>

$$\begin{aligned} L_i(t_i | X_{i1}, \dots, X_{it_i}, v_i) &\equiv P(T_i = t_i | X_{i1}, \dots, X_{it_i}, v_i) = \\ &= \prod_{t=1}^{t_i} \left[ P(Y_{it} = 0 | Y_{it-1} = 0, X_{it}, v_i)^{1-Y_{it}} \cdot P(Y_{it} = 1 | Y_{it-1} = 0, X_{it}, v_i)^{Y_{it}} \right] = \\ &= \prod_{t=1}^{t_i} \left[ (1 - F(X_{it} B_t + v_i))^{1-Y_{it}} \cdot F(X_{it} B_t + v_i)^{Y_{it}} \right] \end{aligned}$$

Where  $T_i$  is the random variable “time length municipality  $i$  takes to get out of 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.

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<sup>13</sup> There are only two exceptions. In one municipality, a joint venture is to be taken over by the municipality by 2030. In a second municipality, the privatization process worked very poorly and the service came back to public hands. This last municipality has been dropped from the sample.

<sup>14</sup> 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 on 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.

<sup>15</sup> 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 well.

It has been said that  $v_i$  collects features that were not possible to observe, and hence the likelihood function may not be directly maximized right now. This variable must be integrated first as follows:

$$\begin{aligned} L_i(t_i|X_{i1}, \dots, X_{it_i}) &= E_v [L_i(t_i|X_{i1}, \dots, X_{it_i}, v_i)] = \int_{-\infty}^{\infty} L_i(t_i|X_{i1}, \dots, X_{it_i}, v_i) \cdot dG(v_i) = \\ &= \int_{-\infty}^{\infty} g(v_i) \cdot \prod_{t=1}^{t_i} [(1 - F(X_{it}B_t + v_i))^{1-Y_{it}} \cdot F(X_{it}B_t + v_i)^{Y_{it}}] \cdot dv_i \end{aligned}$$

Where  $E_v$  is the expectation following the individual unobservable distribution function,  $G$  is this distribution function and  $g$  is the associated density function. Log-likelihood function is obtained as the sum of the logarithm of each individual contribution.

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

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

Gompertz distribution is adequate here against other more commonly used distributions as the normal (*probit* model) and the logistic (*logit* model). The former ones are symmetric, hence assuming a priori certain balance between 0s and 1s in the endogenous variable in each period. This does not correspond to data of this sample, where the number of 1s is clearly lower for each period. Instead, the Gompertz distribution suits better the data, as it is asymmetric in favor of the value 0.

In a first estimation, it is assumed that the individual unobservables variable is distributed as a normal  $N(0, \sigma_v^2)$ . 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), who checked that diverse duration models yielded very different results depending on the assumed time-invariant unobservable distribution function.

Nevertheless, applying Heckman and Singer's approach multiplies model complexity, and our result became so unstable and starting-point-dependent that we gave this estimation up and we used the simple parametric approach above described. The use of the normal distribution for time-invariant individual unobservables is quite

usual, because the Gauss-Hermite's quadrature method manages to simplify the function that is to be maximized.

Now I turn my attention to the coefficient variability along time. Letting coefficient be flexibly time-variant is logical in our 20-year range under study, but imposing some stickiness is also quite convenient. The good properties of maximum likelihood estimation are asymptotic, so that increasing the number of observations per estimated coefficient could be of paramount importance. Constraining coefficients to be equal between period 1 and period 2, for instance, could provoke a slight bias due to lack of flexibility, but in turn it almost double the number of observations per coefficient, hence meeting the large sample condition.

My first approach suggests a panel data discrete choice analysis with individual effects. I estimate two blocks of fixed-coefficient periods, the "eighties" (1980-1991) and the "nineties" (1992-2002)<sup>16</sup>. According to the hypotheses I postulate, this is a good starting point.

There are motivations that justify this separating point in 1991. During the eighties, recovering a good condition for water service infrastructures was the main aim in the local political agenda concerning this service (FMQ Projectes i Estudis, 1999). Privatization was conceived, if so, as a means to reach this aim in municipalities that were running low of funds. During the nineties, once almost every municipality had solved the facilities problem, the agenda was redirected to the efficiency issue, so that privatization was then thought, if so, as a means for improving service performance. Other kinds of reform other than privatization were also starting gaining reputation. It is intuitive, then, that the nineties and the eighties may not have same coefficient values.

I present in Table 1 the results obtained for both blocks of periods through the use of Intercooler Stata 6.0<sup>17</sup>:

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<sup>16</sup> This implies that the random variable  $v_i$  differs and is uncorrelated between blocks. Given the wide length of the blocks under consideration, this is a sensible assumption.

<sup>17</sup> This program is already used on every estimation presented in this paper.



**Table 1. Factors influencing water supply service privatization in Spain.  
Gompertz model with panel data and unobservable individual effects.**

Variables \ Blocks	1980-1991	1992-2002
<i>POP</i>	0.0000232 (2.134)**	-0.0000347 (-1.135)
<i>SPE</i>	-0.0542447 (-0.767)	0.0336874 (1.254)
<i>MASS</i>	0.6421256 (0.808)	-1.031557 (-1.134)
<i>PI</i>	—	0.6934292 (1.828)*
<i>AFB</i>	—	-0.003931 (-0.262)
<i>TOUR</i>	0.0004997 (2.041)**	0.0000207 (0.140)
<i>IND</i>	0.0030173 (0.189)	0.0259726 (1.872)*
<i>NEIGH</i>	-0.0009939 (-0.067)	0.031904 (3.876)****
<i>Constant</i>	-3.375865 (-4.154)****	-4.200829 (-5.730)****
$\rho = \frac{\sigma_v^2}{\sigma_v^2 + 1}$	0.4985037	$8.32 \cdot 10^{-7}$
LR test $\rho = 0$	0.31 {1} [0.5747]	0.00 {1} [0.9985]
Wald test overall signification	7.58 {6} [0.2705]	30.17 {8} [0.0002]****
Number of municipalities	103	82
Number of observations	291	205
$\ln L$	-64.464941	-74.884168

**Notes:**

In brackets, the *z*-statistic (standard normal) values for the hypothesis that the coefficient is not significantly different from zero.

In square brackets, the probability that the statistic is not significantly different from zero.

In braces, the number of degrees of freedom.

Signification levels: \* 10%, \*\* 5%, \*\*\* 2.5%, \*\*\*\* 1%.

Variables *PI* and *AFB* have not been included in the first-block estimation. Data were not available for all or some of its periods, due to reasons that have been explained in previous section, so they have been excluded.

At first glance results are consistent with what was postulated in Hypothesis 1. Results differ between decades. Even overall significance differs between decades. The signs of *POP* and *TOUR* coefficients are positive and significant at 5% level during the eighties, while they are not significant during the nineties. This supports the idea of a necessity of investments during the eighties. These projects were not affordable by municipalities alone. This necessity was stronger in large-populated and tourism-intensive areas, and this led to privatization as a way to undertake these investments. It is also observed that *POP* coefficient is negative during the nineties, according to Hypothesis 2, although the coefficient is not significantly different from zero.

There is also minor evidence in favor of Hypothesis 3. The sign of *PI* coefficient is positive and significant during the nineties, though at 10% level. Unfortunately, we cannot state whether this effect is also present during the eighties or not, so our findings are not conclusive on this issue for the moment.

Results of Table 1 are quite more favorable to Hypothesis 4, the dynamic neighboring effect. It is seen that the sign of *NEIGH* coefficient is positive and significant and the 1% level during the nineties. At the beginning of this decade, each Official Zone in Catalonia had more than 10% municipalities that had privatized the water supply service. So only an expansion-within-the-zone plan was possible for an incumbent firm, as pioneering expansions to other zones were already done. Apparently, the static neighboring effect had its effects during these years. During the eighties, on the contrary, variable *NEIGH* had no significant effects, and it even had (non-significant) negative coefficient sign. Dynamic neighboring effect hypothesis appears to work well given this result. At the first stages of the privatization spreading process, there were zones where none of the municipalities had undertaken privatization processes in this service, so that expansion-to-other-zones plans could be even more appealing for a incumbent firm than expansion-within-a-zone ones, hence outweighing the static neighboring effect.

Concerning Hypothesis 5, our results are less disappointing than could seem given the fact that the sign of *AFB* is not significant at all. In fact, I am postulating that public

finance issues matter in specific periods when there are very hard financial constraints, so only a detailed study of the economic crisis period 1992-1995 would be determinant.

I briefly comment on the rest of explanatory variables. Neither *SPE* nor *MASS* have significant coefficients in any block. Coefficient values are also quite unstable, which suggest a more detailed exploration. The *IND* variable has significantly positive coefficient (at the 10% level) during the nineties, but the coefficient during the eighties is not significant. This also suggests a more detailed exploration, which is given further.

The pseudo-correlation coefficient  $\rho$ , which measures the relative importance of the individual-specific unobservable variable, is definitely higher in the first-block estimation than in the second. This could reveal that omitted variables *PI* and *AFB* play a role during the eighties as well. The possible omitted-variable bias is in great part addressed by the panel data estimation. Moreover,  $\rho$  is not significant at all in any of the blocks. This is important as it reveals that ignoring the existence of individual-specific unobservables would not lead to serious estimation bias. And doing so implies many advantages, as the reasonable specification-test-design flexibility and higher computational precision that a simple pooling estimation model has. So I propose the following simple log-likelihood function, which ignores the individual-specific effect:

$$\ln L = \sum_{t=1}^6 \sum_{i \in N_t} \ln \left[ (1 - F(X_{it} \mathbf{B}_t))^{1-Y_{it}} \cdot F(X_{it} \mathbf{B}_t)^{Y_{it}} \right]$$

Where  $N_t$  is the set of all municipalities than are not censored (or out of the sample) in  $t$ . The good news about this formula is that it means that maximizing global likelihood is equivalent to maximizing associated partial period-specific log-likelihoods one by one. Nevertheless, it is convenient to aggregate periods (assuming constant coefficients between them) whenever possible, so that finite sample problems are avoided. In a first stage, I tried to emulate the block division of Table 1. However, the likelihood ratio test rejects the stability of the model within second block. Its chi-squared statistic is equal to 32.857352 with 16 degrees of freedom, while the 95% percentile is 26.30 and also the 99% percentile is 32.00.

So I have divided the six periods under study in three blocks with two periods in each one: 1980-1987, 1988-1995 and 1996-2002. Likelihood ratio tests yield the following respective results: 4.162724 (6), 14.6407 (7) and 9.320556 (8). Numbers in brackets are the degrees of freedom. Stability of the coefficients is not rejected either in

the first or in the third blocks. For the second block, there are still stability problems as the 95% percentile of the relevant chi-squared distribution is 14.07.

What I do then is to present the results for these three blocks, while I present and discuss a period-by-period estimation of the second block in the appendix. Pooled data maximum likelihood estimation with individual standard-error-estimation clustering is presented in Table 2. In order to avoid redundancies, I shall only discuss on the new information that this more flexible estimation procedure rises concerning my hypotheses.

**Table 2. Factors influencing water supply service privatization in Spain.  
Gompertz model with pooled data and individual clustering.**

Variables \ Blocks	1980-1987	1988-1995	1996-2002
<i>POP</i>	0.0000328 (3.155)****	-8.07·10 <sup>-6</sup> (-0.463)	-0.000048 (-1.908)*
<i>SPE</i>	-0.0398277 (-0.717)	0.0112122 (0.167)	0.0230515 (0.597)
<i>MASS</i>	—	1.230749 (1.254)	-0.9889664 (-0.699)
<i>PI</i>	—	0.2610911 (0.328)	0.8824532 (1.791)*
<i>AFB</i>	—	—	-0.0044086 (-0.206)
<i>TOUR</i>	0.000637 (2.426)***	-0.0000569 (-0.368)	0.0000944 (0.833)
<i>IND</i>	0.0114551 (0.429)	-0.0000512 (-0.002)	0.0399798 (2.684)****
<i>NEIGH</i>	-0.0432482 (-1.751)*	0.0281871 (1.058)	0.0339084 (3.125)****
<i>Constant</i>	-2.941201 (-3.241)****	-4.017493 (-3.283)****	-4.460909 (-5.040)****
Wald Test overall signification	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 <i>L</i>	-38.030545	-36.14809	-55.679699

**Notes:**

In brackets, the *z*-statistic (standard normal) values for the hypothesis that the coefficient is not significantly different from zero.

In square brackets, the probability that the statistic is not significantly different from zero.

In braces, the number of degrees of freedom.

Signification levels: \* 10%, \*\* 5%, \*\*\* 2.5%, \*\*\*\* 1%.

It is immediately seen in the results that the second block coefficients are overall non-significant. Second block is understood as an impasse between two ways of conceiving the privatization decision. A more desegregated estimation of the two periods of this block is shown and discussed in the appendix. As it is already seen there, the only significant result obtained for this block consists of the finding of some weak evidence in favor of Hypothesis 5.

In the first and the third blocks, the model is significant overall. Variables *AFB* and *PI* have not been included in the blocks where there were no data available. Variable *MASS* has been skipped in the first block estimation due to perfect collineality with the endogenous variable. All observations with value 1 for this variable had value 1 for the endogenous one.

Results are again accordant to Hypothesis 1, and give (weak) support to Hypothesis 2. The signs of *POP* and *TOUR* coefficients are positive and highly significant in the first block (early eighties), while *TOUR* makes no significant effect afterwards and *POP* even makes a negative and significant effect at 10% level in the third block (late nineties). Hence, a largely populated municipality, with high-skilled politicians and public servants, that has not privatized the water service during the eighties now tends (on average) to undertake other kinds of service production reform that keep total public control over it. Among these new kinds of reform, creation and operation of publicly owned companies, municipality association and contracting out to another municipality are nowadays frequently used.

Concerning Hypothesis 3, results provide new support to the idea that ideological issues start mattering during the nineties. Although information about it cannot be extracted from the first block, it can be extracted for the second block. In this block, *PI* makes no significant effect at all. In the third block, on the contrary, there is a weakly significant and positive effect of *PI* on the privatization trend. This supports the idea of ideology importance when efficiency issues and uncertainty about the best production method enter the municipal political agenda.

With respect to Hypothesis 4, results confirm the existence of dynamic neighboring effect. *NEIGH* coefficient in the 1980-1987 block is negative and significant at 10% level. It has positive sign afterwards, and this sign is significant at 1% level in the 1996-2002 block. While in the first stages of the privatization spreading process one observes a higher propensity to privatization in zones where it is a seldom practice, in the last

stages privatization spreads over the zones where it is an already usual procedure. This suits perfectly with the dynamic neighboring effect hypothesis that is proposed in this paper.

More comments on Hypothesis 5 are presented in the appendix. The *ESP* variable coefficient is never significant, and this makes us rethink on the role that population dispersion plays in the privatization process. The complexity-by-dispersion argument justifying the inclusion of this variable apparently does not work. The *MASS* variable sign is positive but never significant. In this case, results accord to the trade-off effects I explained in the previous section.

Finally, it is seen that variable *IND* has positive and significant (at 1% level) coefficient only in the third block, that is, between 1996 and 2002. It loses signification in other periods. To find out why this coefficient is significant only in recent years, that is, why industrial interest groups push strongly towards privatization in recent years only, I pay attention to regulatory reforms that water sector experienced in 1999. In this year, the Catalanian Water Agency was created in order to face increasing quality standards in all features of water cycle, which were to be regulated by the European Union. Accomplishment of new standards implied higher prices for polluting water uses (mostly industrial). This price-increasing pressure could worry water-intensive productive sectors. These facts made industrial sector strongly push for better payment conditions. One strategy that, on the light of my results, was put in practice consisted on separating water supply services from the political control, in order to reduce the risk of water price cross-subsidization in favor of households (voters).

## **Conclusions**

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

This model allows us to identify the evolving pattern of these factors, hence supporting that local service privatization do not always respond to the same causes in any period of time. Results do not reject the general idea that in Spain, the first years of its young modern democracy were devoted, with respect to water services, to the

investment in infrastructures that were in bad condition as an inheritance from the previous dictatorial regime. This explains privatization during these years as a way to obtain funds in order to undertake these investments. In the nineties, however, once infrastructures were satisfactorily working, privatization was designed as a way to improve efficiency. In turn, alternative ways to improve service performance started gaining popularity, and municipalities with high-skilled politicians and bureaucrats preferred (on average) to undertake these kinds of reform.

During the nineties as well, this variety of different ways to improve efficiency and the uncertainty around the goodness of privatization in a service were privatized market concentration increases continuously as time goes by were sufficient to allow some space for party differentiation concerning local public sector reform. On average, conservative governments still relied on privatization as the best way to improve efficiency, while non-conservative governments tried alternative ways to achieve the same objectives. 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 water sector private firms. Altogether, this result contradicts what is recursively found in the literature. I break then the consensus about the lack of party differentiation concerning the mode of production of local services. In my paper, I state that there are punctual periods in which the public-private dilemma forms real (not only discursive) part of the political arena in local politics.

As another feature of this paper, I find what I have called the *dynamic neighboring effect*, which is an extension of the “static” neighboring effect of Bel and Miralles (2003) and Christoffersen and Paldam (2003). In recent years, and coinciding with these papers, I find that service privatization decision is more frequent in municipalities that are surrounded by other ones that have previously privatized the service. But in previous stages of the privatization spreading process, privatization decision does not meet this condition. Even the opposite comes true: privatization becomes slightly more frequent in zones where almost all municipalities were producing the service in-house. This phenomenon has to do with private water suppliers’ long-term expansion strategies. It could be more appealing for a firm to try to expand (even by means of wonderful offers to municipalities) to zones that are non-exploited by other firms if firm knows that, once installed in the zone, it is surely going to spread over more municipalities there sooner or later.



Weak evidence has been found in favor of municipal budget and indebtedness constraints as a factor positively influencing privatization decision at the local level. For my sample, indebtedness capacity constraints only mattered when Spain faced the hard 1992-1994 economic crisis. Just valley periods of the economic cycle make budget shortfalls be decisive in the privatization decision at the local level.

In this paper, I also try to assess to which 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 privatization, concerning water supply. I find that, on average, both methods do not have a general relation. In some cases they are incompatible, as municipality association could be viewed as an alternative to privatization in the search for geographical scale economies exploitation. In some other cases, they are complementary, because municipality association implies that privatization decision becomes less politically costly due to the increase in the distance between citizens (voters) and decision-takers.

Finally, I find that the group-of-interest factor has its importance in the privatization decision in some periods of time. For the Spanish case, and particularly for the Catalanian municipality sample, recent regulations increasing polluting water use price in particular and industrial use price in general stimulated industrial sector 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, and hence reducing possible cross-subsidization in favor of domestic consumers (voters).

All these findings were mostly possible because I was able to collect panel data for 133 municipalities and six terms of office per municipality. This allowed me to shed more light to the local service privatization issue as an evolving process than previous static, cross-section discrete choice analyses found in the literature.

The study of other factors influencing local service privatization is addressed in further research. For instance, it would be appealing to test Biais and Perotti (2002) prediction that ideology (and other party's interests) is more influential on the mode-of-production decision when there is a low re-election risk. I also leave for further research the study of the consequences of the local service privatization spreading process on social welfare in Spain.

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## Appendix

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

**Table 3. Factors determining water supply service privatization in Spain.**

**1988-1991 and 1992-1995 periods. Gompertz model with robust standard errors.**

Variables \ Periods	1988-1991	1992-1995	1992-1995(bis)
<i>POP</i>	-0.0000316 (-0.944)	0.0000123 (1.089)	0.0000245 (2.519)***
<i>SPE</i>	-0.2129977 (-1.804)*	0.0770639 (2.214)**	0.1261368 (2.620)****
<i>MASS</i>	2.516838 (2.495)***	—	—
<i>PI</i>	1.910593 (2.010)**	-1.937924 (-2.090)**	-1.62218 (-1.100)
<i>AFB</i>	—	0.107026 (1.757)*	—
<i>TOUR</i>	-0.0000478 (-0.116)	-0.0002943 (-1.727)*	-0.0001051 (-0.220)
<i>IND</i>	-0.0163431 (-0.608)	0.0682209 (0.661)	0.029286 (0.597)
<i>NEIGH</i>	0.1077624 (1.766)*	-0.088493 (-1.209)	-0.0439952 (-1.454)
<i>Constant</i>	-6.249649 (-2.357)***	-5.909557 (-1.281)	-3.696226 (-1.881)*
Wald test overall signification	15.30 {7} [0.0324]**	25.90 {7} [0.0005]****	36.01 {6} [0.0000]****
Number municipalities	92	69	85
Number privatizations	7	3	3

### Notes:

In brackets, the  $z$ -statistic (standard normal) values for the hypothesis that the coefficient is not significantly different from zero.

In square brackets, the probability that the statistic is not significantly different from zero.

In braces, the number of degrees of freedom.

Signification levels: \* 10%, \*\* 5%, \*\*\* 2.5%, \*\*\*\* 1%.

*AFB* variable is not included in the 1988-1991 period because, as explained before, data on this variable are only available from 1990 on. *MASS* has been dropped from the 1992-1995 estimation because of the collinearity problems it was provoking. 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 that *these so variable results must be taken with skepticism*. Only the sign of *TOUR* coefficient does not change between periods. But as its negative sign sounds quite unintuitive, I have investigated on multicollinearity problems giving rise to this sign. I find that *TOUR* is highly correlated to *AFB* in 1992-1995 period (0.45 correlation coefficient). Hence, I have run a new estimation (1992-1995bis) without *AFB*, in order to see what happens with *TOUR* coefficient. It is seen that it loses signification, so I ignore it.

Concerning *MASS* variable coefficient, we see that its sign is positive and significant at the 1% level during the 1988-1991 period. However, recall that there was a perfect negative correlation between *MASS* and the endogenous variable in the 1992-1995 period. Both results could be explained again by typical small sample instability problem. Besides, joint estimation of both periods (see Table 2) revealed no signification for the coefficient of this variable. Under such confusion, I decide to ignore this variable as well.

Consequently, I just comment on the *AFB* 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 *AFB* coefficient is not significant. The test chi-squared statistic, with one degree of freedom, is equal to 5.19444, while the 97.5% percentile of this distribution is 5.02. So I can state that I find weak evidence in favor of Hypothesis 5.