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# Intermodal competition between high-speed rail and air transport in Spain

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ABSTRACT

This paper analyses generalised passenger transport costs for the period 2005 to 2014, following the launch of high-speed rail in Spain for routes on which this mode competes with air travel.

Demand functions for air links are analysed using an empirical methodology. Demand functions depend on income, generalised cost of air transport, and the price of alternative means of transport. The research is original in that, to our knowledge, these cross elasticities for the ten-year study period have not previously been estimated.

The findings suggest that demand for air travel has fallen due to increased competition from high-speed rail.



## 1. Introduction

Spain's first high-speed rail line between Madrid and Seville was inaugurated in 1992. When the new high-speed line came into operation, many if not most commuters between these two cities switched from air to rail transport. Based on the success of the Madrid-Seville line, further high-speed rail lines were built and put into operation in Spain. In 2003, the Madrid-Zaragoza line was launched. Air traffic between the two cities weakened gradually until the only airline operating on the route, Air Nostrum, cancelled its services in early 2011. Subsequent high-speed rail destinations were Malaga in 2007, Barcelona in 2008, and Valencia in 2010. This research is novel, since to the authors' knowledge, no previous study has evaluated the impact of high-speed rail on air transport in Spain over the time horizon of our analysis.

The Spanish rail market is a natural monopoly in which the railway operator RENFE, *Red Nacional de Ferrocarriles* Españoles, provides both conventional and high-speed services. With respect to the air mode, and in the routes in which both modes of transport compete, the degree of competition among airlines has gone through several phases. The Madrid-Barcelona route was born in 1927 with the monopoly of Iberia, which existed until 1993, when Air Europa began to operate, followed by Spanair in 1994 and Vueling in 2005. At present and since the collapse of Spanair in 2012, Iberia, Vueling, and Air Europa operate this route.

Up to the entrance of the high-speed rail lines, the Madrid-Valencia route was operated by the airlines Iberia, Air Nostrum, Spanair, and Ryanair. However, after the entry into operation of the high-speed line between both cities, Ryanair left the route, which together with the bankruptcy of Spanair in 2012 left only Air Nostrum and Air Europa.

Although the air transport mode has not reduced flight durations over the last 30 years, the railway mode was able to significantly increase transport speed. Travel duration for the Madrid-Barcelona route was reduced from 5 h at the end of 2008 to 2.5 h after March 2009. Travel duration for the Madrid-Valencia route was reduced from 3.5 h in November 2010 to 98 min after December 2010.

After the high-speed rail links opened, air traffic on the Madrid-Barcelona route registered a sharp decline in passengers, falling from 4,861,433 in 2007 to 2,203,671 in 2014. Air passengers between Madrid and Valencia fell from 1,063,004 in 2007 to 262,645 passengers in 2014.

The available literature in this area suggests that the launch of a high-speed rail line has a negative impact on domestic air travel along that route. The main objective of this study was to analyse, using air travel demand functions, whether or not the operation of new high-speed rail lines led to the displacement of air transport services. To this end, the remainder of the article is structured into six sections. The next section provides a review of the existing literature. The third section presents the theoretical model. Section

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four details data sources and descriptive statistics. The fifth section highlights the results of the econometric estimates. Finally, the last section highlights and discusses the main conclusions drawn from this research.

## 2. Literature review

There is a rich and varied body of literature in the field of air transport economics related to the possible impact on the air transport system from the introduction of competition via high-speed rail lines, especially in the US, Asia, and Europe.

Capon et al (2003) gave a useful overview of the literature on intermodal competition on medium-haul trips. López Pita (2003) focused, albeit descriptively, on the effects of high-speed rail lines on airlines in Spain. González-Savignat (2004) studied the impact of the high-speed rail connection between Barcelona and Madrid, with an analysis based on stated preference techniques. The author concluded that high-speed rail operations will gain a significant market share, with travel duration time and price being two of the most important competitive factors.

Ivaldi and Vibes (2005) conducted a theoretical simulation exercise for the Berlin-Cologne corridor to describe the behaviour of intermodal competition. In this study, consumers chose both a mode and a transport operator, with the companies determining quality and prices.

This allowed for an analysis of the existing competition on the Berlin-Cologne corridor, which at that time was operated by four air carriers and one rail operator. The results showed that prices declined in all modes following the introduction of multimodal competition and that high-speed rail registered a gradual increase in market share.

Park and Ha (2006) analysed the impact on demand for air travel for airlines operating several domestic routes in South Korea after the launch of high-speed rail lines. The authors analysed and predicted air travel demand before the opening of the rail line operated by Korean Train Express in 2004, and then compared their estimates with demand after the line opened. Their results support the conclusion that the introduction of high-speed rail lines reduces air traffic.

Martín and Nombela (2007) analysed the possible effects of the introduction of high-speed rail on the modal split in Spanish domestic transport, using both a gravity model and a multinomial logit model to estimate the choice of each mode of passenger transport. The authors concluded, among other things, that for long-distance routes (over 500 km), high-speed lines would be able to win passengers from both plane and bus. Overall, they estimated that the market share of rail travel, including all modes of transport, would increase from 8.9% in 2000 to 22.8% in 2010.

For the Madrid-Barcelona route, De Rus and Román (2006) analysed potential competition between high-speed rail and air transport, from the perspective of disaggregate mode choice models. Their results suggested that high-speed rail is more competitive on shorter routes, such as Madrid-Zaragoza and Zaragoza-Barcelona, than on routes where air traffic is more intense, such as Barcelona-Madrid.

Clever and Hansen (2008) carried out an econometric analysis of intermodal competition in Japan between high-speed rail and air transport, emphasising the importance of access times at railway stations that offer high-speed services in enhancing intermodal competition. Givoni and Banister (2008) studied the integration of air and rail transport, analysing how cooperation can promote intermodality when passengers needs to stop over at a hub airport to reach their destinations.

Ortúzar and Simonetti (2008) used data collected through revealed and mixed preference surveys to analyse passengers' choices between different modes (air, conventional train, bus, and a fictitious high-speed line) on the Santiago–Concepción route, noting a likely shift from air travel to high-speed rail. Another study by Behrens and Pels (2009) used revealed preferences to analyse intermodal competition on the Paris-London route and concluded that low-cost carriers do not compete more intensely with high-speed rail lines than they do with other airlines, which demonstrates a degree of comparability between the two modes.

Adler et al (2010) considered the development of high-speed rail infrastructure in Europe, concluding that investments made in the development of high-speed rail networks can be justified by welfare gains for consumers. However, they were also able to identify competitive responses by airlines in terms of prices and frequencies. Bilotkach et al (2010), using a database of several European cities, empirically assessed the importance of the distance variable in determining airline strategy, concluding that the shorter the distance, the greater the possibility that air transport will be replaced by rail, leading airlines to react strategically by offering increased frequency. Dobruszkes (2011) studied the development of high-speed rail lines in several Eastern European countries, concluding that impacts on air travel on the same route depend on several factors, including travel time and the commercial strategy of airlines.

De Rus (2012) analysed the direct and indirect effects of introducing a high-speed rail line between Stockholm and Gothenburg, two Swedish cities located 500 miles apart, and concluded that 71% of the traffic generated would stem from demand from existing air travel passengers, and to a lesser degree road transport passengers otherwise using bus or private vehicles. Clewlow et al. (2014) conducted an econometric analysis to examine the impact of high-speed rail and low-cost airlines on the traffic at 35 airports and 90 origin-destination pairs between 1990 and 2010, finding that a reduction in travel time when traveling by rail was the most significant factor behind the drop in air traffic. Finally, Crozet (2013) analyze the French market. The author confirms that the launch of a high-speed rail line has a negative impact on domestic air travel along these routes.

## 3. Theoretical model

The demand model for domestic air passenger transport is inspired by the model of Coto-Millán, P. (2004) and will be as follows:

$$DN_{i,t} = F(Y_{i,t}; PGA_{i,t}; PGF_{i,t}) \quad (1)$$

$(+) \quad (-) \quad (+/-)$

Where domestic demand $DN_{i,t}$ at the airport in question (in this case, Madrid), depends on income $Y_{i,t}$, generalised cost of air transport $PGA_{i,t}$ and generalised cost of rail transport $PGF_{i,t}$ .

The model for demand from one domestic airport to another can be formulated as a model based on (Adler et al., 2010) as follows:

$$DNOD_{ij,t} = F(Y_{i,t}; PGA_{ij,t}; PGF_{ij,t}) \quad (2)$$

$(+) \quad (-) \quad (+/-)$

Where domestic demand between the airport of origin $i$ and the airport of destination $j$, $DNOD_{i,t}$ (Madrid), will depend on income $Y_{i,t}$ in the region of the origin airport, income in the region of the destination airport, the generalised cost of air transport between the origin $i$ and destination $j$, $PGA_{ij,t}$ and the generalised cost of rail travel between origin $i$ and destination $j$, $PGF_{ij,t}$.

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