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Induced road traffic in Spanish regions: A dynamic panel data model

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ABSTRACT

Distinguishing between traffic generated exclusively from the expansion of the road network (induced demand) and that resulting from other demand factors is of crucial importance to properly designed transport policies. This paper analyzes and quantifies the induced demand for road transport for Spain's main regions from 1998 to 2006, years that saw mobility in Spain attain its highest growth rate. The lack of research in this area involving Spain and the key role played by the sector, given its high level of energy consumption and the negative externalities associated with it (accidents, noise, traffic congestion, emissions, etc.), endow greater relevance to this type of research. Based on a Dynamic Panel Data (DPD) reduced-form model, we apply alternative approaches (fixed and random effects and GMM-based methods) for measuring the induced demand. The results obtained provide evidence for the existence of an induced demand for transport in Spain, though said results vary depending on the estimating method employed.

1. Introduction

The demand for transport in Spain in recent decades has been characterized by a strong increase in road traffic, with a road transport participation rate in domestic transport of over 80%. Between 1990 and 2007, the road passenger per km increased in Spain by 94% (almost 4% per year) and the freight transport (tm. per km) by 159% (5.8% per year), figures that are double and even triple in some cases the traffic demand growth rates of most OECD countries (Ministerio de Fomento, 2008, 2007, 2006a). Moreover, these growth rates were notably higher than those of the population (0.83% per year) and real GDP (3.1% per year).

According to the theory of transport economics, one of the reasons that could cause an increase in road traffic is the growth of the road network, which would favor decongestion and the productivity of existing transport (i.e., reduce the time for each trip). However, because of the decreased congestion and reduction in generalized travel costs, it might generate more transport demand, which could offset the initial effect and lead to similar or even greater overall levels of vehicle traffic and congestion.[1] This indirect effect on demand stemming from the expansion of the road network is known as *induced demand*. The literature on models treating the relationship between road supply and traffic is reviewed in Noland and Lem (2002), Goodwin and Noland (2003), Mokhtarian et al. (2002), and Cervero and Hansen (2002), among others. The majority of researchers define *induced travel demand* to be the increment in new vehicle traffic (measured as vehicle-kilometers travelled, VKT) that would not have occurred without the improvement of the network capacity.[2] This is the definition adopted in this paper.

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[1] A similar line of enquiry could be made to analyze the relationship between the road network growth with fuel consumption and emissions in the transport sector. Thus, although we do not exactly focus on this topic in the paper, our analysis and conclusions could be directly extrapolated to the emissions issue.

[2] Hills (1996) provides a categorization of the various behavioral effects one can expect from capacity expansions.

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The most common approach used for measuring traffic-inducing effects has been project-specific, where the analysis is conducted at the corridor level before and after a change in its capacity. However, some authors, such as Hansen and Huang (1997) and Noland and Lem (2002), have emphasized the importance of analyzing the induced demand in a broader area, since understanding aggregate effects can provide valuable information to policy makers. In the case of Spain, despite having one of the highest growth rates in road traffic within EU countries in recent years, we have not found published papers measuring the induced road transport demand at an aggregate or regional level.[3] This paper contributes to addressing this deficiency in the literature. More concretely, at the Spanish regional level, we estimate a Dynamic Panel Data (DPD) model for the transport demand (measured by VKT) as a function of the lane-km, which we approximate from official statistics. As suggested by Hansen and Huang (1997), Noland (2001), and Noland and Cowart (2000), we consider additional control variables, such as the real regional Gross Domestic Product (GDP), the real fuel price, and the vehicle fleet. For homogeneity and availability reasons, the database used relies on panel data from 1998 to 2006 and for 16 Spanish regions. While most papers have focused on a static relationship, which limits the analysis to the long-term or structural relationship, we follow the argument in Hymel et al. (2010) to promote the use of a dynamic specification: most variables included in the model may only change from one period to the next due to behavioral inertia, transaction costs and other obstructions to adjustment. Moreover, this dynamic specification would allow us to estimate short- and long-term effects simultaneously.

The second contribution of the paper involves the estimation methods used for this type of model. The generalized method of moments (GMM) procedure proposed by Arellano and Bover (1995) and Blundell and Bond (1998), referred to as GMM-SYS, addresses many of the econometric problems faced by DPD models (i.e., endogeneity, inefficient, weak instruments, etc.) when estimated using traditional procedures (i.e., pooled OLS, within-group fixed and random effects, 2-stage least squares or the GMM-DIF procedure of Arellano and Bond, 1991).[4] We show that the results are sensitive to the estimating method utilized, hence the importance of adopting the proper econometric procedure (GMM-SYS in our case). Specifically, while the estimates of traditional methods show little or null statistical evidence to reject the null hypothesis of absence of induced demand, estimates using the GMM-SYS method find strong evidence to reject it in favor of the alternative of induced demand at very low levels of significance.

Finally, we also address the too-many instruments problem emphasized by Roodman (2009), which may arise when using all available moment conditions in GMM-SYS.[5] Among other things, this problem might over reject the non-significance hypothesis of the parameters (i.e., the induced demand hypothesis might be rejected less frequently than it should be). Using Roodman's proposals, we find that our results are robust to the set of instruments used. In all cases, the coefficients associated with the induced demand are always significantly different from zero and their elasticity estimates range from 0.1135 to 0.1742 in the short term and from 0.2671 to 0.3052 in the long term. These estimates are within the lower range of those obtained by Cervero and Hansen (2001) and Fulton et al. (2000), a result that is in line with the aggregate nature of the data utilized in our paper (Noland, 2001; Boarnet, 1997).

This paper is structured as follows. Section 2 presents the theoretical framework on which the induced demand hypothesis is based. Section 3 features a descriptive analysis of the data series used. Section 4 specifies the DPD model to be estimated. The methods of estimation are presented in Section 5. The results and robustness analysis are included in Section 6 and, finally, Section 7 highlights the main conclusions drawn from the work.

2. Theoretical framework

The economic theory of supply and demand explains the presence of induced traffic when an expanded road network decreases the generalized cost of a trip, especially the travel time, and as a consequence increases the distances traveled (Goodwin, 1992).[6] Thus, induced traffic in road transport is typically defined as the rise in kilometers traveled resulting from an increase in the capacity of the road network (SACTRA, 1994). Following Noland and Cowart (2000), the induced traffic should be measured as the increment in VKT that would not have occurred without the capacity improvement. In this context, we consider induced traffic as those trips that are generated by the new road capacity, as trips stemming from a new distribution to

[3] In Spain, there are some papers that analyze the elasticities of demand on toll motorways, although they do not estimate the induced travel demand (see, for example, Matas and Raymond, 2003). Moreover, most research has focused on the estimation of fuel demand elasticities. So, for example, Romero-Jordán et al. (2010) estimates price and income elasticities of fuel demand for passenger transport, while Labeaga and López-Nicolás (1997) and Labandeira and López-Nicolás (2002) focus on analyzing the impact of taxes on overall fuel consumption.

[4] A traditional way to overcome the endogeneity problem in a travel demand model is to use a 2-stage least squares (2SLS) estimator, as in Cervero and Hansen (2001) and Fulton et al. (2000). With respect to our dynamic model, these authors specify a static model. For a DPD model, the 2SLS approach, although consistent, suffers from significant inefficiency problems, especially for small samples. This is the main motivation for Anderson and Hsiao (1982), Holtz-Eakin et al. (1988) and Arellano and Bond (1991), among others, to propose a GMM-based approach to estimate a DPD model. In this respect, we should also emphasize that Noland and Cowart (2000) used an instrumental variable procedure as well, but with unsatisfactory results, mainly because of the weakness of the instruments selected.

[5] We are grateful to an anonymous referee for this suggestion.

[6] The induced demand theory is consistent with the "triple convergence" theory in Downs (1992), developed to explain the difficulties that must be overcome to eliminate rush-hour congestion. This idea was expanded upon by Mogridge et al. (1987), who established the Downs-Thomson paradox, according to which increasing the capacity of roads can cause traffic congestion to worsen (see Arnott and Small (1994), for empirical evidence in this regard).