



Evolution over time of heavy vehicle volume in toll roads: A dynamic panel data to identify key explanatory variables in Spain



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ABSTRACT

Improving the knowledge of demand evolution over time is a key aspect in the evaluation of transport policies and in forecasting future investment needs. It becomes even more critical for the case of toll roads, which in recent decades has become an increasingly common device to fund road projects. However, literature regarding demand elasticity estimates in toll roads is sparse and leaves some important aspects to be analyzed in greater detail. In particular, previous research on traffic analysis does not often disaggregate heavy vehicle demand from the total volume, so that the specific behavioral patterns of this traffic segment are not taken into account. Furthermore, GDP is the main socioeconomic variable most commonly chosen to explain road freight traffic growth over time. This paper seeks to determine the variables that better explain the evolution of heavy vehicle demand in toll roads over time. To that end, we present a dynamic panel data methodology aimed at identifying the key socioeconomic variables that explain the behavior of road freight traffic throughout the years. The results show that, despite the usual practice, GDP may not constitute a suitable explanatory variable for heavy vehicle demand. Rather, considering only the GDP of those sectors with a high impact on transport demand, such as construction or industry, leads to more consistent results. The methodology is applied to Spanish toll roads for the 1990–2011 period. This is an interesting case in the international context, as road freight demand has experienced an even greater reduction in Spain than elsewhere, since the beginning of the economic crisis in 2008.

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1. Introduction

Improving the knowledge of road demand evolution and estimating better traffic forecasts are critical aspects in properly evaluating transport policies and accurately forecasting future investment needs (Matas et al., 2012). Stakeholders involved in roads management (such as governments, and operators) find it indispensable to identify the key parameters influencing road demand, as well as to quantify the strength of the relationships between traffic and certain explanatory variables over time. This issue becomes even more critical in toll roads, as they are financed mainly through user's contributions. However, the state of knowledge concerning demand behavior for toll roads is still limited (Odeck and Brathen, 2008), and leaves some aspects to be investigated in greater detail.

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Previous research studies generally pay little attention to road freight demand evolution over time. Methodological specifications on traffic analysis do not often disaggregate heavy vehicle demand from the total volume, so that the specific behavioral patterns of this segment of the traffic are not taken into account. Furthermore, the literature concerning road freight traffic is mainly focused on urban areas (Cherry and Adelakun, 2012; Holguín-Veras et al., 2006) or on quite specific tolled sections, such as bridges or tunnels (Hirschman et al., 1995; McKnight et al., 1992). By contrast, existing research explaining heavy vehicle demand evolution in interurban toll roads are sparse, and commonly include GDP as the only socio-economic explanatory variable in the analysis. Finally, the impact of the current economic crisis on road freight traffic has barely begun to be analyzed in the literature.

The aim of this paper is to contribute to a better knowledge of the evolution of heavy vehicle demand on interurban toll roads by identifying some of the key socioeconomic variables influencing traffic behavior. Through an original methodology, we discuss the suitability of GDP as a socioeconomic explanatory variable of road freight traffic on toll roads, and propose alternative variables. The main objective is thus to fill the research gap found in the literature regarding the socioeconomic variable that better explains the evolution of road freight demand over time. Additionally, this paper analyzes the effects of the economic crisis on heavy vehicle demand for toll roads, and tests the suitability of the explanatory variables chosen.

The methodology is applied to the Spanish toll road network, which represents a very interesting case in the international context. The deterioration of the economic environment in Spain since 2008 has had a great impact on the level of traffic in the tolled network, particularly as regards heavy vehicle demand. According to data from the Spanish Ministry of Transportation (Ministerio de Fomento, 2013), road traffic has undergone a reduction of 28% compared with the peak attained since 2007. Regarding heavy vehicle demand, traffic in toll roads has fallen, since the beginning of the crisis, after 6 years of consecutive decreases, by a full 40%. As a result, road freight demand has returned to levels of 1994, when the tolled network was 46% smaller. Revenues of private concessionaires have decreased by 10% in 2012 compared with levels in the previous year, which has led the government to take critical measures to relieve their financial situation. Then, we seek to evaluate to what extent significant reductions undergone by road freight traffic in recent years in Spain can be considered an anomalous fact when compared to previous trends.

This paper is organized as follows. After the introduction in Section 1, Section 2 summarizes the state of knowledge regarding heavy vehicle demand, focusing mainly on interurban roads. Section 3 establishes the methodology of this research, by describing both data series and the panel data models used to estimate demand elasticities. Section 4 presents and discusses the results. Finally, Section 5 sets out the main conclusions and suggests avenues of further research.

2. State of knowledge

Road demand evolution over time has traditionally been a matter of interest in transport economics, and numerous studies have been conducted in the last decades to identify the key parameters influencing travel patterns (Khademi and Timmermans, 2011; Dargay, 2007; Joksimovic et al., 2006). However, existing research on the evolution of traffic has focused on light vehicle demand, while road freight traffic has received less attention. Basically, the responsiveness of road demand with respect to different factors is measured through the concept of elasticity, by definition the relative change in travel demand induced by a relative change in a certain explanatory variable.

An overview of previous research studies aimed at analyzing and modeling road freight demand are briefly summarized in the following subsection. Then results specifically focusing on freight traffic analysis in toll roads are commented.

2.1. Previous research for free roads

The existing literature concerning road freight demand has mainly focused on modeling commodity or vehicle movements in terms of certain explanatory variables. Demand modeling has been used for different purposes, such as testing transport policy measures, forecasting transport demand, or predicting the impacts of the provision of new infrastructure (Ben-Akiva and de Jong, 2008). According to Nuzzolo et al. (2013), two main technical approaches have been adopted to that end: behavioral models and macro-economic models (both joint and partial share specifications). An overview of their basic characteristics is included in Table 1. Furthermore, a detailed literature in this field can be found in de Jong et al. (2013) and Chow et al. (2010).

Behavioral models simulate mode and route choice, and generally employ disaggregate information, so more detailed policy-relevant variables can be covered (Nuzzolo et al., 2013). By contrast, macro-economic models, which use aggregate information, are aimed at estimating the level and spatial distribution of goods or traffic flows. Within macro-economic models, partial share specifications progressively calculate consecutive steps of transport modeling (generation, distribution, etc.), while direct models simultaneously consider the whole process.

Some interesting findings have been concluded from disaggregate and partial share models. According to Abdelwahab (1998) and Oum et al. (1990), truck price elasticities significantly vary across commodity groups, so elasticities tend to be larger for lower-value commodities compared to higher-value goods. Nuzzolo et al. (2009) identified statistically significant variables for both import and export freight flows. Rich et al. (2011) assessed the extent to which mode substitution in freight transport was affected by lack of alternative freight networks from origin to destination. Additionally, Bröcker et al. (2011) and Meersmann and Van de Voorde (2013) approached the importance of globalization on road freight flows.

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