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WHAT SHAPES LOCAL PUBLIC TRANSPORTATION IN EUROPE? ECONOMICS, MOBILITY, INSTITUTIONS, AND GEOGRAPHY

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Abstract

This paper analyzes the factors that explain supply and demand of local public transportation. Together with variables related to economics and mobility, we consider variables reflecting institutional characteristics and geographical patterns. Being a political capital increases supply and demand of local public transportation, inequality is associated with higher supply, and contracting out reduces supply. Furthermore, our regional analysis allows us capturing the effect of geographical characteristics and different traditions of government intervention. In all, we provide first evidence on the role played by institutional and regional characteristics useful to achieve a better understanding of local public transportation supply and demand.

Keywords

Urban transportation, Local government, Mobility, Institutions and Geography

Introduction*

Mobility is becoming increasingly essential in large cities as a consequence of its impact on social, economic and geographic development. In fact, transportation potentially affects the nature of the urban area itself (Small, 1997), and for this reason the literature on the relationship between travel behavior and urban form has grown at a fast pace during recent decades (Rodríguez, Targa and Aytur, 2006).[1]

Indeed, citizens in developed economies understand mobility as a right, especially in large cities where congestion and pollution make private transportation more inconvenient and expensive. In such urban environments, transport effectiveness and efficiency not only affect local and regional productivity rates, they also have an impact on citizens' quality of life.

The aim of this paper is to identify those factors explaining local public transportation of large European cities from both the supply and demand sides. In this effort, we characterize aggregate supply and demand equations, which are separately (OLS) and jointly estimated (SUR), and we test the impact of well-known determinants by the transportation literature, as well as new explanatory variables that suggest interesting relationships between urban transport development, institutions and regional heterogeneity within Europe.

The contributions of the present paper are twofold. The first one relies on the fact that, to our knowledge, this is the first study attempting to explain urban transportation – both supply and demand - by using an international sample of large cities.[2] Taking into account supply and demand together, and enjoying a world-wide database of large cities, produces results of interest to both scholars and policy makers. The second contribution is the analysis of institutional and geographical factors as determinants of transport supply and demand, which have also been largely neglected by previous transportation and geographic literature, and which might play an important role on local public transportation determination. Therefore, this paper tries to further connect institutional and geographic fields to transportation at a local level.

As expected, our results confirm that socioeconomic variables and factors related to the generalized cost of transportation play the most important role on local public transportation. However, we also find interesting significant and insignificant relationships between Supply/Demand and institutional variables such as being a political capital, having an elected or appointed mayor, the choice between in house and contracting out production to private firms, among others. Also, we show the existence of regional heterogeneity behind the design of urban public transportation supply that seems to have a significant explanatory power. Some of these results highlight the lower use of public transport in southern countries and the relatively higher provision of public transport in eastern cities as heritage of their communist past.

The rest of the study is organized as follows. The next section is a brief review of the related literature on urban public transportation. Section 3 describes the empirical strategy pursued to determine transport supply and demand equations. Here we offer detailed information on the data and variables used, and the methodology applied. The fourth section presents the main results, and the last

* We are thankful for financial support from the Spanish Commission of Science and Technology (SEJ2006-04985). We have benefited from comments by Xavier Fageda and Anne Yvrande-Billon.

1 Some relevant works are Sasaki (1990), Banister (1995), Banister, Watson and Wood (1997), Giuliano and Narayan (2003).

2 Gordon and Willson (1984) also used an international data set (data for 1978) of metropolitan cities but they only focused on light rail transport and estimated a semilog model of its demand (ridership per Km of lane) with only four exogenous variables. Moreover, they did not carry any analysis on supply determinants.

section (Section 5) concludes with some final remarks on our findings and its main contribution to the literature.

2. Related literature

The literature on public transport demand and supply enjoys a long tradition in the field of transport economics. Nonetheless, given the local dimension of the service, most studies have considered only single metropolitan areas, regions or countries for their analysis. As a consequence, few studies use international samples, and within this group, most studies are constructed as meta-analyses derived from different national or local studies.

Price and time elasticities, modal choice and externalities internalization have been the leading topics in the recent literature on urban public transport demand. The work by Dargay and Hanly (2002) uses data on English counties to estimate a dynamic relationship between per capita bus patronage and bus fares. Their work distinguishes between the short and long-term impact of fare changes on bus patronage--as do most studies on this issue--and provides an indication of the time required for the total response to occur.

Matas (2004) also estimates an aggregate demand function for bus and underground trips in the metropolitan area of Madrid, Spain in order to obtain the demand elasticities of the main attributes of public transport services. The study’s second objective is to evaluate the impact on revenue of the introduction of the travel card scheme by estimating a matrix of own and cross-price elasticities for different ticket types. For the same metropolitan area we have the recent study by García-Ferrer et al. (2006), which studies the incidence of alternative types of public transport modes.

Hensher (1998) also distinguishes between fare classes across train and bus modes of public transportation and the car for commuting travel in the Sydney, Australia metropolitan area, while Marchese (2006) uses her theoretical model to show that integrated tariffs can be used to extract the consumer's surplus if there are a lot of connections supplied.

The meta-analyses by Nijkamp and Pepping (1998), Kremers et al. (2002) and by Holmgren (2007) review the wide variation in demand elasticities found in the literature. The first focuses on price elasticity, while the latter also considers other elements. In fact, it sheds light on the importance of including car ownership, own price, income and some measures of service in demand models. Moreover, it supports the position that explanatory variables should be in per capita terms if population is not included in the model.

Close to these studies but more focused on the determinants of demand of public transport, we find Paulley et al. (2006), which concentrates on the influence of fares in the UK, though it also studies the roles played by quality of service, income and car ownership. Related to this last element, Bresson et al. (2004) present a panel data analysis for French urban areas, finding a clear downward trend in public transport patronage that is mainly due to increasing car ownership. In addition, the use of public transport appears to be quite sensitive to the volume supplied and its price, which makes the financial equilibrium of this industry problematic.

Regarding mode choice we can mention the recent study by Sungyop and Ulfarsson (2008), which analyzes transportation mode choice for short home-based trips using a survey from a part of Washington State, or the paper by Asensio (2002), which reveals elasticities for commuters using different modes in Barcelona, Spain.

Finally, a large group of recent theoretical and empirical studies have worked on pricing schemes to internalize the external costs of transport by linking subsidies, price of public transport and road charges. De Borger et al. (1996) develop a simple theoretical model that determines optimal prices for private and public urban transport services, taking into account all relevant private and external costs.

Similar works with relevant extensions can be found in De Borger, Kerstens and Costa (2002), Pedersen (2003), Small (2004), and Parry and Small (2007), among others.

On the supply side we find that technical efficiency and determinants of production cost structure have been the main foci of study. Less common are works on the determinants of transport supply systems. To this extent, Brueckner and Selod (2006) recently advanced the construction of a political economy model where public transport system (supply) is endogenously determined. Nonetheless, no empirical strategy is used to test their hypothesis. De Borger and Wouters (1998) also simulate a model on supply decisions based on the influence of prices and traffic flows in Belgium, but further research on these determinants is needed. Others like Fernández, Cea and de Grange (2005) and Fernández, de Cea and Malbran (2008) have also recently made efforts to link demand responsiveness to supply design.

On the other hand, we find many relevant works on cost structure and technical efficiency. The work of Farsi, Fetz and Filippini (2007), analyzes the cost structure of the Swiss urban public transport sector in order to assess scale and scope economies. The significant economies of scope estimated favor integrated multi-mode operations as opposed to unbundling. On the other side, van Reeven (2008) shows that scale economies do not provide a justification for general subsidization of urban public transport. The same result was already found in Matas and Raymond (1998) for the Spanish case.

Furthermore, Roy and Yvrande-Billon (2006) use data on French municipalities to estimate a stochastic frontier model that corroborates that technical efficiency of urban public transport operators depends on their ownership regime and the type of contract governing their transactions.

This brief presentation of the main groupings of work in the field of urban transportation systems highlights the relevance of the analysis we propose. This study is embedded within the literature on the determinants of urban public transport demand and supply. Our first contribution is being the first study that uses a rich international sample of large European cities (with detailed information on the local basis) in order to estimate separately and simultaneously both aggregate demand and supply equations. This is especially relevant since past literature has been analyzed these equations separately, focused on one or two modes of public transport, and treated single region samples.

More importantly, our second contribution to the literature is that we explore for the first time the relevance of different institutional or regional frameworks that seem to play an important role in the determination of public transport demand and supply across the continent. This opening up of regional heterogeneity and institutional variability in urban transportation organization is possible thanks to the international nature of our sample, and provides promising results that can stimulate future research on the role of institutions and regional heterogeneity in the formation of supply and demand.

3. Empirical Strategy

In this section we describe the data and the model we have used to explain the demand and supply sides of local public transportation in European cities.

3.1 Data

Most data used in this research are obtained from the Mobility in Cities Database (MCD) provided by the International Association of Public Transport (UITP). This database offers 120 indicators of public transport (not, unfortunately, including ownership data) from 52 worldwide cities in 2001, almost all in Europe. In order to improve the homogeneity of the sample and to be able to carry out our extension regarding institutional and regional factors, we focus particularly on the data from the 45 European cities, although we take advantage as well of the available data for the remaining cities.[3] Institutional data have been collected from different sources as we indicate when describing each of these variables.

Table 1 reports the cities and some of their socio-demographic characteristics in order to illustrate the variability of our sample. Table 2 classifies these cities by region to show that our sample uses cities of sufficient regional variety to capture a wide range of social and economic attributes and heterogeneous institutional frameworks, thus avoiding results led by certain types of cities. In spite of this, we must acknowledge that the weights of Mediterranean and Center-European metropolitan areas are slightly higher than the rest of regional groups (Nordic, Atlantic and Eastern).

Table 1. European cities in the database and socio-demographic characteristics

Metropolitan Area	Population	GDP	Urban Pop. Density
Amsterdam	850 000	34 100	57.3
Athens	3 900 000	11 600	65.7
Barcelona	4 390 000	17 100	74.7
Berlin	3 390 000	20 300	54.7
Bern	293 000	35 500	41.9
Bilbao	1 120 000	20 500	51.9
Bologna	434 000	31 200	51.6
Brussels	964 000	23 900	73.6
Budapest	1 760 000	9 840	46.3
Clermont-Ferrand	264 000	24 200	44.5
Copenhagen	1 810 000	34 100	23.5
Dublin	1 120 000	35 600	25.9
Geneva	420 000	37 900	49.2
Gent	226 000	26 700	45.5
Glasgow	2 100 000	20 600	29.5
Graz	226 000	29 600	31
Hamburg	2 370 000	38 800	33.9
Helsinki	969 000	36 500	44
Krakow	759 000	7 010	58.4
Lille	1 100 000	21 800	55
Lisbon	2 680 000	17 100	27.9
London	7 170 000	36 400	54.9
Lyons	1 180 000	27 100	40
Madrid	5 420 000	20 000	55.7
Manchester	2 510 000	22 400	40.4
Marseilles	800 000	22 700	58.8
Milan	2 420 000	30 200	71.7
Moscow	11 400 000	6,060	161

[3] Thus, seven cities receive minor consideration in our analysis: Chicago, Sao Paulo, Tunis, Dubai, Hong Kong, Singapore, and Melbourne. These cities belong to very diverse World regions: North America, South America, North Africa, West Asia, East Asia, and Oceania). Considering these cities would introduce severe heterogeneity in the sample we use, and would prevent us from undertaking the regional analysis, which is one of the main contributions in this paper. More importantly, the database lacks information on some relevant variables used in our model to test explanatory determinants of supply and demand. Later we come back to this issue.

Munich	1 250 000	45 800	52.2
Nantes	555 000	25 200	34.7
Newcastle	1 080 000	18 400	42.5
Oslo	981 000	42 900	26.1
Paris	11 100 000	37 200	40.5
Prague	1 160 000	15 100	44
Rome	2 810 000	26 600	62.6
Rotterdam	1 180 000	28 000	41.4
Seville	1 120 000	11 000	51.1
Stockholm	1 840 000	32 700	18.1
Stuttgart	2 380 000	32 300	35.3
Tallinn	399 000	6,880	41.9
Turin	1 470 000	26 700	46.1
Valencia	1 570 000	14 300	50.2
Vienna	1 550 000	34 300	66.9
Warsaw	1 690 000	13 200	51.5
Zürich	809 000	41 600	44.5

Source: Mobility in Cities Database (UITP

Table 2. European cities in the database by region.

Southern	Center-Europe	Northern	Eastern
Athens	Amsterdam	Dublin	Budapest
Barcelona	Berlin	Copenhagen	Krakow
Bilbao	Bern	Glasgow	Moscow
Bologna	Brussels	Helsinki	Prague
Clermont-Ferrand	Geneva	London	Tallin
Lisbon	Gent	Manchester	Warsaw
Lyons	Graz	Newcastle	
Madrid	Hamburg	Oslo	
Marseilles	Lille	Stockholm	
Milan	Munich		
Nantes	Paris		
Rome	Rotterdam		
Seville	Stuttgart		
Turin	Vienna		
Valencia	Zürich		

3.2 The Basic Model

In this study we attempt to estimate both aggregate supply and demand equations for local public transport for our 45 European cities. On one hand, our basic supply equation can be considered as a production function of urban transport expressed in the following form:

$$Supply = f\,(income,\ operational\_costs,\ city\_characteristics) \qquad \textbf{(1)}$$

Therefore, supply for local public transport is supposed to rely on the recovery rate of the service by the producer (income over costs) and other city characteristics like economic wealth or density.[4]

[4] The labor factor can be considered to be included in the operational costs variable. City characteristics could have a significant impact on supply given the needs of citizens, or due to their impact on efficiency and equity.

On the other hand, the aggregate demand for public transport services can be assumed to depend on the attributes of the service affecting the generalized cost of transport (monetary cost, time cost,….), but also on the properties of the alternative modes and city characteristics as well. For this reason our demand equation considers all these factors by assuming they can be expressed as an extension of the generalized transport cost equation, which can be assumed to follow the next form:

$$Demand = h\ (price,\ time,\ city\_characteristics) \qquad \textbf{(2)}$$

In this case demand is affected by the price of the service for the user, the time spent in the journey (walking time, waiting time, in-vehicle time, as well as the time spent in the alternative mode) and city characteristics. For this reason we will consider not only urban public transport variables, but also variables describing private transport and city characteristics that can capture these time dimensions.

As a result, the basic equation system to be estimated – still without considering institutional and regional variables - in order to explain local public transport supply and demand for these 45 European cities can be expressed in the following double log form:

$$Supply_i = \ln(\frac{place-km}{population})_i = \alpha + \beta_1 \ln(GDP_i) + \beta_2 \ln(DENS_i) + \beta_3 \ln(PRICE_i) + \beta_4 \ln(OCOST_i) + \varepsilon_1 \qquad (3)$$

$$Demand_i = \ln(\frac{passenger-km}{Population}) = \delta + \lambda_1 \ln(GDP_i) + \lambda_2 \ln(DENS_i) + \lambda_3 \ln(PRICE_i) + \lambda_4 (FLEET_i) + \lambda_5 \ln(PUBSPEED_i) + \lambda_6 \ln(PRIVATE\_TIME_i) + \lambda_7 \ln(MOTOR_i) + \lambda_8 \ln(PARKING_i) + \varepsilon_2 \qquad (4)$$

where the first equation (3) refers to the supply equation and the second (4) to the demand equation. The sub-index i makes reference to each city.

3.3 The Functional form choice

The double-log specification facilitates the interpretation of the estimated coefficients in terms of elasticities and has been selected after considering the results of the Box Cox test for functional form choice.[5] In order to choose the appropriate functional form, comparisons of the estimated Box Cox regressions were made by using log likelihood ratio tests. As a result of the hypothesis tests that are displayed in table 3, we expect better performance of double log specification given that we reject the hypothesis of lambda (λ) being equal to 1, which means that transformation is needed to the linear model. On the contrary, the assumption of lambda (λ) and theta (θ) being equal to 0, what implies a log-linear functional form, is not rejected by the Box Cox test. This result is valid for both supply and demand equations.

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[5] The Box Cox transformation is used in many empirical works since it appeared in Box and Cox (1964). Formally, the transformation is presented as $g^{(\lambda)}(x) = (x^{\lambda}-1)/\lambda$. This implies that when $\lambda = 1$ it is a linear model, while when $\lambda = 0$ we have a log-lineal model (Greene, 2000). Estimation is by maximum likelihood, assuming a normal error. LR tests are usually employed to test if the variables should appear in linear or log form (Kennedy, 2003). For a deeper overview on this and other methods of testing functional forms see MacKinnon, White and Davidson (1983).

Table 3. Hypothesis test´s results for determining the appropriate functional form

Model	Null Hypothesis	Statistic	Conclusion on null hypothesis
Supply			
Linear	Ho: λ=θ=1	5.11**	**Reject**
Double log	Ho: λ=θ=0	0.80	**Accept**
Demand			
Linear	Ho: λ=θ=1	12.11***	**Reject**
Double log	Ho: λ=θ=0	1.21	**Accept**

Note 1. Significance at 1% (***), 5% (**) and 10% (*).

In any case, we provide estimates based on linear functional forms in the appendix (A2) to show that this assumption is not critical for the purpose of our study because almost all our results remain unchanged.

3.4 Basic model variables

The dependent variables are, respectively, the number of place-km per capita in the case of the supply equation, and the number of passenger-km per capita for the demand equation.

Several variables enter as covariates in supply and demand equations in order to explain local public transportation. The variables and their expected relationships with the dependent variables are described below.

Background variables

GDP: Gross domestic product per capita. This variable captures income and economic wealth. Richer cities can provide better and more extensive local public transportation. At the same time mobility is positively correlated with the economic activity and for this reason we expect to confirm positive impacts on both demand and supply equations due to the introduction of this variable.[6]

DENS: Urban population density. This variable captures city characteristics and urban form. It is well known and widely recognized that mobility and mode choice is affected by city form (Nijkamp and Rienstra, 1996). Cameron, Kenworthy and Lyons (2003) stress that private motorized mobility, for instance, although arising from local decisions, is determined by the structure of the urban environment. In general, dense cities are associated with a high use of public transport (Newman and Kenworthy, 1989). Therefore, the choice between public and private transport systems is influenced by urban form. For this reason dense cities are expected to have large transport systems since supply becomes profitable (or less expensive) by taking advantage of scale and density economies. In addition, density is expected to explain both transport demand and supply. In the case of demand it is worth pointing out that the expected positive correlation that exists between dense cities and short distances to public transport stations implies a negative correlation between dense cities and walking time, which is one of the temporal dimensions of the generalized cost of travel.

PRICE: Average price charged to urban transport users. Prices are usually regulated by public authorities and are rarely driven by market (demand) forces. Price is usually considered a political issue, and for this reason we do not suffer from endogeneity problems in the supply equation by its presence. This rigidity makes us expect no influence of prices on transport supply because public

[6] It is important to highlight that the database "Mobility in Cities" does not contain information related to personal income in these cities, which is a variable usually introduced in this kind of transport models.

transport in Europe is highly subsidized and regulated. Indeed, the average subsidy in Europe is 48% according to UITP (2005) estimates. On the other hand, prices always affect individual demand decisions, and for this reason we will expect strong impacts on transport aggregate demand.

OCOST: Average operating cost of one public transport place-km. This variable reflects the operating cost of providing each place-km. For this reason we expect a negative relationship between the operational cost and transport supply. The more expensive the place –km is, the lower the number of place-km offered by public authorities.

FLEET: The fleet of vehicles available for public transport purposes. Within this category we include the number of buses, metro wagons, and trams.[7] Having more public vehicles implies better service in the sense that the number of vehicles is associated with frequency, which captures a temporal dimension "out of vehicle" (waiting time) resulting in the service being more convenient and of higher quality. Given this rationale, we expect higher transport demand in cities providing more vehicles. In fact, this is a supply variable and it is usually assumed that there is an indirect effect from supply to demand.[8]

PUBSPEED: Average speed of public transport vehicles in operation. Speed is associated with service quality and is correlated to "in vehicle" time. Since this is extremely related to time savings, it becomes an essential factor of the generalized costs of transport equation. A consequence, we expect positive relationships between speed and transport demand.[9]

PRIVATE_TIME: Average time spent by private vehicle trip. Time spent in private transport has an increasing impact on demand for public transport since private transport is negatively related to public transport demand as a substitute commodity. Therefore, it is a relevant factor of the generalized transport cost equation for the traveler since it captures the opportunity cost--in terms of time--of choosing public transport. As private journey duration grows, public transport, at a reasonable speed, becomes relatively more convenient for the traveler.

MOTOR: Motorization constructed as the number of private vehicles per thousand population. More private vehicles tend to lower incentives to use public transport. For this reason we expect negative relationships between car ownership and public transport demand.[10] However, there is an important caveat. This figure reflects the motorization of the metropolitan area, but private transport from outside the limits of the metropolitan area is to be expected. For this reason our variable cannot capture the whole participation of private vehicles in the metropolitan area, but it does represent an important share.

PARKING: The number of parking spaces per thousand jobs in the Central Business District. This indicator offers information on private transport convenience for the traveler needing mobility to work. Parking space is an essential factor in private transport choice. As a result, we expect negative

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7 Some potential problems could emerge from aggregating different types of public transport. For instance, Farsi, Fetz and Filippini (2007) analyze the existence of scale and scope economies for a sample of 16 multimodal transport firms (tram, trolleys and motor buses) in Switzerland and find evidence of important scope economies. Given that the cities in our sample differ regarding the combination of types of public transport provided, different cost structures could be at work. Being this said, we believe this does not significantly undermine our analysis.

8 As pointed out by a referee, somehow demand is expected to affect supply design as well. Nonetheless, entering demand as covariate would generate endogeneity and multicollineality problems and would partially prevent us to test the simple relationship between supply and the demand-enhancing variables already introduced.

9 One can argue that speed also affects transport supply since it decreases operational costs. However, we already introduce the operational cost in the supply equation.

10 Low supply of public transport could increase the need of having private vehicles to travel. In this sense, motorization would be affected by public transport supply. The inverse relationship is not so clear. For this reason we avoid the use of motorization in the supply equation. In fact, even when we introduce this variable our results do not change and motorization itself is not statistically significant at all.

impacts on demand for public transport as parking spaces increase. Button (2006) recognizes the importance of this necessary supply, since he suggests that automobiles spend over 95% of their time ‘parked’, and trucks over 85%.

3.5 Institutional variables

One of the aims and contributions of this paper is to study the effect of institutional factors and the role of geography (regional heterogeneity) in supply and demand determination. For this reason we extent the basic model by adding several institutional variables to test their impact on local public transportation. Next we describe the variables introduced and the expected relationships.

Institutional variables

Dcapital: A dummy variable taking value one if the city is a political capital and zero otherwise. By using this variable we are interested in possible biases derived from politics on supply and from administrative services as well as from other specific characteristics of political capitals on demand. If this view is right, then we would expect positive impacts on the number of passenger-Km per capita due to services provided in political capitals. If this variable is also positively correlated to supply (places-Km per inhabitant) then we would find higher supply where political powers are hosted, although we should also consider the indirect effect of demand on supply.

ELECTED_MAYOR: Similarly, with this variable we capture the political restrictions of those in charge of the design of public transportation. Whether the mayor is appointed or elected might affect the need of policy makers to win elections. To this regard, elected mayors might have higher incentives to seek political objectives by promoting more and better transport supply to voters. This is a usual assumption in a political economy framework, especially for national policy formation, but this is not commonly tested at local level. Data to construct this binary variable, which identifies with value 1 when the mayor is elected and 0 when appointed, is obtained the Database of Political Institutions by the World Bank, as well as from own consultation and collection of political institutions and electoral systems.

CONTRACTING: This binary variable identifies with value 1 those cities that by 2001 had either totally or significantly contracted out the bus public transportation service and 0 otherwise. The aim of introducing this institutional factor (or regulatory type) is to capture the effect of privatization compared to the production in house of the service. We introduce this variable both in the supply and demand equations since contracting might also have impacts on the demand if contracting implies differences in quality (as hypothesized in Hart, Shleifer and Vishny, 1997). In fact, according to Public Choice views, contracting out could be associated with a lower supply of transportation, since privatization and competition for the contracts would reduce incentives for oversupply existing under public management, as hypothesized since the seminal work by Niskanen (1971).[11] We test this hypothesis with the addition of this variable as a covariate in the supply equation.

We have used several sources to construct this variable, from academic works - as van de Velde (2001, 2005, 2007), Preston and van de Velde (2002), Donchenko, Kunin and Kazmin (2003), Gleijm (2003), Cambini and Filippini (2003), Ojala, Naula and Queiroz (2004), and Farsi, Fetz and Filippini (2007) - to direct contact to local public transportation entities from the cities in the sample, such as Helsinki, Nantes, and Clermont-Ferrand.

GINI: With this variable we are interested in finding whether personal income inequality can lead to higher public transport supply on one hand and less private transport use (Demand) on the other. This variable is the gini index at the national level and we collected its value for each country from Eurostat.

[11] See Boyne (1998) for a wider explanation linking public choice and the delivery of local public services.

DECENTR: This last institutional variable reflects the degree of political decentralization. We think it is interesting to check whether higher empowerment of sub-national governments, resulting in enhanced fiscal capabilities, might positively affect the supply of local public transport. Decentr takes value 1 when there is some degree of decentralization (regional institutions having authority over taxing, spending or legislating), and 0 otherwise. Data on this variable are obtained from the Database of Political Institutions by the World Bank.

Our small sample sets limits to our ability to extent the model by adding many institutional variables. In fact, we are aware that it is not possible to capture all relevant institutional determinants. Our attempts to characterize local public transportation by means of regional variables also try to better identify the institutional factors behind the choice of local public transport supply and its implications on demand.

3.6 Geographical variables

As stated, this work tries to test the impact of regional variables on the determination of public transportation supply and demand. On our view, regional factors capture geographical characteristics, behavior and mobility patterns, different traditions of government intervention in the economy, as well as other institutional factors not singled out previously. Next we describe the variables used to test the impact of regional factors on transportation supply and demand.

Regional variables

DSOUTH: A binary variable identifying cities close to the Mediterranean Sea with value 1, and 0 otherwise. This variable includes cities from Greece, Italy, Portugal, Spain, and Southern France.

DNORTH: A binary variable identifying cities from the north of the continent (Nordic and Atlantic cities) with value 1 and 0 otherwise. In this category we find cities from Denmark, Finland, Ireland, Norway, Sweden, and the United Kingdom.

DEAST: A binary variable identifying cities from the east of the continent (former Communist countries) with value 1, and 0 otherwise. The variable includes cities from Czech Republic, Estonia, Hungary, Poland, and the Russian Federation.

These dummy variables will be compared to the reference region that is the group of Center-European cities, which includes Austria, Belgium, Germany, the Netherlands, Northern France, and Switzerland. Therefore, the interpretation of the impact of the coefficients associated with these binary variables must take into account this reference group.

Besides these dummy variables we also treated regional determinants by introducing two continuous geographical variables as longitude and latitude instead of the binary regional variables to better identify regional effects in a more flexible form. To construct these variables we used the geographical coordinates of each city.

The summary of definitions, descriptive statistics and expected signs associated with all variables defined in these sections, are displayed in table 4. A correlation matrix is also available in the appendix (A3)

Table 4. Independent variables. Definition, descriptive statistics and expected relationship with dependent variable.

Regressors	Definition	Mean	Std. Dev.	Max.	Min.	Impact Supply	Impact Demand
Transportation variables							
GDP	Gross Domestic Product per inhabitant (Euro)	25 577	10 361	45 800	6,060	+	+
DENS	Urban population density	49.29	21.59	161.0	18.1	+	+
PRICE	Average cost of one public transport passenger-km for the traveler (0.01 Euro)	9.32	5.00	23	0.6	+/-	-
OCOST	Average operating cost of one public transport place-km (0.01 Euro)	3.42	1.55	8.06	0.48	-	
PUBSPEED	Average speed of public transport vehicles in operation (Km/h)	27.54	1.11	41.8	14.1		+
PRIVATE_TIME	Average duration of a private motorized trip (minutes)	21.76	0.72	32	14		+
PARKING	Number of parking spaces per thousand jobs in the Central Business District.	222.77	28.00	778	30		-
MOTOR	Private passenger cars per thousand inhabitants	468	119	770	193		-
Institutional variables							
$D^{capital}$	Binary variable taking value 1 if the city is a political capital and 0 otherwise.	0.48	0.07	1	0	+/-	+
$D^{CONTRACTING}$	Binary variable taking value 1 if the service is contracted out and 0 otherwise.	0.30	0.07	1	0	-	+/-
$D^{ELECTED\_MAYOR}$	Binary variable taking value 1 if the city Mayor is elected and 0 otherwise.	0.69	0.06	1	0	+	
$D^{DECENTR}$	Binary variable taking value 1 if there is some degree of political decentralization in the country and 0 otherwise	0.70	0.07	1	0	+/-	
GINI	Gini index for income inequality	29.50	0.64	41.3	22	+	+
Institutional variables							
D^{SOUTH}	Binary variable taking value 1 if the city is Mediterranean, and 0 otherwise	0.36	0.07	1	0	-	-
D^{NORTH}	Binary variable taking value 1 if the city is Nordic or Atlantic and 0 otherwise	0.21	0.06	1	0	+/-	+/-
D^{EAST}	Binary variable taking value 1 if the city is an Eastern city and 0 otherwise	0.11	0.05	1	0	+	
LATIT	Geographical latitude	48.38	090	60	37	+/-	+/-
LONGIT	Geographical longitude	7.56	1.43	-9	37	+/-	+/-

4. Estimation and Results

We first estimate our equation system using the Heteroskedasticity-Robust Ordinary Least Squares estimator (OLS) for each equation separately. Afterwards we implement a SUR model (Seemingly Unrelated Regression, also called joint generalized least squares or Zellner estimation), which jointly estimates the equation system allowing for correlation between error terms through equations.[12] This last strategy is used when it is unrealistic to expect that in a set of equations, errors would be uncorrelated. This is in turn a more efficient estimator than OLS. Indeed, substantial efficiency gains are expected while contemporaneous disturbances in different equations are highly correlated.[13] The SUR method uses the correlations among the errors in different equations to improve the regression estimates, but requires an initial OLS regression to compute residuals. The OLS residuals are used to estimate the cross-equation covariance matrix. Indeed, it is very likely that some factors not included in the equation may affect both urban supply and demand.

Table 5 displays our results for separate and joint estimations. Overall explanatory power is high for every method of estimation, especially for demand equations. As results show, the goodness of fit of the models is satisfactory for each separate equation and for the joint estimation as well. Moreover, no substantial differences are found between OLS and SUR estimates, which imply that OLS was already highly efficient in our case.

Table 5. Least-squares estimates and Seemingly unrelated regression results for the basic model (45 European cities)

Regressors	OLS		SUR	
	Supply	Demand	Supply	Demand
GDP	1.069 (5.08)***	0.7202 (3.05)***	1.159 (4.80)***	0.7852 (3.85*)**
DENS	0.0856 (0.50)	-0.1172 (-0.83)	0.0606 (0.30)	-0.1133 (-0.79)
PRICE	-0.2246 (-1.64)	-0.6279 (-6.68)***	-0.2371 (-1.54)	-0.7021 (-6.55)***
OCOST	-0.7789 (-3.88)***	-	-0.8373 (-4.00)***	-
FLEET	-	0.5454 (3.60)***	-	0.3724 (3.11)***
PUBSPEED	-	0.5008 (1.34)	-	0.3920 (2.00)**
PRIVATE_TIME	-	0.7730 (3.56)***	-	0.6142 (2.55)**
PARKING	-	-0.1584 (-1.46)	-	-0.1395 (-2.02)*
MOTOR	-	-0.0012 (-2.22)**	-	-0.0011 (-2.01)**
Intercept	-5.489 (-2.50)**	-4.651 (-2.31)**	-6.215 (-2.36)**	0.3724 (3.11)***
R^2	0.40	0.84	0.46	0.83
F- Test (Joint significance)	11.23***	45.37***	-	-
Ramsey RESET test for omitted variables	0.07	0.49	-	-
Chi2 (Joint significance)	-	-	31.41***	180.77***

Note 1. T-statistics and Z-statistics based on robust to heteroskedasticity standard errors are in parenthesis.
Note 2. Significance at 1% (***), 5% (**) and 10% (*).

Interesting results arise from our estimations. In separate estimations for the basic model we find that GDP produces positive impacts on the supply side of local public transportation across the 45 European cities. Therefore, being richer implies higher number of place-km per inhabitant than relatively poorer cities. On the other hand, the operational cost of the service is the main variable pushing to negatively impacts on place-km per capita supplied. The other variables, including the average price of a passenger-km and urban population density, do not present statistically significant coefficients. This result of fare effects on supply is not strange if we consider that prices are highly

[12] In SUR strategy the equations are estimated as a set in order to increase efficiency.

[13] See the seminal work by Zellner (1962) on Seemingly Unrelated Regression Equations.

regulated and usually driven by political goals, rather than operational costs. At the same time, urban population density was thought to affect supply through its impacts on economic efficiency, but its coefficient does not seem statistically significant at all. It is possible that urban population density is not able to capture urban form by itself.

Regarding demand equations we find that coefficients associated with GDP, with the fleet of vehicles provided, the average time spent in private transport trips, and the average speed of public transport are all positively correlated with passenger-km per capita. On the other hand, the coefficients associated with the average price of public transport, the level of motorization and the number of parking spaces in the central business district, are statistically significant but impose negative impacts on public transport demand. All impacts work in the expected direction, while density does not provide any statistically significant impact on demand.

Furthermore, paying attention to the differences between the OLS and SUR estimations, we realize that the results displayed provide few and almost insignificant changes on the statistical significance of the coefficients related to the variables used in the separate models. As is shown, the explanatory power of this estimation remains the same for demand and slightly increases for supply. Several coefficients improve their statistical significance. Particularly, we find that the average speed of public transport is now statistically significant at 5% and the coefficient associated with the number of parking spaces is now significant at 10%. As a result, there are efficiency gains from the use of SUR models, but these are rather small.

As mentioned, the original data base contained seven non-European cities. By taking advantage of the available data on them, we have been able to extend this basic estimation by including as well Chicago, Dubai, Hong Kong and Singapore (whereas Sao Paulo, Tunis, and Melbourne were not possible to include do to too many missing values). In the appendix (A1) we provide some estimates for models in which these four additional cities are included in the regression. We show that introducing these observations does not change results on structural variables (with the only exception being density regarding supply). More interestingly, we provide some evidence that this group of non-European cities seems to enjoy lower supply values, since the associated coefficient to a dummy variable identifying these observations is negative and statistically highly significant for the supply equation, although it is not for demand.

Institutional variables

Once we have determined the basic factors affecting urban transportation supply and demand from a statistical point of view, we attempt to replicate the estimation by introducing the selected institutional variables described in section 3. For this reason we extent the model by adding the different institutional variables, and replicate the same estimation strategy. The first column in Table 6 displays SUR estimates with the institutional variables, which allow a comparison with results presented in the last column of Table 5.

Table 6. Seemingly unrelated regression results with institutions and regional covariates (45 European cities)

Regressors	SUR		SUR		SUR	
	Supply	Demand	Supply	Demand	Supply	Demand
Background variables						
GFP	.8308 (3.76)***	0.6854 (3.48)***	0.6786 (3.34)***	0.6327 (3.13)***	0.5545 (2.62)***	0.8647 (3.76)***
DENS	-0.1073 (-0.51)	0.0631 (-0.40)	0.0054(0.03)		-0.1818 (-0.89)	-0.1026 (-0.61)
PRICE	0.0247 (0.16)	-0.5685 (-4.32)***	-0.0173 (-0.10)	-0.6275 (-3.18)***	0.0870 (0.63)	-0.6149 (-4.52)***
OCOST	-0.7391(-3.59)***	-	-0.3993 (-1.96)**	-	-0.7467 (-4.16)***	-
FLEET	-	0.2213 (1.44)	-	0.1330 (0.76)	-	0.3062 (1.73)*
PUBSPEED	-	0.2750 (1.34)	-	0.1086 (0.50)	-	0.3981 (1.96)**
PRIVATE_TIME	-	0.5076 (1.84)*	-	0.3568 (1.21)	-	0.1582 (0.61)
PARKING	-	-0.1807 (-2.31)**	-	-0.2132 (-2.13)**	-	-0.2196 (-3.17)***
MOTOR	-	-0.0009 (-1.51)	-	-0.0006 (-0.99)	-	-0.0010 (-1.52)
Institutional variables						
$D_{capital}$	0.5586 (4.17)***	0.3859 (3.03)***	0.4526 (3.64)***	0.4418 (3.26)***	0.7011 (5.19)***	0.3401 (2.44)**
CONTRACTING	-0.1224 (-1.80)*	-0.0032 (-0.03)	-0.1012 (-1.01)	-0.0095 (-0.07)	-0.2139 (-2.16)**	-0.0005 (-0.00)
DECENTR	0.0405 (0.27)	-	0.0832 (0.69)	-	0.1159 (1.00)	-
ELECTED_ MAYOR	-0.0616 (-0.34)	-	0.0953 (0.64)	-	-0.0303 (-0.16)	-
GINI	0.0212 (1.61)	0.0020 (0.16)	0.0201 (1.81)*	0.0122 (0.91)	0.0298 (2.79)***	0.0035 (0.28)
Geographical variables						
D_{south}	-	-	-0.2993 (-2.42)**	-0.2176 (-1.65)*	-	-
D_{north}	-	-	0.1940 (0.90)	-0.0168 (-0.09)	-	-
D_{east}	-	-	0.4477 (1.67)*	-0.1001 (-0.25)	-	-
LATIT	-	-	-	-	0.4577 (3.64)***	0.1809 (1.18)
LATIT^2	-	-	-	-	-0.0044 (-3.38)***	-0.0020 (-1.35)
LONGIT	-	-	-	-	-0.0163 (-1.00)	-0.0217 (-1.37)
LONGIT^2	-	-	-	-	0.0005 (0.60)	0.0014 (1.57)
Intercept	-3.751 (-1.56)	-1.142 (-0.49)	-3.005 (-1.34)	0.8441 (0.31)	-12.558 (-3.41)***	-6.284 (-1.79)*
R^2	0.65	0.84	0.78	0.84	0.79	0.87
Chi2 (Joint significance)	67.59***	204.50***	126.46***	213.16***	139.11***	256.66***

Note 1. Z-statistics based on robust to heteroskedasticity standard errors are in parenthesis.
Note 2. Significance at 1% (***), 5% (**) and 10% (*).
Note 3. Notice that we use only 44 observations, because of the lack of institutional information on the city of Moscow.

As is shown, few differences are found for the basic model variables, while interesting results are achieved with this new group of variables. Being a political capital seems to affect supply decisions, because there is a positive and statistical significant correlation between its associated coefficient and the number of place-km per inhabitant, while also affects positively the number of passengers-km (Demand). On the contrary, the type of electoral system adopted to elect local mayors does not play any role on supply. The same happens for political decentralization.

On the contrary, as the Public Choice literature suggests, contracting out seems to push supply downwards, given that its coefficient appears to be negative and statistically significant. This is particularly interesting due to the ongoing reform that several cities carried out during the last decade. However, results on this point need to be considered with caution. First, because we could not obtain detailed and precise data on the level of contracting out in these cities that use it, so we needed to rely on a dummy variable. Second, the early 2000s was a period of ongoing reform in this field, which may suggest quickly evolving environments regarding the use of contracting-out.

In all, we have seen how some institutional variables seem to play a role in the determination of local public transport supply and demand. Particularly we realize that explanatory power seems to significantly increase when institutional variables are considered, especially for the supply equation.

Regional variables

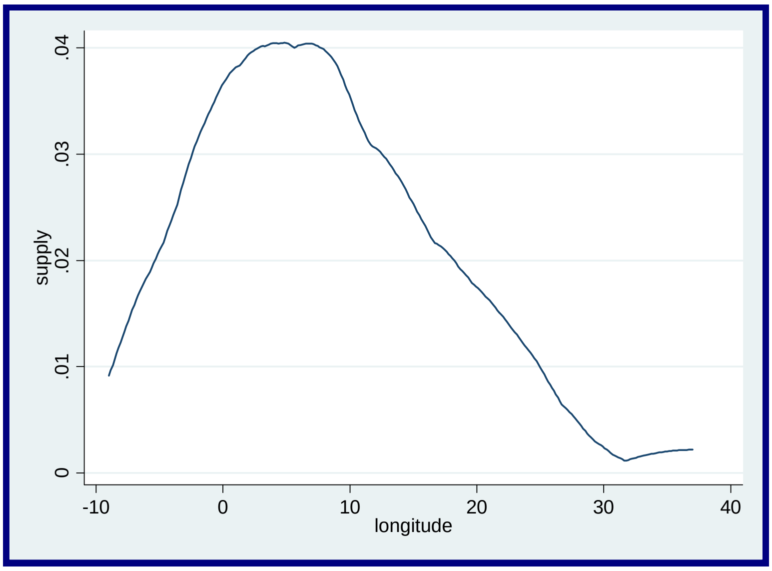
After considering institutional variables we proceed now to provide the estimates by extending the model with regional variables that can capture institutional and geographic information not contained in the institutional variables already used. By doing this we wish to identify any regional effect or regularity having an impact on local public transportation.

First of all, it is important to mention that all the other covariates from the basic model don't change significantly. Being this said, we can analyze the selected results of table 6 and see that Mediterranean metropolitan areas have lower levels of public transport supply and demand than do the reference group of cities (Center-European). The coefficient associated with the Northern cities does not appear to be statistically significant in the supply and demand equations, while Eastern cities provide mixed results. On one hand, these cities seem to deliver higher supply than the other groups. On the other, the coefficient is not statistically significant in the demand equation. We must take into consideration that the number of observations in this last group of cities is smaller and we should be cautious about extracting general conclusions. Nonetheless, these cities are former Popular Republics and heritage from Communism might explain why they provide higher number of place-km per inhabitants than Center-European cities.

As a result, institutional characteristics seem to play a role in the determination of the urban public transportation in the cities considered. These results suggest the direction chosen by each region.

To go deeper into regional effects, we provide Non-parametric analysis (kernel densities) that relates the supply of urban public transport in the cities of our sample with their geographical latitude and longitude. This is a more flexible way to control for regional effects than the rigidity forced by binary variables. Figures 1 and 2 show the results of those kernel densities.

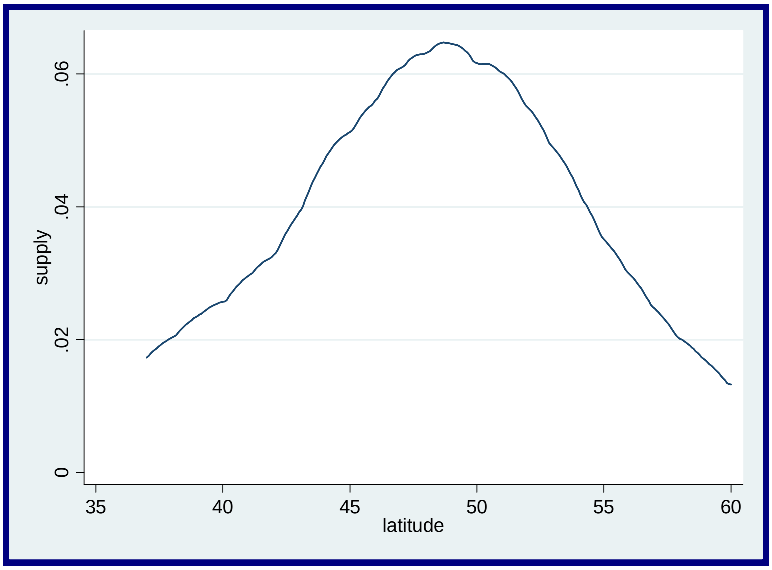
Figure 1. Kernel density.
Relationship between geographical longitude and public transport supply



Note:

- Cities between -9º and 0º (ordered by longitude degree): Lisbon, Dublin, Seville, Glasgow, Madrid, Bilbao, Manchester, Valencia, Newcastle, Nantes, London,
- Cities between 1º and 10º (ordered by longitude degree): Barcelona, Paris, Clermont-Ferrand, Ghent, Lille, Amsterdam, Brussels, Lyon, Rotterdam, Marseilles, Geneva, Bern, Turin, Zurich, Hamburg, Milan, Stuttgart, Oslo.
- Cities between 11º and 20º (ordered by longitude degree): Bologna, Munich, Copenhagen, Rome, Berlin, Prague, Graz, Vienna, Stockholm, Budapest, Krakow.
- Cities between 21º and 37º (ordered by longitude degree): Warsaw, Athens, Helsinki, Tallinn, Moscow.

Figure 2. Kernel density.
Relationship between geographical latitude and public transport supply



Note:

- Cities between 37º and 44º (ordered by latitude degree): Athens, Seville, Lisbon, Valencia, Madrid, Barcelona, Rome, Bilbao, Marseilles, Bologna.
- Cities between 45º and 50º (ordered by latitude degree): Clermont-Ferrand, Lyon, Milan, Turin, Bern, Geneva, Budapest, Graz, Nantes, Zurich, Munich, Paris, Stuttgart, Vienna.
- Cities between 51º and 55º (ordered by latitude degree): Ghent, London, Rotterdam, Amsterdam Berlin, Warsaw, Dublin, Hamburg, Manchester, Newcastle, Copenhagen, Glasgow, Moscow.
- Cities between 56º and 60º (ordered by latitude degree): Oslo, Stockholm, Tallinn, Helsinki.

As the reader can observe, we find an inverted U-shape relationship between urban public transport supply and both geographical longitude and latitude. This means that the higher supply is expected in cities in the center of the continent. Therefore, we find a center-periphery scenario that tends to have its center on cities between 0º-10º of longitude and between 45º and 55º of latitude. The cities within this area are: Paris, Clermont-Ferrand, Ghent, Lille, Amsterdam, Brussels, Lyon, Rotterdam, Geneva, Bern, Turin, Zurich, Hamburg, Milan, and Stuttgart. Departing from this area, both Northern and Southern cities and both Western and Eastern cities seem to provide lower supply per capita.

Regarding geographical longitude, we realized that western cities (Irish, British, Portuguese and most Spanish) provide lower urban public transport supply per capita. However, the level served is higher than the one delivered by Eastern cities.

In order to further analyze this issue and confirm this quadratic functional form we substitute the regional dummies in the parametric estimation by latitude and longitude variables and their squared. The last column in table 6 provides these results. As can be checked, the parametric estimation confirms the importance of latitude in the supply determination, but longitude loses its impact, probably because parametric estimates cannot fully account for the real inverted U-Shape found in the Non-parametric analysis. Therefore, we find that supply tends to increase the higher is the latitude in which the city is placed, while for the highest degrees of latitude we find the inverse trend. However, as happened with regional dummies, geography does not seem to be as important for demand determination.

5. Conclusions

This paper investigates the factors that explain supply and demand of local public transportation by considering variables related to economics and mobility -already well established in the literature-, and by considering as well new variables reflecting institutional characteristics and geographical patterns. We find that being a political capital, the level of personal income inequality and contracting out to private firms influence supply, and have some influence on demand as well. Furthermore, by means of our regional analysis we capture geographical characteristics, behavior and mobility patterns, different traditions of government intervention in the economy, and other institutional factors that we are not able to single out with the available information.

This paper contributes to the literature in several ways. First, we add to the existing literature on factors explaining demand and supply of local public transport by using an international sample of cities to jointly investigate demand and supply, whereas until now demand and supply had been analyzed separately using cross-country data on smaller samples, and supply and demand had been estimated simultaneously only using data from a single country. Our results are basically in line with those obtained in previous works, and our SUR estimation provides increased efficiency of the estimates.

More importantly, we contribute to the literature as well by introducing in our analysis institutional and geographical factors as determinants of transport supply and demand. These types of factors have been largely neglected by previous empirical literature on demand and supply of local public transportation, but they might indeed play an important role on local public transportation determination. Therefore, this paper further connects the institutional and geographic fields to transportation at local level.

Our analysis provides interesting results and new insights that add to the existing knowledge on urban public transportation, and open new avenues for research on factors related to institutions and geography. Future research should endeavor to further enrich this type of analysis by using larger and truly global samples of cities, as well as more refined data on institutions.

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APPENDIX

Table A1. Seemingly unrelated regression results (45 European cities + Chicago, Dubai, Hong Kong and Singapore)

Regressors	SUR	
	Supply	Demand
Background variables		
GDP	1.073 (4.22)***	0.5105 (2.78)***
DENS	0.4367 (2.73)***	0.1536 (1.14)
PRICE	-0.1641 (-1.14)	-0.5467 (-4.79)***
OCOST	-0.7236 (-3.26)***	-
NON_EUROPEAN	-0.9544 (-2.68)***	0.1273 (0.45)
FLEET	-	0.6274 (5.21)***
PUBSPEED	-	0.6514 (3.58)***
PRIVATE_TIME	-	0.6495 (2.48)**
MOTOR	-	-0.1120 (-0.77)
Intercept	-7.067 (-2.67)***	-5.167 (-2.29)**
R^2	0.40	0.77
Chi2 (Joint significance)	24.56***	130.79***

Note 1. Z-statistics based on robust to heteroskedasticity standard errors are in parenthesis.
Note 2. Significance at 1% (***), 5% (**) and 10% (*).
Note 3. Cities excluded due to several missing values are Melbourne, Tunis and Sao Paulo. We excluded the variable PARKING from the model in order to keep Hong Kong in the sample, since it is the unique missing value for that city.

Table A2. Seemingly unrelated regression for linear specification results with institutions and regional covariates (45 European cities)

Regressors	SUR	
	Supply	Demand
Background variables		
GDP	.0010 (1.71)*	0.0312 (2.01)**
DENS	-0.3977 (-1.09)	-6.541 (-0.99)
PRICE	1.559 (1.19)	-108.63 (-3.72)***
OCOST	-12.804 (-3.77)***	
FLEET	-	1.0321 (3.45)***
PUBSPEED	-	21.782 (1.57)
PRIVATE_TIME	-	-1.559 (-0.07)
PARKING	-	-1.151 (-1.95)**
MOTOR	-	-1.123 (-1.01)
Institutional variables		
$D_{capital}$	54.999 (5.43)***	483.49 (2.11)**
CONTRACTING	-9.221 (-1.81)*	60.742 (0.31)
DECENTR	1.191 (1.08)	-
ELECTED_MAYOR	1.531 (0.11)	-
GINI	2.433 (2.83)***	5.077 (0.22)
Geographical variables		
LATIT	31.588 (3.27)***	542.82 (2.33)**
LATIT^2	-0.3100 (-3.08)***	-6.090 (-2.60)***
LONGIT	-0.6979 (-0.54)	-7.7072 (-0.28)
LONGIT^2	0.0398 (0.53)	1.1683 (0.74)
Intercept	-797.377 (-3.36)***	-1101 (-1.82)*
R^2	0.77	0.85
Chi2 (Joint significance)	117.46***	210.81***

Note 1. Z-statistics based on robust to heteroskedasticity standard errors are in parenthesis.
Note 2. Significance at 1% (***), 5% (**) and 10% (*).

Table A3. Correlation matrix

	GDP	DENS	PRICE	OCOST	FLEET	PUBSPEED	PRIVATE_TIME	MOTOR	PARKING	Dcapital	ELECTED_ MAYOR	DECENTR	CONTRACT	GINI
GDP	1													
DENS	-0.4294	1												
PRICE	0.5280	-0.3668	1											
OCOST	0.6020	-0.2286	0.5357	1										
FLEET	-0.0490	-0.0407	-0.0668	-0.1641	1									
PUBSPEED	0.4072	0.0816	0.0552	-0.1334	0.0113	1								
PRIVATE_TIME	-0.1483	0.3927	-0.4777	-0.1211	-0.1187	0.0792	1							
MOTOR	0.3474	-0.2386	-0.0450	0.4301	-0.1128	-0.2467	0.1730	1						
PARKING	-0.1205	-0.0763	-0.1387	0.0463	-0.3241	-0.3743	-0.2158	0.2812	1					
$D^{capital}$	-0.0265	0.1655	-0.2654	-0.1607	0.4259	0.2306	0.2142	-0.2520	-0.2533	1				
ELECTED_MAYOR	-0.0619	0.0078	0.0994	-0.0327	-0.0442	-0.0192	0.0914	0.2340	0.0575	-0.1581	1			
DECENTR	0.0738	0.3513	-0.2255	0.2106	-0.1349	-0.0136	0.0067	0.5018	0.2048	0.3190	0.0374	1		
CONTRA	-0.0730	-0.2182	0.1984	-0.2593	0.0947	0.0381	-0.5419	-0.2578	0.2931	-0.1494	0.0315	-0.2282	1	
GINI	0.2871	0.0712	0.3584	0.2518	0.0693	0.2166	0.1359	0.0400	-0.0164	-0.2662	0.1131	0.0041	0.0795	1

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