LOCAL TOURISM EFFECTS OF HSR IN SMALL CITIES: THREE SYNTHETIC CONTROL CASE STUDIES[1]

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Abstract. The inauguration of high-speed rail (HSR) services is often associated with renewed expectations of revitalization of local tourism activity in sparsely populated regions. However, the empirical literature on the actual ex-post effects of this transport mode is scarce. This paper contributes to this line of research by estimating the causal impact of the HSR on the number of visitors in three small cities located in low-density areas in Spain. Our results, using the synthetic control method, robustly show that the ex-post causal effects of the HSR on overnight visitors are insignificant and, if any, they seem to exert a negative influence rather than a positive contribution. This suggests that smaller cities should be very cautious about the short-run expected impacts of transport improvements, and policy makers and planners should be aware of the actual contribution of such investments in their assessment of the net social benefits of HSR projects.

Keywords: HSR; Tourism; Local effects; Small cities.

JEL. Codes: L92, L83

[1] Authors thank comments and suggestions by three anonymous referees. Nevertheless, all errors are ours.

1. Introduction

In many countries around the world high-speed rail (HSR) is widely regarded as a notable upgrading in the existing transport system, a remarkable time-saving progress and as undeniable accessibility improvement for cities located in the range of 200-600 kms.[2] Politicians, businessmen and consumers alike often greet the opening of a new HSR line with great joy assuming that it will immediately boost local economic activity by attracting new visitors and investors. Indeed, the tourism sector usually joins them in lobbying and pushing to welcome this modern mode of transport in the expectation of revitalizing their tourist demand. This is especially striking in lagging territories, where the promise of greater economic opportunities and dynamism associated with such infrastructure promotes greater hopes and attachment to the project. The argument is that improved accessibility – decreasing the generalized cost of travel - will increase demand for transportation and thus, spur business and leisure travel. This will benefit connected cities thanks to their gained relative competitive advantage, what would create wider economic effects (See Blanquart and Koning, 2017; Vickerman, 2018).

Scholars have proposed categorizations of tourism determinants and all of them highlight the role of accessibility, on which transport infrastructure and travel services are of critical importance. Della Corte *et al*. (2010), for instance, proposed a six "A's" scheme of determinants in which "Accessibility" to the destination was the first mentioned. Thus, following the mechanisms proposed by Litman (2021), there 12 traits of transportation that explain why its improvements could induce tourism benefits. Among them, he highlights transport quality (speed, comfort, and safety), network connectivity, cost and affordability, intermodal integration, etc. All of them lowering the generalized cost of travel which should induce new demand, especially in isolated lagged territories.

In Spain, for instance, the Transportation Ministry presented a comprehensive study on the improvements in the railway sector, which explicitly declared that "connecting de-populating areas" and "promoting tourism" were among the objectives of the Spanish government with these transportation infrastructures (Ministerio de Fomento, 2014).

Unfortunately, these ex-ante expectations are not always confirmed, and both economic growth and decays might appear at the local level with and without HSR investments. The literature on the effects of HSR investments on the local economy has produced mixed results, which justifies the need for case studies accounting for the specific context of each experience.[3] In relation to the impact on tourism, for example, there remains a need for disaggregated empirical evidence on the actual impact of these rail services on the number of visitors in HSR-connected areas and the extent to which causality can be accurately attributed to these transport improvements. Some recent papers for the Spanish

[2] Socioeconomic impacts of HSR undertakings go well beyond the accessibility-related ones and affect project assessment, as recently pointed out by Cheng and Chen (2021).

[3] See Blanquart and Koning (2017) for a review of theories and evidence on the relationship between High-Speed Rail and tourism.

case suggest that HSR might not have the expected effects in attracting more visitors to tourist sites (Albalate and Fageda, 2016; Albalate *et al*., 2017). This is particularly disappointing for low-density lagging areas that place their hopes on the positive shock that the arrival of high-speed rail can bring. Therefore, and following the findings in Albalate *et al*. (2021), this paper aims to examine the effects of the arrival and consolidation of HSR services on local tourism in some of the most depopulated provinces in Spain, focusing on their main municipalities (i.e., the province capital cities).

We believe that the Spanish experience – a leader in Europe both in terms of tourism and in the deployment of high-speed rail services (named AVE, or *Alta Velocidad Española*) – provides a valuable case study of what can be expected in terms of tourism development from the arrival of a large network infrastructure in low-density areas. We aim to contribute to the policy debate on infrastructure spending and allocation decisions at both national and local levels, as well as to better inform the perception of tourism managers and planners on the real effects of transport investments.

For this purpose, we have built an *ad hoc* database that includes all AVE connections to low-density Spanish provinces (less than 30 inhabitants per km^2) whose capital cities – where the HSR station is located – have less than 200,000 inhabitants. Then, we empirically analyze the local effects of the new rail services in terms of local tourism activity. From a methodological point of view, we robustly estimate the causal effect of HSR services on overnight tourists with a synthetic control method for three selected treated cities that are capitals of low-density areas far enough (at least 100 km) from large nodes and metropolitan areas: Albacete, Cuenca, and León.

The structure of the rest of our work is as follows. First, in *Section 2*, we will briefly review the relationship between the expected impact of high-speed rail investments on regional growth and, particularly, on tourism. *Section 3* summarizes the main descriptive statistics of tourism outcomes for the municipalities considered in our database, as well as their comparison with the average of other municipalities with similar characteristics but that did not receive HSR investments. Using the synthetic control methodology, we devote *Section 4* to analyze the impacts of HSR on the local tourism activity for each of the three selected (or 'treated') case study municipalities, whereas *Section 5* concludes with a summary and brief discussion of our most relevant empirical findings in order to shed some light on what policy makers and tourist managers could expect from the connectivity produced by HSR.

2. Related literature

Economic activity is generally characterized by great spatial inequality, such as disparities between densely populated manufacturing areas and sparsely populated agricultural regions, between congested cities and abandoned rural areas. This may not be the result of natural differences between locations, but rather the result of cumulative processes, which necessarily involve some form of increasing returns, so that geographic concentration may be self-reinforcing. The role of transport investments in reversing the

negative consequences of these effects is based on their effective capability to increase proximity for people and firms.

This is the idea posed in Albalate *et al.* (2021) regarding high-speed rail (HSR), where despite acknowledging the existing consensus on its ability to increase the accessibility in its routes, it also suggests that the overall results are not always evenly distributed, a key point in this literature. HSR destinations (and surrounding areas) often earn new economic opportunities, while 'in-between' areas receive a lower share of benefits due to the so-called 'tunnel effects'; they may even reduce their previous attractiveness. Bazin *et al.* (2006), for example, studied the impact of new French TGV services in rural areas on different industries from 1990 to 1999, and found that larger impacts on productivity and higher GDP gains were often associated to the areas that were already most developed prior to the investments.

A number of recent papers studying the case of China – the country with the largest HSR network – also provide mixed results. Some of them[4] challenge these conclusions by finding the positive impacts on rural areas (which, as opposite to Europe, are also densely populated), whereas others suggest that the development of HSR promotes the growth in large cities, but not in small and medium-sized ones. In routes where HSR is relatively backwards, it increases its marginalization, resulting in a negative impact (Shi, 2019), and there are cases that even suggest that HSR connections hinder the local economy, especially in peripheral regions (due to population relocation and restructuring of industries, Gao *et al*., 2020). Li *et al*. (2020) also show that the net effect is positive for cities with already high growth rates, and negative for cities with lower ones, in a sort of siphon effect.

Other papers have specifically focused on the relationship between new HSR stations and tourism performance at the local and regional level (see Duval, 2020 or Garau *et al*. 2021). Most of them consider that an accessibility improvement in a tourism destination will lead to an expansion of visitors figures due to the reduced generalized transport cost. This positive impact is confirmed by several studies (Masson and Petiot, 2009; Bazin *et al.* 2010; Wang *et al.*, 2012; Delaplace *et al*., 2014) and is often regarded as the most relevant positive externality associated with new rail investments (see Murakami and Cervero, 2017, for example). Unquestionably, this expected improvement in the tourism attractiveness of a destination, if true, provides new opportunities for additional services, businesses, and employment (see Feliu, 2012 or Guirao *et al*., 2018), and a boost for local public revenues (see Hernández and Jiménez, 2014).[5]

[4] See, for example Jia *et al.* (2017), Chen and Haynes (2017), Wang and Duan (2018) or, more recently, Liang *et al.* (2020) or Li and Ma (2021). An extensive review, including some empirical estimates, can be found in Wang and Dong (2022).

[5] Although it is not the only factor, the future of tourism is undoubtedly connected to transport improvements, not only from a technological point of view, but also in relation to the accessibility of hitherto unreachable destinations, as pointed out by Galvagno and Giaccone (2019), or Bastidas-Manzano et al. (2021).

However, ex-post evaluations of the relationship between high-speed rail and its effects are often much more modest. Analyses of several lines in France show that the availability of a HSR connection adds value to already popular tourism destinations but does not suffice by itself to promote less-known areas. Although the initial impact of High-speed Rail on tourism figures may be positive, the number of overnight stays may decrease (Bonnafous, 1987; Klein and Claisse, 1997), and the type of visitor often becomes more oriented towards business travel due to this new service. In some cities the arrival of HSR led to the disappearance of small hotels with limited attractions, while large national chains increased their supply. Similarly, Bazin et al. (2014) examined the effect on destinations located less than one-and-a-half hours from Paris, finding some positive (but not long-lasting) effects. They also confirmed the decrease in overnight stays. More recently, Delaplace and Bazin-Benoit (2017), concluded that HSR seems to be more profitable in terms of its contribution to tourism in large municipalities, where local agents are more able to cooperate and provide additional amenities and incentives for travelers to stay longer.

Similar results have been found for Spain. For example, Clavé *et al.* (2015) showed that the improvement in visitors figures due to the AVE connection was irrelevant around the coast of Tarragona. In Alicante, Ortuño-Padilla *et al.* (2015) estimated an increase of just over 20,000 tourists per year in the province after the AVE connection with Madrid and Valencia, and Albalate (2015) showed that the number of tourists grew faster in Spanish provinces not connected to the HSR network than in connected destinations, suggesting that factors other than the availability of rail services may have a greater influence on tourism attraction.[6]

One reason for this unexpected lack of significance of the AVE at the local level could be found in how the availability of rail services affects local destination choices. Guirao and Soler (2008) study the case of the small city of Toledo, while Pagliara *et al.* (2015) focus on Madrid and Gutiérrez *et al*. (2019) on the Catalan coast. Overall, their results indicate that the presence of HSR services is not a key factor influencing visitors' choices, since most of them are international tourists who can only arrive by air. However, the availability of AVE routes seems to be attractive for them when visiting nearby locations in short trips or one-day excursions. Curiously, a similar conclusion is reached by Chen and Haynes (2015) when investigating the impact of Chinese HSR services on their international tourism demand.

From an empirical point of view, some recent works have further explored the always controversial causality direction of all these effects. For example, Gao *et al.* (2019) evaluated the impact of high-speed rail investments on tourism growth in China using a difference-in-differences approach and found that HSR connections did not promote tourism revenue despite boosting tourist arrivals, leading to a negative net effect on tourism revenue per arrival. Hou (2019) confirmed these conclusions using a quasi-

[6] These results were later confirmed by Albalate and Fageda (2016), Campa *et al*. (2016), Vázquez and Navarro (2016) and Albalate *et al.* (2017).

experimental methodology, arguing that there were significant differences in results depending on the city size and whether domestic or international tourism arrivals were considered. As noted by all these studies, the evidence is not yet conclusive. For that reason, the following sections present, as a case study, a detailed causal analysis of the relationship between tourism and high-speed rail investment in Spain.

Finally, it is worth mentioning this paper builds on previous works and previous evidence and contributes to this line of research in several ways. Some recent works drawing into the Spanish experience have explored the average treatment effect of HSR considering all provinces (Albalate and Fageda, 2016) or all local touristic enclaves (Albalate, Campos and Jiménez, 2017). The goal of these papers was to evaluate and estimate average impacts of HSR arrivals on heterogeneous samples of Spanish provinces and touristic enclaves, respectively. Both used panel data econometric methods, which were suitable for the objective and data of their empirical strategies. Guirao and Campa (2016) and Campa et al. (2019) also provided very interesting empirical evidence both at provincial and enclave level.

We also build on previous research to account for tourist demand predictors other than HSR infrastructure to implement synthetic control methods. Assaf and Josiassen (2012), categorize tourism determinants into 8 groups: Infrastructure, Economic Conditions, Security, price competitiveness, government policies, environmental sustainability, labor skills, and natural resources. Some of these determinants are more relevant for international tourism attraction in developing countries (i.e., Security, government policies, labor skills, natural resources), where alternative destinations may vary greatly in these features. In developed European economies with consolidated and specialized tourism industries, accessibility provided by transportation, the relative economic conditions –income, business cycle-, demographic features – population and its density- and price competitiveness are expected to be good predictors of tourism demand as shown in several recent studies (Massidda and Etzo, 2012; Serra et al. 2014).

Our paper contributes to this literature by focusing on low density lagged areas to evaluate whether HSR can be a driver of regional development through its impact on the tourism industry, as has been claimed and expected by policy makers and local tourism lobbies. This relationship was first explored, very descriptively, in Albalate et al. (2021), where we just computed the main differences in tourism outcomes before and after the inauguration of HSR stations in low density province capitals and compared them to a sample of other control province capitals that were not affected by this infrastructure. That analysis was not causal but substantiates the hypothesis tested in this paper. Thus, we contribute to the literature by providing the first quasi-experimental causal evaluation of how HSR do affect tourism in lagged low-density and isolated areas. With this, we contribute to the debate on the real ex-post impacts of HSR rail and, as a result, to the design of infrastructure policy for the development of lagged and rural territories.

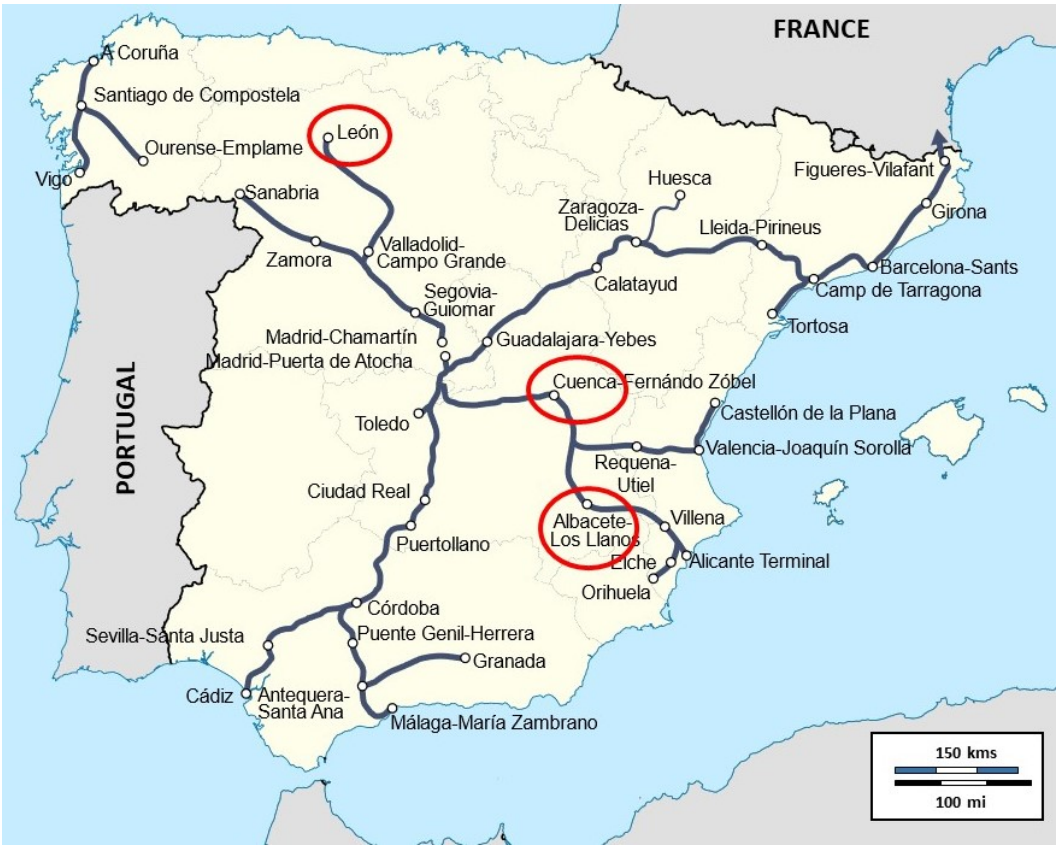
3. Data and methodology

In this paper we have built a panel dataset of all Spanish municipalities (unit of analysis) with a population lower than 200.000 inhabitants (on average, for the whole period considered), followed for 15 years. It includes detailed information about their monthly number of visitors extracted from the 'Hotel Occupancy Survey' (*Encuesta de Ocupación Hotelera*), the most reliable tourism source in the country, which is available online at the Spanish Statistical Office (www.ine.es). Specifically, we use as our dependent variable the total number of overnight visitors (i.e., those spending one or more nights in a hotel of any category) in city *i*, during month *m* of year *t*. Our initial period is January 2005, and the final period is December 2019. In total, we have 13,860 observations related to 77 cities.

As widely recognized since Song et al. (2010, 2012), tourism activity can be measured in terms of four main variables: people (tourists, accommodation), money (expenditure, income), time (stays, trip length) and space (distance, trip length). An appropriate combination of these variables would certainly provide a complete picture of tourism demand and supply for a particular destination. When some of them are not available, this overall picture can be approximated by simplified (but imperfect) indicators such as the number of overnight stays. This is a typical unit of measurement accepted by the Eurostat office under the EU Directive 95/57/EC on tourism statistics, as it provides an advanced indicator on the foreseeable evolution of the remaining indicators, especially at local level. A similar approach is found in Gössling et al. (2018) and Baggio (2019).

Our analysis focuses on the effects of AVE services in three Spanish cities, which are low-density provincial capitals: Albacete, Cuenca, and León. The selection of these three cities is justified by the following criteria. First, we are interested in the expected revitalization effects of the new rail services in less populated regions. These three cities belong to provinces with less than 30 inhabitants per km^2 and have less than 200,000 inhabitants. Second, we are considering only cities that are at least more than 100 km from any major city or main AVE station, to focus on the effects in relatively isolated areas, which do not receive HSR spillover effects from major cities, such as Toledo and Segovia, for example, which may receive tourists whose main destination is the city of Madrid. Third, given that the AVE network in Spain is precisely designed to connect provincial capitals, we expect that the main effect of the HSR on tourism will be found, if any, in the municipality closest to the station, i.e., the provincial capital (see Figure 1). Fourth, we consider provinces with at least 5.000 hotel beds. This means that our results cannot be extrapolated or inform about HSR effects on any context, but to a very specific and singular context of small and medium cities in low-density provinces.

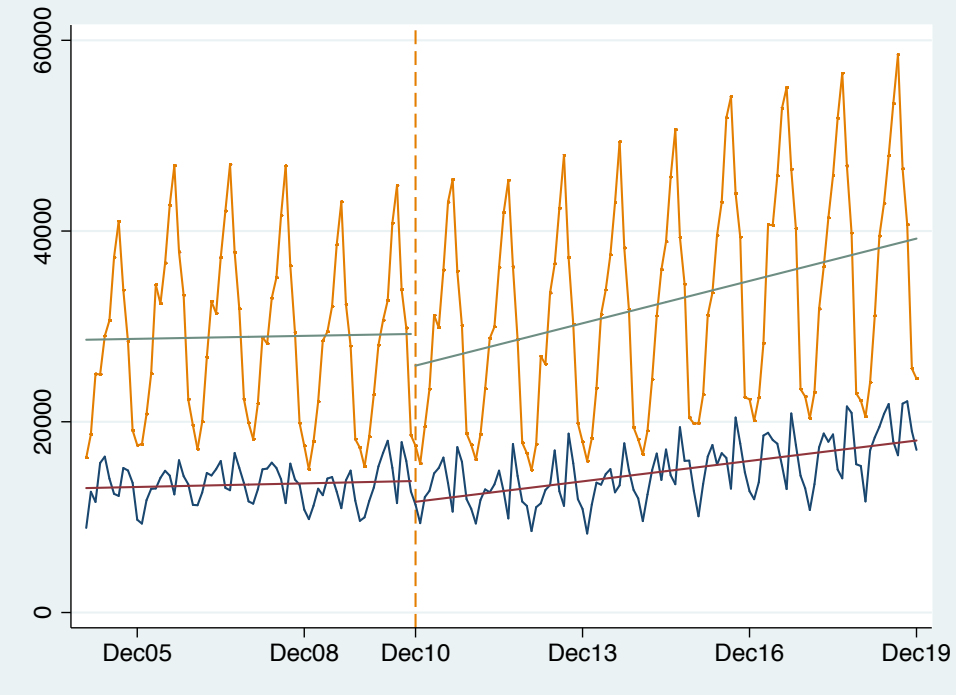
Figure 1. Spanish AVE network (2021) and location of case study cities



Source: Adapted from www.adif.es. The map includes the name of the HSR stations and the provinces where they are located. Total network length is 3,400 kms.

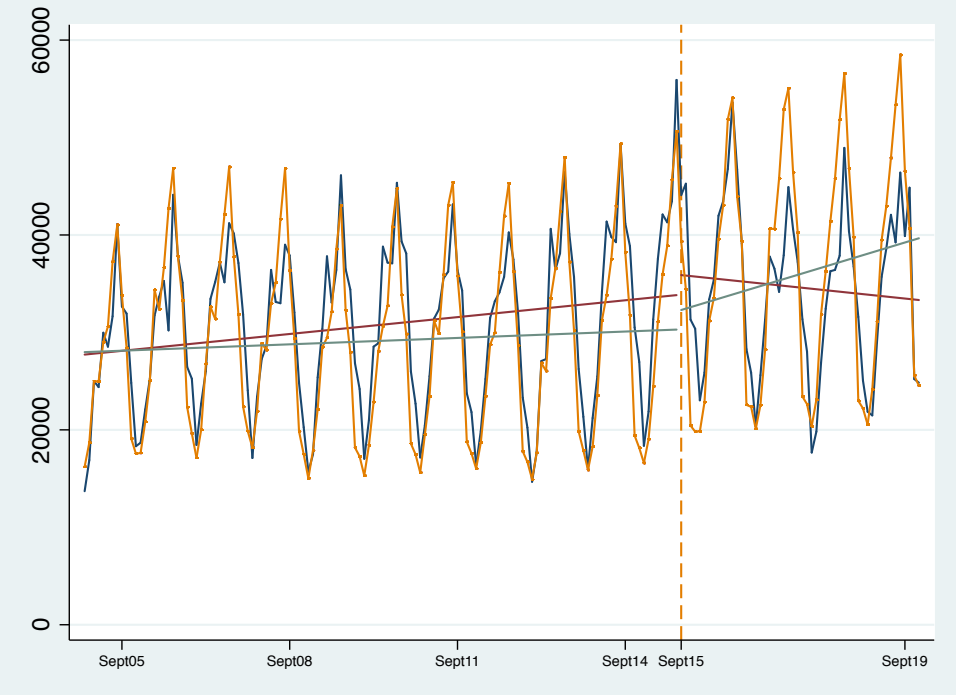
To evaluate the causal effect of AVE arrivals, the treated cities and their actual evolution should be compared with their counterfactual, which is unobserved and can only be estimated by means of control units. Figures 2, 3 and 4 depict the evolution of overnight visitors for the case of each selected treated city (Albacete, León, and Cuenca) compared to the average of the rest of the Spanish cities under 200,000 inhabitants (controls) for the period of analysis 2005-2019. Vertical lines in each figure show the date of AVE inauguration in treated cities, establishing the pre-treatment and the post-treatment periods for each experience. The figures show that the comparison between the treated cities and the average of the control cities is not satisfying the parallel trend assumption of differences-in-differences methods, what would bias the average treatment effect to be estimated with this widely used policy evaluation method. Moreover, we have not been able to find a subsample in the control group that meets this condition. Consequently, we have opted for a more flexible approach to evaluate the causal relationship between HSR services and tourism outcomes in the selected treated cities: the synthetic control method.

Figure 2: Monthly tourists. Albacete versus average cities under 200,000 inhabitants



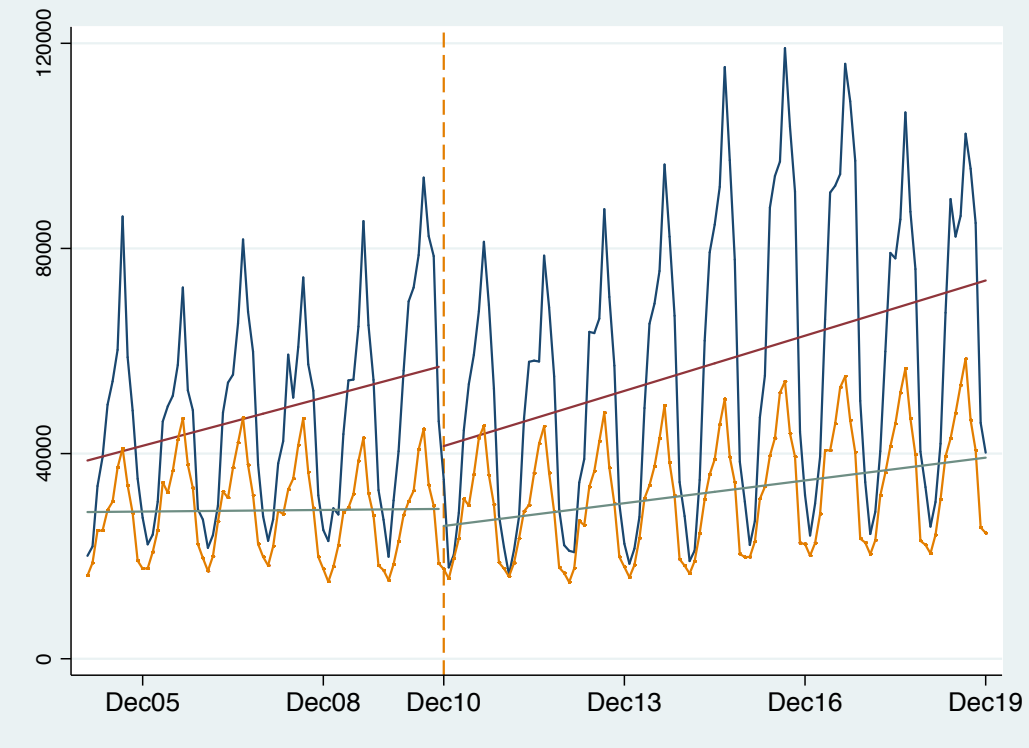
Source: Own elaboration. Obs.: Observations. Blue line: Albacete; Red line: *lfit* before and after for Albacete. Orange line: Control cities; Green line: *lfit* before and after for them.

Figure 3: Monthly tourists. León versus average cities under 200,000 inhabitants



Source: Own elaboration. Obs.: Observations. Blue line: León; Red line: *lfit* before and after for León. Orange line: Control cities; Green line: *lfit* before and after for them.

Figure 4: Monthly tourists. Cuenca versus average cities under 200,000 inhabitants



Source: Own elaboration. Obs.: Observations. Blue line: Cuenca; Red line: *lfit* before and after for Cuenca. Orange line: Control cities; Green line: *lfit* before and after for them.

The synthetic control method, firstly proposed in Abadie and Gardeazabal (2003) and developed in Abadie *et al.* (2010) as a comparative method, is a quasi-experimental methodology that has been increasingly adopted in the last decade as the standard technique to evaluate causal impacts, providing a practical solution to the evaluation of case studies. Indeed, Athey and Imbens (2017) consider this approach as one of the most influential recent contributions to empirical policy evaluation. This methodology is particularly appropriate in our setting, as it allows us to address case studies without renouncing to a causality analysis. Intuitively, it compares the evolution of each city during the treatment period with that of a weighted combination of other Spanish cities chosen to resemble the characteristics and tourism outcomes of the treated city before the treatment, in our case, the inauguration of AVE services.

Following Abadie and Gardeazabal (2003), let J be the number of available control cities (the 74 Spanish cities other than Albacete, León and Cuenca included in the sample under 200,000 inhabitants), and $W = (w_1, \dots, w_J)'$ a $(J \times 1)$ vector of nonnegative weights which adds to one. The scalar w_j $(j = 1, \dots, J)$ represents the weight of each city j in the synthetic treated city. The weights are chosen so that the synthetic unit most closely resembles the actual one before the treatment. Let X_1 be a $(K \times 1)$ vector of pre-treatment values of K predictors. Let X_0 be a $(K \times J)$ matrix which contains the values of the same variables for the J possible control provinces and let V be a diagonal matrix with nonnegative components. The values of the diagonal elements of V reflect the relative

importance on the different predictors. The vector of weights W^* is chosen to minimize $(X_1 - X_0W)'V(X_1 - X_0W)$ subject to $w_j \geq 0$ $(j = 1, 2, \ldots, J)$ and $w_1 + \cdots + w_J = 1$. The vector W^* defines the combination of control cities which best resemble the treated one before the treatment takes place.

The predictors included in our analysis are the city's population, the province's unemployment rate and the province's hotel price index (*HPI*). The first two variables are published by the Spanish Statistical Office, whereas the latter is constructed with the prices charged by hotels considering all their guests' types (households, firms, tour operators and travel agencies). The 'Hotel Occupancy Survey' provides all the required data to build this index, which includes information received from approximately 6,000 hotel establishments in winter and 8,500 in summer. The *HPI* is compiled on a continuous monthly basis. The sample is quite representative for hotels with three or more stars (quality rating) in all Spanish provinces.

By running the model, we find that, in all three cases, the synthetic control method can provide a control unit much more similar to the treated units than the average of all other control cities. Table 1 displays the information regarding predictor balance, with results on the average predictors' values for Albacete, Cuenca, and León, respectively, and their synthetic counterparts. The donor pool is formed by all other municipalities with less than 200,000 inhabitants, excluding those with AVE services, which could bias the true effect of HSR in the three cities considered. The first two numerical columns in Table 1 show how close to the real city the synthetic unit is to validate the use the evolution of this unit as counterfactual of the evolution of the real city. The causal effect of the treatment is then quantified by the simple difference between the treated unit and its synthetic cohort after the treatment (post-treatment period).

Table 1: Predictor balance

Predictors	**ALBACETE**	**Synth**	**Average**
Average Tourists jan05-nov10	13,413	13,386	28,887
Population	165,412	165,410	139,204
Unemployment rate	6.5	6.5	7.9
HPI	97.5	97.1	95.7
	CUENCA	**Synth**	**Average**
Average Tourists jan05-nov10	17,137	17,009	28,887
Population	53,420	53093	139,204
Unemployment rate	5.1	5.1	7.9
HPI	97.5	97.2	95.7
	LEON	**Synth**	**Average**
Average Tourists jan05-sep15	30,775	30,895	29,110
Population (average)	133,283	133,451	139,204
Unemployment rate	7.5	7.5	7.9
HPI	94.15	94.46	95.7

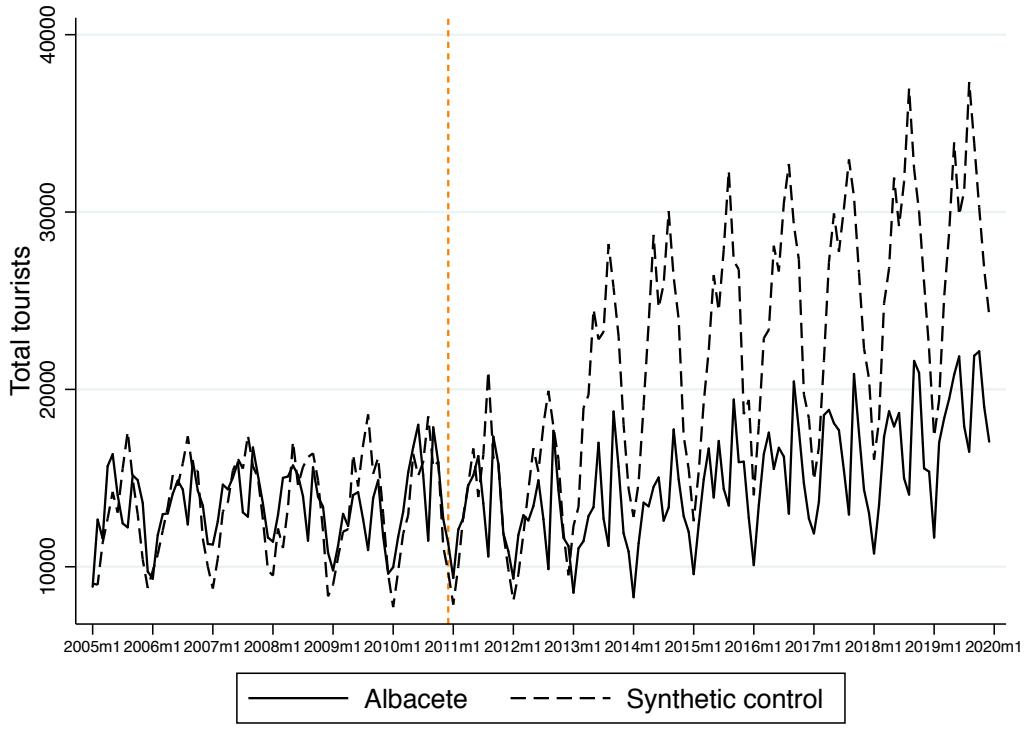
The synthetic control method is also appropriate in our setting because it is able to estimate causal effects for one-shot exogeneous shocks, such as the AVE arrival, both

shortly after entry and well after some periods, allowing us to examine the timing of the effects, whether they existed and whether they were statistically significant or not. In this sense, we consider three policy shocks, namely the inauguration of the AVE connections in Albacete, Cuenca, and León. In the first two cities, the AVE operated its first services on December 15th, 2010. In León, it arrived 5 years later, on September 29th, 2015.

4. Results

This section presents our main results from the implementation of the synthetic control method to the three case studies of AVE inaugurations (treatment) effects on overnight tourists in Albacete, Cuenca, and León.

Figure 5: Albacete vs. Synthetic Albacete (counterfactual).



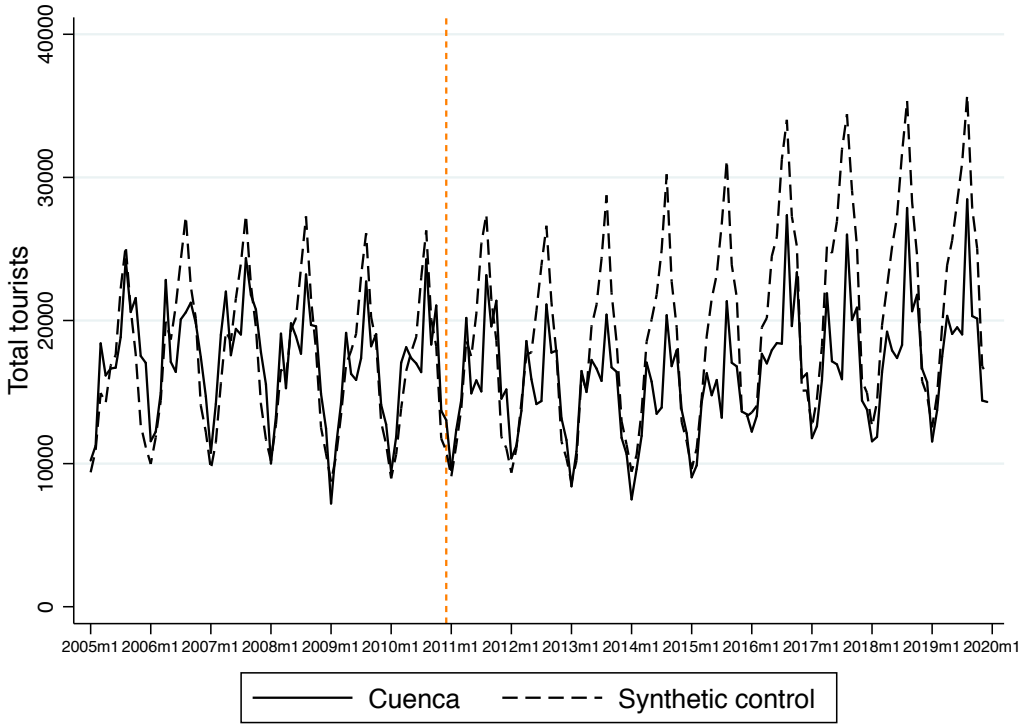
Source: Own elaboration.

First, for Albacete (see Figure 5), we find that the synthetic unit is formed by the following combination of weights: Pamplona (0.48), Badajoz (0.38), Antequera (0.07) and Burgos (0.07). The figure shows how this synthetic control is able to resemble the number of tourists staying overnight in Albacete during the pre-treatment period. In contrast, during the post-treatment period, we get a divergence between the real and the synthetic control, but, contrary to what would imply a contribution of the AVE on tourism outcomes, we find that the real Albacete received fewer overnight tourists than its counterfactual. Thus, not only do we not find a positive impact of the AVE, but our evidence seems to point to the opposite effect. A closer look at the seasonal distribution of the results suggests that the divergences are mainly found during the most touristic

seasons, while we still find less marked differences in the off-peak seasons (winter), although still statistically significant.

Our results for Cuenca are very similar. In this case, the synthetic unit is made of a combination of the several donors, mainly by Soria (0.41) and Naut Aran (0.07). The rest of donors have a very limited contribution with less than 0.05 weight each. As shown in Figure 6, the synthetic unit also resembles very closely the pre-treatment evolution of overnight tourists in Cuenca, but again, we find an increasing divergence between the real and the synthetic Cuenca in peak seasons. On the contrary, we do not find differences during off-peak seasons over the years. As a result, we do not find evidence of any positive contribution effect of AVE on overnight tourists as could be expected. If any, the effect seems to be the opposite.

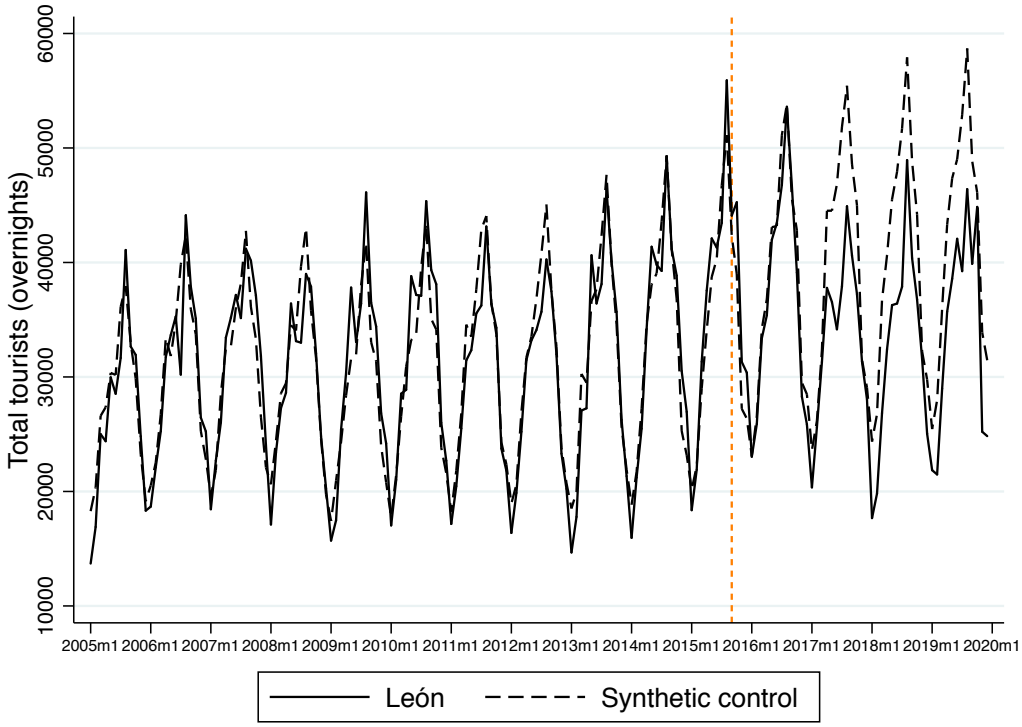
Figure 6: Cuenca vs. Synthetic Cuenca (Counterfactual).



Source: Own elaboration.

We finally replicate the same analysis for León (Figure 7), where the donor pool includes Donostia (0.24), Pamplona (0.18) and Almería (0.09), followed by other controls with weights lower than 0.05. Our results are consistent with the previous cases. In León, the synthetic unit is also able to resemble very closely the outcome variable during the pre-treatment period, and the first two years of post-treatment, what indicates lack of causal impact. After these years, the synthetic unit starts to deviate, indicating higher expected overnight tourists than the ones actually received. Again, our findings suggest that the AVE is not only unable to revitalize the tourism industry in this city, but also that during peak seasons it seems to be associated with lower tourism demand.

Figure 7: León vs. Synthetic León (Counterfactual).



Source: Own elaboration.

The descriptive analysis based on the figures derived from the synthetic control method can be statistically checked to evaluate whether the trends of treated and synthetic control units are really different over time during both the pretreatment and the post-treatment periods. Table 2 displays these tests in its last column. Before AVE arrivals, the null hypothesis of equal trends between treated and synthetic units cannot be rejected. This validates the identification strategy of creating a synthetic control unit to estimate a counterfactual. After AVE inaugurations, our tests suggest there are statistically different trends between real and synthetic units, but contrary to what could be expected, the sign of the difference imply that the AVE is associated with a lower number of overnight tourists. The hypothesis is rejected at a 1% significance level in all three cases.

Table 2: T-test. Treated vs Synthetic, before and after treatment.

	Total tourists (overnights) Treated	Total tourists (overnights) Synthetic	t-test
Albacete (Before)	13,413 (243.5)	13,386 (334.5)	0.0990
Albacete (After)	14,821 (310.1)	21,860 (686.9)	-13.2696***
León (Before)	30,775 (756.8)	30,895 (716.5)	-0.4886
León (After)	34,604 (1,187.5)	39,618.6 (1,407.2)	-7.3071***
Cuenca (Before)	17,137 (455.5)	17,009 (579.4)	0.4071
Cuenca (After)	16,235 (387.2)	19,354 (618.3)	-8.4016***

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5. Placebos

Because we do not find a positive effects of AVE arrivals on local tourism outcomes, we are not particularly concerned about anticipatory effects or confounding factors of spurious impacts that are usual issues in synthetic control method studies finding causal effects. However, we are finding a sort of negative effect associated with HSR that could be explained by these sources of bias. This negative influence does not seem to appear immediately, but with some lack, generally of about two years.

Following this idea and as robustness check, we conducted two placebo tests. First, a test over time, in which we assume that the treatment took place 24 months before the actual inauguration. We then repeat the above analysis to find any statistical significance (or not) between the treatment and the synthetic. The results show that this fake treatment analysis does not report any statistically significant difference between treated and synthetic units in post-treatment periods, as should also be the case for pre-treatment periods. Table 3 shows our main results, and the last column summarizes the results of the t-test of the null hypothesis of equal trends. The conclusion of this placebo experiment shows, as expected, that we cannot reject the null hypothesis in any of the three cases studied, which supports our findings of a negative effect of the AVE on local tourism in both the medium and long term.

Table 3: T-test. Treated vs Synthetic, before and after fake treatment analysis.

	Total tourists (overnights) Treated	Total tourists (overnights) Synthetic	t-test
Albacete (Before)	13,431 (326.5)	13,436 (413.2)	-0.0152
Albacete (After)	13.396 (365.0)	13,226 (411.1)	0.4599
León (Before)	29,985 (808.9)	30,087 (807.9)	-0.3636
León (After)	32,797 (1,696)	32,309 (1,667)	1.0488
Cuenca (Before)	17,850 (628.2)	17,989 (924.2)	-0.2410
Cuenca (After)	16,445 (646.5)	17,160 (932.2)	-1.3612

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Second, we replicate the synthetic control estimators by replacing each city (Albacete, León, and Cuenca) with another city not affected by the HSR. In this case we selected Cáceres, a city of less than 100,000 inhabitants in southwestern Spain that also meets all the selection criteria defined above. In addition, there are no plans to build a high-speed line in this city, so the results would not be affected by this change. Table 4 includes the results of this second robustness experiment: the t-test after the synthetic analysis also indicates that there are no differences between groups.

Table 4: T-test. Treated vs Synthetic, before and after fake city analysis.

	Total tourists (overnights) Treated	Total tourists (overnights) Synthetic	t-test
Cáceres as Albacete or Cuenca (Before) [(1)]	17,964.93 (424.5)	17,989.18 (626.7)	-0.0599
Cáceres as Albacete or Cuenca (After) [(1)]	22,663.17 (588.6)	22,679.18 (752.9)	-0.0455
Cáceres as León (Before)	19,108.09 (406.0)	19,164.75 (497.2)	-0.1972
Cáceres as León (After)	24,999.21 (859.7)	25,323.89 (1,000.7)	-0.8421

Standard errors in parentheses. [(1)] Note that HSR entrance in Albacete and Cuenca was at same date.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6. Conclusions

Spain is the European country that has made the greatest commitment to high-speed rail (HSR), thus becoming the leader at a good distance from other comparable countries in terms of network length and coverage, only behind China in the world ranking. One of the usual arguments in the extension of its network is the objective of promoting greater social cohesion and favoring regional development, providing new opportunities to the most backward territories, which justifies an extensive HSR network deployment that aims to connect all provincial capitals with Madrid. These declared opportunities and the implicit association of the HSR with progress and regional convergence also tend to justify the demands of the regional and local authorities to receive such a virtuous infrastructure.

One of the new common opportunities expected with the arrival of the HSR is the revitalization of tourism activities. HSR projects are expected to improve the accessibility of the area for new visitors. However, not many papers have addressed the ex-post evaluation of HSR projects, and even less research has focused on the particular case of medium and small cities in low-density areas. This paper contributes to this literature and to the improvement of knowledge about the true impacts of this infrastructure, opening the field for similar and comparable studies in other countries. Our results should be only extrapolated or representative of the contribution of this infrastructure in this specific and singular context of medium and small cities in low density areas.

Our empirical results, in fact, call into question the contribution of HSR projects to revitalize the tourism activity in low-density areas, either relatively isolated or far from/to large more dynamic cities. Consequently, these results raise reasonable doubts as to whether investing in HSR is indeed the holy grail and the only solution to the regional growth of lagging rural territories. We think that, at the very least, HSR is not a sufficient condition, and we agree with Jia *et al.* (2017), which stated that the role of high-speed rail mainly depends on whether a location has the necessary conditions to achieve the desired effects. If not, HSR is likely to adversely impact the local economy, deepening its backwardness. This is consistent, as well with the results of papers showing that tourism benefits depend on the size and dynamism of the cities, suggesting that major nodes tend to benefit centralizing and sucking up economic activity, leaving small intermediate cities in a worse position.

Contrary to what is usually expected or declared by planners or local politicians pushing to get these investments and gain access to this new mode of transportation, our causal evidence robustly suggests HSR does not contribute positively with more overnight tourists. Conversely, according to our most striking findings, it seems it could even exert the opposite effect.

It is true, however, that the adverse impact of the HSR on the local economy of small cities might be exaggerated, as this study does not examine any direct economic index (although tourism accounts for almost 75% of Spain's GDP). As has been recently pointed out for the case of China (see Xu and Sun, 2020 or Li et al., 2022), large cities usually have a huge siphon effect on small cities in terms of internal immigration after the HSR connection and similar differences have been accounted for in the literature for tourism inflows.

However, the problem of causality remains and is the main one we have tried to study in this paper. Our analysis is based on the variation experienced in the number of visitors that were accommodated in tourist establishments. These are the only ones for which a long series of comparable data (from 2005 to 2019) at the municipality level is available from the Spanish National Statistical Institute. Therefore, we are not able to capture the effects of HSR on same-day visitors or other tourism outcomes, such as tourism average expenditures. For those reasons, our results and conclusions must be taken cautiously. For example, in-vehicle AVE time to Madrid is 55 minutes from Cuenca and 1:30 hours from Albacete with several frequencies, what makes easy same day returns of travelers that perhaps before HSR services had to spend at least one night in these two cities. Only León is at 2 hours trip from Madrid. This motive, which cannot explain the whole effect, is consistent with the evidence provided in other experiences such as the French one (See Bazin *et al*. 2014).

This measurement bias from missing same-day travelers might not be very large due to: 1) the low number of total passengers - of which only a part would correspond to same-day tourists - that daily uses HSR services at the treated cities (around 950 in Albacete, 780 in Cuenca, and 240 in León) 2) part of them being intra-organization journeys (work-related) (Bonnafous, 1987) and, 3) the positive correlation between time spent at destination and tourist expenditures (Thrane and Farstad, 2011; Brida and Scuderi, 2013) and smaller wider economic effects. More and better information would be necessary to carefully disentangle the effects of HSR on alternative tourism outcome variables.

In all, according to the evidence provided in this paper, demanding HSR stations by lagging areas as a solution to their regional growth problems does not seem justified from the point of view of promoting local tourism, which is one of the usually expected positive outcomes. At least it is not in the specific context of the design of the AVE in Spain, which, according to the latest available socio-economic evaluations, will never cover its investment costs with the expected net social benefits mainly due to its low demand (see Betancor and Llobet, 2017). Somehow, our findings are consistent with the papers that showed that biggest and most dynamic nodes are the winners of HSR deployments.

The 'new economic geography' theory may help us understand why this reduction in the generalized cost of transport does not produce the expected regional convergence. Although it is not inevitable, the core-periphery effects produced by agglomeration economies suggest that lowering transport costs will always increase movement towards the core and hence centralization and increasing inequality between regions – and not the opposite (Vickerman, 2015; 2018). This also certifies the expectations by Vickerman et al. (1999) where it was shown that relative accessibilities would change very little with TEN-T and the main gainers would be just the regions which already had the highest levels of accessibility. While accessibility may not be the deciding factor in promoting tourism in small cities (as people are more likely to choose to visit places for their attractiveness as a tourist destination rather than for the convenience of transport), policy makers or local governments should pay attention to building and polishing local attractiveness and leverage the inauguration of HSR for place branding, at least in the short run. Otherwise, receiving the coveted HSR investments could sometimes be another kind of winner's curse for small cities.

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