

# THE ROLE OF TRANSACTION COST ON MIXED DELIVERY ANALYSIS: EVIDENCE FROM THE BARCELONA LOCAL BUS SYSTEM

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## Abstract

Recent evidence on public-private cost production of local public services has become ambiguous, while in-house production has been maintained even a privatization process has taken place. The objective of this paper is to compare the public and private provision in a mixed delivery scheme, analyzing the role of ownership, competition and transaction costs on local public services delivery in the same jurisdictional area. Using a stochastic cost frontier, we compare Barcelona public-private urban bus lines. We obtain that private provision is more expensive than public, tender process do not reduce costs and the inclusion of the totality of transaction costs favors public provision. The results support the existence of relational contracting on mature competitive environments.

**Keywords:** costs, transaction costs, mixed delivery, local governments,

**JEL Codes:** H0, H7, K00, L33

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# **THE ROLE OF TRANSACTION COST ON MIXED DELIVERY ANALYSIS: EVIDENCE FROM THE BARCELONA LOCAL BUS SYSTEM**

## **1. INTRODUCTION**

The developed countries governments have introduced competition in the organization of public services. The eighties dichotomy between governments or markets is merely being relegated for mixed models where it is intended to get the better of the public and private sector. The public sector has the ability to order the private sector through regulations. Beyond these regulations, competition between public and private companies is a way to prevent the system from rusting over time. Private companies have incentives to be competitive as the public company can move out of the market. The public company has to seek efficiency, and thus workers awareness of the importance of wage restraint. The regulator gets the monitoring of public company costs as compared to the private, and avoids some anticompetitive behaviour by private operators. At the end of the day, it is the consumer who benefits from this scheme. Mixed delivery implies that a government divides her jurisdiction in several areas, and pure public delivery is used in one or more areas while pure private production is used in other district(s) within the same jurisdiction (Warner and Bel, 2008). The aim of this paper is to compare a mixed delivery scheme and show what happens over time, when competition for the market evolves. The role played by transaction cost on contracting out has gained ground last years; thanks to transaction costs we can compare the cost of planning and monitoring under different delivery structures.

The coexistence of the two worlds in the urban bus system of the Barcelona metropolitan area shows us an interesting case to prove that. Using a stochastic cost frontier we will demonstrate the firm efficiency related to the ownership, the

implications of the tender process, the role of the transaction cost and the optimality of the regulatory scheme. Our main contribution is the cost comparison of a public-private mixed delivery system in the same jurisdictional area. The Barcelona bus system scheme is one of the unique cases of mixed delivery and also on urban bus. Several studies make comparisons with different cities or countries with homogenizer's assumptions among regulators, but it is not our case. Comparing the same area and also taking into account the role of transaction costs is an innovative way that has not been done, according to our knowledge.

This paper is divided into five sections. In the first section, we outline the current state of local public services, specially focusing on urban bus transit. In the second section, we describe the regulator and the public and private firms on the Barcelona metro area. In the third section, we describe the empirical strategy: the data and the used model. Next section we comment the most important results and finally we conclude with some policy implications.

## 2. LITERATURE REVIEW

### 2.1. Local public services

On local public services debate, ownership has been relegated by competition. Bel et al. (2010) do not find cost savings resulting from private production; they point to transaction costs and competition environment as two important cost savings factors. Domberger et al. (1986, 1987) found that in cases where public firms bid against private contractors and won, the level of savings achieved was not significantly different from that realized by private firms. If the public incumbent persistently under-performs compared to private contractors, then competition is not effective. The existence of pure

public and pure private companies providing the service within one jurisdiction has been called mixed delivery: regulators can compare firms' production processes and costs, while still retaining direct involvement in service delivery (Miranda and Lerner 1995). They argued that redundancy in delivery method could in fact be efficient, as a form of benchmarking with the private sector, and a means to promote bureaucratic competition in house. The rise in mixed forms of delivery reflects a continuing process of change and innovation at the local government level that combines the market and public delivery benefits (Warner and Hefetz, 2008). Private firms are interested in profit, efficiency and control. The public sector is also interested in efficiency, but is expected to provide failsafe delivery and ensure a higher level of public accountability and involvement. Geographic zone can be a relevant factor to find more or less competition for the market: moderate positive correlation between choice of delivery form and level of competition on metro core areas is found (Girth et al., 2012). They find also qualitative result on government "relational contracting" dynamics: regulators tend to devote more time to helping with low performance, because they could lose the only vendor available to provide the service. After all, this low competition implies an increase of the transaction costs. Johnston and Girth (2012) offer insights into how weak vendor competition affects contract management and overall contract effectiveness. Local governments regulators tend to place more confidence in their vendors' faithfulness and honesty when there had been reputation prior to the relationship, have strong community ties and perform their tasks well (Lamothe and Lamothe, 2012).

Transaction costs are the other key issue on cost savings. Contracting out is not free of charge; it generates transaction costs on private companies and on the regulator. Contracting agencies can underestimate the cost of contracting because transaction costs

are often excluded on the analysis of public-private debate. Williamson (1991, 1999) gave specific attention to transactions costs inside the public sector. First attempts to classify local government services and assess the form of delivery using transaction costs were carried by Stein (1990). Pursuing local government transaction costs, Brown and Potoski (2005) focus on two transaction costs specific factors: asset specificity and ease of measurement. However, they do not analyse costs of communication, coordination or planning with the vendor, among others. On a previous study, Brown and Potoski (2003) conduct a survey on 64 local services in the US at municipal and county level, finding that transaction costs alone cannot account for why governments select particular modes of delivery over others. For meterable services, they find that local authorities are more likely to contract private firms that rely on direct service provision. If these services are in a metropolitan area, is more likely to engage with private firms relative to direct service provision. The role of transaction costs are not sufficiently taken into account, as Croissant et al. (2013) conclude.

## 2.2. Local bus transportation system

When competition in the market is not possible, the best way to promote efficiency is to encourage competition for the market (Laffont and Tirole, 1993). There is empirical evidence that competitive tendering reduces cost, even when there are public monopolies and private bus operators. Great Britain, specially London, Netherlands, Sweden, Finland, United States and Australia are example of countries where the tendering process has reduced the urban bus cost (Hensher and Wallis, 2005). But the most transcendent result is that when the tendering second round takes place many years after the first tendering process, they find an increase in the average in gross cost in the majority of the countries. Not only after the second round of a tender process there are

not cost savings, but also there is certain quality deterioration (Mouwen and Rietveld, 2013). The lack of bidding parity at the time of recontracting can arise as an important issue. Williamson (1976) argues that incumbents enjoy advantages over new entrants, avoiding real competition in the new contract renewal.

The commercial bus market is imperfectly contestable (Mackie et al., 1995). Entry may occur where the incumbent is inefficient, where the incumbent is efficient but weak enough to be supplanted, or simply through incumbents' over-optimism. Incumbents deter entry by tightly controlling costs and by not leaving profitable gaps in service. Incumbents are better informed regarding assets, quality and demand features than potential entrants. Besides, some authors accept that on the bus markets there are not sunk costs, because it can be recovered through sale or alternative use if a service is abandoned. For example, the employees must be transferred to the new winner. A study based on local public services, operation and maintenance of bus system is classified as an easy to measure service and high asset specificity (Brown and Potoski, 2005). It's easy of measurement is in the 27<sup>th</sup> position of 64 services, while asset specificity increases, being in 39<sup>th</sup> position. Reducing bus asset specificity can be achieved by dividing entire service area into several smaller before the contracting process. The service of bus system is classified between a service delivery choice under monopoly and/or low competition (Girth et al., 2012).

However, a loss in the number of bidder companies and a market concentration has been described, for example in France (Yvrande-Billon, 2006), Sweden (Alexandersson, Hultén and Fölster, 1998) and Norway (Mathisen and Solvoll, 2008), among others. This situation is repeated in Italy, besides the incumbent operator wins the majority of tender process (Boitani and Cambini, 2006). However, in Germany there is a renewal rate of 74% and an average of more than 5 bidders per tender process (Beck and Walter,

2013). The relation between the buyer and the vendor evolves, and the dependence of each part on each other increases. Putting this relationship to the tender process with small number of bidders and incompleteness and complex contracts, may not be the best solution when compared to negotiated performance-based contracts (Hensher and Stanley, 2008).

There are no such studies controlling for competition before the actual century, and the inexistence of them taking into account transaction costs. Leland and Smirnova (2009) compare the evolution of efficiency and effectiveness on the US urban bus services. They take as a reference Perry and Babitsky (1986). Both studies find that privately owned and managed transit systems are no longer more efficient and effective providers than government owned agencies. They point to a lack of competition among contractors and transaction costs as factors. Also both studies find that general-purpose governments that contract out services are still more efficient and effective than special-purpose governments.

The evidence provided by stochastic frontier studies in favour of private sector delivery should be weighed against the fact that almost none of these studies controls for the degree of competition and the nature of government (De Borger et al., 2002). Recent stochastic studies control for the existence of public and private companies and for the level of comp, but none of them only focus on the same jurisdiction and take into account the totality of transaction costs (Table 1). Other non-parametric or regional bus studies, such as Fazioli, Filippini and Prioni (1993), found no relation between technical efficiency and ownership among Italian urban transit firms. Filippini and Prioni (2003) for Swiss bus lines have found a better performance of private operators. A Trans European study finds that public firms are less productive than private ones, and partial privatize firms are more productive than totally public (Boitani et al., 2013). Roy and

Yvrande-Billon (2007) find that private operators selected through competitive tendering are more efficient than public. Using a stochastic production frontier for 135 urban transport networks, they find only marginal gains on technical efficiency from regulatory changes that would consist in a shift to delegated management and high-powered incentives regulatory contracts.

Table 1: Parametric urban bus studies comparing public-private firms

Autor	Country and type of service	Are there tender process?	Impact of tender process	Is private production cheaper?	Economies of scale and density
Matas and Raymond (1998)	Spain Urban	No	-	No clear evidence	Economies of density and U-shaped average cost function
Jørgensen et al. (1997)	Norway Urban	Yes	Yes	No evidence	U-shaped average cost function
Gagnepain (1998)	Urban	No	-	Do not check it	Do not check it
Fraquelli et al. (2004)	Urban and interurban	No	-	Do not check it	Scale economies
Roy et al. (2007)	France Urban	Yes	Yes, it reduces costs		Decreasing returns to scale
Ottoz et al. (2009)	Piemonte (Italy) Interurban and urban	Yes	Do not check it	Yes	Diseconomies of scale and density
Scheffler et al. (2013)	German Urban and interurban	Yes	Yes, it reduces cost	No evidence	Do not check it

There is an acceptance of economies of scale on regional bus transportation. When we focus on urban bus there is a more tendency to a less economies of scale or non-economies of scale. European urban bus studies as Fazioli et al. (1993), Filippini and Prioni (1994), Fazioli et al. (2002) find increasing economies of scale. Some studies



find no economies of scale in the Barcelona metro (Matas and Raymond, 1998) and the traditional u-shaped mean costs curve for company size, with constant economies of scale on medium and large firms, as Berechman (1993) suggests. Also it is widely accepted that urban bus transportation has economies of density; Matas and Raymond find economies of density in Spain. Also Viton (1981) and aforementioned Europeans studies find economies of density.

### 3. BARCELONA'S BUS SYSTEM

#### 3.1. The regulator and the public and private companies

Public transport service provision in the Metropolitan Area of Barcelona has not changed substantially over the last decades. The bus transport supply (and all public transport supply except airport bus shuttle and touristic bus) has a fare integrated policy since 2001. The local bus transportation in this metropolitan area is a mixed system in which one public and several private firms supply the service in different areas under the supervision of a regulator.

In Barcelona, two agencies with different responsibilities co-exist and work together. This model is extended on most European cities: the one regulator (EMT) designs routes and timetables, covers private firms deficits while ATM regulator sets fares for all transport modes. The Entitat Metropolitana del Transport (EMT, henceforth) is the regulator, which defines the characteristics of the service offered by the concessionaires, establishes network routes, quality levels and organizes the tenders (Albalade et al. 2012). The exploitation regime of private companies is by franchise (in risk and

venture), by interested management contracts (tendering process) or profitable routes (airport and touristic lines). The EMT provides the buses and the garages, and is the owner of both. The EMT is not a newcomer in organizing tender process. On the nineties it organizes the first tender process, besides being a management contractor since decades ago. So, the contractual design has been evolved and information failures have been reduced. The jurisdictional area of the regulator is the city of Barcelona and surroundings municipalities.

The public company Transports Metropolitans de Barcelona (TMB, henceforth), owned by the EMT, operates in Barcelona downtown and daily routes. TMB also operates interurban routes between Barcelona and surroundings municipalities and urban metropolitan municipalities routes. On 2012, TMB carried 174 million passengers. Approximately, the number of carried passengers has not increased since the eighties, due to some privatization lines and metro network expansion. Supply indicators also remain stable during decades: on 2012 the offered places-km (millions) were 3,182, while on 1989 were 3,050. Nowadays, TMB operates 106 lines. This public company has not participated in any tender process in the Barcelona metropolitan area, but on 2011, the group formed by TMB and Vectalia has been awarded to operate the public transport of the Perpignan Méditerranée metropolitan area. TMB enjoys freedom to design and plan its services and is not subject to a concession contract with the EMT.

The private concessionaires connected the suburban areas with the downtown and also operate surroundings municipalities routes. We are going to focus on competitive contracts, because the contracts of risk and venture not present the same fares integrated policy, they are not required to report data to the regulator and the majority of lines are far from the city of Barcelona. These competitive contracts represent 81% of the total passengers of the EMT (excluding TMB). The cost that the concessionaire assumes is

only the operational cost. The average concession length is five years, with a possibility of an extension of three years as an average. The tender concessions follow a Net Cost Contract scheme or Minimum Subsidy: the firms receive the difference between the expected passenger's revenues and the bidding cost. Private operators have far less management autonomy than TMB.

### 3.2. The tender process

The strategy of putting different areas on tender has been applied in the Barcelona metropolitan area during the nineties. The first tendering process took place on 1998, and the latest process on 2013 (Table 2). In every process, between 1 and 5 companies bid for the subsidize concession. The incumbent has never been removed by a new entrant except the airport concession. In seven of eight contests, the incumbent has never effort the lowest price. It only has happened in Hospitalet concession on 2001. The financial proposal punctuation is between 25-30% of the total. Other aspects as experience in the sector, expected demand or staff and equipment used are the other important aspect. So, incumbents always obtain better punctuation in these aspects that allow them to win the contest easily. This incumbent power has been described by Williamson (1976). The author goes further and points out to the better knowledge of communication channels, procedure routine or red tape of the incumbent as an advantage.

Table 2: Bus tendering process on the Barcelona metropolitan area

Concession area	Tender date	Winner	Number of bidders	Winner lowest price?	
Barcelonè	1998	Tusgsal	4	No	Tusgsal, Autocares

s Nord					Ravigo SL, UTE Urbaser-Alsa and CTSA
	2010	Tusgsal	1	-	
Barcelonès Nord (Night)	1998	Tusgsal	4	No	
	2006	Tusgsal	3	No	Tusgsal UTE Martí Renom and TCC SA
L'Hospitalet de Llobregat	2001	Rosanbus	5	Yes	Rosanbús, CTSA, TRAPSA, UTE Alsa and UTE Sarbús
	2011	Rosanbus	5	No	
West Barcelona	1998	Soler Sauret	3	Yes	
	2008	Soler Sauret	-	-	

So, the majority of the private firms that offer the services operate under a tender process and these areas are operated by a reduced number of companies. There is a market concentration on some ownership groups. Figure 1 shows the temporal evolution of cost per kilometer for several concessions. The line of the graph is shown with a dot in the year when there is a tender process, being the following year when it enters into force. We cannot know if the tender processes increase costs or keep them, but we can rule out that these processes have led to a reduction in costs the years immediately following the bidding process in the area of Barcelona. From Table 2, the Catalan external audit institution analyses three concessions areas: Barcelonès Nord (daily and nightly) and L'Hospitalet de Llobregat.

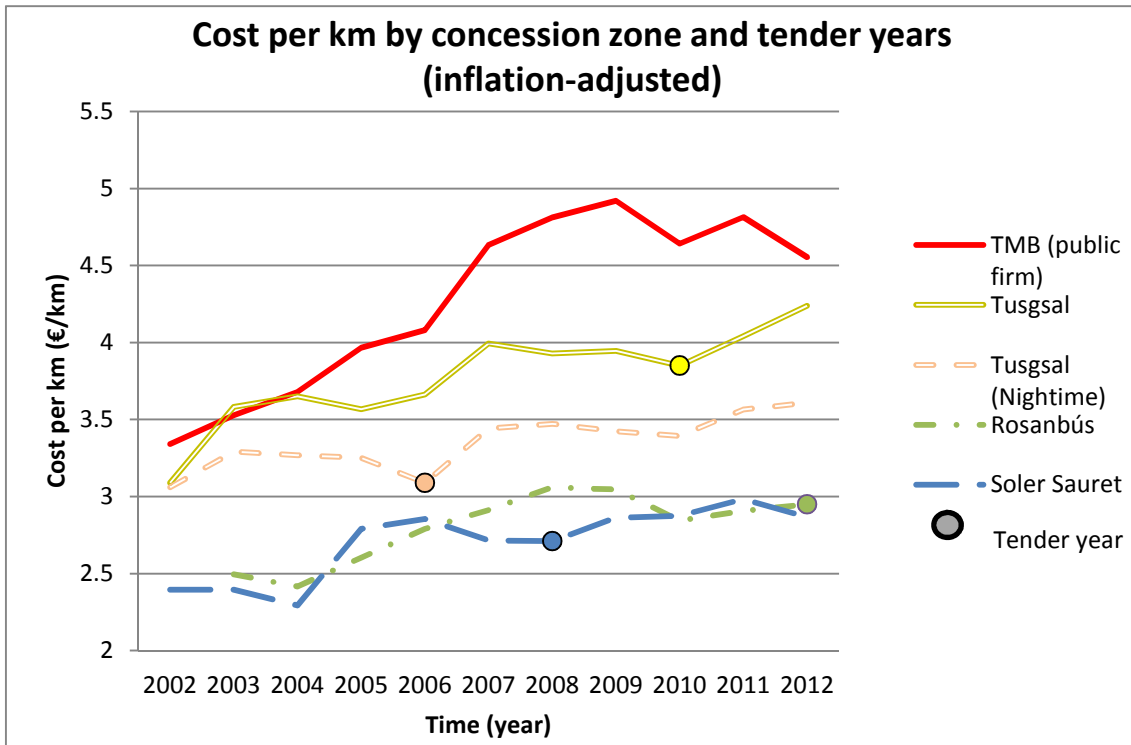


Figure 1 Temporal evolution of the cost per km by concession zone and tender years

### 3.2.1. Urban bus passenger transportation in Barcelonès Nord

Tusgsal is the company that performs the bus urban passenger transportation in Barcelonès Nord. This company serves legally this area since January 1999, and its contract has been extended by four years from January 2007. Previously the service was provided through a management interest contract since the beginning of the nineties to December 1998. The contract has been modified several times between 1999 and 2006: 32 modifications in lines and timetables, 4 general contract clauses modified and 2 operational cost clauses modification, among other. In 1999, Tusgsal operates 17 lines in this zone with 6.6 million km ran. In 2008, the number of lines has increased to 30 and to 10.1 million ran km. The yearly net hours has increased an 80% in this concession period. The Catalan external audit institution considers that after these

substantial changes, EMT should have opened a new bid in 2007, and not to extend the contract.

### 3.2.2. Night bus urban passenger transportation in Barcelonès Nord

On November 1998 there was the first tendering process in Barcelonès Nord. It was the most turbulent episode known in the EMT. First of all, TB union's and opposition parties denounced a report from the EMT that prohibited the public company TB enter the contest. The EMT justified their position because the regulator was and is the owner of the public company; TB managers would become part of the adjudication process as members of the EMT. Second, the debate was open during the punctuation process. Two of the four companies were disqualified for failure to meet the tender specifications. The offered price weighted for 27% of the total points of the contest. Tusgsal offered a higher price than its competitor, but the jury corrections applied, giving a lower price to Tusgsal. The price difference and the other criteria were extremely favourable to Tusgsal score, leading her to keep the award of the tender.

Despite being a different concession than the previous, is also operated by Tusgsal. The initial contract was signed in September 2006 and his validity began in January 2007. Between the firm and the beginning of this concession, the EMT approved extend lines and five months after the entry into force of the concession, new variations in the frequency and the extension of a line. The new situation implies a 36.4% increase on expected ran kilometers. The public audit institution considers that these changes would have involved a new bidding process.

### 3.2.3. Urban bus passenger transportation in Hospitalet de Llobregat and surroundings municipalities

Rosanbús is the company that performs the bus urban passenger transportation in Hospitalet de Llobregat and surrounding municipalities. This company serves legally with a tender process this area since July 2002 (it has served the area for several decades), and its contract has been extended by four years from July 2007. The contract has been modified several times between 2002 and 2008: 16 modifications in lines and timetables and 1 operational cost clauses modification, among other. In 2002, Rosanbús operates 7 lines in this zone with 2.2 million km ran. In 2008, the number of lines has increased to 10 and the ran km to 2.9 million. The yearly net hours has increased 32.6% in this concession period. The Catalan external audit institution considers that after these substantial changes, EMT should have opened a new bid in 2007, and not extends the contract. Furthermore, EMT decided to create three new bus routes in Prat de Llobregat and give them directly to Rosanbús. In 2012, there was a new bidding process. Although Rosanbús did not do the lowest bid, thanks to the good reputation and management experience, it won the contest again.

## 4. EMPIRICAL STRATEGY

### 4.1. Data

The dataset is an unbalanced panel for the period 2002-2012. The number of observations is 377 and the number of companies 4; being one of them public (TMB) and the other ones completely private. Data are provided by the public bus company (TMB) and the regulator (EMT), which provides data from the private firms. The first year after the fare integrated policy is 2002.

We choose private bus lines that connect Barcelona with nearby cities and urban lines in surrounding cities. We avoid choosing lines that run along motorways or high capacity, since the characteristics of these lines are not similar to those of the public company. We choose all TMB lines that connect Barcelona with neighbouring cities and lines within the municipality of Barcelona but far from Barcelona downtown. We exclude the nightly routes because there are many differences daily routes: price of labour, average speed, network length... On Figure 2 we represent our study area. The municipalities are represented by polygons, being the largest of them Barcelona, with a length of 9 km and a width of 8 km. The solid lines represent public bus routes and broken lines ones operated by private concessionaires. The three companies operate in three geographic areas: the northern is operated by Tusgsal, Soler i Sauret in the West and Rosanbus in the south. An important point is that the different lines overlap over time, and even there are different concession areas, they have similarities that allow us to compare it.

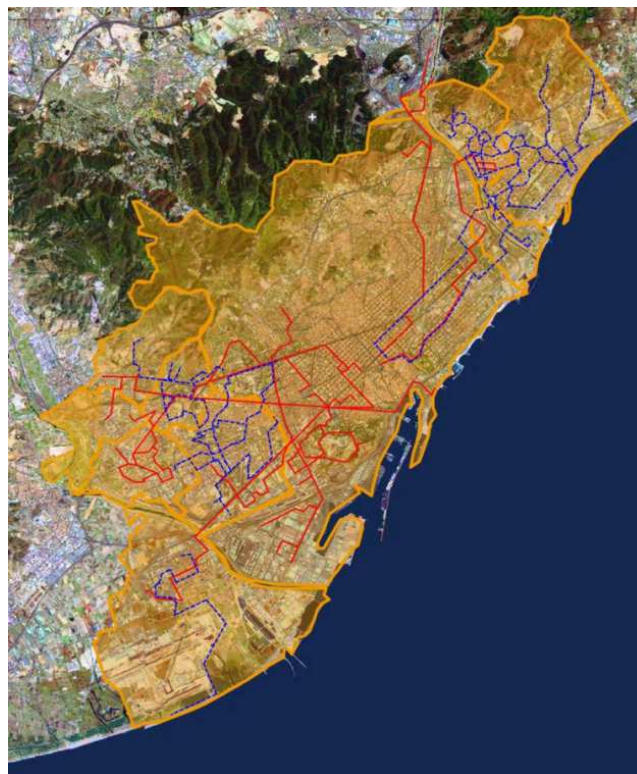


Figure 2. Public and private bus lines in our study area



Table 3 reports some summary statistics about the concessionaire firms included in the analysis. The available information includes per concession the number of analysed lines, the length line, the number of vehicles, the number of employees and the cost and revenue per net km, among others. The most important differences between concessions on the descriptive statistics are on the number of analysed lines, the passengers carried, the number of vehicles and the costs, total costs and cost per net km run. More than a half of the analysed lines are public ones, while the others are distributed between the three private companies. There is also a difference between the public and private companies on the net km, the passengers carried and the kilometres run. Due to the similarity on the length line, it is clear that TMB has a higher bus frequency than the private companies, carrying more passengers. However, some private companies use more workforce than TMB compared with the run kilometres, or TMB is more efficient than the privates. Another difference is the age of the fleet, where the public company has a rate of fleet renewal much lower than the main private operators. TMB has its own purchasing policy, while the EMT pays the private bus fleet. Another difference is that the number of employees is greater and significantly different in the public lines than in private. There are clear differences on costs: the public company is the expensive firm by line, but when we compare the total costs by net km, is not the most expensive. The transaction costs are constant each year by private line. However, these cost can represent between 3.5 and 14% of total costs.

Table 3: Mean (standard error) based on 377 bus lines observations (2002-2012)

	Concessionaires			
	TMB	Tusgsal	Rosanbus	Soler Sauret
Analysed lines	21	9.4	5.4	1.6

Length line (km)	10.454 (0.223)	8.576 (0.496)	11.396 (0.82)	10.308 (0.364)
Average speed (km/h)	12.91 (0.147)	10.72 (0.203)	12.604 (0.307)	12.58 (0.408)
Net km (km)	430,924 (13337.5)	293,336 (20762.6)	306,643 (19145.1)	123,504.7(10751.1 )
Vehicles	10.96 (0.343)	5.48 (0.399)	6.155 (0.392)	2.63 (0.176)
Passengers	1,569,978 (69639)	883,722 (61527)	1,129,646 (121391)	176,540 (20299)
Bus age (years)	6.49 (0.04)	4.47 (0.05)	5.02 (0.09)	6.23 (0.29)
Employees	32.0 (1.05)	27.02 (1.46)	16.59 (1.28)	6.25 (0.5)
Cost per net km	4.10 (0.059)	5.13 (0.116)	3.85 (0.131)	3.33 (0.183)
Revenues per net km	1.62 (0.04)	1.47 (0.06)	1.55 (0.13)	0.59 (0.04)
Total costs (€)	1,784,709 (62,653)	1,391,206 (78,470)	1,073,187 (76,330)	379,854.4 (44,492)
Transaction costs (€)	0	52217.17 (971.94)	51435.91 (1389.95)	51172.17 (2556.01)

#### 4.2. The model

A firm converts inputs into output. A bus firm uses employees as labour force, fuel and other materials to obtain energy and rolling stock as capital. The purpose is to move passengers documented, assuming total costs as a function of input and output prices. Coelli (2003) describes that when data is comparable and consistent over time, the most functional form found in the literature is a translog cost function, which essentially has cost as a function of input prices and the production level. We use an approximation of the translog cost function used by Fraquelli et al. (2004), Matas and Raymond (1998) and Ottoz et al. (2009). This flexible functional form is a second-order logarithmic approximation to any arbitrary twice-differentiable cost function. We assume that input prices and output are exogenous. We assume that the cost function is the result of cost minimization given input prices and output. Therefore, it should satisfy concavity in

input prices and monotonicity in input prices and output. The literature evidence suggests that the following cost function is specified:

$$TC_{it} = f(Y_{it}, PL_{it}, PC_{it}, PM_{it}, N_{it}, t) \quad (1)$$

Where the total cost of an urban bus firm  $TC$  is assumed to be a function of the output  $Y$ , the factor prices  $P$  (labour  $L$ , material and energy  $M$ , and capital  $C$ ), the network  $N$  and the effect of time  $t$ . As a result, the cost function equation to be estimated can be expressed in the following double log form:

$$\begin{aligned} \ln TC_{it} = & \beta_0 + \beta_Y \ln Y_{it} + \beta_N \ln N_{it} + \beta_{SP} \ln SP_{it} + \frac{1}{2} \beta_Y (\ln Y_{it})^2 + \frac{1}{2} \beta_N (\ln N_{it})^2 + \\ & \frac{1}{2} \beta_{SP} (\ln SP_{it})^2 + \beta_{YN} \ln Y_{it} \ln N_{it} + \beta_{YSP} \ln Y_{it} \ln SP_{it} + \beta_{NSP} \ln N_{it} \ln SP_{it} + \\ & \beta_{PL} \ln PL_{it} + \beta_{PC} \ln PC_{it} + \frac{1}{2} \beta_{PLPL} (\ln PL_{it})^2 + \frac{1}{2} \beta_{PCPC} (\ln PC_{it})^2 + \beta_{YPL} \ln Y_{it} \ln PL_{it} + \\ & \beta_{YPC} \ln Y_{it} \ln PC_{it} + \beta_{NPL} \ln N_{it} \ln PL_{it} + \beta_{NPC} \ln N_{it} \ln PC_{it} + \beta_{SPPL} \ln SP_{it} \ln PL_{it} + \\ & \beta_{SPPC} \ln SP_{it} \ln PC_{it} + \beta_{PLPC} \ln PL_{it} \ln PC_{it} + \beta_{YT} Tender\_year_{it} + \\ & \beta_{OW} Private_i + \beta_{CON} Concession_i + \beta_{BCN} Barcelona_i + \beta_{MET} Metro_{it} + \\ & \beta_{YEAR} Year_t + v_{it} + u_{it} \end{aligned} \quad (2)$$

$$\text{with } i = 1, 2, \dots, 42 \quad \text{and } t = 2002, 2003, \dots, 2012$$

where subscripts  $i$  and  $t$  denote the line and year respectively. We can provide estimators for two different specifications of  $u_{it}$ . It follows a truncated-normal distribution  $N^+(\mu, \sigma^2)$ . The simplest specification is when  $u_{it}$  is uncorrelated with the explanatory variables and is assumed to be constant over time. Also  $u_i \sim N^+(\mu, \sigma_u^2)$  and  $v_{it} \sim N(0, \sigma_v^2)$ . This model assumes that the line-specific stochastic term  $u_i$ . So, the inefficiency is time-invariant and the firm specific unobserved effects are due to

efficiency differences. The other specification is considering a time-variation inefficiency, described by Battese and Coelli (1995),

(3)

$$u_{it} \equiv \exp\{-\eta(t - T_i)\}u_i$$

Where  $T_i$  is the last period in the  $i$ th panel,  $\eta$  is the decay parameter,  $u_i \sim N^+(\mu, \sigma_u^2)$  and  $v_{it} \sim N(0, \sigma_v^2)$ , and  $u_{it}$  and  $v_{it}$  are distributed independently of each other and the covariates in the model. Linear homogeneity in input prices is imposed by dividing total costs and input prices by material and energy price. We decide to include the tender year to capture the impact of the contracted out process over time and ownership line's nature. On 2010, two new metro lines were opened, so we control this effect.

The actors with transaction costs are private firms and the regulator. Private companies should devote part of their time to prepare a bid for the contest as well as monitoring costs if they win the tender. The regulator must organize processes, as well as monitoring private firms. When private companies bid for the concession, they charged its transaction costs in their bid, while the regulator transaction costs is their budget. Some papers take into account the transaction costs of private firms, but never regulator transaction costs. If the regulator does not exist, and therefore private concessions, TMB would also be responsible of these functions, implying an increase in costs as of today assumed by the regulator. Thus, allocating regulator costs equally to all private companies allows us a better comparison of the bus lines.

One consequence of the chosen model is the possibility of calculating the economies of density, which are defined as the inverse of the elasticity of costs with respect to output, holding all input prices and the network size fixed:

$$ED = \frac{1}{\frac{\partial \ln C}{\partial \ln Y}} = \frac{1}{\beta_Y + \beta_{Y'} \ln Y + \beta_{YN} \ln N + \beta_{YSP} \ln SP + \beta_{YPL} \ln PL + \beta_{YPC} \ln PC}$$

If the value of ED is greater than one, the economies of density exist: a less than proportional increase in cost when the output increases while all the network characteristics and input prices remain unchanged. An unitary value means that the company is operating at the optimal output level given its network size.

#### 4.3. Model variables

The cost function includes three inputs, one output and other variables.

*TC*: The total cost is the dependent variable and include labour, fuel, maintenance, bus fleet and other indirect costs. This total cost has two variants, whether we include the totality of transaction costs or not. The transaction cost is the regulator total budget, and we charge it equally to each line.

*PL*: The price of labour is given by the ratio of total salary expenses to the total number of worked hours. Private companies do not facilitate the entire number of workers, so we use the worked hours as a price of labour instead of number of employees.

*PM*: The price of material has been obtained by dividing fuel and maintenance material costs by net kilometres.

*PC*: The price of capital is given by the ratio of vehicles cost by the number of vehicles.

*Y*: The output variable is the vehicles·kilometres, as a supply-related measure. Seat-kilometres would have been another good measure, but we do not have data for private companies. Even demand-related indicators as number of passengers or passenger-km could be more relevant and they do not ignore fully o empty buses, we choose supply-related because they vary with inputs. The three inputs and output are expected to have a positive sign.

*N*: As described by the literature, the length line is another network characteristic that influence total costs.

*SP*: Network speed represents a typical indicator that if a trip is covered by shorter time, a lesser amount of vehicles and labour force is needed. Therefore, costs are expected to lower with increasing network speed.

*Tender year*: This dummy variable takes value 1 for the year after a tender process. The new contracts come into force on January 1, even though the contest has been celebrated the previous year.

*Private*: This binary variable takes value 1 if the line is operated by a private company and 0 if it is operated by the public company TMB.

*Concession and time dummies*: These dummies group the same concession bus lines, having a total of four (TMB, Rosanbus, Tusgsal and Soler i Sauret). Moreover, the time dummies aim to collect temporal effects of each year on all lines, having a total of eleven.

*Barcelona*: This dummy variable takes value 1 if all the bus length line is inside the municipality of Barcelona, and 0 otherwise. We try to control the effect of the city of Barcelona on the cost function.

*Metro*: This dummy variable takes value 1 if the bus line is affected by the new metro line opened on 2010, and 0 otherwise.

*Year*: These dummy variables captures time effects.

## 5. RESULTS

We estimate the model by applying OLS to the equation X. For year dummies and concession dummies, we take as a reference 2002 and Soler Sauret concession, respectively. Since all variables are expressed in logarithms (except the dummies), the coefficients can be interpreted as elasticities. The original values of monetary variables

are deflated by a price index. Table 4 presents the parameter estimates of the different specification of the translog cost function not allowing time variant inefficiencies.

Table 4: Total-cost parameter estimates with time invariant inefficiency term

Significance levels: \* 10 per cent; \*\* 5 per cent; \*\*\* 1 per cent.

	(1)	(2)	(3)	(4)	(5)	(6)
$\beta_Y$	0.632***	0.460***	0.601***	0.429***	0.581***	0.394***
$\beta_N$	0.189	-0.124	0.085	-0.054	0.200	0.180
$\beta_{SP}$	-1.056**	-1.099***	-0.954**	-0.945**	-0.868**	-0.826**
$\beta_{PL}$	0.667**	0.546*	0.502	0.584*	0.410	0.497
$\beta_{PC}$	-0.471***	-0.433***	-0.448***	-0.441***	-0.435***	-0.462***
$\beta_{BCN}$			0.006	-0.025*	0.007	-0.02
$\beta_{MET}$			0.014*	0.01	0.011	0.007
Tender year			0.014	-0.003	0.017*	-0.001
Private			0.067***	0.112***		
Tusgsal					0.10***	0.149***
Rosanbus					0.064***	0.109***
Soler Sauret					0.024	0.069***
$\gamma$	0.873	0.875	0.986	0.728	0.986	0.971
Transaction Costs	No	Yes	No	Yes	No	Yes
Log likelihood	722.41	723.64	738.97	746.91	748.76	756.08
Observations	377	377	377	377	377	377

The majority of the most important variable have the correct sign and are statistically significant. Half of the specifications have been estimated with the dependent variable total cost including transaction costs while the other half without. Thus, no significant differences were found between using a dependent variable or another.

Output elasticity is between 0.632 and 0.394, implying that a 1% increase in the supplied bus vehicle-kilometers will increase total cost only by 0.632-0.394%. The network length is not statistically significant in any specification. A possible

multicollinearity problem between the output and the network length variables affects the coefficient, as Ottoz et al. (2009) find and suggest. The average speed is negative and always significant; our findings confirm that affects firms' cost performance. Speed up public policies might be desirable to be implemented by the government, because passengers (and/or taxpayers) could pay less for the bus public transportation. The labour input price is not statistically significant in all models, even for mean bus line the coefficient varies across 41 and 67% of total costs, as literature points. The price of capital coefficient is negative and highly significant. This is a controversial issue derived from the generous government programs of subsidizing investments (Levaggi, 1994). The private firms do not minimize costs in the long term and therefore employs too much capital.

The Barcelona control variable is not statistically significant on the majority of the specifications. This implies inexistences of a biased sample selection or a local effect of the Barcelona bus lines. The tender year is statistically significant and positive, or not significant. These results confirms our empirical data that tenders process do not diminish bus costs, moreover the cost increased due to the tender process can be confirmed. The metro variable is only significant on specification 4; the new metro lines imply a cost increase on several bus lines.

The private dummy and concession dummies can have a joint interpretation on the four specifications: there are not cost savings on private production compared with the public company. The public company is the cheapest one except on specification 5, which the private company Soler Sauret costs are not different than TMB.

Table 5: Total-cost parameter estimates with time invariant inefficiency term

Significance levels: \* 10 per cent; \*\* 5 per cent; \*\*\* 1 per cent.



	(7)	(8)	(9)	(10)	(11)	(12)
$\beta_Y$	0.547***	0.319***	0.561***	0.406***	0.534***	0.401***
$\beta_N$	0.191	0.42*	0.118	0.059	0.178	0.164
$\beta_{SP}$	-1.364***	-1.448***	-1.299***	-1.008***	-1.214***	-0.922***
$\beta_{PL}$	0.554*	0.858***	0.602**	0.506*	0.478*	0.486*
$\beta_{PC}$	-0.641***	-0.715***	-0.636***	-0.57***	-0.658***	-0.605***
$\beta_{BCN}$			0.005	-0.024*	0.006	-0.018
$\beta_{MET}$			0.002	0.009	-0.002	0.004
Tender year			-0.016	-0.013	-0.018	-0.015
Private			0.003	0.080***		
Tusgsal					0.045***	0.115***
Rosanbus					-0.007	0.07***
Soler Sauret					-0.018	0.051***
2003	0.023***	0.038***	0.023***	0.025***	0.024***	0.025***
2004	0.032***	0.048***	0.032***	0.032***	0.033***	0.032***
2005	0.038***	0.063***	0.038***	0.041***	0.039***	0.04***
2006	0.039***	0.061***	0.039***	0.033***	0.039***	0.032***
2007	0.014*	0.029***	0.014	0.008	0.013	0.007
2008	0.016*	0.042***	0.016	0.011*	0.017*	0.011
2009	-0.011	-0.003	-0.011	-0.018	-0.010	-0.018**
2010	0.024***	0.041***	0.024**	0.01***	0.027***	0.011
2011	0.041***	0.048***	0.044***	0.017***	0.047***	0.019*
2012	0.073***	0.069***	0.079**	0.034***	0.084***	0.038***
$\gamma$	0.848	0.879	0.907	0.666	0.987	0.965
Transaction Costs	No	Yes	No	Yes	No	Yes
Log likelihood	794.34	776.11	798.5	797.09	810.9	808.79
Observations	377	377	377	377	377	377

On Table 5 we replicate the same specifications than in Table 4 but we add time control variables. There are no such differences between the specifications in all variables. The most significant is that the average speed is highly significant and its impact is over the unit, the price of labour has gained significance and in specification 9 the private dummy has lost its significance. The time trend is positive, indicating an increase in cost, related or not to technological progress. There are three periods of time: from 2003

to 2006 and from 2010 to 2012 there is a cost increase over years, while the intermediate period 2007-2009 the coefficients are not significant. This result does not agree with the expected in development of technology regarding costs, one would expect a cost decrease due to technology advance.

Table 6: Total-cost parameter estimates with time-varying inefficiency term

Significance levels: \* 10 per cent; \*\* 5 per cent; \*\*\* 1 per cent.

	(13)	(14)	(15)	(16)	(17)	(18)
$\beta_Y$	0.619***	0.483***	0.576***	0.526***	0.596***	0.513***
$\beta_N$	0.554	-0.032	0.768**	-0.012	-0.622	0.076
$\beta_{SP}$	-0.874**	-0.962**	-0.854**	-0.821*	-0.682**	-0.718*
$\beta_{PL}$	0.701**	0.552*	0.567*	0.594**	0.505**	0.551*
$\beta_{PC}$	-0.439***	-0.425***	-0.436***	-0.447***	-0.428***	-0.459***
$\beta_{BCN}$			0.007	-0.011	0.008	-0.008
$\beta_{MET}$			0.021***	0.023***	0.017**	0.014
Tender year			0.027***	0.015	0.024**	0.008
Private			0.062***	0.112***		
Tusgsal					0.089**	0.154***
Rosanbus					0.07***	0.117***
Soler Sauret					0.039**	0.09***
$\gamma$	0.968	0.857	0.988	0.821	0.94	0.82
$\eta$	0.038*	0.013**	0.087***	0.154***	0.091***	0.162***
Transaction Costs	<i>No</i>	<i>Yes</i>	<i>No</i>	<i>Yes</i>	<i>No</i>	<i>Yes</i>
Log likelihood	723.15	726.61	749.34	763.80	751.69	766.69
Observations	377	377	377	377	377	377

If the inefficiency is time variant, a bus line specific unobserved effect is not only caused by a fixed effect, but also there is a time effect. Table 6 we estimate the same specifications than in Table 4, but we use the Battese-Coelli model (1995) for a time variant inefficiency. Comparing the estimates provided by the time invariant model in and the time-varying model shows that these are different: parameter  $\eta$  is positive and

highly significant in all specifications; so firms tend to improve their level of technical efficiency over time.

The estimated values in the time-varying model have hardly changed compared to the time invariant model. The average speed variable has less impact and is less significant. The Barcelona control variable is not significant in any specification, while the metro variable is significant in specifications 15 and 16. The tender year is positive and highly significant if we include the transaction costs, so there is empirical evidence that tender process do not diminish cost or also it can increased it. The private and concessions dummies are positive and significant; it is confirmed that all private companies are more expensive than the public one.

Table 7 presents the estimated economies of scale and density for the median bus operator for all specifications and for different concessions at the sample mean. The results show increasing returns to density for all specifications and for all concessions areas, meaning for the whole sample a less than proportional increase in cost when the output (bus-kilometers) increases while all the network characteristics remain unchanged. Reduction in costs could be achieved by increasing the density of the routes, not by increasing the size of the company. There are not clearly differences between concessions or public-private firms; even the inclusion of transaction costs implies higher values. Reduction in unit cost could be achieved by increasing the density of the routes and not by increasing the size of the concession area.

Table 7: Economies of density by specification (calculated at the sample mean)

Specification	Economies of density			
	TMB	Tusgsal	Rosanbus	Soler

	Sauret			
1	1.65 (0.294)	1.64 (0.287)	1.57 (0.307)	1.56 (0.259)
2	2.23 (0.509)	2.32 (0.537)	2.35 (0.550)	2.34 (0.561)
3	1.71 (0.255)	1.67 (0.241)	1.675 (0.244)	1.56 (0.214)
4	2.35 (0.482)	2.50 (0.550)	2.56 (0.581)	2.54 (0.583)
5	1.74 (0.258)	1.76 (0.264)	1.80 (0.28)	1.68 (0.243)
6	2.55 (0.560)	2.77 (0.667)	2.829 (0.707)	2.89 (0.751)
7	1.64 (0.244)	1.65 (0.249)	1.68 (0.255)	1.59 (0.231)
8	2.11 (0.434)	1.63 (0.252)	2.22 (0.488)	2.25 (0.510)
9	1.76 (0.247)	1.78 (0.253)	1.82 (0.277)	1.71 (0.235)
10	1.89 (0.292)	2.02 (0.335)	2.03 (0.341)	1.65 (0.221)
11	1.69 (0.229)	1.72 (0.236)	1.76 (0.248)	1.65 (0.220)
12	1.94 (0.310)	2.09 (0.374)	2.10 (0.370)	2.14 (0.389)
13	1.87 (0.264)	1.84 (0.256)	1.85 (0.261)	1.75 (0.234)
14	3.21 (0.900)	3.50 (1.116)	3.57 (1.184)	3.88 (1.550)
15	1.80 (0.261)	1.82 (0.267)	1.87 (0.281)	1.75 (0.247)
16	2.40 (0.06)	2.55 (0.07)	2.58 (0.08)	2.66 (0.09)
17	1.89 (0.264)	1.91 (0.268)	1.95 (0.284)	1.85 (0.254)
18	2.49 (0.460)	2.69 (0.549)	2.72 (0.567)	2.86 (0.638)

Throughout all empirical specifications it is repeated a set of results in our jurisdictional area. First, private bus lines are more expensive than public ones, whether we include all transaction costs or not in most specifications. In the specifications that we do not

include all transaction costs, we consider only the transaction costs of private firms, while the costs of the regulator, also paid by citizens, are not taken into account. In the specifications that we do not consider all transaction costs, private companies should devote also part of their time negotiating with the regulator, being these costs internalized, explaining perhaps why the majority of private lines are almost more expensive than public ones. The ambiguous result of the literature on private property achieving lower costs would be clarified when we include all transaction costs, increasing private costs and being public provision cheaper. This increase reflects the cost paid by the citizens to maintain the regulator, and allows a better comparison of the cost paid by the citizen between a type of property or another. This result is not only the first to compare costs of public and private companies in a scheme of mixed service, but emphasizes that the public company can provide the service cheaper than a private firm in a jurisdiction.

Second, we have no empirical evidence that competition achieved lower costs. Or the contests do not involve changes in the costs or they increase it. Low market competition implies that competition does not get to order the private incumbent, implying higher costs over time. This low market competition is not linked to the number of bidders in our case, but not aggressive price bidding is described on the tender process section. The incumbent knows that does not need to make the most competitive offer, as the price does not exceed 35% of the total score of the contest, and the regulator maintains some discretion power. This relationship does not have to be a regulatory capture, but a situation in which the transaction costs for the regulator with the incumbent are lower than if an entrant would remain the market. Our study would be providing data to Albalade et al. (2011), which concluded that the EMT is using his bargaining power to complement a formal and relational contracting. This might not be an isolated case in

the city of Barcelona, but these behaviors may be appearing in places where competitive tendering has been gaining ground (Yvrande-Billon, 2006) and also where the regulator has gained enough experience.

## 6. CONCLUSIONS

In order to study the impact of a mixed delivery scheme under the presence of transaction cost, the aim of this article is to evaluate the role of ownership, competition and transaction cost on local public services' total costs. Based on the Barcelona metropolitan bus transportation, we estimated a translog stochastic cost frontier to shed light on the mixed delivery scheme on local services.

The main results can be summarized as follows. First of all, the public firm performs better than private operators selected through competitive tendering. The public company can provide the service cheaper than the private companies; even we do not take into account transaction costs that affect directly the private firms. We cannot check if the poor performance of private operators affects TMB's performance or not. But the inclusion of the totality of transaction costs implies that all forms of private production become more expensive than public production. This result would come up if both the other studies of comparisons of public and private property in local services, particularly in urban transport are not biased towards lower costs of private firms. Secondly, we find that operating under a tender process does not imply cost savings, not only because private operators are more expensive than public lines, but also because the tender process increases or does not affect the total costs. One possible explanation is the existence of relational contracting due to incomplete or complex contracts. Another explanation is the preference to establish "familiar" contractors because the

EMT needs to change constantly the contract for adapting the contract to its needs. This thesis would be supported by the Catalan external audit recommendations.

The first policy recommendation to the regulator is to allow TMB to bid on the future concession tenders. The public company is in a good position to make competitive offers and can discipline the private companies, not only offering a competitive price but also by its area knowledge. The loss of government in-house experience is an irreplaceable cost when relational contracting exists, but this is not Barcelona case. The public company would undergo a threat of privatization that may well encourage performance improvements to the public managers and employees of TMB. The second policy recommendation is to separate the regulator and the public company. Even the technical structure is separated and both pursue benevolent goals for society, the EMT has a fully participation on TMB and the incentives that the regulator and the public company have are different. The third recommendation is to incorporate an external company to reduce the regulator dependence to only few local bus groups. TMB participation in contests processes can alleviate the present situation, but not solve it. And lastly, the regulator must achieve neutrality between private tenderers, and also between future public-private tenderers to achieve real and effective competition for the market.

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