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Measuring the substitution effects between High Speed Rail and air transport in Spain

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ABSTRACT

The main objective of this paper is to estimate the impact that the expansion of the HSR network has had on air transport in Spain by estimating the substitution effect between the two types of transportation. This paper considers the way that the HSR network has grown and how this growth could have affected air transport dynamically. The findings show that a dynamic vision of this substitution rate should be adopted, as opposed to assuming that the rate is constant, as has been the case in previous references. Although the rate varies significantly over the study period, only 13.9% of HSR passenger demand was found to have come from air travel during the 1999–2012 period, meaning that HSR and airlines would seem to offer more independent services than at first it might appear. This confirms the hypothesis as to the HSR's great ability to generate its own demand. The substitution rate between the two transport modes seems to be closely linked to the way that any new stations are incorporated into the HSR network. Convergence between the seasonality of HSR and air transport has also been examined. The results show that it is difficult to talk of a real HSR transport network in Spain.

1. Introduction

In these times of economic adversities (see Trachanas and Katrakilidis (2013) and Ali (2012) on this aspect) while emerging countries are preparing to start building their High Speed Rail (hereinafter HSR) networks, others, such as France, which were pioneers in this type of transport (Marti-Henneberg, 2013), have decided to postpone some schemes while continuing with others (Leheis, 2012; Bayon, 2013), or to upgrade their conventional rail increasing speeds on existing tracks up to 200 km per hour (De Rus, 2012). In this context, there are growing numbers of papers that place increased importance on the cost and economic development (Givoni, 2006), on the need for a proper prior cost assessment of the investment (De Rus and Nombela, 2007; De Rus and Roman, 2006), and the need to prevent the HSR network being developed on the basis of political, rather than economic criteria (Albalate and Bel, 2012; Bel, 2011).

A major part of this discussion about the suitability of developing HSR networks or lines focuses on the analysis of the competition or collaboration between the HSR and other means of transportation. Competition between the HSR and the car has been addressed by Gonzalez-Savignat (2004b) and Roman et al. (2007), and collaboration between the HSR and other land transport by Tapiador et al. (2009). With respect to competition between the HSR and air traffic, Kappes and Merkert (2013) indicate that the two biggest obstacles to breaking into the European air market are access to slots and competition from HSR lines. There are also studies that address collaboration between air transport and the HSR, such as those by Givoni and Banister (2006), Lythgoe and Wardman (2002), Redondi et al. (2013) and Socorro and Viecens (2013). Other paths of collaboration could emerge if secondary airports were linked to the main hub by HSR, as is the case in Spain, as this would allow international flights to be dispersed around the country (Sismanidou et al., 2013).

Specifically, the implementation of the HSR in Spain and the way that the country has become an exporter of a mode of transport is a case study of international significance (see Campos and De Rus (2009), Marti-Henneberg (2013), Redondi et al. (2013), Socorro and Viecens (2013), and Martin and Nombela (2007) on this topic). When the most recent Madrid–Barcelona–Figueres and Madrid–Valencia–Alicante lines came into service Spain quickly advanced to the position of having the second largest HSR network in the world behind China, a country that is not easily comparable to Spain due to its size and population (see Albalate

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and Bel (2011) on this topic), with, specifically, over 3100 km in service in 2013 (Adif, 2014). However, this expansion could impact negatively on regional cohesion, although the extent of any impacts varies depending on the area (see Ortega et al., 2014) or the planning level. Ortega et al. (2012) conclude that the effects are positive on the nationwide and corridor levels but that on the regional level, they might be negative.

In this context, the main objective of this paper is to estimate the effect that the expansion of the HSR network has had on air transport in Spain by estimating the substitution effect between the two types of transport. This will be done over the broad timeframe of January 1999–December 2012 that was marked by the expansion of the Low Cost Carriers (hereinafter LCCs) that included both international – for example, Ryanair and Easyjet – and domestic – especially Vueling – companies (Castillo-Manzano et al., 2012b; Bel and Fageda, 2010). This went hand-in-hand with the decline of the leading national airline, i.e., Iberia, which closed the year (2012) with losses of 351 million Euros. Obviously, this expansion of the LCCs, especially on domestic routes, is an important factor that should be taken into account as, *a priori*, the fall in the cost of air travel should increase competition with the HSR (Yang and Zhang, 2012) by reducing the appeal of the HSR compared to air transport.

The article is organized as follows: Section 2 presents a literature review of the substitution effects between the HSR and air transport. Section 3 lays out the data and presents the methodological approach. Section 4 presents the empirical results and the discussion of these findings and, finally, Section 5 presents the conclusions of the study.

2. Literature review

The analysis of the substitution rate between the HSR and air transport is especially relevant for the economy. Firstly, an estimate is required to enable the demand forecasts and/or the Social Cost/Benefit Analysis (De Rus and Roman, 2006) to be drawn up that are used to justify/not justify the viability or non viability of a new HSR line. In this line, Carrera-Gomez et al. (2006), for example, indicate that from the economic point of view the HSR between Madrid and Seville would not be socially profitable when analyzing congestion, maintenance costs, accidents and environmental costs for the car, the train, and the long distance bus along the Seville–Madrid corridor, and the elasticity of prices between them, using a function to maximize the sum of consumer and producer surpluses. From another point of view, Givoni and Banister (2006) conclude that airlines can use railway services as spokes of their own network of services. In such cases the railway infrastructure complements the air transport infrastructure, and should also be seen as part of the latter. Socorro and Viecens (2013) also use a theoretical model to conclude that plane–train integration is beneficial, or at least not detrimental, by which they are arguing that the complementary nature of the two has primacy over the substitution effect.

Martin and Nombela (2007) use an aggregate multinomial logit model to study competition according to distance. Their study concludes that the HSR will mainly attract passengers from airlines and the long distance bus on journeys of over 500 km, while for shorter journeys, the main competition will come from cars. A similar conclusion can be found in Armstrong and Preston (2011). Using logit discrete choice models González-Savignat (2004a) also concludes that the HSR may be considered as a truly competitive product to air transport over distances that can be covered in a maximum of 3 h. However, none of these studies goes so far as to offer estimations that quantify the substitution relationships between air transport and HSR.

In the case of the Madrid–Seville HSR line, DeRus and Inglada (1997) use passenger data from Iberia and RENFE (the Spanish national railway company) and demand elasticity with respect to the GDP to indicate that air passengers between the two cities fell from 694,400 (25.1%) in 1992 to 352,200 (10.1%) in 1996, the year that the HSR was brought into service, and that passengers on this new mode of transport stood at 1,438,200 (41.3%). Using an analysis based on disaggregated mode choice models with information from a mixed revealed preferences/stated preferences database, Roman et al. (2007) estimated that in the best Madrid–Barcelona scenario that they analyzed, HSR's market share would not exceed 35% of all air and train passengers. However, in reality the HSR market share of the Madrid–Barcelona route stood at around 50% in 2012, the last year for which it was analyzed.

Using a Two-Stage Least Square estimator (2SLS-IV) to estimate the equations, Jiménez and Betancor (2012) indicated that the introduction of HSR in Spain led to air operations reducing by 17% at the same time that overall demand for transport increased, which meant an even greater fall in their share.

Basing his focus on competition between the HSR and the plane, Dobruszkes (2011) finds that air companies could reduce the number of passengers per flight and increase frequency to respond to the introduction of HSR, and that this would prevent a fall in overall passenger numbers. In the same line, Fageda et al. (2011) state that air companies would also lower their prices to increase their competitiveness. For this they use a pricing equation with the two-stage least squares estimator. Yang and Zhang (2012) use a variation of the classic Hotelling model to indicate that the variables that have the greatest effect on the decision to use one mode of transport or the other in China are price and frequency. One last antecedent to this study that can be cited is Fröidh (2008), which compares generalized costs faced by plane and HSR passengers and arrives at the broad conclusion that traveling time is the most important factor for gaining market share in Sweden.

The focus of this paper offers the following advantages compared to these earlier papers. Firstly, it considers the way that the HSR network has grown and how this growth could have affected air transport dynamically. This enables the effects of new high-speed routes and of new airport terminals to be quantified. In addition, previous references have employed regression type models in order to explain the influence of new HSR stations on flight traffic by means of dummy variables and constant coefficients. Here, we report a more flexible and robust methodology that is capable of allowing parameters that vary over time. The idea behind this is to explore the substitution factor between HSR and planes on a dynamic basis. Essentially, the substitution effect between the two transportation methods can be a non-stationary stochastic variable instead of a constant coefficient. In particular, the proposed model is a Dynamic Linear Regression that belongs to the family of Time Varying Parameter (TVP) models (West and Harrison, 1989; Harvey, 1989). The advantages of our approach over the focuses of the prior literature will be analyzed in Section 3.

Finally, as the analysis extends through December, 2012, both the new lines that have been brought into service (the Cuenca–Albacete–Valencia line, for example) and the effect of the economic crisis can be included. The basis from which we start is that HSR is a high cost means of transport for the traveler, although in general terms fares will not cover the overall cost of its construction. The explosion of the LCCs onto the Spanish market as a whole also led to LCCs taking 52.5% of commercial passenger air transport in the last month of the sample.