Transport Policy 42 (2015) 173–179

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

Public transport demand elasticities during the recessionary phases of economic cycles

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ARTICLE INFO

Article history:
Received 18 February 2015
Received in revised form
30 April 2015
Accepted 28 May 2015
Available online 26 June 2015

Keywords:
Public transport demand
Elasticities
Travel behavior modeling
Business cycle

ABSTRACT

The serious recession suffered by the Spanish economy has had an important impact on the working of transport systems. This article provides evidence of how the state of the economy, measured using per capita income levels and unemployment rates, can influence the demand for public transport by bus with data from the city of Santander (Spain) for the period 2001–2012. The methodology used has involved the short and long run equilibrium demand elasticities estimation using a log–log regression model considering the presence of autocorrelation in the residuals and the endogeneity of the transport supply. The results show that the demand for transport is sensitive to changes in unemployment rates with an elasticity estimated at 0.133 in the static equilibrium model and of 0.210 in the long run dynamic model. The resulting elasticity for income levels was not significant in all the models, with a parameter estimated in the static model of −0.505 and of −0.861 in the long run dynamic model. The model estimated by two stage least squares validated using data from 2013 with unemployment rate as an independent variable gave the lowest average square error in validation.

1. Introduction and aims

The deep recession suffered by the economies of Southern Europe, among them Spain, has had a strong impact on a multiplicity of social dynamics, including those related to the transport system. Macroeconomic variables such as per capita income levels or unemployment rates could have an important influence on transport demand. This relationship is of great interest to public transport operators and managers because changes in demand may, in turn, impact income, vehicle occupancy and more generally affect the quality and sustainability of the overall system (Litman, 2014). The available bibliography provides various empirical estimations about changes in the direction and magnitude of transit demand to help in the decision making process. Low or non-significant elasticities imply variables which have a low impact on demand, while high, either positive or negative, elasticities show variables which can be effectively addressed to increase the demand for public transport.

The variables studied most in the bibliography are those related to the internal characteristics of the public transport system such as the fare or the level of service. Other variables related to the system's environment, such as car ownership, income levels or the price of fuel, have also been considered by the available research, although to a lesser degree than the others (Balcombe et al., 2004). Finally, macroeconomic variables like the unemployment rate have not generally been considered as relevant although they could have a direct impact on transit demand as a result of oscillations in the economic cycle.

Economic cycles can be broken down into two simple large phases. An expansive phase with growth in the Gross Domestic Product (GDP), and a regressive phase when the GDP contracts (Filardo, 1994). After a period of expansion during 1996–2007 the Spanish economy entered into recession from 2008 and by 2013 had not yet recovered to the GDP values at the high point of the cycle (GDP of 100 in 2008 versus 94 in 2013). This dynamic was, in turn, associated with a steep increase in the unemployment rate which increased from about 8% in 2007 to around 25% in 2013 (INE, 2013).

This study proposes the use of an econometric model to evaluate the influence these macroeconomic variables have on the demand for public transport. For this purpose, data on the unemployment rate and per capita income levels from the city of Santander (Spain) have been used.

The elasticities of the relevant variables were initially calculated using a static log–log regression model. This particular functional form allows the estimated parameters to be directly interpreted as elasticities, in other words, as the percentage change in the equilibrium of the independent variable against the percentage changes of the dependent variables, ceteris paribus. Additionally, the short and long term elasticities were estimated

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http://dx.doi.org/10.1016/j.tranpol.2015.05.022
0967-070X/

using a dynamic model with the specification of the dependent variable lagged (Balcombe et al., 2004). The models were specified considering possible autocorrelation in the residuals, which are typically present in time series data, as well as endogeneity in the transport supply, an important aspect underlined by previous research (Holmgren, 2007). In order to address this endogeneity, the models were estimated using two stage least squares (2SLS).

The models were estimated using a time series provided by the Santander public transport company (TUS). This time series contains data on passenger demand (passenger trips) for the period 2001–2012 as well as different factors relating to the transport service such as the fare and service levels measured as vehicle-kilometer (vehicle-km). The influence of the economic cycle was measured using structural indicators such as the population's per capita income levels and unemployment rate. Finally, the model was also estimated using indicators of external phenomena which may be important in influencing transit demand such as variations in the price of fuel and car ownership.

The results provide evidence about the influence of macroeconomics on the demand for transport. According to the static equilibrium model, an increase in the unemployment rate may carry with it, ceteris paribus, an increase in the demand for public transport. The dynamic model showed a positive long run elasticity with a higher value than the equilibrium elasticity, whereas the elasticities obtained for the income levels were not clearly significant in all the estimations, although they did provide the expected negative sign. Both results point to the fact that economic recession carries with it an increase in the demand for transit services, an effect which also reflects on the fact that public transport is an inferior good.

The following section reviews the available bibliography which has provided evidence on the transit demand elasticity against different variables. Section 3 describes the methodology followed, the data used for estimating the models and the results. The conclusions drawn are presented in Section 4.

2. State of the art

Many studies have provided evidence about the influence of different variables on transit demand. Most of the work has centered on the effect of 2 variables: fare and service levels. Transit demand is usually measured as passenger trips or boardings over a time period, whereas service levels are measured as vehicle-km or seat-km, i.e. the total kilometers covered by all the buses in service or the total kilometers multiplied by the supply of seats over a time period.

In Spain, de Rus (1990) estimated a regression model using panel data for various Spanish cities for 1980–1988. The elasticities estimated for the fare and the service levels showed that transit demand, i.e. the number of passenger trips, was sensitive to these factors. The author calculated an elasticity in the static model of −0.3% for the fare and 0.71% for the level of service, suggesting that the number of passengers could be increased at the same time as fares were increased along with service levels.

Goodwin (1992) reviewed more than 50 existing research works on the influence fare had on transit demand and found an average elasticity of −0.41%, greater than the value of −0.3% (Webster and Bly (1981) considered at the time to be the reference in Great Britain. The author also estimated that long term elasticities are between 2 and 3 times higher than short term elasticities.

Balcombe et al. (2004) elaborated a guide for the Transport Research Laboratory (TRL) on the factors affecting the demand for surface public transport. This guide updated the results presented in the 1980s by Webster and Bly (1981). The authors looked at existing research and established that the short run elasticity of the bus fare was around −0.4% and the long run −1%. These results can also be found in a later article (Paulley et al., 2006).

Bresson et al. (2004) estimated by generalized method of moments (GMM) models for a data sample from 62 French public transport areas during 1975–1995. The authors calculated a long run fare elasticity of -0.65. These authors also provided estimations of the kilometers covered by the buses calculating a positive long run elasticity of 0.68.

More recent research by Holmgren (2007) have used the meta-analysis of diverse research to explain the different elasticities obtained by different studies. The author found an average fare elasticity of −0.38 for a group of 81 studies. The average value for the service level from 58 studies was 0.72. The author recommended the endogenous treatment of the service level variable, because if it was not treated this way then the estimated parameters in this and other variables could be biased. Taking this endogeneity into account, the author calculated the elasticities to be −0.75 for the fare and 1.05 for the service level, which is notably above those calculated without considering the dependence of the service level on the demand for transport.

Another group of studies have also calculated the elasticities of variables related to determinants within the environment of the public transport system, such as population income levels, car ownership and the price of fuel. Goodwin (1992) summarized three studies with data on the transit demand elasticity with respect to fuel prices finding an average result of 0.34. The research of Paulley et al. (2006) also summarized various results for income level and car ownership elasticities. In the case of income, if public buses were considered an acceptable, normal commodity then the elasticity should be positive. However, various studies have found negative elasticities meaning users consider bus transport to be an inferior good. This is the case found by Paulley et al. (2006) for Great Britain with long run elasticity estimations of between −0.5 and −1. Problems of colinearity may appear if the income and car ownership variables are also introduced into the model so some studies decided to only use one of them. The studies that only used car ownership as a function of demand are fewer than those that used the price of fuel, but they also generally found negative elasticities. This problem is frequently found in research because colinearity is not only found between income levels and car ownership but also with the price of fuel and other variables.

Bresson et al. (2004) estimated the long run elasticities of income level to be −0.23. Holmgren (2007) in his meta-analysis clearly recommended using this type of variable in the demand functions to avoid biased parameters in the variables related to the fare or the service levels. According to Holmgren, the short term estimations made with the available research for Europe presented elasticity values of −0.62 for income, 0.4 for the fuel price and −1.48 for car ownership. The author asserted that these figures demonstrate that public transport in Europe is seen as an inferior good and therefore could continue to suffer falls in usage if incomes and car ownership levels continue to rise.

Other variables related to the economic environment such as the unemployment rate have hardly been addressed by previous research. In general this research has shown a loss (White, 2008) or a stagnation in the number of trips during recessionary periods (Transport for London, 2010). As far as the authors are aware, the present study is the first to estimate a positive elasticity of the unemployment rate on the demand for public transport.

Knowledge about this factor could be useful information for public transport managers and operating companies given that oscillations in demand may have an important impact on the system's sustainability through changes in income, occupancy and other factors.