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High Speed Rail and Tourism: Empirical evidence from Spain's provinces and cities.

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Abstract: This paper evaluates how changes in the provision of high-speed rail (HSR) services affect tourism outcomes in Spain, a tourist country with the newest and longest HSR network in Europe. To do so it employs an empirical strategy based on the differences-in-differences panel data method with double fixed effects. The principal data are provided by Spain's National Statistics Institute (INE) and cover 50 provinces over a 15-year time span (1998-2013). In addition, the paper considers a sample of tourist cities (as identified by the INE) and monitors their tourism outcomes using monthly data between 2005 and 2013 comparing 'before' and 'after' situations. The results indicate that HSR accessibility does not promote tourist activity; however, a statistically significant negative impact on tourism outcomes is recorded at the provincial level. An analysis of timing effects shows that HSR is only associated with higher numbers of tourists (in instances when recorded) during the first year, but that this effect is reversed in the second and third years of operation. This pattern might be attributed to a rigid network design that does not respond to ridership needs and which has a substitution effect on air transportation, the main mode for long-distance tourist mobility. Finally, the impact analysis of HSR on tourist cities served by this mode of transportation does not reveal any noticeable changes following the opening of HSR services.

Keywords: High-Speed Rail, Tourism, Transportation.

JEL Codes: H54; L83; O18; R41

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1. Introduction

Transportation and tourism are closely related economic activities, so much so that promoting transportation infrastructure and guaranteeing efficient mobility are usually seen as contributing to the development of the tourism industry. As early articles have shown there is a well-established relationship between transport infrastructure and demand in the tourist sector (Chew, 1987; Martin & Witt, 1988; Abeyratne, 1993; Khadaroo and Seetanah, 2007, 2008). Thus, transportation acts on one of the determinants of a tourist destination, i.e., it improves accessibility to a particular location (Della Corte et al., 2013) and, moreover, it plays a critical role in mobility once tourists are at their destination. It is hardly surprising therefore that a number of recommendations have been forwarded for integrating transport and tourism policies (see Scuttari et al., 2013).

However, the impact of transportation on tourism is not solely positive. As Hall (1999) claimed, tourist mobility can be critical for such social concerns as inequality and sustainability. Thus, tourism mobility can produce negative externalities, with residents and tourists competing for scarce and constrained transport supply (Albalade and Bel, 2010), and other environmental impacts including climate change, air quality, noise, and nature/landscape (Peeters, Szimba and Duijnisveld, 2007). In short, while all modes of transportation can produce both positive and negative externalities, transportation infrastructure and services can reasonably be considered allies of tourist development strategies. This point of view is typically the one adhered to by local policy makers and local actors in the tourist sector, as reflected by their frequent lobbying to receive more infrastructure and transport service supply.

All modes of transportation can be considered allies of tourism. Local transportation, for example, facilitates tourist mobility, while long-distance transportation is critical for the overall number of tourists that a destination receives, with airports being the primary gateways for tourist arrivals. However, the precise relationship of other modes of medium- and long-distance transportation with tourism has been largely overlooked in the literature. Among these modes, high-speed rail (HSR) represents a contemporary revolution in transportation technology and has been promoted in various countries around the world (Albalade and Bel, 2012).² HSR typically has a very specific passenger orientation, hence its importance for the tourism industry, but recent studies indicate that its main impact on mobility is to substitute airline passenger volumes, rather than to induce a higher number of new trips. Given that HSR may be weakening air transportation, this as yet unidentified net effect of HSR on tourism needs to be tested.

This paper contributes to the literature by calculating the impact of the opening up of new HSR lines on tourism outcomes. This infrastructure policy and its impact on the tourism industry are examined in Spain, Europe's leader in the adoption of this transportation technology and one of the continent's main tourist destinations. The analysis is conducted at the provincial level using an econometric strategy based

² Here we understand HSR technology to refer to trains capable of reaching speeds of ≥ 250 km/h.

on the implementation of the differences-in-differences panel data method. The overall aim is to test whether or not claims of positive externalities of HSR in the tourism industry are well founded.

The rest of the paper is organized as follows. In the next section, the related literature is reviewed in order to build hypotheses about the role of HSR and tourist outcomes. The development, design and characteristics of Spain's HSR network are then described. Section four outlines the empirical strategy adopted in evaluating the impact of HSR on tourism at the provincial and municipal levels. This is followed by a presentation and discussion of the main results. The last section offers some brief conclusions.

2. Literature Review

Various studies of the deployment of HSR lines and their impact have addressed this specific relationship with the tourism sector. Thus, the improved accessibility of a tourist destination is reported as being expected to revitalize urban and business tourism (Delaplace and Perrin, 2013; Bazin et al., 2010; Masson and Petiot, 2009) and promoters associate the arrival of HSR with an improvement in the attractiveness of tourist destinations and as an opportunity to renew the tourist supply (see Delaplace et al., 2014; Feliu, 2012). A number of articles have forecast gains for the tourism industry from HSR links in Amsterdam (Riitveld et al., 2001), Kent (Gibb, 1986), Anaheim and San Diego (Murakami and Cervero, 2012), Melbourne and Canberra (Edwards, 2012), and the Chinese Provinces (Chen and Haynes, 2012) among others.

The ex-post evaluation of the relationship between HSR and tourism

However, results from ex-post evaluations of the impact of HSR are far from being so enthusiastic. A sound contribution is Bazin et al. (2006), which studied the impact of new TGV services on different economic sectors in France between 1990 and 1999. They reported that the new services failed to excite much curiosity, except for a somewhat sporadic impact on initial demand as passengers tried out the service. They argued that the availability of HSR gave value to already popular tourist destinations, but that it was insufficient to promote further tourist development, and that additional policies were required to sustain the initial demand shock. Interestingly, the authors found that the number of overnight stays fell and the profile of the typical visitor changed, to the extent that a restructuring was noted in the tourist industry. Thus, in some cities small hotels with limited services disappeared, while France's large national chains increased their offer and enhanced their quality to satisfy the demands of business tourism. The impact of HSR on leisure tourism appeared to be much more limited, and several projects developed on the basis of increased visitor numbers had to be abandoned (see Bazin et al., 2006, for specific examples).

City size appears to be an important determinant of the impact of HSR on tourism (Delaplace, 2012b). Thus, Bazin et al. (2013) reported that the increase in the number of tourists attributable to a new HSR service was minimal in many small and medium-sized European cities, although positive effects were detected in intermediate cities pre-equipped with tourist amenities. Similarly, SEEDA (2008) examined

HSR impacts on the tourism of thirteen cities in Germany, the Netherlands, the United Kingdom and France and found that only a few cities experienced a revitalization of their tourist industries. In contrast, evidence from Asia points in the opposite direction. This is the case in Japan (Okabe, 1979), Taiwan (Cheng, 2009) and China (Wang et al., 2012; Chen and Haynes, 2012).

A recent study by Pagliara et al. (2015) have evaluated the impact of Madrid's HSR on tourist destination choice employing a revealed preference survey. Their results, which are closely associated with the findings reported herein, suggest that HSR is not a key determinant of tourists' choice of destination since the majority are international tourists arriving by air. However, Madrid's HSR appears to be attractive to international tourists when visiting nearby towns and cities. A similar conclusion is reached by Chen and Haynes (2015) in their study of the impact of Chinese HSR systems on international tourism demand. They find a small demand elasticity (0.057) with respect to an HSR station on international tourism arrivals. However, when the railway network density is included a larger impact is recorded.

The substitution effect between HSR and other modes of transportation

Bolstering tourism with transportation is only of any relevance when it increases the overall number of users or the number of a given type of visitor (high income, long-stay tourists, etc.). However, if HSR is unable to generate new journeys and so increase demand in the sector, it merely takes on a predatory role as it competes with other modes of transportation. There is a growing body of literature examining the modal competition between HSR and air transportation (see Givoni and Dobruszkes, 2013, for a review) that stresses the former's ability to attract a relatively large market share of medium-distance travelers. This market share gain is won mainly at the expense of the airline industry. As a result, HSR has become a major determinant of market power loss (Zhang et al., 2014) and a major barrier to entry for airlines (Kappes and Merkert, 2013).

The interaction between airlines and HSR is of essential importance in any analysis of the impact of the latter on tourism given that airports are the main gateways for tourists and air transportation is the chief mode for long-distance mobility. Furthermore, the relationship between air transportation and tourism has been well established in the literature (see Bieger and Wittmer, 2006; Rey et al., 2011; Dobruszkes and Mondou, 2013, among others). If we consider HSR as being able to compete with airlines over distances under 700 km and as being faster than conventional rail and road over distances of more than 200 km, then there is a significant range within which HSR substitution effects can occur. In Spain, since most HSR connections lie within this range, we would expect a marked substitution effect with the introduction of new lines and the undermining of air transportation.

Evidence of sizeable losses in airline market shares and reductions in airline operations due to the opening up of HSR lines are documented for all countries with high speed lines. The substitution effect is well documented from the pioneering inaugurations of HSR lines in Japan and continuing network developments (Taniguchi, 1992; Clever and Hansen, 2008; Albaladejo and Bel, 2012) in the European pioneering state, France (Bonnafoy, 1987; European Commission, 1996; Vickerman, 1997; Klein, 1997) and in other European countries, including: Spain (European Commission, 1996; Román et al., 2007; Martín and Nombela, 2008; Jiménez and Betancor, 2012; Pagliara, Vassallo and Román, 2012), Italy

(Cascetta et al., 2011) and Germany (Ellwanger and Wilckens, 1993; Dobruszkes, 2011). Dobruszkes, Givoni and Dehon (2014) and Albalate, Bel and Fageda (2015) also show this substitution effect using various econometric techniques and for a sample of European routes. Similar impacts on air transportation have been documented in Asia, including Korea (Suh, Yang and Kim, 2005; Lee, Yo and Jung, 2012), China (Fu, Zhang and Lei, 2012; Wu 2013) and Taiwan (Yung-Hsiang Cheng, 2010).

Despite the foregoing, Steer Davies Gleave (2006) recognizes that competition between HSR and air transportation is not so straightforward when the air routes are operated by low-cost carriers. Similarly, Beherens and Pels (2012) show that while HSR is a competitor for both conventional and low-cost carriers, some conventional airlines subsequently pulled out of the London-Paris market. Indeed, the airline industry in Japan has only been able to grow with the appearance of low-cost carriers following air transport liberalization (Albalate and Bel, 2012).

In contrast to the above studies that have identified a substitution effect, a number of articles focus on the possible complementarities between modes (see Givoni and Banister, 2006). Dobruszkes (2011) finds that the flag carrier airline Lufthansa increased its services after the entry into service of the Cologne-Frankfurt HSR line.³ This showed that under certain circumstances HSR could complement rather than substitute air transportation. Dobruszkes, Dehon and Givoni (2014) also found complementarities in hubbing strategies led by the airlines. Likewise, Albalate, Bel and Fageda (2015) found some room for complementarities where HSR services have stations located within hub airports, since in such instances HSR could feed air demand. In contrast, Dobruszkes, Dehon and Givoni (2014) were unable to find any statistical support for airline/HSR integration at airport stations. Overall, in the European markets considered, the main relationship detected between HSR and air services is that of substitution. Albalate, Bel and Fageda (2015) show that airlines subject to competition from HSR reduce the number of seats made available on the route, while flight frequencies are not always subject to any reduction. In contrast, Dobruszkes, Dehon and Givoni (2014) found reductions on both seats and flights.

If we extend our analysis beyond the impact on air transportation and airports (which appear to be the main gateway for tourists), HSR is also found to substitute conventional rail services (typified by a higher number of stops and cheaper tickets). This substitution effect is usually triggered by rail service managers themselves as they seek to increase the occupancy rate of high-speed trains. As a result, it is not usual to see conventional and regional services being dismantled, as HSR is established as a node-to-node transportation mode, serving the main urban agglomerations. This process creates a tunnel effect, with the degradation of areas not served by the new HSR services, and a suction effect, as the main network nodes attract economic activity away from the smaller, less dynamic nodes. In studying the effect of HSR on tourism we need, therefore, to consider whether the tourist activity attracted – if any – is new or simply activity attracted from other locations that have seen a deterioration in their accessibility.

³ However, the airline was later forced to reduce flight frequencies with the entry into service of the Cologne-Munich HSR line, despite the fact that this service includes a number of stops and does not cover the whole trajectory at high speed.

3. High-Speed Rail in Spain

According to the International Union of Railways (UIC), Spain ranks second only to China in terms of the length of its HSR network, and first if we correct figures by population. In Europe, therefore, it is the clear leader and HSR has been and remains the main transportation development project for all Spanish central governments even under current budgetary constraints. However, this situation contrasts markedly with HSR ridership (number of trips) figures, which show that ridership is much higher in France, Germany and Italy despite their more limited networks. While ridership in Japan is well over 300 million, and over 110 million in France, the number of trips on the Spanish HSR network in 2010 was just 16.8 million. If we consider the intensity of network use (passenger-km per km of network), the ridership in France is five times greater than in Spain, while in Germany and Italy it is 4.4 and 2.6 times greater, respectively (Albalate, Bel and Fageda, 2015). Indeed, current figures are likely to show even greater divergences as low density HSR lines have been opened up in Spain, while the economic crisis has reduced demand across the whole network.



Figure 1. Spanish High Speed Rail network, 2014.

Source: International Union of Railways, UIC

This contrast between supply and demand highlights the fact that Spain's transport policy has not been governed by goals of efficiency, but rather on providing this new technology to all provincial capitals with the aim of connecting them to Madrid in the shortest possible time (Bel, 2011; 2012). The network structure illustrated in **Figure 1** is clearly radial, giving priority to connections between Madrid and the periphery as opposed to developing the country's transversal corridors, i.e., linking the tourist enclaves along the Mediterranean and Cantabrian Seas to the east and north of Spain, respectively. Albalate, Bel and Fageda (2012) have shown empirically that centralization has been the clear driver of transportation investments in network modes (railways and roads) in Spain, while mobility needs have been relegated to a secondary plane. For this motive, Spain represents an interesting case study as it does not suffer from

any selection bias that might arise from the fact of investing in and building HSR services in the country's main tourist locations. This disconnection between the location of HSR lines and economic decisions, especially tourist demand, strengthens the empirical strategy adhered to in the next section.

4. Empirical strategy

The empirical strategy adopted here to evaluate HSR impacts on tourism outcomes takes two different approaches. First, an extension of the differences-in-differences evaluation method is implemented for the Spanish provinces in an attempt at identifying whether HSR availability affects tourism at the provincial level. Second, an analysis is undertaken of the evolution of tourist numbers in ten Spanish cities before and after the arrival of HSR in order to identify any relevant structural changes at the local level.

4.1 HSR impact on tourism in the Spanish provinces

This study evaluates how HSR impacts on two tourism outcome variables: the total number of tourists (visitors) and the mean duration of their stays. We draw on tourism data provided by Spain's National Statistics Institute (INE) that covers 50 provinces with a 15-year time span (1998-2013).⁴ The method chosen is a slight extension of the differences-in-differences estimation procedure specified as a two-way fixed effects model that takes the following form:

$$Y_{ist} = X_{pt}\beta + \delta Z_{pt} + w_p + v_t + \varepsilon_{pt} \quad (1)$$

where Y_{pt} is the dependent variable (tourism outcome), X_{pt} contains the vector of time-varying control covariates, and Z_{pt} is the policy dummy variable to be evaluated – in this case, the availability of HSR services (D^{HSR}) or the number of HSR destinations (HSR_dest). As usual, w_p and v_t are province-specific and year-specific fixed effects and ε_{pt} is a mean-zero random error. Province fixed effects control for time-invariant province-specific omitted variables and year dummies control for province trends. The key element in this differences-in-differences model is the parameter δ , which measures the difference between the average change in tourism outcomes for provinces with HSR availability and the average change in those provinces without HSR.

Specifically,

$$\delta = [E(Y_A / G = 1) - E(Y_B / G = 1)] - [E(Y_A / G = 0) - E(Y_B / G = 0)] \quad (2)$$

where Y_B and Y_A denote tourism outcomes before and after HSR inauguration and $G = 1$ and $G = 0$ denote the treatment (provinces with HSR services) and control (provinces without HSR services) group observations, respectively.

Descriptive statistics for the variables included in model (1) are provided in **Table 1**. Two different dependent variables are included: the total number of tourists received (with a distinction being drawn

⁴ The autonomous cities of Ceuta and Melilla in Africa are not included.

between those of national and international origin) and the average number of overnight stays per tourist. Two policy variables are employed that consequently produce different specifications and evaluation outcomes. First, the impact of HSR is evaluated using a binary variable that takes a value of 1 if HSR is available in the province and 0 otherwise. Second, a discrete variable is used to identify the number of HSR destinations available from any given HSR node.

Note that following a standard transport economics rationale the variable of interest could be considered as being simultaneously determined by the number of tourists. Indeed, transportation policy could be designed so as to supply services and accessibility according to demand. Tourism would be a credible source of such demand, pointing to a problematic inverse causal relationship between the dependent and treatment variables. However, as explained in the previous section, transportation policy in Spain (especially with regard to HSR service endowments) bears no relationship with tourist activities. Indeed, the government policy has been to connect all the provincial capitals to Madrid, regardless of the demand in these corridors and tourism has never been officially recognized as a driver of HSR investment. This offers an appropriate source of identification.

Beyond these policy variables, three different groups of explanatory variables are controlled for here. First, time varying provincial characteristics that can affect the growth of tourism are considered. Thus, province size is introduced by including the total number of inhabitants (population), given that the total number of tourists is the dependent variable. Moreover, changes in the weather over time are controlled for by including annual precipitation (rainfall) and changes in the economic cycle are taken into consideration by including the unemployment rate of the province. Features of the climate and weather (Lise and Tol, 2002; Gómez, 2005; Day et al., 2013) and economic cycle characteristics (Bramwell and Lane, 2009; Guizzardi and Mazzocchi, 2010; Alegre, Mateo and Pou, 2013) are well-known determinants of tourism demand.

The second group of controls considers other simultaneous infrastructure policies and private initiatives within the transportation sector that might influence tourism outcomes and thus confound the effects of HSR openings. These simultaneous shocks are treated as dummy variables. Thus, the expansion of Spain's two hub airports (Barcelona and Madrid), which represents major infrastructure changes impacting the country's air transport market, and the decisions adopted by Ryanair to establish operating bases in selected provinces as part of its long-term strategic plan, are taken into account. Ryanair is Europe's leading airline and the most influential carrier in the tourist sector. In Spain, moreover, Ryanair is the leading airline in terms of passenger traffic. Vowles (2001) and Gillen and Lall (2004) show the competitive effect of low-cost carriers, which force regular carriers to cut their prices. This effect may well increase traffic in those provinces in which Ryanair establishes an operating base. As Castillo-Manzano et al. (2012) claim, the fact that Ryanair provides connections with Europe's main cities can have an effect on connections but it also reduces the number of flights to hubs such as Madrid and Barcelona, which were previously obligatory stopovers when travelling on to new destinations. This, therefore, reduces the traffic of regular carriers operating a hub-and-spoke strategy as opposed to a point-

to-point strategy. These substitution effects have been found to be especially detrimental to conference tourism (see Castillo-Manzano et al., 2011). Castillo-Manzano et al. (2012) also show that the arrival of Ryanair in Spain has meant that the majority of the airports (above all those in urban areas not specializing in sun-and-sand tourism charter flights) have benefited from the positive effects of Ryanair, especially those airports that were underutilized before the arrival of the airline. For these reasons, the inclusion of the impact of Ryanair in the equation is essential.

Table 1. Descriptive statistics for dependent and explanatory variables.

Variable	Description	Mean	Std. Dev.	Max	Min
Tourists	Number of tourists (visitors)	1402608	1807291	1.04e+07	135906
International_Tourists	Number of international tourists (visitors)	631940	43637	7435403	5305
Overnights	Nights spent in tourist installations	4963461	8832064	5.87e+07	207935
D ^{HSR}	Binary variable taking value 1 if HSR is available, 0 otherwise	0.1975	0.3983618	1	0
HSR_dest	Number of HSR destinations accessible from HSR station	0.72375	1.758921	15	0
Population	Inhabitants	877910.6	1070920	6498560	85101
Unemployment	% of unemployed in the province	14.62578	7.653943	42	3
Rainfall	Milliliters of rain recorded at the province's control station	554.1469	324.5671	2450	64
MAD_T4	Airport enlargement in Madrid	0.01	0.099561	1	0
BCN_T1	Airport enlargement in Barcelona	0.005625	0.072715	1	0
Ryanair	Ryanair operating base	0.0542625	0.2202728	1	0

Finally, time fixed effects are considered in addition to province fixed effects, omitting the initial year from the time span, i.e., 1998, which acts as a benchmark for the coefficients attached to all remaining year-specific binary variables. As discussed above, this strategy allows us to account for all factors that have a common influence on the tourism outcomes of the provinces, but which can change over time. Additionally, it allows us to account for year-specific shocks not considered in the group of controls or other simultaneous policies.

Because differences-in-differences in panel data with long time spans can be misleading in the presence of serial correlation (see Bertrand, Duflo and Mullainathan, 2004), an arbitrary variance-covariance matrix is used to account not only for heteroskedasticity but also for serial correlation within provinces. In addition, the same estimations are included using an AR(1) error structure.

Note that the differences-in-differences method assumes that a counterfactual is estimated by considering the change in the outcome variable for the control group and the expected change recorded by the treated group if treatment had not occurred. However, for this assumption to be valid it is necessary to demonstrate that the temporal effect in the two groups of provinces (treated and controls) is the same in the absence of HSR. A simple strategy for verifying this assumption is to estimate the equality between average changes in the two groups in the absence of intervention (see Galiani, Gertler and Schargrodsky, 2005). Here, the equality between average changes in the two groups in the pretreatment period is tested

for in order to assess the plausibility of the fundamental identifying assumption. The strategy involves considering only the pretreatment years in each treated province, excluding observations from the treated years, in addition to the observations from each control province for the whole time span. Equation 1 can now be estimated, but the time dummies for the treatment and control provinces are dealt with separately because this enables us to determine whether the time trends in the pretreatment period are the same. The HSR binary variable is also dropped from the equation. The results for this test confirm that we cannot statistically reject the hypothesis of having the same time trends in the pretreatment period for the control and treatment groups. This reaffirms the fundamental identifying assumption and ensures that the differences-in-differences method is an appropriate quantitative impact evaluation strategy.

5. Results

5.1 HSR impact on tourism in the Spanish provinces

The econometric results of the impact of HSR on tourism at the provincial level are presented in **Table 2**. It can be seen that HSR had a detrimental impact on tourism in the provinces of Spain in which this mode of transportation was introduced. Overall, the mean impact can be calculated as a reduction of around 128,000 tourists following the introduction of HSR services (Column 1) and an average of roughly 30,000 fewer tourists for each destination considered (Column 2). This result is consistent across all policy variables, although the statistical significance differs between the simple binary variable (D^{HSR}) and the number of extensions and destinations, the latter being much higher although the coefficients are lower. This result is attributable to the fact that HSR has substituted air transportation, a major mode for tourism mobility, in many corridors. Following the inauguration of HSR services, the airlines reduced their flight frequencies and seat numbers and even stopped serving various routes in Spain. According to the figures reported here, HSR has been unable to offset these losses and is incapable of generating new traffic. In fact, overall it would appear that the net changes corresponding to mode substitution are negative in terms of tourist numbers. Yet, these effects are not statistically significant when using an AR(1) error structure, albeit that the coefficients remain negative.

Indeed, the amount of traffic actually induced by the introduction of HSR services has been much lower than forecast. By way of illustration, 50% of the traffic on the Madrid-Seville route (de Rus and Inglada, 1997) and 20% on the Madrid-Barcelona route (Coto-Millán et al., 2007) were expected to be induced. In practice, however, only 26% on the Madrid-Seville and 9% on the Madrid-Barcelona route (PWC, 2010) is induced traffic, with the rest being attributable to mode substitution. These figures are in line with the results reported by Preston (2013) and Givoni and Dobruzskes (2014).

This interpretation is consistent with recent results published by Albaladejo, Bel and Fageda (2015), who found that airlines reduced both the number of seats and flight frequencies when faced with competition from HSR services in Spain during the period 2002-2010. Similar results were also found for Italy and France, but only on routes with a hub airport at one of their ends. In contrast, the results reported herein show that hub airport enlargements have been net contributors of tourists due to their externalities in the

Spanish airport system. This suggests the relationship between tourism and airlines is closer than that between tourism and HSR.

Table 2.

Least squares estimates for the double fixed effects equation. Total number of tourists.

Variables	FE Tourists (1)	FE Tourists (2)	FE Time effects (3)	FE with AR(1) (4)	FE with AR(1) (5)	FE with AR(1) Time Effects (6)
D^{HSR}	-128504.2* (64980.67)	-	-	-75150.9 (65235.12)	-	-
HSR_Destinations	-	-28970.01***	-	-	-294.879 (20010)	-
HSR First Year	-	-	75303.25 (95116.14)	-	-	90250.29 (71841.55)
HSR Second Year	-	-	-76804.55* 46040.24	-	-	-3907.42 (80127.7)
HSR Third Year	-	-	-124193.9** 49788.95	-	-	-95015 (79206.2)
Population	2.340*** (0.5632)	2.40031*** (0.5462)	2.29512*** 0.5394624	1.397644 *** (0.2948)	1.38375*** (0.30286)	1.382582*** (.2962744)
Unemployment	-1464.191 (8702.91)	-1880.163 (8590.80)	-2058.201 8701.01	-3877.271 (5534.37)	-3721.878 (5541.818)	-3466.59 (5543.55)
Rainfall	36.1262 (78.124)	31.21176 (76.4071)	43.23696 79.237	51.229 (69.297)	51.35 (69.34)	51.42 (69.23)
BCN_T1	2203263*** (256520.7)	2197522*** (242279.6)	2136085*** 226659.2	1647926*** (300559)	1622310*** (301362)	1672297*** (305569)
MAD_T4	1096757*** (394038.1)	1234238*** (362456)	1153071*** 366400.8	1308277*** (246089.6)	1318034 (247277)	1314342*** (246256.8)
Ryanair	384719.8 (363656.9)	383457.8 (363974.8)	389148.8 (362559.5)	497265.3*** (86079.06)	496802.7*** (86230.37)	246256.8*** (86251.24)
Time and Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	Yes	Yes	Yes	No	No	No
R2	0.71	0.71	0.71	0.55	0.55	0.68
F-test of Joint Significance	75.75***	75.35***	74.84***	8.60***	8.59***	13.55***

*Note: Standard errors in parentheses (Robust to heteroskedasticity) and clustered by province
Significance at 1% (***), 5% (**), 10% (*).*

The results reported herein are also likely to be affected by the typical profile of the HSR user. HSR services are not cheap but rather attract business users who are more willing to pay for time savings. Leisure passengers, by contrast, are more price sensitive and more willing to wait, prioritizing monetary costs over time costs. This could also account for the mix of users found on HSR.

The analysis of timing effects presents a number of interesting findings. Thus, the opening up of a new HSR service appears to induce traffic in the short run, even though in the long run the service may have a negative impact on tourism. Destinations, because they are fixed and only a small number of options exist, are naturally limited. However, if there is a positive effect of HSR on the number of tourists, this can be expected in the first few years following the inauguration of the service. This hypothesis is tested

in equation (4). In line with Eisenberg (2003) and Albalade (2008), a flexible specification is included here in which binary variables are used to identify the first, second and third years following service inauguration. The results show that while the coefficient associated with HSR is not statistically significant for the first year, it is positive. However, this effect is quickly reversed. Thus, in the second year of operation, a negative outcome is recorded at the 10% level of statistical significance, while in the third year a large negative coefficient is obtained with a more efficiently estimated magnitude at the 5% significance level. Thus, HSR may enjoy a premium in the first year of operation but apparently it quickly damages tourism with respect to its counterfactual. This can be explained in part by the fact that tourists tend not to repeat destinations and also in terms of a sector adjustment, a restructuring of the airline market that takes place during the first year of competition.

Very similar results are found for international tourists, although the coefficients in this case present a lower magnitude at a lower level of statistical significance. According to the results in **Table 3**, HSR does not affect international tourist arrivals in terms of HSR station availability or in terms of destination. Moreover, according to the magnitude of the results, the impact of HSR on tourism does not vary with the origin of tourists (i.e., national or international). Thus, the mean impact on national tourists (-62.669) is very similar to that on international tourists (-65.835), albeit that the effect on the latter is more precisely estimated. We also find a very similar timing for the effects, with positive (but not significant) coefficients for the first year following inauguration of an HSR station but negative and statistically significant coefficients in the second year which increase in the third year.

Finally, **Table 4** shows the results for the same equations but for a different variable of tourism outcomes. Here, interest is not solely in the number of tourists but in the number of overnight stays as well. The results indicate that HSR does not affect the number of overnight stays, although in the case of the timing effects equation a negative and statistically significant impact is found in the third year. If we consider the average number of overnights (as opposed to the total number of overnights), the impact of HSR does not differ. Overall, HSR does not seem to exert any influence on the duration of stays, not even in the timing effects model.

Table 3.*Least squares estimates for the double fixed effects equation. International tourists.*

Variables	FE	FE	FE	FE with	FE with	FE with AR(1)
	International Tourists	International Tourists	International Time effects	AR(1)	AR(1)	Time Effects
	(1)	(2)	(3)	(4)	(5)	(6)
D^{HSR}	-65834.63 (45213.39)	-	-	-25139.25 (35567.78)	-	-
HSR_Destinations	-	-13124.99 (14811.45)	-	-	5377.87 (10943.23)	-
HSR First Year	-	-	60131.16 (58093.22)	-	-	-7992.463 (34976.3)
HSR Second Year	-	-	-65421.23 (46394.95)	-	-	-86875.22* (42764.25)
HSR Third Year	-	-	-143134.7** (59653.58)	-	-	-109312.9*** (42541.56)
Population	1.2590*** (0.4675)	1.28415*** (0.4726)	1.235467*** (0.44986)	0.72412*** (0.16459)		0.7196*** (0.16439)
Unemployment	1435.614 (6661.40)	1207.08 (6555.25)	1496.105 (6509.92)	-4704.44 (3011.65)		-4367.02 (2998.09)
Rainfall	-39.749 (40.171)	-41.617 (40.940)	-36.0249 (37.001)	-15.6996 (37.347)	-15.287 (37.344)	-15.360 (37.09)
BCN_T1	1991273*** (204789.3)	1983776*** (190282.7)	2010270*** (180106.7)	1311401*** (165358.2)	1296458*** (165571.5)	1363300*** (167189.6)
MAD_T4	182082.3 (350131)	247151.8 (316078.7)	202194.8 (337971.5)	471728.8*** (134205.2)	469284.1*** (134638.6)	471468.5*** (133484.5)
Ryanair	181871.9 (132814)	181422.1 (132493.3)	190447.5 (131001.1)	191121.8*** (46819.78)	190012.5*** (46856.47)	192263.5*** (46630.5)
Time and Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	Yes	Yes	Yes	No	No	No
R2	0.69	0.69	0.69	0.33	0.33	0.34
F-test of Joint Significance	68.16***	67.72***	62.73***	13.73***	13.69***	

*Note: Standard errors in parentheses (Robust to heteroskedasticity) and clustered by province
Significance at 1% (***), 5% (**), 10% (*).*

Table 4.
Least squares estimates for the double fixed effects equation.

Variables	FE	FE	FE
	Overnights	Overnights	Overnights
	(1)	(2)	(3)
D^{HSR}	-456532.8 (331298.4)		-
HSR_Destinations	-	-102046.6 (105766.4)	-
HSR First Year	-		357454.4 (238716.5)
HSR Second Year	-		195538.6 (141783.3)
HSR Third Year	-		-578682.3* (297357)
Population	3.538383*** (.87689)	3.748285*** (.9430769)	3.439533*** (.8433509)
Unemployment	20307.66 (57906.81)	18822 (57272.87)	19513.45 (57327.26)
Rainfall	-262.67 (356.)	-279.7986 (356.2294)	-242.5841 (351.4628)
BCN_T1	6181373*** (430891.9)	6158658*** (431406.2)	6095105*** (388929.4)
MAD_T4	949728.5 (1081310)	1435422* (758564.8)	1062982* (996845)
Ryanair	1226339 (1001450)	1221956 (999455)	1256211 (1012904)
Time fixed effects	Yes		
R2	0.39	0.39	0.39
F-test of Joint Significance	-		

Note: Standard errors in parentheses (Robust to heteroskedasticity) and clustered by province.

*Significance at 1% (***), 5% (**), 10% (*).*

5.2 HSR impact on tourism in selected cities

Given the possibility that HSR generates local effects that contribute solely to tourist activity in cities with new infrastructure, the relationship between HSR openings and tourist outcomes needs to be examined. **Figures 2-11** illustrate the impact on a sample of ten tourist cities that received HSR services during the period January 2005–September 2013. Specifically, they show the monthly number of tourists in each tourist enclave before and after the inauguration of HSR services. Tourist data were obtained from the INE. The analysis concerns itself exclusively with national tourists since they enjoy better accessibility to Spanish cities via HSR services, while it is expected that international tourists are not affected so markedly by the fact of having HSR in their city of residence. Moreover, if it is not possible to identify an impact of HSR services on national tourists, it is unlikely that this effect is to be found for international tourists (as we have seen in the previous empirical exercise). Note that this analysis does not include tourist cities in which HSR services were already present before the start date (January 2005) – namely, Madrid, Seville and Cordoba – and those that have yet to receive HSR services.

As the figures below show, it is hard to identify a clear relationship between HSR and tourist outcomes in any of the ten cities. Indeed, HSR does not appear to produce a noticeable impact even among national tourists.

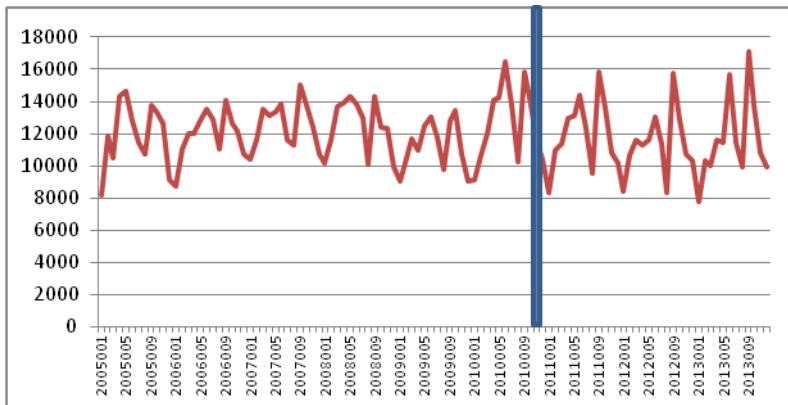


Fig. 2. Albacete. Monthly number of national tourists before and after HSR inauguration.

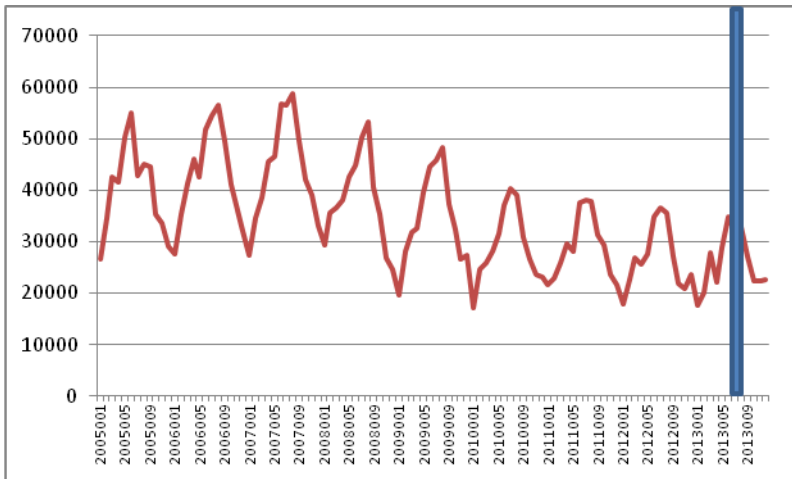


Fig. 3. Alicante. Monthly number of national tourists before and after HSR inauguration.

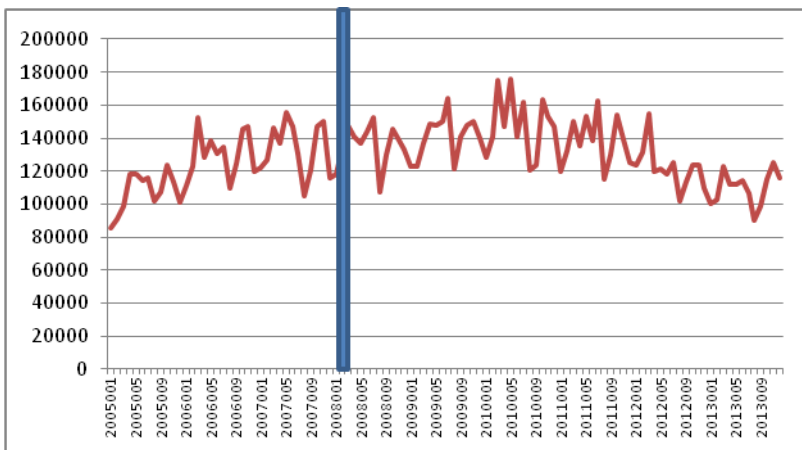


Fig. 4. Barcelona. Monthly number of national tourists before and after HSR inauguration.

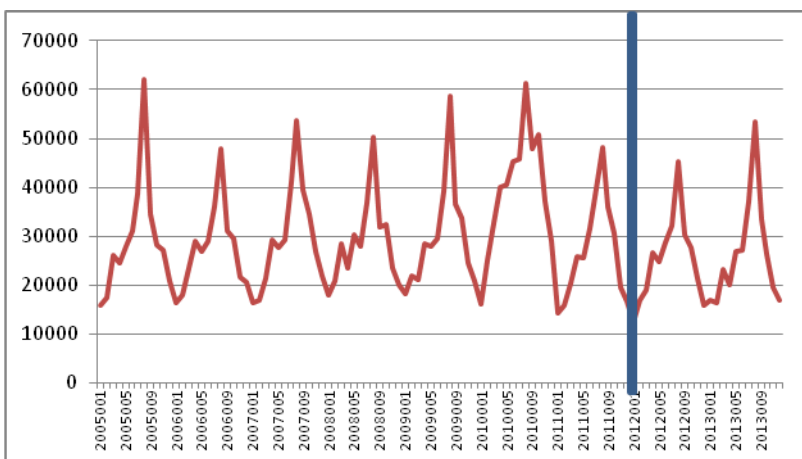


Fig. 5. Santiago de Compostela. Monthly number of national tourists before and after HSR inauguration.

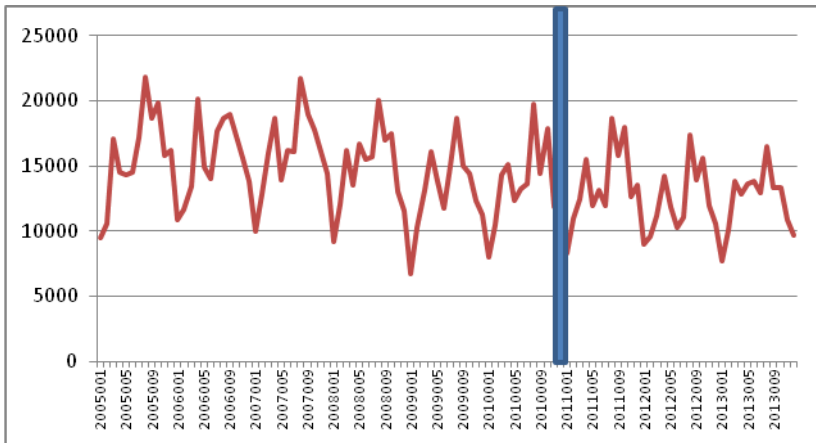


Fig. 6. Cuenca. Monthly number of national tourists before and after HSR inauguration.

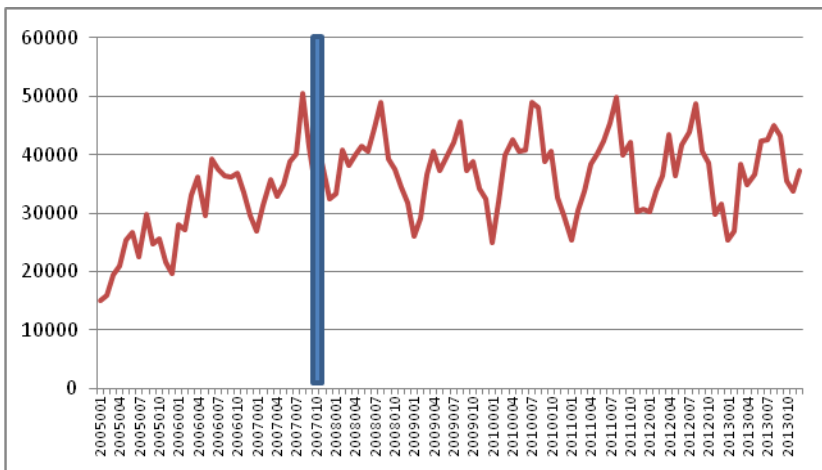


Fig. 7. Málaga. Monthly number of national tourists before and after HSR inauguration.

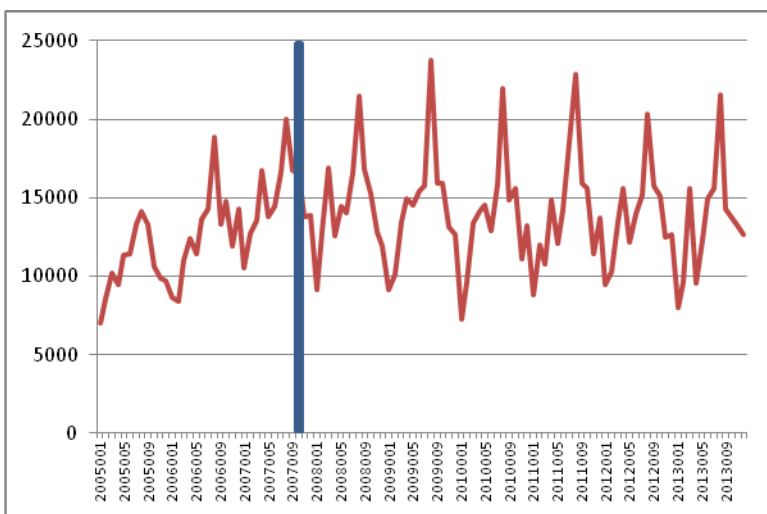


Fig. 8. Segovia. Monthly number of national tourists before and after HSR inauguration.

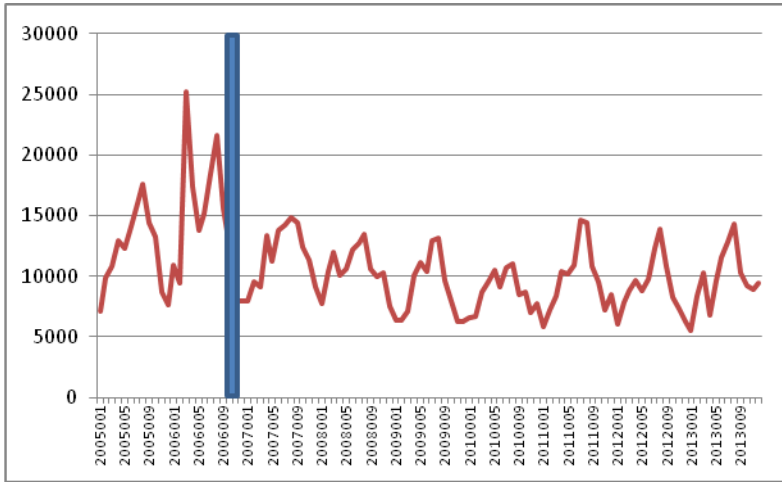


Fig. 9. Tarragona. Monthly number of national tourists before and after HSR inauguration.

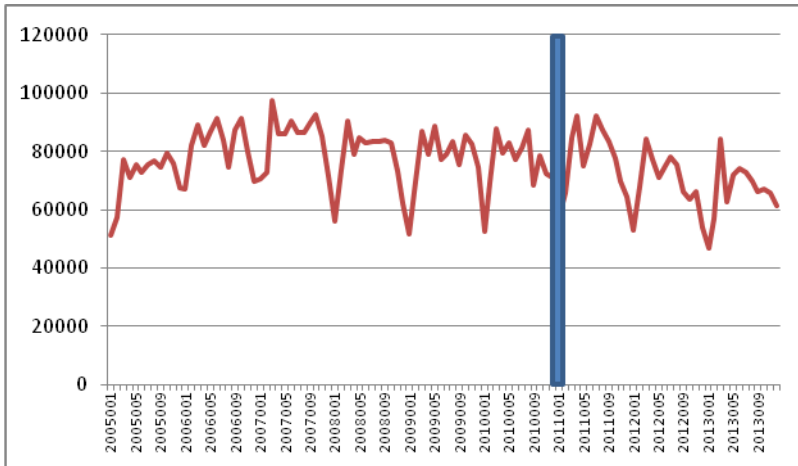


Fig. 10. Valencia. Monthly number of national tourists before and after HSR inauguration.

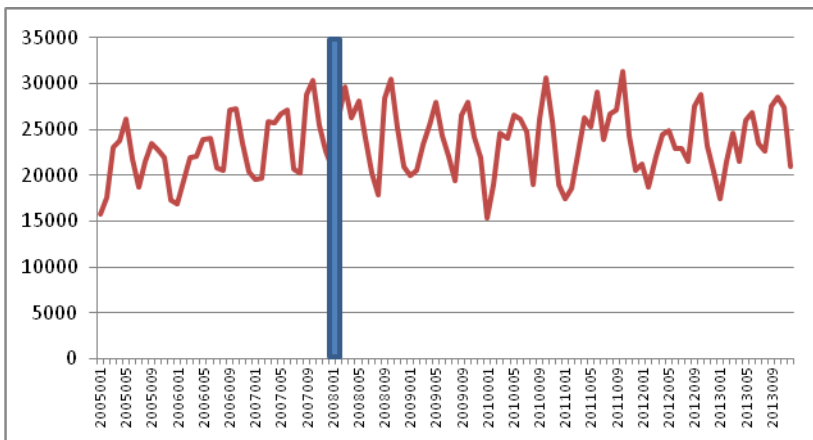


Fig. 11. Valladolid. Monthly number of national tourists before and after HSR inauguration.

6. Concluding remarks

Little is known about the relationship between HSR and tourism, although new transport infrastructure is commonly believed to have positive impacts on the tourist areas it serves. However, this paper has unexpectedly presented evidence of contrary outcomes in Spain. It appears that not only has HSR failed to promote tourism in the areas (provinces) receiving new HSR lines, but it has also damaged to some degree the development of the tourist industry. These effects would seem to be attributable to the fact that HSR has undermined the most important mode of transportation for tourism, namely the airlines. This is particularly true for the case of international tourists, given that around 80% of tourist arrivals in Spain take place via the air. Timing effects tests appear to show that the introduction of HSR led to an increase in the number of tourists during the first year of operation, though this increase cannot be shown to be statistically significant. Moreover, this positive effect has been reversed by the second and third years of operation when a large and statistically significant fall is seen in the total number of both national and international tourists being carried. This absence of a positive impact is further confirmed at the local level, though we are unable to provide multivariate statistical estimates. The examination conducted here of the evolution in tourist numbers before and after the inauguration of HSR services for a sample of Spain's tourist cities does not identify any noticeable effect.

In short, this paper highlights the importance of intermodal interactions and the pressing need to develop integrated transportation plans. Interestingly, the paper's findings illustrate that at times more can in fact mean less. Augmenting the supply of transportation with additional modes can have a detrimental effect on economic activities (including tourism) when the mode that loses out is air transportation. Although further research is required to understand fully the impact of HSR on mobility and, particularly, on tourism, this paper provides a more skeptical view of HSR development projects, which are usually initiated with great enthusiasm and optimism and often with the full backing of the tourism industry. This paper's conclusions, therefore, are very much in line with the findings from the ex-post literature that point to the potentially disappointing impact of HSR developments.

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