



# The Open Transportation Journal

Content list available at: [www.benthamopen.com/TOTJ/](http://www.benthamopen.com/TOTJ/)

DOI: 10.2174/1874447801610010084



## How to Choose the Most Efficient Transport Mode for Weekend Tourism Journeys: An HSR and Private Vehicle Comparison

Amparo Moyano<sup>1,\*</sup>, José M. Coronado<sup>1</sup> and Maddi Garmendia<sup>2</sup>

<sup>1</sup>Department of Civil Engineering, University of Castilla-La Mancha, Ciudad Real, Spain

<sup>2</sup>Engineering college of Gipuzkoa, University of the Basque Country UPV/EHU, San Sebastian, Spain

Received: April 20, 2015

Revised: May 15, 2015

Accepted: September 17, 2015

**Abstract:** The present paper focuses on an analysis of the efficiency of High-Speed Rail (HSR) connections in comparison to private vehicles, with the aim of identifying the most convenient mode of transportation for weekend tourism journeys. This efficiency is centred on a person based assessment and will depend on the time available at the destination, the convenience of the timetables and travel times, and the associated costs related to accommodations and travel expenses. Because travel costs may amount to a significant share of the total expenses for recreational travel, individuals and groups may consider using a car to reach their destination, especially for journeys of short distances. However, the development of the HSR system in Spain provides an important increase in accessibility that is generating changes in the way people travel. The accessibility of the HSR service has brought an interesting alternative whose attractiveness (in terms of comfort and speed) rises with the distance travelled. In addition, RENFE (Spanish rail operator) is now reorienting its services and fares to compete in the tourism market, improving the competitiveness of HSR for weekend tourism trips relative to other transport modes.

In this framework, the paper demonstrates that HSR is a real alternative, in terms of connection efficiencies, for weekend journeys, as almost half of the Spanish cities served by HSR are more efficiently connected to Madrid through HSR than by private cars. In addition, the paper offers a person-based approach that should be taken into account in future research on transport mode choices.

**Keywords:** Efficiency, High Speed Rail, Mode choice, Tourism, Weekend.

### 1. INTRODUCTION

Currently, tourism is one of the most important issues in Spain. During the year 2013, the number of journeys, excluding urban proximity displacements, reached the 140 million; tourism journeys, at 52% of these, constituted the highest percentage [1]. In this sense, the transport system plays an important role because, to an extent, the appeal of cities as tourist destinations is influenced by their accessibility through different transport networks [2, 3]. The choice of destination is in part influenced by the ways each city can be reached, which is mainly related to the transportation system (travel times, timetables, travel costs...). There are also considerations related to accommodations and other travel expenses.

There is a very large imbalance in the transportation mode distribution in Spain. Private vehicles are the clear winner; they involve around the 84% of journeys. Other transport modes, such as trains, buses and airplanes, are used in around 5% of journeys [1]. The clear superiority of car travel can be attributed to several reasons, such as the possibility of beginning the trip whenever desired, the ability to use the car for transport at the destination and its competitive travel costs, especially for travels as a couple or in groups. However, car users perceive travel costs incorrectly, usually underestimating them. It is common to consider only the fuel expenses, but private vehicles also incur other costs related to acquisition fees, car insurance and maintenance costs [4, 5]. Also, difficulties of parking the car at destination

\* Address correspondence to this author at the Department of Civil Engineering and City and Regional Planning, University of Castilla-La Mancha, Ciudad Real, Spain; E-mail: [amparo.moyano@uclm.es](mailto:amparo.moyano@uclm.es)

and its additional costs when using a secure parking lot may be considered as an important disadvantage of this mean of transport.

In the last year, RENFE (the Spanish rail operator) has started exploring recreational travel as an interesting new market in which the High Speed Rail (HSR) system should compete. Although the initial conception of HSR was primarily oriented to business travel, RENFE is reorienting its services to the tourism market in an attempt to compete against private vehicles.

RENFE's commercial policies are focused on increasing the occupancy of all the trains by offering more economical ticket prices in order to attract travellers who would otherwise use other transport modes. In 2013, they introduced the new AV City service to expand traditional long-distance high speed train (AVE) service to off-peak hours. Fares were discounted up to 70% depending on the train (timetables and connections) and how far in advance the ticket was purchased. Since being launched in 2013, these policies have generated a 23% increase in the number of passengers and around a 12% increase in the trains' occupancies [6].

Additionally, RENFE entered the tourist package market, offering the 'Spain Pass', which allows foreign tourists unlimited travel by HSR so they can visit several cities using the train. Another tourism product is the 'Avexperience' that offers train tickets between two cities served by HSR, hotel accommodations, and city cards for discounts on museums, transport, restaurants, *etc.* for weekend visits.

The present paper is focused on assessing how competitive the HSR and its new services for weekend tourism journeys are compared to private vehicles. Weekend trips represent around 55% of tourism in Spain [1]; therefore, evaluating their efficiency in terms of the money invested can contribute to simplifying the choice of an appropriate mode of transportation for each destination.

## 2. TRANSPORTATION MODE CHOICE: LITERATURE REVIEW

The arrival of HSR systems generates changes in mobility patterns in the cities involved. Ex-post research studies on the assessment of high-demand transportation corridors have demonstrated the variations in modal shares that have been produced by the opening of new HSR lines. These studies are mainly centred on the competition between air and rail transportation because of the initial conception of HSR as a potential alternative to air travel in routes of approximately 400-600 km [7, 8]. Some high-demand routes, such as London - Paris [9], Paris - Lyon, or Madrid - Seville [7], have experienced a remarkable modal substitution by transferring passengers from air travel to HSR services.

Nevertheless, HSR is currently not only an alternative to air travel but also to road transportation. The development of the HSR network, through the involvement of many different cities and the introduction of different types of services, makes it possible for HSR to also compete in the short- and medium-distance travel market. Literature on the topic has identified different ranges of travel times for which HSR can compete against other transportation modes and found a limit of 2 hours of travel time for road transportation and 2.5-3 hours for air transportation [10]. These short- and medium-distance HSR connections, generally between smaller intermediate cities and a main metropolis, have also displayed variations in modal shares and mobility patterns, experiencing a significant decrease in private vehicle demand in favour of HSR service [11]. In addition, the modal share of a specific route may be conditioned by certain characteristics of the travel, such as the final destination (arriving to or leaving from the destination city), trip length, use of luggage, and temporal restraints in terms of travel and arrival times for certain trip purposes [10].

These ex-post studies and the effects they discovered on the modal share based on the travel context lead to questions about the different factors that affect choices for modes of transportation from the perspective of the user. The studies centred on modal share assessments are concerned about the characteristics of the service that directly affect the traveller. They are usually carried out using logit models that represent the probability of a traveller choosing among several transport options. They consider different factors that influence the traveller's choice, which are generally related to both socioeconomic and transportation factors [12, 13].

Factors such as the travellers' age, gender, income, socioeconomic background or level of education may influence their choice of transportation mode. Some studies have analysed the effects of socioeconomic characteristics on modal choice and their variations across different trip purposes, such as business, tourism and commuting [14, 15]; and distances and lengths [16].

However, the most important factors included in the literature are those related to transportation itself, such as travel

times, frequencies and costs [17, 18]. First, travel time could be considered as the most representative factor in the modal choice, as it could be a useful tool to identify the most convenient transport mode between origins and destinations. It also makes it possible to pre-establish what ranges of travel times within each mode of transport have the highest demand [19]. Regarding travel time, some studies have analysed the effect of shrinkage of space due to the arrival of new infrastructure in terms of travel time reduction as a measure of network accessibility [20]. In addition, in some means of transport, including air and rail transport, it is necessary to spend extra time in reaching the train station/airport, increasing the total travel time. That is why, apart from the travel time, another variable related to the access time has been introduced in some mode choice studies [18]. Access to stations is not only a relevant factor in terms of time spent but also in terms of travel comfort. Private vehicles allow a journey to start directly from home without concerns about how to reach the station or how far in advance it is necessary to be there. Additionally, travel cost is another relevant factor that affects transport mode preferences. Although it is closely related to socioeconomic characteristics, it can also be considered as an independent feature to compare the competitiveness of different transportation options. In this factor, access to a station also plays an important role because, in many cases, the money spent on reaching the station represents a high percentage of the total travel expenses. Finally, the third factor used in the literature is frequency. This could also be useful, as it is closely related to waiting times when passengers arrive at the station. However, it is more representative for means of transport such as urban buses or undergrounds where the number of services per day is very high. For transport modes such as the HSR system, it loses representativeness because of the lower frequency and important variations in the number of services depending on the time of the day. In those cases, the convenience of timetables becomes a key factor [21, 22], especially when travelling for a weekend, because people usually organise their journeys and purchase train tickets some time in advance [12]. Therefore, timetables are much more important than frequencies in this transport mode.

In the transport mode choice process, assessing the convenience of schedules, which will influence the time available at the destination, is an approach based on individuals' needs that has its origins in the Time Geography principles [23]. This concept refers to the useful time a person has for doing certain activities through the available transport systems with consideration for the temporal restraints of daily life. The application of these principles was undertaken in 1970 by Törnqvist [24], who developed the concept of 'potential contacts', that is, cities that could be reached from a certain origin and allow for more than 6 hours at the destination. Coming back to this study, French researchers carried out an assessment of European transport networks in the framework of an ESPON project [25]. The application of the Time Geography principles to the HSR system was undertaken by Coronado *et al.* (2013) [26] by means of an efficiency assessment, which is used in this paper to evaluate transport mode choices with a focus on travellers' needs. This efficiency assessment involves both the time available at the destination, using real timetables, and the associated costs, which will determine the real competitiveness of the available service supply.

### 3. CASE STUDY

The case study encompasses the 27 cities served by HSR that were included in the Spanish HSR network at the beginning of 2015. There are actually 30 HSR cities in Spain, including the Galician corridor, but the latter is not connected with rest of the network at this time (Fig. 1). Therefore, the assessment carried out in this paper takes into account all of the Spanish HSR connections with Madrid as their origin for travel over a whole weekend. The choice of Madrid is due to its location in the core of the radiocentric HSR network and its favourable service supply, which is the widest in the network. Additionally, the capital of the country covers almost 35% of the total population linked by the HSR system, so it supposes the biggest potential tourism market that can be attracted.

Currently, the Spanish HSR supply offers four main services:

- AVE: Long-distance HSR services with speeds of up to 310 km/h, in place since the HSR system was conceived in Spain.

- ALVIA: Long-distance HSR service with a top speed of 250 km/h that has the ability to use both Iberian and standard gauges, which allows it to utilise both high-speed and conventional rail lines in the same journey.

- AVANT: Regional HSR services that are slower than AVE services but have more economic fares and are aimed at commuters

- 'AV City' is a new service whose aim is to complete the HSR supply in off-peak hours in areas with no AVANT service. They offer competitive fares and normally stop in all cities on the lines on which they run.

In addition to these services and related to the new tourist-oriented fares, RENFE has introduced:

- ‘Promo’ fares: The ‘Promo’ ticket is available for AVE and AV City services and is based on a dynamic pricing system that allows for discounts of up to 70% depending on the train (type of train and timetables) and how far in advance the ticket is purchased. In fact, there are a limited number of tickets with this ‘Promo’ fare, so its availability is influenced by the demand and varies depending on the HSR line and destination. This fare is neither reimbursable nor exchangeable.

- ‘Mesa’ fare: This is intended for trips for families and small groups of 1 to 4 people and is available for AVE, ALVIA and AV City services. The ticket includes four seats facing each other in pairs. They are sold as a package with a 60% discount on the general rate. They can be occupied by fewer travellers if desired, though the total cost of the space is still charged.



Fig. (1). Spanish HSR network in 2015. Source: Authors.

4. OBJECT AND METHODOLOGY

This new arrangement of the Spanish HSR services and fares makes it interesting to carry out an assessment of the capability of HSR as an alternative transport mode for tourism travel. Therefore, the present paper is focused on the analysis of the HSR supply efficiency [26] for weekend tourism trips in comparison to private vehicles. To achieve this, a person-based assessment has been considered in order to introduce the points of view of travellers and not only the characteristics of the infrastructure.

The measurement of this efficiency (1) is based on the time available at destination ( $t_{dest}$ ) and the associated costs ( $\text{€}_{travel}$ ) following the formula [26]:

$$E = \frac{t_{dest}}{\text{€}_{travel}} \tag{1}$$

To compute this efficiency indicator, some hypotheses must be established in relation to the departure and return times (total time budget) in order to obtain the time available at the destination (Fig. 2) and the associated costs.

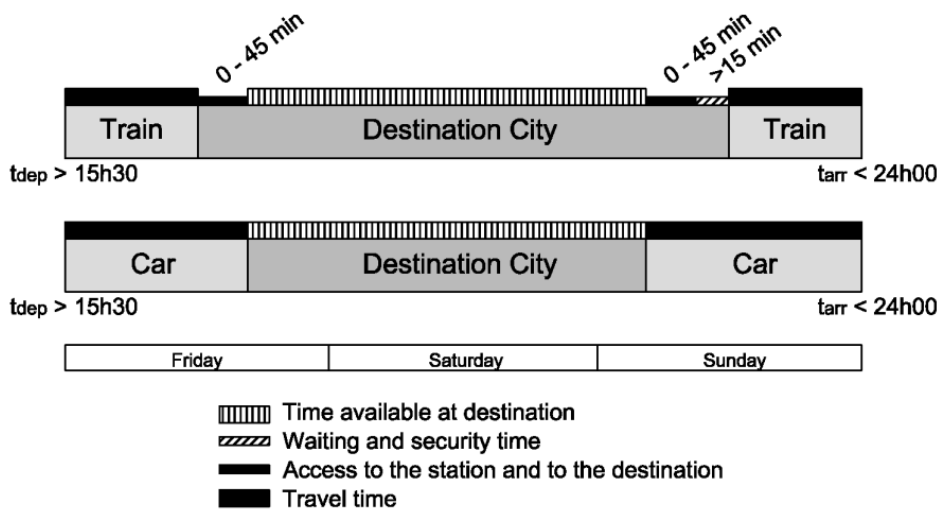


Fig. (2). Transport chain hypotheses for a weekend journey. Source: Authors (adapted from L’Hostis and Leysens, 2012)

For travel by car, the efficiency calculation is quite direct. Given a total time budget, the available time at the destination will only be reduced by the travel time (Fig. 2). According to the travel costs, an average consumption value is used. The expenses of travelling by car are related not only to the fuel but also to the proportional costs of maintenance, insurance, the initial purchase, etc. [4, 5, 27]. Including all of these expenses, travel costs will be:  $\text{€travel} = K (\text{€/km}) \cdot D (\text{km})$ , where, for a certain private vehicle, K varies only depending on the fuel price .

The fluctuations in fuel prices make it necessary to assess how much they influence travel costs for a private vehicle. The variations in K for different fuel prices are presented in the following table (Table 1).

Table 1. Variations in K with fuel prices.

Fuel price (€/L)	Fuel expenses (€/km)	K (€/km)
1	0.060	0.280
1.2	0.072	0.292
1.4	0.084	0.304
1.6	0.960	0.316

Considering an initial purchase of 20,000€, 15,000 km of travel per year and an average fuel consumption of 6L/100km: Maintenance and fixed costs (assurance, taxes, revisions, etc): 0.10 €/km

- Amortization of the initial purchase: 0.12 €/km

- Fuel expenses = Fuel price  $F_p$  (€/L)\*Fuel consumption (L/km) =  $F_p \cdot 6/100$

In the period between January 2010 and January 2015, fuel prices reached a maximum in September 2012 (1.52 €/L for gasoline and 1.44 €/L for diesel) and a minimum at the beginning of 2010 (approximately 1.1€/L). On average, fuel prices have fluctuated around 1.30 - 1.40 €/L in the last two years [28], which led to a value of 1.4 €/L (K = 0.304) being chosen for this research. However, an analysis of sensitivity will be carried out in order to check the influence of fuel prices on the main results of the paper.

When travelling by HSR, the time available at the destination will depend on the time budget, travel times, access and security times and, especially, the timetables. The efficiency will be higher when the timetables fit the established departure and return times. The access time is considered the time needed to travel from the HSR station to the city centre and vice versa using public transit (urban buses). A period of fifteen minutes was added at all of the stations to account for security checks.

For associated costs, the HSR ticket prices for different fares will be included. For both return and ‘Mesa’ fares, the ticket prices maintain their values; however, the ‘Promo’ fares utilise a dynamic pricing system, as previously mentioned. Fig. (3) displays the price evolution of the ‘Promo’ fares depending on the destination city, the time of purchase and the day of the week. It can be observed that the variations in the ticket prices are higher on Fridays (Fig. 3a) because the demand is influenced not only by weekend journeys but also by same-day business travel or even commuting. However, on Sundays (Fig. 3b), the ticket prices rise, in general, in relation to how far in advance the ticket

was purchased, although there are also differences between destinations.

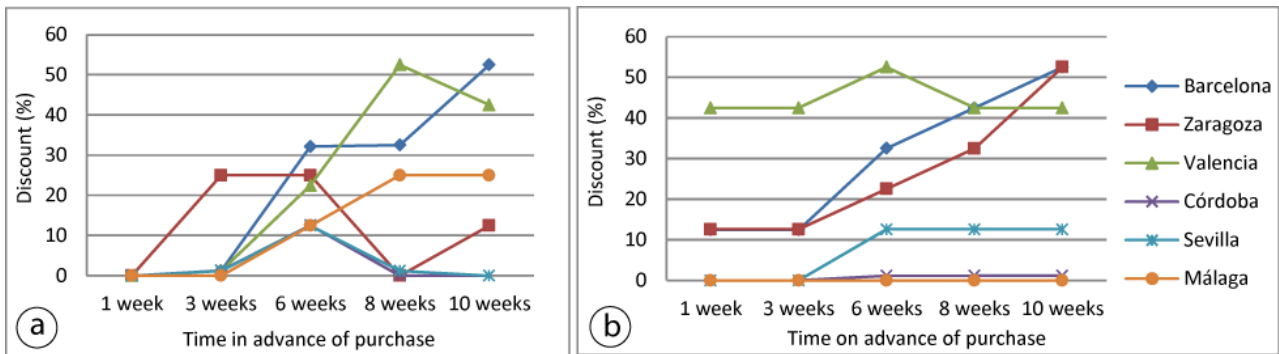


Fig. (3). ‘Promo’ fare evolution on Fridays (a) and Sundays (b) for purchases in October 2014 Source: Authors.

Having established the previous hypotheses, 3 different scenarios are considered (Table 2). They correspond to 1, 2 and 4 travellers, respectively, as the differences in efficiency depending on the number of travellers must be considered. Each of these scenarios are evaluated considering only the transportation costs in order to exclusively assess the influence of the transportation network and services and both the transportation and accommodation costs, which is a more realistic assumption for assessing a weekend tourism trip.

Table 2. Characteristics of the scenarios considered.

Scenario	N travellers	HSR fare	Associated Costs
1	1	Return and ‘Promo’ fares*	a. Transportation: Those related to the €km and tolls in the case of private vehicles and ticket prices in the case of HSR. b. Transportation and accommodations: Hotel expenses are added to the transportation costs. The data concerning the Hotel Price Index for all of the Spanish cities served by HSR was used ( <a href="http://www.trivago.es">http://www.trivago.es</a> ). This index is based on bookings made on the website, so it represents an average value of the prices that are actually paid by customers per room per night.
2	2		
3	4	Return, ‘Promo’* and ‘Mesa’ fares*	

\*Among the different prices found within the ‘Promo’ fares based on the time of purchase, the most favourable situation was considered.

\* As ‘Promo’ and ‘Mesa’ fares do not exist in certain connections, the lower ticket price for each case was considered instead.

## 5. RESULTS

### 5.1. Efficiency Comparison Between Road and HSR Transportation.

The new HSR service configuration is changing its competitiveness against private vehicles for weekend tourism trips. Fig. (4) displays the relationships between efficiencies and distances, using Madrid as the origin and considering the three different scenarios described above. In this case, the associated costs are exclusively those related to transportation. The efficiency varies depending on the number of travellers and the HSR fare. For one traveller, HSR is always more competitive than a private vehicle, as the €/km is much higher than that of train tickets, even considering HSR return fares (Fig. 4a). For two travellers, a private vehicle begins to compete with HSR return fares; however, thanks to the reduced ‘Promo’ fares, HSR offers a more efficient connection (Fig. 4b).

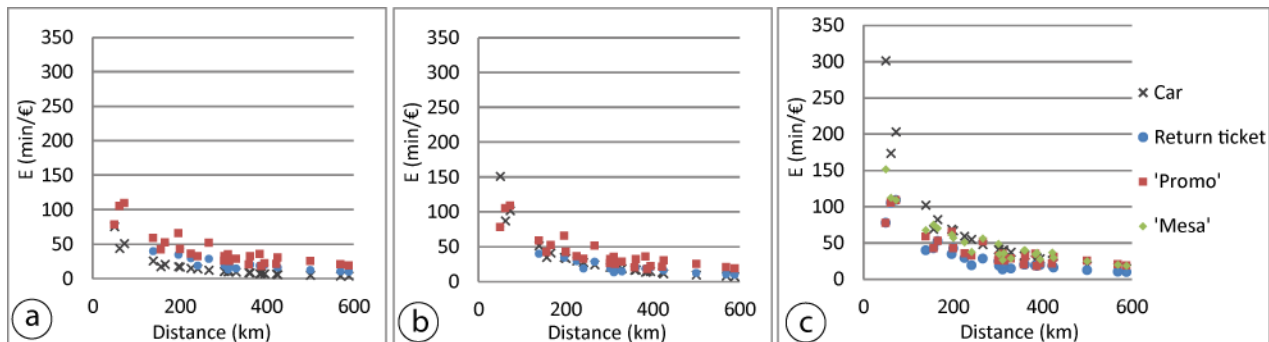


Fig. (4). Efficiency comparison exclusively considering transportation costs: a. one traveller; b. two travellers; c. four travellers Source: Authors.

For families or groups of four, the car’s efficiency increases, generally to the point of overcoming the HSR ‘Promo’ fare, as travel costs are divided among four passengers. In this situation, ‘Mesa’ fares make HSR an interesting choice for group travel, putting it at almost the same level as a private vehicle (Fig. 4c).

Focusing on the graphs’ trends, efficiencies of both HSR and cars follow a potential expression that decreases with distance, but there are some differences between them. On one hand, the efficiency of cars had a very good adjustment ( $R^2=0.98$ ) because the time available decreases with the distance (higher travel time) while the associated costs increase. There are some slight alterations due to tolls that increase travel costs independently of the distance.

On the other hand, although the efficiency of HSR also decreases with distance, it has a higher dispersion that makes its fit with the efficiency formula worse ( $R^2 = 0.8$ ). The efficiency in this case is a function that depends on (2):

$$E = f\left(TB, 1/t_{travel}, 1/\epsilon_{ticket}\right) = f\left(TB, V_m/D_r, 1/Q \cdot D_r\right) \tag{2}$$

where

TB is the time budget, which is constant for every connection

$t_{travel}$  is the travel time, which depends on the commercial speed  $V_m$  and the rail distance  $D_r$ .

$\epsilon_{ticket}$  is the ticket price, which depends on a coefficient  $Q$  (€/km) and the rail distance  $D_r$ .

Initially, the HSR efficiency could be expected to decrease following a potential expression with the distance, as in the case of the private vehicle. However, the higher dispersion is due to the different service conditions in terms of commercial speed and €/km (Fig. 5).

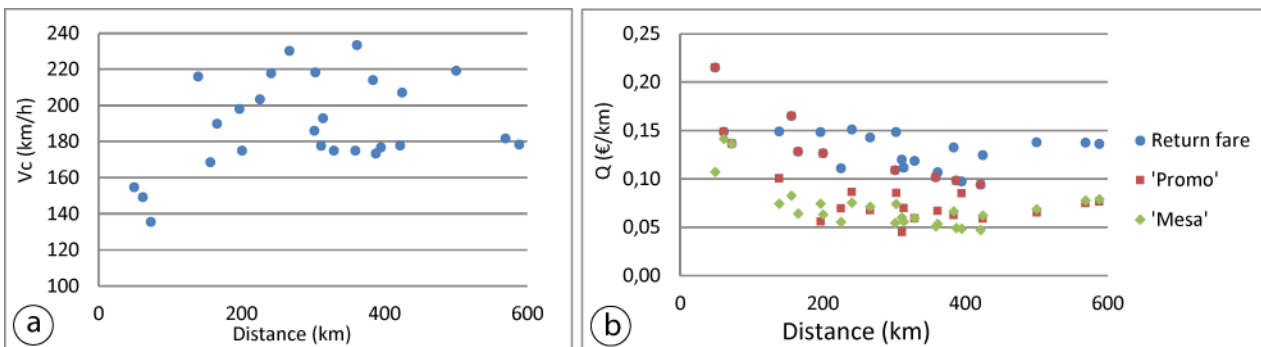


Fig. (5). Commercial Speed  $V_c$  (a) and €/km  $Q$  (b). Source: Authors

As presented in Fig. (5a), the commercial speed ( $V_c$ ) is not constant for every relationship, resulting in a different quality of HSR service depending on the cities connected. Even for the same distance between the origin and destination,  $V_c$  presents variations of up to 60 km/h. In the same way, in the case of €/km, this heterogeneity occurs due to the different types of services, such as AVE, AV City or AVANT, with different prices. It also depends on the time of day (peak hours) and the time of purchase, especially in the case of ‘Promo’ fares. Both factors affect the efficiency of HSR, resulting in differences between the cities in the network.

$$E = f\left(TB, 1/t_{travel}, 1/(\epsilon_{ticket} + H)\right) = f\left(TB, V_m/D_r, 1/(Q \cdot D_r + H)\right) \tag{3}$$

Nevertheless, for a weekend trip, the costs are not only confined to transportation; accommodations are an important part of the total expenses (3). Hotel costs vary by destination; therefore, they constitute another dispersion factor in the results. In some cases, the relative weight of the hotel expenses in each destination in relation to the travel costs is very relevant. That happens, for instance, in cities that are close to Madrid, such as Guadalajara, Segovia or Toledo, where the hotel represents the highest percentage of the total costs (Fig. 6).

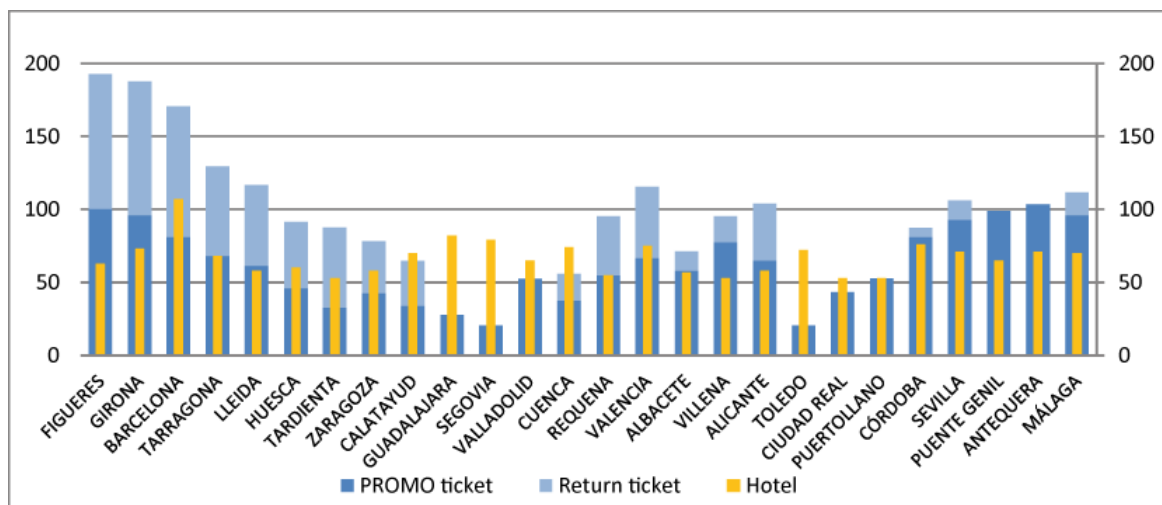


Fig. (6). Relationship between HSR (return travel) and accommodation costs (considering one night of hotel expenses) Source: www.renfe.com, www.trivago.es.

Coming back to the efficiencies comparison and considering both the transportation and accommodation costs, the efficiencies for private vehicles and HSR were obtained (Fig. 7). In relative terms, the mode of transportation that presents with the higher efficiency maintains it for different numbers of travellers; however, the relationship between the efficiency and the distance is more scattered, with an adjustment  $R^2$  of approximately 0.8 for travel by car and between 0.5 (for one traveller) and 0.65 (for two or more travellers) when using HSR. In addition, the differences between vehicular and HSR efficiencies in each case declines due to the effect of the hotel costs.

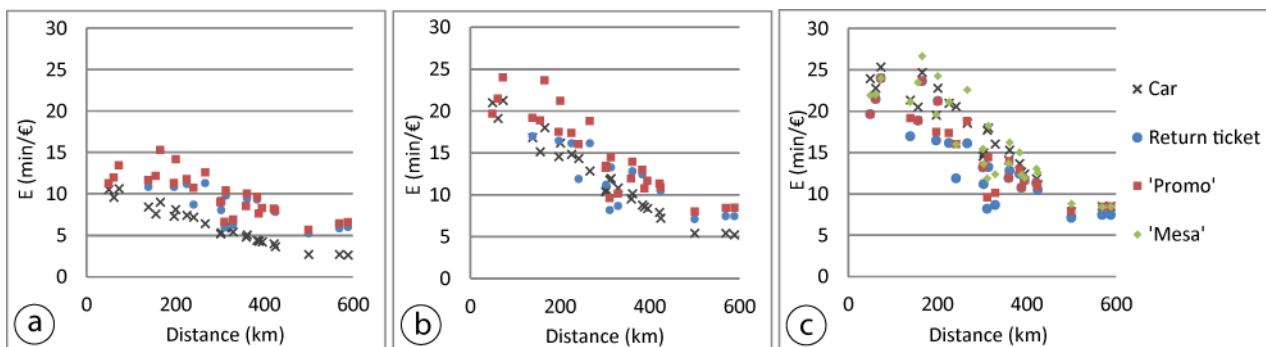


Fig. (7). Efficiency comparison considering transportation and accommodation costs: a. one traveller; b. two travellers; c. four travellers Source: Authors.

### 5.2. Efficiency of Weekend Tourism Trips: How to Choose the Mode of Transportation for Each Destination?

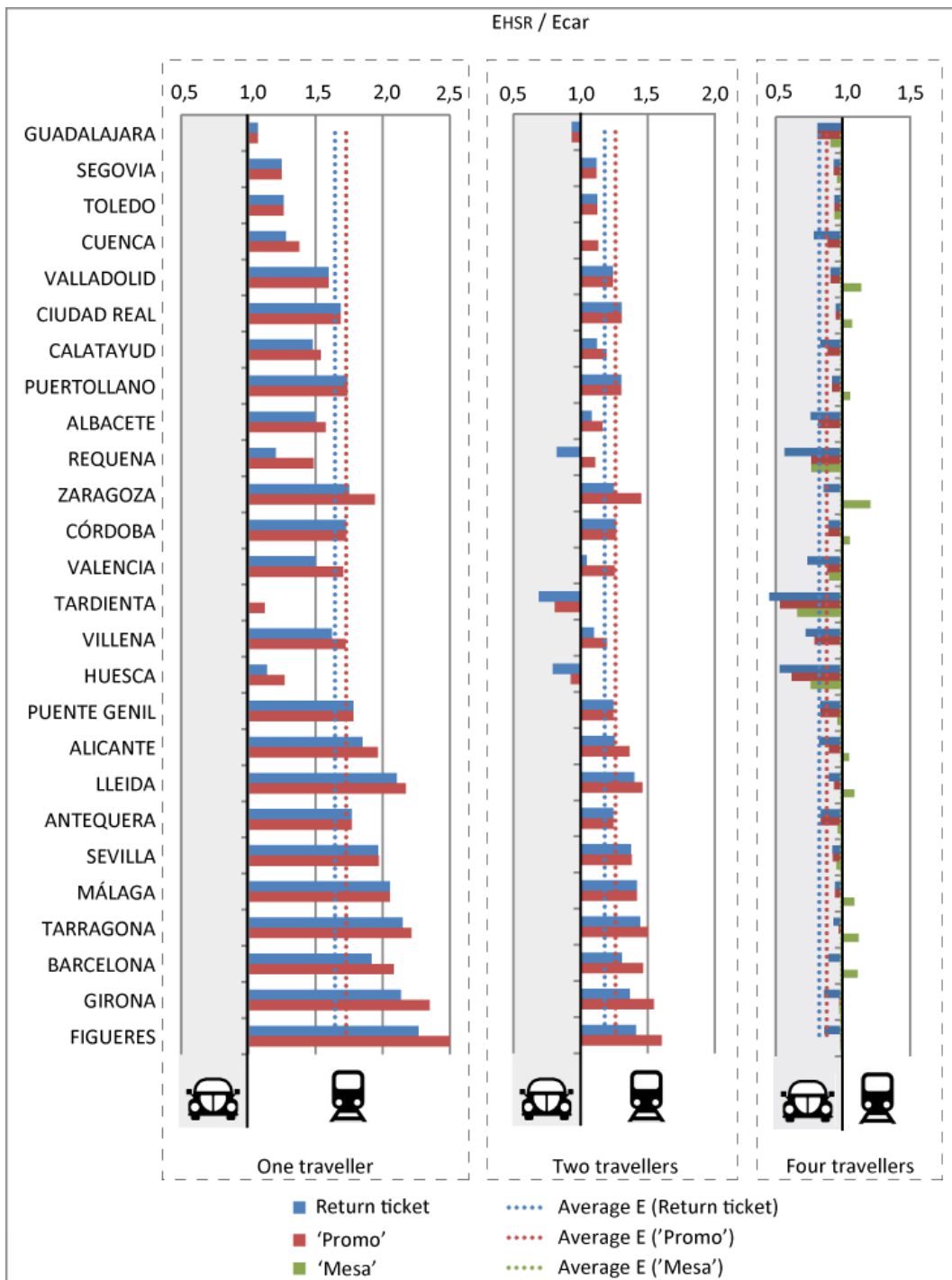
Once the efficiencies and their relevant factors were analysed, the most efficient transport mode for spending a complete weekend in each destination was assessed (Fig. 8). This assessment was carried out by comparing both efficiencies and obtaining the ratio  $E_{HSR}/E_{car}$ . Thus, results higher than 1 indicate that HSR is a better transport mode and *vice versa*.

For one traveller, HSR is more competitive than a private vehicle in all of the cities considered, with efficiency improvements generally greater than 50%. The cities that benefit the most are those located far from Madrid, such as Girona or Figueres, where the distance results in a significant increase in private vehicle costs. Even in the cases of Tardienta or Huesca, where HSR offers only one service per day, HSR is the better choice.

When considering two travellers, HSR remains the most efficient mode of transportation. However, there are fewer differences, and the average improvement decreases to around 20%. In this case, cities like Tardienta or Huesca are better connected through road transportation. A remarkable case is Guadalajara, a city very close to Madrid, what



makes the car connection more efficient. In addition, its HSR services are limited to AVE and ALVIA services, whose prices are not as competitive as those of the AVANT service. Cities such as Segovia or Toledo, which are also located in the metropolitan area of Madrid, count on the latter services to improve their HSR competitiveness.



**Fig. (8).**  $E_{HSR}/E_{car}$  for different number of travellers Source: Authors (\*car and train symbols were obtained from [www.freepik.es](http://www.freepik.es)).

Regarding the effect of ‘Promo’ fares, both for one and two travellers, an increase in the efficiency in relation to the return fares of nearly 10% was observed using the ratio  $E_{HSR}/E_{car}$ . The greatest improvement is observed for the cities located on the Barcelona line, such as Tarragona, Figueres and Girona, and cities like Valencia or Alicante, located at the end of the East lines. There was no benefit for the Andalusian cities because their high demand reduces the offer of

these ‘Promo’ tickets.

In the final scenario that considers travel in groups of four, car expenses are divided by four. The HSR return and ‘Promo’ fares are not able to compete in terms of efficiency in any of the cases analysed. The only exception is for the ‘Mesa’ fare; there are 10 cities, including Zaragoza, Tarragona and Barcelona, for which the HSR efficiency reaches or exceeds that of a private vehicle. In general terms, for travelling with four people, the car is approximately 20% more efficient relative to the return ticket and 12% more efficient relative to the ‘Promo’ ticket. The ‘Mesa’ fare allows HSR to directly compete with private vehicles. Its average  $E_{HSR}/E_{car}$  ratio was around 0.98, indicating that the differences between HSR and private vehicles are very small. This is evidence of a balanced situation.

This situation is slightly altered when considering different fuel prices. For instance, when using the lower fuel price recorded at the beginning of the year 2010, (approximately 1 €/L, as mentioned before), the HSR efficiency for four travellers in the same 10 cities still overtakes the efficiency of a privacy vehicle. However, the cases of Cordoba, Puertollano or Alicante are very close to a balanced situation. Considering the opposite case, in which fuel prices rise to 1.6 €/L, the HSR efficiency would be higher in 5 additional cities, but the  $E_{HSR}/E_{car}$  ratios would only be approximately 1.

Returning to the efficiency analysis, and considering the fuel price of 1.4 €/L established in the methodology section, it is useful to present the geographical location of cities in order to explain the differences among them. Fig. (9) displays the  $E_{HSR}/E_{car}$  ratios for the ‘Mesa’ fares (or the lower ticket price for each case) and four travellers, because in the other scenarios, HSR is clearly the most efficient transport mode.

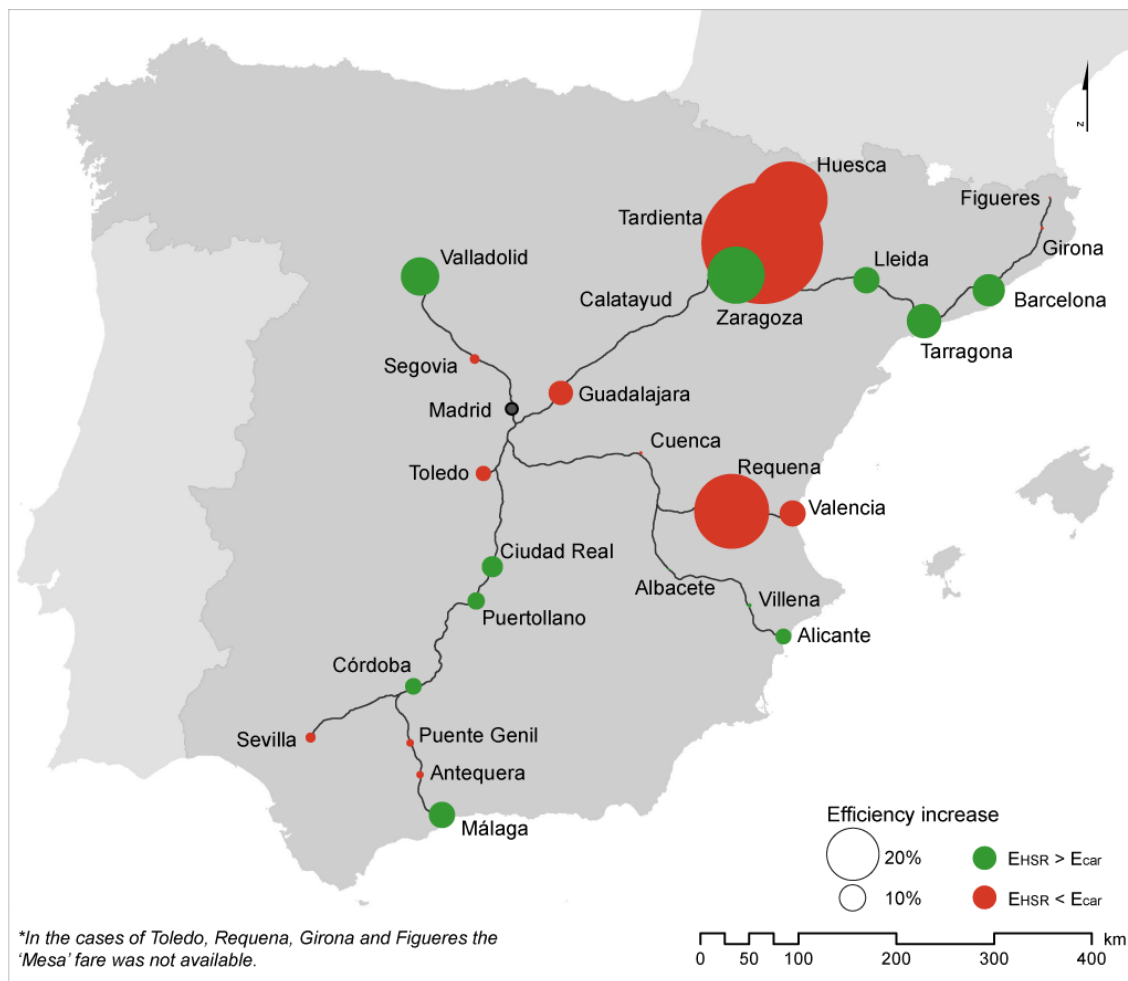


Fig. (9).  $E_{HSR}/E_{car}$  for four travellers using ‘Mesa’ fares Source: Authors.

As mentioned before, the benefits of ‘Mesa’ fares are unequally distributed within the HSR services and

connections. First, cities in the metropolitan area of Madrid, such as Toledo, Segovia and Guadalajara, are better connected using private vehicles, which require less spending to cover shorter distances. These cities do not qualify for 'Mesa' fares because of their demand, as in the case of Guadalajara, or because their services mainly comprise AVANT services, which are cheaper than AVE services but do not offer reduced fares, as in Toledo and Segovia. Quite the opposite happens in the cases of Ciudad Real and Puertollano, where the combination of AVANT and AV City services and 'Mesa' fares make for more competitive HSR connections. Second, cities located at the ends of the lines are, in general, benefited by the HSR system. The exceptions are the cases of Seville and Valencia, where their high demand does not favour the offer of more economical tourist fares. Third, cities located on the Barcelona line profit from the price reduction of the 'Mesa' fares more than cities on other HSR lines, while the cases of Tardienta, Huesca and Requena involve the lowest HSR efficiencies due to their deficient service supply, which cannot compete with road transportation.

## **DISCUSSION AND CONCLUSIONS**

The Spanish rail operator, RENFE, has reoriented its service supply to compete in the tourism market. New services, fare reductions and tourist packages are some of the strategies that have been introduced. Until now, tourism travel has been clearly linked to private vehicle use, but this new arrangement is making HSR an interesting transportation alternative for weekend journeys.

The HSR system in Spain is becoming a very complex transportation option, and it has different properties between cities. Having an HSR station is not linked with being well connected, which is why the analysis of the service supply and real timetables seems so relevant. In general terms, the HSR connections have higher efficiencies than private cars for one and two travellers and rise to a balanced situation when four people travel together due to the availability of 'Promo' and 'Mesa' fares.

In the latter scenario, short-distance travel is slightly dominated by private vehicles because the travel expenses are reduced, especially for four people. However, for medium and long-distance travel, the HSR system becomes more competitive, except in those cases where the service supply is very deficient.

The methodology used in this paper is centred on a service supply analysis, considers the principles of Time Geography, and focuses on travellers' needs. It is a powerful approach as it recognises the real constraints found when travelling using different transport systems. However, it presents some limitations concerning the previous hypotheses. For instance, some destinations benefit from convenient timetables or competitive fares, even when their service supplies are reduced, only because the departure or arrival time hypotheses are well adapted. Apart from that, it is necessary to underline that the HSR's 'Promo' and 'Mesa' fares are not always available and that their competitiveness varies depending on the time of purchase. In this sense, the new tourism arrangement for Spanish HSR is very similar to the air travel pricing system, making it difficult to assess it in a categorical way. Additionally, it must be highlighted that the efficiencies assessment carried out in this paper is exclusively focused on the service supply analysis, but there are other factors, such as travel comfort, availability of a private car, and even the willingness to drive, that could influence the choice of transport mode. For instance, access to stations is a weak point of HSR in relation to private car because it increases the total travel times and expenses. Additionally, carrying luggage to the train station may not be comfortable. However, travelling by car has the drawback of needing to find parking close to the hotel and in a sufficiently safe area. Also, traffic congestions, especially in highly demanded holiday periods, may be a determinant negative factor when considering the car travel efficiency. All of these factors may tip the scale in favour of one or another mode of transportation when travelling for a whole weekend.

Besides, this new approach to addressing transportation mode analyses should be developed further, as it could become a useful tool for simplifying the choice of the most convenient transport mode for each destination. In future research, this could also be compared to the real demand for each option.

## **CONFLICT OF INTEREST**

The authors confirm that this article content has no conflict of interest.

## **ACKNOWLEDGEMENTS**

This study was supported by a grant from the Spanish Ministry of Education (Programa FPU del Ministerio de Educación, Cultura y Deporte) and the Ministry of Science and Innovation (Grant N TRA2011-28465-C03-01).

## REFERENCES

- [1] Turespana, "S.G.Conocimiento y Estudios Turísticos", Available from: [www.iet.turespain.es](http://www.iet.turespain.es), 2013. [online]
- [2] S. Masson, and R. Petiot, "Can the high speed rail reinforce tourism attractiveness? The case of the high speed rail between Perpignan (France) and Barcelona (Spain)", *Technovation*, vol. 29, no. 9, pp. 611-617, 2009. [<http://dx.doi.org/10.1016/j.technovation.2009.05.013>]
- [3] M. Delaplace, F. Pagliara, J. Perrin, and S. Mermet, "Can high-speed rail foster the choice of destination for tourism purpose?", *Procedia Soc. Behav. Sci.*, vol. 111, pp. 166-175, 2014. [<http://dx.doi.org/10.1016/j.sbspro.2014.01.049>]
- [4] AA Company, "Ireland motoring organisation", Available from: <http://www.theaa.ie/AA/Motoring-advice/Cost-of-motoring/Cost-of-Motoring-Explained.aspx>, 2014. [online]
- [5] RACV, "Royal Automobile Club of Victoria", RACV's car owning and operating costs guide, Available from: <http://www.racv.com.au/wps/wcm/connect/racv/Internet/Primary/my+car/Operating+Costs>, 2014. [online]
- [6] RENFE, "Balance Política Comercial 2013 y novedades 2014. Ministerio de Fomento", Available from: [https://www.fomento.gob.es/NR/rdonlyres/3DC66696-DBC6-410F-B742-00DC52E7ADE4/123960/140320BalancePol%C3%ADticaComercial Renfe.pdf](https://www.fomento.gob.es/NR/rdonlyres/3DC66696-DBC6-410F-B742-00DC52E7ADE4/123960/140320BalancePol%C3%ADticaComercial%20Renfe.pdf), 2014. [online]
- [7] M. Givoni, "Development and impact of the modern high speed Train: A review", *Transp. Rev.*, vol. 26, no. 5, pp. 593-611, 2006. [<http://dx.doi.org/10.1080/01441640600589319>]
- [8] J.M. Ureña, J.M. Coronado, M. Garmendia, and V. Romero, "Territorial implications at national and regional scales of high-speed rail", In: *De Territorial Implications of High Speed Rail: A Spanish Perspective..* Ashgate: London, 2012, pp. 129-162.
- [9] M. Givoni, and F. Dobruszkes, "A review of ex-post evidence for mode substitution and induced demand following the introduction of High-Speed rail", In: *Transport Reviews: A Transnational Transdisciplinary J.*, vol. 33, 2013, no. 6, pp. 720-742.
- [10] J.M. Ureña, P. Menerault, and M. Garmendia, "The high-speed rail challenge for big intermediate cities: A national, regional and local perspective", *Cities*, vol. 26, pp. 266-279, 2009. [<http://dx.doi.org/10.1016/j.cities.2009.07.001>]
- [11] M. Garmendia, J.M. Ureña, and J.M. Coronado, "Long-distance trips in a sparsely populated region: The impact of high-speed infrastructures", *J. Transp. Geogr.*, vol. 19, no. 4, pp. 537-551, 2011. [<http://dx.doi.org/10.1016/j.jtrangeo.2010.06.002>]
- [12] M. Gonzalez-Savignat, "Will the high-speed trains compete against the private vehicle?", *Transp. Rev.*, vol. 24, no. 3, pp. 293-316, 2004. [<http://dx.doi.org/10.1080/0144164032000083103>]
- [13] F. Dobruszkes, C. Dehon, and M. Givoni, "Does European high-speed rail affect the current level of air services? An EU-wide analysis", *Transp. Res. Part A Policy Pract.*, vol. 69, pp. 461-475, 2014. [<http://dx.doi.org/10.1016/j.tra.2014.09.004>]
- [14] N.L. Georggi, and R.M. Pendyala, "Analysis of long-distance travel behavior of the elderly and low income", *Personal Travel: The Long and Short of it, Transportation Research Circular E*, vol. C026, pp. 121-150, 1999.
- [15] N. Limtanakool, M. Dijst, and T. Schwanen, "The influence of socioeconomic characteristics, land use and travel time considerations on mode choice for medium and longer-distance trips", *J. Transp. Geogr.*, vol. 14, pp. 327-341, 2006. [<http://dx.doi.org/10.1016/j.jtrangeo.2005.06.004>]
- [16] J. Scheiner, "Interrelations between travel mode choice and trip distance: trends in Germany 1976-2002", *J. Transp. Geogr.*, vol. 18, pp. 75-84, 2010. [<http://dx.doi.org/10.1016/j.jtrangeo.2009.01.001>]
- [17] C.R. Bhat, "A heterodastic extreme value model of intercity travel mode choice", *Transp. Res., Part B: Methodol.*, vol. 29, no. 6, pp. 471-483, 1995. [[http://dx.doi.org/10.1016/0191-2615\(95\)00015-6](http://dx.doi.org/10.1016/0191-2615(95)00015-6)]
- [18] F. Dobruszkes, "High-speed rail and air transport competition in Western Europe: A supply-oriented perspective", *Transp. Policy*, vol. 18, pp. 870-879, 2011.
- [19] O. Klein, and G. Claisse, "Le TGV-Atlantique: entre récession et concurrence -Evolution de la mobilité et mise en service du TGV-Atlantique: analyse des enquêtes réalisées en Septembre 1989 et Septembre 1993 ", The TGV Atlantique: between recession and competition. Evolution of mobility and setting TGV Atlantique service. Analysis of surveys conducted in September 1989 and September 1993. Lyon, 1997.
- [20] K. Spiekermann, and M. Wegener, "Trans-European networks and unequal accessibility in Europe", *Europ. J. of Reg. Devel.*, vol. 4, no. 96, pp. 35-42, 1996. [EUREG].
- [21] E. Cascetta, and A. Papola, "A joint mode-transit service choice model incorporating the effect of regional transport service timetables", *Transp. Res., Part B: Methodol.*, vol. 37, pp. 595-614, 2003. [[http://dx.doi.org/10.1016/S0191-2615\(02\)00031-0](http://dx.doi.org/10.1016/S0191-2615(02)00031-0)]
- [22] E. Cascetta, A. Papola, F. Pagliara, and V. Marzano, "Analysis of mobility impacts of the high speed Rome-Naples rail link using within day dynamic mode service choice models", *J. Transp. Geogr.*, vol. 19, pp. 635-643, 2011. [<http://dx.doi.org/10.1016/j.jtrangeo.2010.07.001>]

- [23] T. Hägerstrand, "What about people in regional science?", *Pap. Reg. Sci.*, vol. 24, no. 1, pp. 6-21, 1970. [<http://dx.doi.org/10.1007/BF01936872>]
- [24] G. Törnqvist, *Contact Systems and Regional Development*. The Royal University of Lund: Lund, 1970.
- [25] A. L'Hostis, and T. Leysens, "Les méthodes de mesure et de représentation de l'accessibilité dans les méthodes d'évaluation des projets de transport interurbains et périurbains de voyageurs, (Rapport final)", Available from: <http://hal.archives-ouvertes.fr/hal-00734212>, 2012.
- [26] J.M. Coronado, M. Garmendia, A. Moyano, and J.M. Urena, "Assessing Spanish HSR network utility for same-day tourism, ?? RTS - Recherche", *Transport et Sécurité*(c), vol. 29, no. 3, pp. 161-175, 2013.
- [27] Betcars, "Blog - Betcars", Available from: <http://www.betcars.com/blog/el-coste-por-kilometro-de-nuestro-coche/>, 2013.
- [28] DatosMacro, "Precios de los derivados del petróleo: España", Available from: <http://www.datosmacro.com/energia/precios-gasolina-diesel-calefaccion/espana>, 2015. [Last access: 24 03 2015].

---

© Moyano *et al.*; Licensee *Bentham Open*.

This is an open access article licensed under the terms of the Creative Commons Attribution-Non-Commercial 4.0 International Public License (CC BY-NC 4.0) (<https://creativecommons.org/licenses/by-nc/4.0/legalcode>), which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.