**LIBERALIZATION AND RAIL ACCESS CHARGES IN HIGH SPEED TRAIN**

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**Abstract**

This paper develops an ex ante analysis of the introduction of on track competition in High Speed Rail (HSR) lines. The distinctive elements of our analysis are the consideration of the vertical structure of the rail sector, operators that compete in prices and number of services, and access charges for the use of the rail infrastructure that are endogenous. We provide simulation results for three Spanish HSR routes. The socioeconomic viability of entry is found to depend on whether infrastructure and rail operations are integrated or separated, and also on the policy rule to set rail access charges. Firstly, separation without entry is not an appropriate good policy: the reduction in prices is followed by a reduction in the number of services that leads to lower consumer surplus and lower industry profits. Secondly, marginal cost pricing, that would entail losses to the infrastructure manager, would be in the range of 6% to 9% higher than in the pre-entry scenario. This conclusion holds for large increases in rail traffic. Thirdly, the consideration of a more realistic scenario, while encouraging entry, would imply welfare losses yet consumer surplus would go up as long as access charges are set to marginal cost pricing.

# 1 Introduction

European rail policy has long been concerned with developing a strong and competitive rail transport industry. Over the years, the rail sector has undergone notable restructuring in the separation of rail infrastructure from operations, and the various Railway Packages and directives have, among other things, steadily encouraged a market-opening process in the supply of rail services. Liberalization plans, in high speed rail (HSR) lines in particular, have been implemented, or about to be, in several European countries. HSR lines are expensive and so it is understandable that governments seek to recover part of the infrastructure investments through rail access charges. How these are set becomes crucial for an effective competition within the rail sector. Thus, some countries follow social marginal cost pricing (comparable to an integrated structure comprising the infrastructure manager and the operator); others set a markup over the social marginal cost (a situation that would naturally arise when there is separation, particularly if firms obey some kind of profit maximizing behavior and are willing to eliminate state compensations). In this framework, which industry structure may favour the entry of a new operator remains an open research question. It is therefore important to quantify the impact of HSR charges on prices, number of services and traffic which will ultimately determine the social desirability of specific structural changes.

We propose an ex ante analysis of the introduction of competition in HSR lines, which may be helpful for informed policy making in rail passenger transport. The distinctive elements of our analysis are the consideration of: i) the vertical structure of the rail sector, ii) operators that compete in prices and number of services, and iii) access charges for the use of the rail infrastructure that are endogenous. After building a model with these elements, we proceed to calibrate it for several Spanish HSR routes. Then we simulate how structural changes, that result in different access charges, affect market entry conditions. From a transport policy perspective, it is our purpose to provide a contribution that allows for a more efficient exploitation of the HSR services.

In June 2012, the Spanish government announced plans to boost the liberalization process in the rail system. Some of the measures proposed, such as the introduction of new operators into the HSR lines, have been postponed at different times. The tendering process to select the competitor of RENFE, the public incumbent operator, has not yet been opened and there are actually both political and interest group pressures against liberalization plans stimulated by European authorities. Still, questions related with the access pricing policy by the infrastructure manager naturally arise: Will it follow a first best pricing policy? What would happen if the Spanish public entity that owns and manages the rail infrastructure (ADIF) followed a profit-maximizing rule? What would be the implications of different and non-discriminatory access pricing policies if there were on-track competition between different rail operators?

Recent news on different media has noted the tensions between RENFE and ADIF. The latter has historically complained about the imposition of very low access charges by the public regulator. In fact, ADIF has got a significant revenue increase for its charges by 16% with respect to 2013 and by 58% with respect to 2012. Even so, ADIF attained losses of €230 million in 2014. At the same time, RENFE has recently objected to these recent increases by stating that such charges are inefficient: they are clearly above the marginal infrastructure costs and they are reducing the optimal rail traffic. This debate is on the rise due to the opinion of the potential entrants who support the incumbent's position, and add that high infrastructure charges will make entry more difficult. Finally, public administrations are being forced to introduce break-even constraints, and even the privatization of ADIF has been suggested as a possible measure. In view of the preceding arguments it is understandable that HSR, and any plans associated with it, has lost political and social support.

Rail liberalization has been widely examined in the transport literature – see Beria et al (2012) for a European comparison and the references therein. There are few experiences of "competition in the market" in the rail passenger industry. Franchising systems have been the most usual policy to foster competition in this market. Entry of new operators has occasionally occurred, as in the case of the rail lines connecting London with Birmingham, Peterborough and Cambridge. However, this on-track competition has occurred between companies offering services of different quality, usually an inter-city operator and a regional or commuter operator, with the latter offering slower and less comfortable services at lower fares. Regarding HSR services, the Italian passenger market has actually experienced the entry of a new operator, NuovoTrasporto Viaggiatori (NTV), which competes with the incumbent operator, Trenitalia, in several city-pair markets. Bergantino et al. (2015) provide a thorough analysis of the Italian case. They find that the incumbent has not reduced its supply and that entry has led to a greater utilization of the network. The two railway companies do engage in strategic pricing; besides, intra-modal competition has had a moderating effect on the fares charged by airlines, the competing mode.

We develop an imperfect competition model where strategic interaction among the different transport operators will be considered in a differentiated products long distance route. The initial situation considers intermodal competition between private transport (car) and rail transport. It is assumed that car transport is the result of a competitive market, where prices are exogenously determined, meanwhile the rail transport operator sets prices and number of services; rail access charges are also endogenous. Next we consider the entry of a new rail operator competing on the track with the rail incumbent. The different scenarios will be solved in a three-stage game where: first, the infrastructure manager chooses the access charge, second, the rail operator(s) select the number of services, and finally, the rail operator(s) set final prices. Besides we compare the results of the entry process depending on the vertical structure of the rail market, that is, depending on whether infrastructure and rail operations are integrated or not and also considering whether the access charge follows a marginal cost rule or is set to maximize infrastructure manager profits. Once the formal analysis has been presented, the model is calibrated for the Spanish HSR services between Madrid-Barcelona, Madrid-Sevilla and Madrid-Valencia using the available data on elasticities, prices, traffic levels, and operating costs. That is, we use the available data to construct compatible values for the unknown parameters of the model. We may subsequently simulate how structural changes affect market conditions, regarding industry profitability, consumer surplus and social welfare.

Our paper emphasizes the relevance of endogenous access charges. We find that when the infrastructure manager behaves as a profit maximizer, entry typically leads to more services, lower prices, more rail passengers, lower operator profits, higher consumer surplus and welfare barely changes. These results change when the infrastructure manager follows marginal cost pricing: there are significant increases in the number of services, prices are also much lower and therefore greater increases in passenger traffic happen. Therefore, lower access charges would make entry more likely to be profitable and welfare gains would be in the range of 6% to 9% higher than in the pre-entry scenario. The structural change brought about by the entry of a new rail operator is found to be socially beneficial only when it entails large increases in rail traffic demand. This result is similar to the one obtained by Johnson and Nash (2012) who find, with a different approach, that only with high enough additional traffic can entry of a new HSR operator be justified in social terms. Certainly, such high increases in the number of rail traffic may not be realistic. Controlling for this effect, our simulation results show that entry would bring social welfare losses between 7-14% and industry profitability falls dramatically. We therefore conclude that (low) access charges according to marginal cost pricing favour entry although this is at the expense of notable losses for the infrastructure manager. Alternatively, setting an access charge such that ADIF breaks even would still result in profitable entry. Finally, our analysis has considered what would happen if fixed operating costs for entrant were lower than the incumbent's. When these costs are 25% lower there is a 2% welfare increase.

*Related literature*

There is a lot of literature devoted to the analysis of the organizational changes occurred in the rail industry. Asmild et al.(2009), Friebel et al. (2010) and Cantos et al. (2010) assess the impacts on productivity and efficiency of the rail system of some of these changes. Also, Lalive and Schmutzler (2008) examine the effects of a German law passed in 1993 regarding changes in the procurement of regional passenger transport. Most of the papers conclude that horizontal reforms (through franchising systems and entry of new operators) have generically improved the efficiency levels, but vertical separation has not produced the same conclusive results. However, there are fewer papers which have analyzed the implications of access charges in the competition in rail markets. The paper by Sánchez-Borrás et al. (2010) offers evidence on the marginal infrastructure and external costs of HSR services. Then, actual charges are examined for the main European countries and conclude that their levels are indeed reducing traffic on and benefits from these lines. More recently, Meunier and Quinet (2012) provide a careful analysis of the consequences of market imperfections both on infrastructure pricing and project assessment. These authors argue that optimal infrastructure charges under imperfect competition differ substantially from the standard theory of marginal cost pricing; suboptimal charges may induce notable welfare losses. Finally, Crozet and Chassagne (2013) develop a detailed framework to shed light on the dilemma between competition and financing with regard to how infrastructure access charges are set. Their analysis concludes that, despite the fact that charges are not acting as a barrier to entry, it will be difficult to introduce competition in the French HSR network – it is contended that the new operator would need to make considerable profits in peak periods since its off-peak services would not suffice to cover their total costs.

Regarding papers studying the impact of the entry of new companies in the rail industry, the following contributions merit to be cited. Preston et al. (1999), Johnson and Whelan (2003) and Johnson and Nash (2012) use different models to assess the introduction of a new rail operator in the rail network. They obtain that on-track competition has benefits to users in terms of fares and services, but there is a larger loss of profitability for the industry, resulting in a social welfare decrease. In particular, entry is only feasible if it leads to a notable cost reduction and additional traffic is generated. Their findings take us back to whether it would be better to franchise the services instead of allowing the entry of a new operator. Ivaldi and Vibes (2008), develop a simulation model, based on a strategic setting, to analyze inter and intra-modal competition in the European passenger transport sector. They focus on the changes in the market shares and the impacts on user surplus from different changes in market structure (like the introduction of a new train operator or a low cost airline). Ivaldi and Vibes conclude that entry of low cost operators can notably improve the levels of consumer surplus, and that incumbents would lose traffic, particularly airlines. Intra-modal competition is also contemplated by Adler et al.(2010) and Bergantino et al.(2015). Recently, Álvarez et al.(2015) analyze the effects of the entry of a new rail operator in the Spanish HSR, although neither the impact of changes of the infrastructure charges nor the vertical structure of the industry are not taken into account. Entry is found to be welfare improving only when it generates large increases in traffic.

As noted above, our focus is to provide an ex ante analysis with regard to the introduction of within HSR competition. Whether the infrastructure manager and the incumbent operator are integrated or separated is relevant to how access charges are determined, and these ultimately influence the profitability of entry and its welfare effects.[1] With regard to rail cost studies, econometric approaches have been recently developed to estimate infrastructure cost functions in order to know the cost elasticities, that is, to provide evidence on the magnitude of variation in infrastructure costs when traffic volumes change. Results of these estimates may be found in Wheat and Smith (2008) and Gaudry and Quinet (2003). Cost elasticities from such studies are generally low (in the range between 0.1–0.4). Thus marginal cost-based prices will need substantial mark ups if full cost even of maintenance and renewals is to be covered, let alone a contribution made to investment costs (see Sánchez-Borrás et al, 2012).

The next section will describe the main features of the theoretical model. Section 3 will provide the data sources, and present the calibration and simulation process; the main results of the analysis are reported. Finally we conclude with some remarks and policy recommendations.

[1] Regarding the importance of infrastructure charges and its relationship with competition there are many works on some transport markets, like road or air (see, e. g., Lindsey (2012) and Zhang and Czerny (2012) for excellent surveys on pricing on roads and airports respectively). The optimal infrastructure prices can be defined in a very precise way, but the market imperfections, the presence of externalities or the budget constraints can make very difficult its practical implementation.

# 2 The Model

Consider a transport market between two cities with only inter-modal competition where an HSR service operator competes with private transport by car. Next, intra-modal competition is introduced in the HSR service.

## 2.1 The monopoly case

Assuming that there is one HSR service operator competing with private transport by car, the utility function of a representative passenger is given by (Dixit and Stiglitz, 1977):

$$U = y + {}_r Q_r + {}_c Q_c - \frac{1}{2}(b_r Q_r^2 + b_c Q_c^2 + 2dQ_r Q_c); \tag{1}$$

where $y$, $Q_r$ and $Q_c$ denote income spent in goods different from transport, number of passengers by rail and by car, respectively. Subscripts $r$ and $c$ stand for rail and car, respectively. Parameter $d$ measures the degree of substitutability between modes, so that a higher $d$ implies less differentiated transport modes. The constant ${}_r$ is equal to $a_r + \delta_r n_r$, where $a_r$ is the lower bound of the maximum willingness to pay for traveling by rail, the one that corresponds to the case where users do not care for the number of rail services. The term $\delta_r n_r$ is the total effect in utility due to the number of rail services, which are denoted by $n_r$. It enters positively thus increasing the willingness to pay for the service because a higher number of services will reduce the schedule delay; $\delta_r$ stands for the users' utility per additional train services. Finally, ${}_c$, indicates the maximum willingness to pay for car transport. Maximization of $U$ subject to the budget constraint yields a system of inverse demand functions. Inverting that system, we have:

$$Q_r = \frac{a_r b_c - a_c d}{b_r b_c - d^2} + \frac{b_c \delta_r}{b_r b_c - d^2} n_r - \frac{b_c}{b_r b_c - d^2} p_r + \frac{d}{b_r b_c - d^2} p_c, \tag{2}$$

$$Q_c = \frac{a_c b_r - a_r d}{b_r b_c - d^2} - \frac{d\ \delta_r}{b_r b_c - d^2} n_r - \frac{b_r}{b_r b_c - d^2} p_c + \frac{d}{b_r b_c - d^2} p_r; \tag{3}$$

so that a higher number of rail services enhances the demand for that mode, but decreases the demand for car transport.

Next, we assume that infrastructure rail costs, subscript $I$ denotes infrastructure manager, are split between a fixed component denoted by $F_I$ (which is independent of the number of rail services and the traffic level) and a variable component, where costs per train service are denoted by $t_r$. Then the cost function for the rail infrastructure manager is expressed as follows:

$$CT_I = t_r n_r + F_I \tag{4}$$

The cost function for the rail operator is expressed as:

$$CT_r = c_r n_r^2 + f_r n_r + F_r \tag{5}$$

where $f_r$ stands for the access charge per service paid by the rail operator, subscript $r$ denotes rail operator, $c_r n_r^2$ denotes the variable costs of the rail operator depending on the number of supplied trains, assuming that variable operating costs are increasing with the number of train services.[2] Finally $F_r$ denotes the fixed costs associated with the rail operations which are independent on the number of services.

Two scenarios will be assumed: i) a vertically integrated structure (VIM) between infrastructure and rail operations with a monopolistic rail operator, and ii) a fully vertically separated structure (VSM) with a monopoly rail operator too. Superscripts $VIM$ and $VSM$ denote the expressions corresponding to the vertically integrated and the vertically separated market structures, respectively. Under the VIM structure the profit function for the integrated rail company to be maximized will be as follows:

$$\pi_r^{VIM} = p_r Q_r - (c_r n_r^2 + t_r n_r + F_r + F_I). \tag{6}$$

For the VIM scenario the integrated company sequentially selects the number of trains before prices to maximize profits. Under this scenario the access charge is formally defined, however it does not affect the equilibrium expression since it cancels out.

For the VSM structure, there are two profits functions to be considered, one for each separated entity:

$$\pi_r^{VSM} = p_r Q_r - (c_r n_r^2 + f_r n_r + F_r), \tag{7}$$

$$\pi_I^{VSM} = f_r n_r - (t_r n_r + F_I). \tag{8}$$

In this scenario a three-stage game is solved: firstly, the rail infrastructure manager decides on the access charge, secondly the train operator chooses the number of services, and finally

[2] This is a technical assumption to reach interior solutions for the equilibrium number of train services and it also reflects the idea that the management of more train services in a route becomes increasingly complex. Brueckner (2009) and Flores-Fillol (2009) also introduce decreasing returns to scale in the cost function of airlines to generate sensible results. These can be produced at higher flight volumes.

the train operator sets prices. Any rail entity will make decisions to maximize its own profits. The game is solved backwards to obtain the corresponding subgame perfect Nash equilibria for each of the two scenarios. Notice that equilibrium prices, traffics and the number of services coincide with those obtained in the vertical integrated monopoly scenario in case the access charge is required to coincide with the marginal cost of providing a service.

## 2.2 The duopoly case

Now we assume that intra-modal competition is introduced in the HSR service by entry of a new rail operator. Then the utility function in (1) is extended in the following way:

$$U = y + {}_{r1}Q_{r1} + {}_{r2}Q_{r2} + {}_{c}Q_c - \frac{1}{2}(b_r Q_{r1}^2 + b_r Q_{r2}^2 + b_c Q_c^2) - d(Q_{r1}Q_c + Q_{r2}Q_c + Q_{r1}Q_{r2}); \quad (9)$$

where ${}_{r1}$ is equal to $a_r + \delta_r n_{r1}$, and ${}_{r2}$ is equal to $a_r + \delta_r n_{r2}$, where $n_{r1}$ and $n_{r2}$ stand for the number of services offered by the rail incumbent and by the rail entrant, respectively. We proceed in the same way as in the monopoly subsection, first obtaining the system of demands that will be used to find the equilibrium prices and number of services for the two rail operators. Again we consider two market structures depending on whether the infrastructure and rail operations are integrated or not. Two new scenarios will be defined: i) a vertically integrated (VID) structure with two rail operators competing on the track where rail operator 1 is the one integrated with the infrastructure manager, and ii) a vertically separated (VSD) structure with two rail operators and a third rail firm, who is the infrastructure manager. Access charges are non-discriminatory. Therefore, under an integrated structure (VID), where there is competition between two asymmetric rail operators, profits read:

$$\pi_{r1}^{VID} = p_r Q_{r1} + f_r n_{r2} - (c_r n_{r1}^2 + t_r(n_{r1} + n_{r2}) + F_I + F_{r1}), \quad (10)$$
$$\pi_{r2}^{VID} = p_r Q_{r2} - (c_r n_{r2}^2 + f_r n_{r2} + F_{r2}). \quad (11)$$

$F_{ri}$ stands for the fixed operating costs associated to each rail operator (where $i = 1, 2$). Finally for the case of a separated structure (VSD), with two symmetric rail operators and a separate infrastructure manager, profits read:

$$\pi_{r1}^{VSD} = p_r Q_{r1} - (c_r n_{r1}^2 + f_r n_{r1} + F_{r1}), \quad (12)$$
$$\pi_{r2}^{VSD} = p_r Q_{r2} - (c_r n_{r2}^2 + f_r n_{r2} + F_{r2}), \quad (13)$$
$$\pi_{I}^{VSD} = f_r(n_{r1} + n_{r2}) - (t_r(n_{r1} + n_{r2}) + F_I). \quad (14)$$

Since the profitability of entry is very sensitive to changes in the pricing policy of the infrastructure manager, we are going to consider a further case, denoted by VR. This case differs from the other two in that the access charge is not set by the infrastructure manager but imposed by the regulator authority so that it coincides with the marginal cost. Then, marginal infrastructure cost ($t_r$) will be the access charge fixed for both operators. Once marginal cost pricing for the access charge is implemented, whether there is separation or integration in the market does not affect the results.

For the three defined scenarios we assume a three-stage game: firstly, the rail infrastructure manager decides on the access charges for cases VID and VSD, or it is bound to marginal pricing for the VR case, secondly the train operators choose the number of services, and finally the train operators set prices. Any rail entity will make decisions to maximize its own profits, where appropriate. The game is solved backwards to obtain the corresponding subgame perfect Nash equilibria for each of the three scenarios.[3] Here we provide some discussion on the main results analytically obtained.

*Discussion of the analytical results*

First and focusing on the monopoly case, the move from a separated structure to an integrated one implies that the cost of one more rail service decreases since the access charge considered is just the infrastructure marginal cost. Since the equilibrium number of rail services is the one that equals marginal revenue to marginal cost and marginal revenue is increasing in the number of services, a parallel shift downwards of the marginal cost of services implies a larger number of services at equilibrium. Then, what we find is that a vertically integrated monopoly structure implies more train services, more train passengers and higher equilibrium prices as compared to the VSM structure. Notice that the VIM structure internalizes the negative vertical externality also known as double marginalization and therefore, provides an equilibrium that is closer to the social optimum, in fact at equilibrium $n_{r}^{VSM} < n_{r}^{VIM} < n_{r}^{opt}$, where the superscripts denote the market structure considered and superscript *opt* denotes social optimum (the number of services that maximizes the social welfare function). The access charge does not affect the equilibrium number of rail services in a VIM scenario, it is only the term that splits profits between the upstream division and the downstream one.[4]

[3] Given that most of the analytical equilibrium expressions are long and tedious, these are relegated to a separate appendix which can be obtained upon request from the authors.

[4] In fact, the difference between the VIM structure and the social optimum is that in the social optimum, the equilibrium rail price is equal to zero which implies a larger number of rail passengers, which in turn implies a parallel shift outwards of the marginal revenue of the number of train services with the conclusion

For the duopoly case the move from separation to integration has more effects. First notice that the equilibrium train prices are those that correspond to the crossing of both rail operator reaction functions. Since both rail operators offer substitute services and they compete in prices, reaction functions for prices are upward sloping and a change in the number of rail services by one rail operator implies a shift outwards in its own reaction function, while the shift is inwards for that of the rival. After solving, we know that equilibrium prices are increasing in the number of services of each rail operator, although the effect is larger for own services. We also know that the equilibrium number of passengers of one rail operator, once equilibrium prices are substituted back in the demand functions, are increasing with own number of services and decreasing with that of the rival. The above properties of the third stage equilibrium are common to both the VID and the VSD market structures.

Considering the second stage, the equilibrium number of rail services is also the result of the strategic interaction of both rail operators, so the crossing point between the rail operator reaction functions implicitly defines the equilibrium. It is important to highlight that the number of rail services behave as strategic substitutes, that is the marginal benefit of the number of services for one rail operator is decreasing with the number of services of the other. This is equivalent to saying that each firm's reaction function for the number of services is downward sloping. Also, reaction functions shift inwards as the access charge increases. Now, when the market structure is a VSD, both rail operators marginal cost of services depend on the same access charge set by the infrastructure manager, then a symmetric equilibrium in the number of services is reached. The infrastructure manager will optimally set an access charge which is greater that the infrastructure marginal cost and lower that the one in the VIM (since now it faces a more elastic derived demand). However for the VID, the second stage equilibrium is different since the vertically integrated rail operator faces a marginal cost of the number of services that depends on the infrastructure marginal cost and not on the access charge, while the not integrated operator marginal cost of services depends on the access charge. This implies an asymmetric equilibrium in the number of services where the strategic advantage of the integrated rail operator materializes in a higher number of services compared to that of the rival. Furthermore, the integrated rail entity now sets an equilibrium access charge greater than the infrastructure marginal cost. The reason is that now the access charge has strategic effects on the rival and increasing it pays off. Now the access charge is not just the variable that splits profits between both divisions of the integrated entity, but has market effects. Finally, when the infrastructure manager is forced to set the access charge equal to the

that the optimal number of train services is larger.

infrastructure marginal cost, the VR scenario, either the strategic behavior that arises in the VID case disappears, or the double marginalization inefficiency arising in the VSD scenario is eliminated. By implementing the VR regime the equilibrium prices, the total number of services increases and the rail operator profits increase at the expense of lower profits for the infrastructure manager entity.

# 3 The empirical application

Our following step in the analysis will be to carry out a simulation using actual data. In particular, we are going to employ data from three HSR lines: the HSR between Madrid-Barcelona, Madrid-Sevilla and Madrid-Valencia. Figure 1 displays a map with the main HSR lines in Spain. Currently there is only one operator in the rail market (RENFE which is the incumbent public operator), and so the initial situation replicates the monopoly structure presented in the previous section. Future situations simulate the entry of a new rail operator in the routes between Madrid-Barcelona, Madrid-Sevilla and Madrid-Valencia.

[Insert Figure 1 about here]

## 3.1 Calibration process

In order to calibrate the model we employ actual data for the three corridors reported in Table 1:

| | Madrid-Barcelona | Madrid-Sevilla | Madrid-Valencia |
|---|---|---|---|
| Rail traffic point to point per year | 2,428,118 | 2,140,942 | 1,925,000 |
| Rest of internal traffic per year | 2,738,092 | 656,298 | 448,000 |
| Total rail passengers per year | 5,166,210 | 2,797,240 | 2,373,000 |
| Average rail price per passenger | €105 | €88 | €75 |
| Train services per day and direction | 27 | 18 | 15 |
| Total car passengers per year at the corridor | 4,728,500 | 3,100,000 | 3,062,000 |
| Car price trip | €80 | €65 | €57 |

Source: own elaboration from RENFE

Table 1: Data from the three corridors in 2011.

The calibration process is divided in several steps: i) the recovery of the utility parameters $b_r$, $b_c$, $d$ and $\delta_r$, ii) the recovery of the cost parameters of the infrastructure manager $t_r$ and $F_I$, iii) the recovery of values for the willingness to pay $a_r$ and $a_c$ and for parameter $c_r$ related to the variable rail operating costs, and iv) the measurement of the values for $F_r$ denoting the fixed component of the rail operating costs.

In order to obtain the utility parameters, estimates for the relevant elasticities are necessary and they can be found in previous papers by González-Savignat (2008), and Álvarez et al.(2009).[5] The considered values are the following:

| | Own-price elasticity | Cross-price elasticity | Own frequency elasticity |
|---|---|---|---|
| Rail | -0.75 | 0.12 | 0.15 |
| Car | -0.30 | 0.12 | - |

Table 2. Values for elasticities used in the calibration process

Then, the following system of four equations with four unknowns ($b_r$, $b_a$, $\delta_r$ and $d$) is defined below:

$$-\frac{b_c}{b_r b_c - d^2}\frac{\overline{p_r}}{\overline{q_r}} = -0.75$$
$$\frac{d}{b_r b_c - d^2}\frac{\overline{p_c}}{\overline{q_r}} = 0.12$$
$$-\frac{b_r}{b_r b_c - d^2}\frac{\overline{p_c}}{\overline{q_c}} = -0.30$$
$$\frac{b_c\ \delta_r}{b_r b_c - d^2}\frac{\overline{n_r}}{\overline{q_r}} = 0.15$$

Values for $\overline{p_r}$, $\overline{q_r}$, $\overline{p_c}$, $\overline{q_c}$ and $\overline{n_r}$ are taken from actual values in Table 1 for the year 2011. After solving the system of equations the calibrated values for the parameters were the following:

| | Madrid-Barcelona | Madrid-Sevilla | Madrid-Valencia |
|---|---|---|---|
| $b_r$ | 0.021 | 0.031 | 0.033 |
| $b_c$ | 0.042 | 0.056 | 0.048 |
| $d$ | 0.009 | 0.011 | 0.010 |
| $\delta_r$ | 3.472 | 4.514 | 4.750 |

Table 3: Calibration of the utility function parameters

In the second step we proceed to obtain values for the cost parameters of the infrastructure manager $t_r$ and $F_I$. We will consider €112,723 per km as the total maintenance costs per

[5] These estimates are aggregate estimates for interurban traffic. There are no individual estimates for each route.

km of HSR, data provided by ADIF. Then, we proceed to break down the costs into those depending on the traffic level and fixed costs. The literature reports cost elasticities that vary in the range of 0.2 and 0.5 (see Silavong, 2014, for a recent review, or Wheat et al, 2009, for a set of estimates for different countries). Assuming a mean value of 0.35, and considering the average current trains supplied daily in each route, current variable maintenance costs can be estimated aproximately by €1,400 per train service in the three routes that we are going to study. The rest of the costs (per day and direction) were used as an approximation for the fixed maintenance infrastructure costs denoted by $F_I$, which are, €47,675 for Madrid-Sevilla, €39,244 for Madrid-Valencia, and €66,143 for Madrid-Barcelona.

Additionally we need calibrated values for the parameters $a_r$, $a_c$ and $c_r$. Given the values obtained in the two previous steps, and assuming that the VIM scenario is the one that is closer to the current scenario,[6] a system of three equations equalizing the actual values to the equilibrium expressions obtained for traffic levels in car (expressed in passenger per day and direction), the average rail price (approximated by the mean revenue of a user in the line) and the number of rail services under the VIM structure is defined:

| | Madrid-Barcelona | Madrid-Sevilla | Madrid-Valencia |
|---|---|---|---|
| $n_r^{VIM}(a_r, a_c, c_r)$ | 27 | 18 | 15 |
| $p_r^{VIM}(a_r, a_c, c_r)$ | 115 | 88 | 75 |
| $Q_c^{VIM}(a_r, a_c, c_r)$ | 6,477 | 4,110 | 4,194 |

Table 4: Actual traffics and number of trains in 2011 for the three corridors.

After solving the system of equations for each corridor, the calibrated values obtained for parameters $a_r$, $a_c$ and $c_r$,are:

| | Madrid-Barcelona | Madrid-Sevilla | Madrid-Valencia |
|---|---|---|---|
| $a_r$ | 207.68 | 145.58 | 126.78 |
| $a_c$ | 406.48 | 329.74 | 285.14 |
| $c_r$ | 362.65 | 338.55 | 339.35 |

Table 5: Calibrated values for $a_r$, $a_c$ and $c_r$.

Finally, an estimate for the fixed operating costs denoted by $F_r$ in equation (5) is required. Note that in $F_r$ we include any cost independent from the number of servicies supplied. Crozet

[6] We have to choose between VIM and VSM as the benchmark scenario. Although the actual market structure can be defined as a separated structure, the levels of access fees are much closer to the levels set in the VIM scenario than the levels in the VSM scenario.

and Chassagne (2013) provide a detailed breakdown of the different types of rail operating costs. If one considers charges like ticketing, marketing and station costs, and some structure costs like buildings or other fixed assets, these stand by around one third over the total operating costs. In equation (5) variable operating costs are approximated by the term $c_r n_r^2$. These values appear in the second row of Table 6. Following Crozet and Chassagne (2013), these represent two thirds of total operating costs and the remaining third corresponds to $F_r$. Indeed similar figures are obtained from data provided by RENFE (see www.ferropedia.es). At any rate the costs independent from the number of trains supplied will be sensitive to the route analyzed.[7] Therefore the calibration process provided the following results:

| | Madrid-Barcelona | Madrid-Sevilla | Madrid-Valencia |
|---|---|---|---|
| Total operation costs | 396,624 | 164,535 | 114,531 |
| Variable costs ($c_r n_r^2$) | 264,416 | 109,690 | 76,354 |
| Fixed operation costs ($F_r$) | 132,208 | 54,845 | 38,177 |

Table 6: Operating costs per route

## 3.2 Simulation results

Tables 7a, 7b and 7c show the results for the three routes Madrid-Barcelona, Madrid-Sevilla and Madrid-Valencia. The first columns show the results for the five different scenarios: VIM, VSM, VID, VSD and VR. As we explained above, we consider the VIM scenario as the market structure that is closer to the actual one. Therefore, for some variables, we will include in small font figures and italics a figure indicating the relative variation with respect to this situation. VR stands for the scenario of entry under vertical integration, where the infrastructure manager does marginal cost pricing in setting the access charges. VID is the same scenario with the difference that the incumbent maximizes its integrated profits. The novel feature of these scenarios is the existence of different results for the incumbent and the entrant, because both companies maximize different objective functions. Finally we have considered different situations for the fixed operating costs of the entrant. In Tables 7a, 7b and 7c we consider that these costs are the same for the incumbent and the entrant. In Tables 8a, 8b and 8c we have considered that fixed operating costs can be significantly lower for the

[7] With these figures, the scenario defined in the VIM case allows, with the traffic revenue, to recover approximately the aggregate costs (excepting construction costs). These recovery indexes are similar to the real figures of 130%, 114% and 110% respectively for the services Madrid-Barcelona, Madrid-Sevilla and Madrid-Valencia in 2011 (see B. O. C. G. no. 139 and forodeltransporteyelferrocarril.blogspot.com.es).

entrant (Crozet and Chassagne, 2013, point out that the entrant could reduce significantly the ticket and marketing costs selling tickets on internet). Other structure costs could be notably lower. We only show the results for operators' profits and social welfare, because the fixed costs do not affect the strategic variables of the model, and therefore, consumer surplus is not affected either.

Note that relative results are very similar in the three routes, and only absolute levels are significantly different. We have already noted that VIM can be interpreted alternatively as a separated scenario where the infrastructure manager follows a marginal cost pricing rule. We shall discuss the results for Madrid-Barcelona (which is the route with the highest traffic level), but note that results for the other two routes are qualitatively similar. Firstly, we will explain the effects of a move from the VIM to a VSM scenario, where the rail infrastructure manager maximizes profits. This move would produce a reduction by around 20% in prices and by 50% in the number of services, provoking a significant decrease in the rail operating profits by 43%. The good news are for the infrastructure manager ADIF, which obtains positive and high profits due to the notable increase in the access charges (although the aggregate profits for the rail industry, adding the profits for ADIF and the rail operator, are lower in the VSM structure by 19%). Finally, the VSM reduces consumer surplus by around 8% and social welfare falls by 9%.

The results reported in the third to the seventh columns show the simulation outcomes when a new rail operator enters the market. Note that the VR scenario, column five, is the best one in terms of consumer surplus and social welfare. In particular the move from the VIM to the VR scenario provokes an increase by 17% in consumer surplus and by 9% in social welfare. The model predicts a 30% reduction in prices and a 52% increase in the number of train services. And the increase in the number of rail passengers would be around 62% whereas car traffic would be lessened by 12%. In the VID scenario asymmetric results between the incumbent and the entrant are produced. The incumbent would offer a combination of 23 trains at a price of €89, while the entrant would offer around 4 services at a price of €53. This scenario produces losses for both rail operators, but is the best scenario for ADIF, the infrastructure owner. This scenario, as VR, produces a high increase in rail traffic by 45%.

Such high increases in the number of rail passengers in VR and VID is due to the properties of the theoretical model, and might not be realistic. To control for this effect, the values for parameter $a_r$ in Table 5, standing for the willingness to pay for rail travel, have been multiplied by 0.90 and the simulation of entry is reworked. These results are shown in the seventh column for the VR scenario, and show that the entry of a new rail operator would provoke an increase in new rail traffic by 36%, and even so, the loss in social welfare would be around 8%. Given that, the decrease in car traffic would be around 7%, the rest of the increase in the rail traffic should be induced or coming from other transport modes, specifically air. Another interesting result is that entry would produce a significant loss in the profitability of the rail operators (by 58% in the aggregate profits for the whole industry).[8] Note that these results, with a very different approach, are qualitatively similar to those obtained by Johnson and Nash (2012) and Álvarez et al (2015), where the loss in social welfare provoked by entry is explained by the large fall in industry profitability that is higher than the increase in consumer surplus.

Finally, let us comment the simulation results when entry is accompanied with the separation of infrastructure and operations. The comparison of VIM with VSD throws the following results. The prices and the number of trains would go down by 43% and by 24% respectively. Note that this scenario is a second best option for the rail infrastructure manager. As we did above, we contemplate a similar reduction in the value for $a_{r}$□in order to report a more realistic scenario. In this case, the sixth column shows that the increase of rail traffic would be modest, by 13%, and that the decrease in prices and number of trains would be again by 50% and 37% respectively. Consumer surplus would slightly decrease by 3%, but the profitability loss in the rail industry would end up reducing social welfare by 14%.

Tables 7b and 7c show the results for the other two corridors, Madrid-Sevilla and Madrid-Valencia. As we pointed out above, the results are qualitatively similar. In quantitative terms, we must emphasize the economic losses of ADIF in both corridors for many of the scenarios. As in Madrid-Barcelona, rail operators clearly prefer a regime with a rule of marginal cost pricing for the access charges, which leads to significant losses to ADIF. Furthermore, if we assumed a realistic assumption where we control for new traffic following entry of a new operator, we find that entry would be economically feasible only in the case for Madrid-Barcelona and for a VR regime. A further consideration is to analyze the effects of an access charge that makes ADIF to break-even. Is this alternative regulation system consistent with entry? For Madrid-Barcelona, the access charge per service, which is set equal to average cost, would be €3,176. With respect to the VR scenario, this would lead to a decrease in prices and frequencies, still resulting in profitable entry.

As mentioned before and as a measure of sensitivity, we have assumed that costs for the entrant might be notably lower than the incumbent's. We have considered two hypothesis: fixed operating costs are reduced by 25% and by 50%. The results are shown in Tables 8a, 8b and 8c for the three routes. As expected, now the feasibility of entry notably increases, but the

[8] This result explains the reluctance of RENFE to allow the entry of a new operator in Madrid-Barcelona.

ranking in terms of profitability remains, Madrid-Barcelona is the most profitable, followed by Madrid-Sevilla and Madrid-Valencia. Also the ranking in terms of social welfare hardly changes. An increase by 2 percentage points in social welfare is produced when fixed costs for the entrant are reduced by 25%. Note that cost efficiencies make entry profitable even in the more realistic scenarios (see columns six and seven in Tables 8a, 8b and 8c). However, the improvement in profits does not suffice to generate welfare gains after entry; in fact, losses are in the range of 4-11% when the costs of the entrant are 50% lower than the incumbent's.

# 4 Concluding remarks and policy implications

This paper has presented a model of competition between HSR and car transport to capture market behavior in several Spanish HSR routes. Our purpose is to provide an ex ante analysis of entry liberalization in HSR lines, which may be helpful for informed policy making in rail passenger transport. Our analysis has considered the vertical structure of the rail sector, operators that compete in prices and also in the number of services, and most importantly, access charges that are endogenous. Welfare conclusions and entry profitability are found to depend on i) whether infrastructure and rail operations are integrated or separated, and also on ii) the policy rule to set rail access charges. Our paper has emphasized the relevance of the level of access charges regarding entry while advising some side effects of separation.

As for policy implications, and abstracting from any other gains derived from the separation of activities, we may conclude that separation without entry is not a good policy, since the reduction in prices is followed by a reduction in the number of services that leads to fewer rail traffic, lower consumer surplus and lower industry profits. The only increase is produced in car traffic and infrastructure manager's profits. Therefore, separation has the effect of transferring surplus from consumers and the rail operator to the infrastructure manager with the consequence of reducing social welfare due to the double marginalization inefficiency.

Regarding entry, two issues are relevant. The first one is whether entry is profitable for the entrant and the second one is to assess its effect in welfare terms. We find that entry is profitable for the three corridors regardless of any other consideration on the vertical structure and the policy rule followed to set rail access charges whenever the entrant's fixed costs are half the incumbent's or lower. As the entrant's fixed costs increase entry becomes more difficult but entry still arises when the VSD or VR scenarios are implemented, where the latter favours entry the most for the three corridors. However, entry is found profitable under those scenarios because it generates increases in passenger traffic of about 30% and 60%, respectively. When entry is assumed to generate more modest increases, i.e. about 13% and 35%, only the regulated scenario ensures entry and only for the Madrid-Barcelona corridor. We have also shown that entry occurs even if the regulation of the access charge is such that the infrastructure manager breaks-even. Regarding the social welfare issue, what we find is that entry is never welfare improving unless it generates enough passenger traffic. If it does, then an integrated vertical structure is better than a separated one. However, the best option is the VR scenario when the society assumes the losses generated on the infrastructure manager, or else the regulation of the access charge that ensures zero profits for the infrastructure manager if the society prefers that users bear the losses generated by the regulation. Further research should distinguish peak and off-peak travel and access charges that account for investment infrastructure costs to study their role regarding the socioeconomic viablity of on track competition.

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Figure 1. Map of Spanish HSR services

**Table 7a. Madrid-Barcelona**

| | VIM | VSM | VID | VSD | VR | VSD pessim | VR pessim |
|---|---|---|---|---|---|---|---|
| **Train price inc.** | 115 | 92 | 89 | 66 | 80 | 56 | 67 |
| | *1* | *0.80* | *0.77* | *0.57* | *0.70* | *0.49* | *0.58* |
| **Train price entr.** | | | 53 | 66 | 80 | 56 | 67 |
| **# trains inc.** | | | 23.38 | 10.30 | 20.58 | 8.48 | 17 |
| **# trains entr.** | | | 4.23 | 10.30 | 20.58 | 8.48 | 17 |
| **# total trains** | 27 | 13.5 | 27.61 | 20.60 | 41.16 | 17 | 34 |
| | *1* | *0.50* | *1.02* | *0.76* | *1.52* | *0.63* | *1.26* |
| **# pass. inc.** | | | 5492 | 4044 | 4883 | 3408 | 4101 |
| **# pass. entr** | | | 3251 | 4044 | 4883 | 3408 | 4101 |
| **Total rail pass.** | 6044 | 4812 | 8743 | 8088 | 9766 | 6816 | 8202 |
| | *1* | *0.80* | *1.45* | *1.34* | *1.62* | *1.13* | *1.36* |
| **Road traffic** | 6477 | 6742 | 5896 | 6037 | 5675 | 6311 | 6013 |
| | *1* | *1.04* | *0.91* | *0.93* | *0.88* | *0.97* | *0.93* |
| **Access fee** | 1400 | 6916 | 7076 | 6055 | 1400 | 5238 | 1400 |
| | *1* | *4.94* | *5.05* | *4.33* | *1.00* | *3.74* | *1.00* |
| **Incumb. var. prof.** | 392866 | 281169 | 127928 | 165845 | 206386 | 118744 | 145919 |
| | *1* | *0.72* | *0.33* | *0.42* | *0.53* | *0.30* | *0.37* |
| **Incumb. profits** | | | -4280 | 33637 | 74178 | -13464 | 13711 |
| **Entrant's var. prof.** | | | 125361 | 165845 | 206386 | 118744 | 145919 |
| **Entrant's profits** | | | -6847 | 33637 | 74178 | -13464 | 13711 |
| **Total oper. Prof.** | 260658 | 148961 | -11127 | 67274 | 148356 | -26928 | 27422 |
| | *1* | *0.57* | *-0.04* | *0.26* | *0.57* | *-0.10* | *0.11* |
| **ADIF's profits** | -66143 | 8323 | 90571 | 29750 | -66143 | -897 | -66143 |
| **Total rail profits** | 194515 | 157284 | 79445 | 97024 | 82213 | -27825 | -38721 |
| **Consum Surplus** | 1636935 | 1509729 | 1805475 | 1718285 | 1914955 | 1594068 | 1730476 |
| | *1* | *0.92* | *1.10* | *1.05* | *1.17* | *0.97* | *1.06* |
| **Social Welfare** | 1831450 | 1667013 | 1884920 | 1815309 | 1997168 | 1566243 | 1691755 |
| | *1* | *0.91* | *1.03* | *0.99* | *1.09* | *0.86* | *0.92* |

**Table 7b. Madrid-Sevilla**

| | VIM | VSM | VID | VSD | VR | VSD pessim | VR pessim |
|---|---|---|---|---|---|---|---|
| **Train price inc.** | 88 | 68 | 72 | 52 | 65 | 43 | 54 |
| | *1* | *0.77* | *0.82* | *0.59* | *0.74* | *0.49* | *0.61* |
| **Train price entr.** | | | 41 | 52 | 65 | 43 | 54 |
| **# trains inc.** | | | 15.84 | 6.87 | 13.74 | 5.52 | 11.04 |
| **# trains entr** | | | 3.61 | 6.87 | 13.74 | 5.52 | 11.04 |
| **# total trains** | 18 | 9 | 19.45 | 13.74 | 27.48 | 11.04 | 22.08 |
| | *1* | *0.50* | *1.08* | *0.76* | *1.53* | *0.61* | *1.23* |
| **# pass. inc.** | | | 2754 | 1947 | 2426 | 1627 | 2013 |
| **# pass. entr** | | | 1556 | 1947 | 2426 | 1627 | 2013 |
| **Total rail paseng.** | 3010 | 2315 | 4310 | 3894 | 4852 | 3254 | 4026 |
| | *1* | *0.77* | *1.43* | *1.29* | *1.61* | *1.08* | *1.34* |
| **Road traffic** | 4110 | 4243 | 3881 | 3940 | 3756 | 4063 | 3915 |
| | *1* | *1.03* | *0.94* | *0.96* | *0.91* | *0.99* | *0.95* |
| **Access fee** | 1400 | 4358 | 4411 | 3934 | 1400 | 3437 | 1400 |
| | *1* | *3.11* | *3.15* | *2.81* | *1.00* | *2.46* | *1.00* |
| **Incumb. var. prof.** | 130009 | 90083 | 43182 | 57826 | 73542 | 41142 | 51062 |
| **Incumb. profits** | | | -11663 | 2981 | 18697 | -13703 | -3784 |
| **Entrant's var. prof.** | | | 42929 | 57826 | 73542 | 41142 | 51062 |
| **Entrant's profits** | | | -11916 | 2981 | 18697 | -13703 | -3783 |
| **Total operating Profits** | 75164 | 35238 | -23579 | 5962 | 37394 | -27406 | -7567 |
| **ADIF's profits** | -47675 | -21053 | 10889 | -12858 | -47675 | -25187 | -47675 |
| **Total rail profits** | 27489 | 14185 | -12690 | -6896 | -10281 | -52593 | -55242 |
| **Consumer Surplus** | 752938 | 698850 | 807880 | 764454 | 844190 | 721079 | 774435 |
| | *1* | *0.93* | *1.07* | *1.02* | *1.12* | *0.96* | *1.03* |
| **Social Welfare** | 780426 | 713034 | 795190 | 757558 | 833909 | 668486 | 719193 |
| | *1* | *0.91* | *1.02* | *0.97* | *1.07* | *0.86* | *0.92* |

**Table 7c. Madrid-Valencia**

| | VIM | VSM | VID | VSD | VR | VSD pessim | VR pessim |
|---|---|---|---|---|---|---|---|
| **Train price inc.** | 75 | 57 | 63 | 45 | 57 | 38 | 47 |
| | *1* | *0.76* | *0.84* | *0.60* | *0.76* | *0.51* | *0.63* |
| **Train price entr.** | | | 38 | 45 | 57 | 38 | 47 |
| **# trains inc.** | | | 12.92 | 5.78 | 11.56 | 4.53 | 9.05 |
| **# trains entr.** | | | 3.49 | 5.78 | 11.56 | 4.53 | 9.05 |
| **# total trains** | 15 | 7.5 | 16.41 | 11.56 | 23.12 | 9.06 | 18.10 |
| | *1* | *0.50* | *1.09* | *0.77* | *1.54* | *0.60* | *1.21* |
| **# pass. inc.** | | | 2178 | 1574 | 1981 | 1298 | 1617 |
| **# pass. entr.** | | | 1314 | 1574 | 1981 | 1298 | 1617 |
| **Total rail paseng.** | 2438 | 1859 | 3492 | 3148 | 3962 | 2596 | 3234 |
| | *1* | *0.76* | *1.43* | *1.29* | *1.63* | *1.06* | *1.33* |
| **Road traffic** | 4194 | 4316 | 4025 | 4045 | 3874 | 4161 | 4027 |
| | *1* | *1.03* | *0.96* | *0.96* | *0.92* | *0.99* | *0.96* |
| **Access fee** | 1400 | 3740 | 3769 | 3424 | 1400 | 2985 | 1400 |
| | *1* | *2.67* | *2.69* | *2.45* | *1.00* | *2.13* | *1.00* |
| **Incumb. var. prof.** | 85497 | 59173 | 31609 | 39871 | 50916 | 27805 | 34396 |
| **Incumb. profits** | | | -6568 | 1694 | 12739 | -10372 | -3781 |
| **Entrant's var. prof.** | | | 32598 | 39871 | 50916 | 27805 | 34396 |
| **Entrant's profits** | | | -5579 | 1694 | 12739 | -10372 | -3781 |
| **Total oper. profits** | 47320 | 20996 | -12147 | 3388 | 25478 | -20744 | -7562 |
| **ADIF's profits** | -39244 | -21694 | -369 | -15847 | -39244 | -24884 | -39244 |
| **Total rail profits** | 8076 | -698 | -12515 | -12458 | -13766 | -45628 | -46806 |
| **Consumer Surplus** | 628439 | 590168 | 664809 | 633190 | 689340 | 602412 | 638474 |
| | *1* | *0.94* | *1.06* | *1.01* | *1.10* | *0.96* | *1.02* |
| **Social Welfare** | 636515 | 589470 | 652294 | 620732 | 675574 | 556784 | 591668 |
| | *1* | *0.93* | *1.02* | *0.98* | *1.06* | *0.87* | *0.93* |

**Table 8a. Madrid-Barcelona**

| | VIM | VIS | VID | VSD | VR | VSD pessim | VR pessim |
|---|---|---|---|---|---|---|---|
| | | | ***$F_r$ is 25% lower for the entrant*** | | | | |
| ***Entrant's profits*** | | | 107230 | 26205 | 66689 | 19588 | 46763 |
| ***Total oper. prof.*** | 260658 | 148961 | 21925 | 100326 | 181408 | 6124 | 60474 |
| ***ADIF's profits*** | -66143 | 8323 | 90571 | 29750 | -66143 | -897 | -66143 |
| ***Total rail profits*** | 194515 | 157284 | 112497 | 130076 | 115265 | 5227 | -5669 |
| ***Consum. Surplus*** | 1636935 | 1509729 | 1805475 | 1718285 | 1914955 | 1594068 | 1730476 |
| | *1* | *0.92* | *1.10* | *1.05* | *1.17* | *0.97* | *1.06* |
| ***Social Welfare*** | 1831450 | 1667013 | 1917972 | 1848361 | 2030220 | 1599295 | 1724807 |
| | *1* | *0.91* | *1.05* | *1.01* | *1.11* | *0.87* | *0.94* |
| | | | ***$F_r$ is 50% lower for the entrant*** | | | | |
| ***Entrant's profits*** | | | 140282 | 59257 | 99741 | 52640 | 79815 |
| ***Total oper. Prof.*** | 260658 | 148961 | 54977 | 133378 | 214460 | 39176 | 93526 |
| ***ADIF's profits*** | -66143 | 8323 | 90571 | 29750 | -66143 | -897 | -66143 |
| ***Total rail profits*** | 194515 | 157284 | 145549 | 163128 | 148317 | 38279 | 27383 |
| ***Consum. Surplus*** | 1636935 | 1509729 | 1805475 | 1718285 | 1914955 | 1594068 | 1730476 |
| | *1* | *0.92* | *1.10* | *1.05* | *1.17* | *0.97* | *1.06* |
| ***Social Welfare*** | 1831450 | 1667013 | 1951024 | 1881413 | 2063272 | 1632347 | 1757859 |
| | *1* | *0.91* | *1.07* | *1.03* | *1.13* | *0.89* | *0.96* |

**Table 8b. Madrid-Sevilla**

| | VIM | VIS | VID | VSD | VR | VSD pessim | VR pessim |
|---|---|---|---|---|---|---|---|
| | | | | ***$F_r$ is 25% lower for the entrant*** | | | |
| ***Entrant's profits*** | | | 1795 | 16692 | 32408 | 8 | 9928 |
| ***Total oper. prof.*** | 75164 | 35238 | -9868 | 19673 | 51105 | -13695 | 6145 |
| ***ADIF's profits*** | -47675 | -21053 | 10889 | -12858 | -47675 | -25187 | -47675 |
| ***Total rail profits*** | 27489 | 14185 | 1021 | 6815 | 3430 | -38881 | -41530 |
| ***Consum. Surplus*** | 752938 | 698850 | 807880 | 764454 | 844190 | 721079 | 774435 |
| | *1* | *0.93* | *1.07* | *1.02* | *1.12* | *0.96* | *1.03* |
| ***Social Welfare*** | 780426 | 713034 | 808901 | 771269 | 847620 | 682198 | 732905 |
| | *1* | *0.91* | *1.04* | *0.99* | *1.09* | *0.87* | *0.94* |
| | | | | ***$F_r$ is 50% lower for the entrant*** | | | |
| ***Entrant's profits*** | | | 15506 | 30403 | 46119 | 13719 | 23639 |
| ***Total oper. prof.*** | 75164 | 35238 | 3843 | 33384 | 64816 | 16 | 19856 |
| ***ADIF's profits*** | -47675 | -21053 | 10889 | -12858 | -47675 | -25187 | -47675 |
| ***Total rail profits*** | 27489 | 14185 | 14732 | 20527 | 17141 | -25170 | -27819 |
| ***Consum. Surplus*** | 752938 | 698850 | 807880 | 764454 | 844190 | 721079 | 774435 |
| | *1* | *0.93* | *1.07* | *1.02* | *1.12* | *0.96* | *1.03* |
| ***Social Welfare*** | 780426 | 713034 | 822612 | 784981 | 861331 | 695909 | 746616 |
| | *1* | *0.91* | *1.05* | *1.01* | *1.10* | *0.89* | *0.96* |

**Table 8c. Madrid –Valencia**

| | VIM | VIS | VID | VSD | VR | VSD pessim | VR pessim |
|---|---|---|---|---|---|---|---|
| | | | ***$F_r$ is 25% lower for the entrant*** | | | | |
| ***Entrant's profits*** | | | 3965 | 11238 | 22283 | -828 | 5763 |
| ***Total oper. prof.*** | 47320 | 20996 | -2603 | 12932 | 35022 | -11200 | 1982 |
| ***ADIF's profits*** | -39244 | -21694 | -369 | -15847 | -39244 | -24884 | -39244 |
| ***Total rail profits*** | 8076 | -698 | -2971 | -2914 | -4222 | -36083 | -37262 |
| ***Consum. Surplus*** | 628439 | 590168 | 664809 | 633190 | 689340 | 602412 | 638474 |
| | *1* | *0.94* | *1.06* | *1.01* | *1.10* | *0.96* | *1.02* |
| ***Social Welfare*** | 636515 | 589470 | 661838 | 630276 | 685118 | 566328 | 601212 |
| | *1* | *0.93* | *1.04* | *0.99* | *1.08* | *0.89* | *0.94* |
| | | | ***$F_r$ is 50% lower for the entrant*** | | | | |
| ***Entrant's profits*** | | | 13510 | 20783 | 31828 | 8717 | 15308 |
| ***Total oper. prof.*** | 47320 | 20996 | 6942 | 22477 | 44567 | -1655 | 11527 |
| ***ADIF's profits*** | -39244 | -21694 | -369 | -15847 | -39244 | -24884 | -39244 |
| ***Total rail profits*** | 8076 | -698 | 6573 | 6630 | 5323 | -26539 | -27717 |
| ***Consum. Surplus*** | 628439 | 590168 | 664809 | 633190 | 689340 | 602412 | 638474 |
| | *1* | *0.94* | *1.06* | *1.01* | *1.10* | *0.96* | *1.02* |
| ***Social Welfare*** | 636515 | 589470 | 671382 | 639820 | 694663 | 575872 | 610756 |
| | *1* | *0.93* | *1.05* | *1.01* | *1.09* | *0.90* | *0.96* |

***DOCUMENTOS EDITADOS POR LA DIRECCIÓN GENERAL DE PRESUPUESTOS***

1.- Título: "Una función de consumo privado para la economía española"
Autores: Javier Andrés, César Molinas y David Taguas
Número: D-1987-002

2.- Título: "Especificación de una función de exportaciones para la economía española: estimación y predicción"
Autor: Luis Mañas
Número: SGPE-D-1987-003

3.- Título: "Déficit, inflación y deuda"
Autores: Miguel Sebastián, César Molinas y Josep Baiges
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Autor: Laureano Lázaro Araujo
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Autor: Laureano Lázaro Araujo
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Autores: Juan A. Bertrán e Iñigo de la Lastra
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11.- Título: "Determinación desagregada de la recaudación y progresividad del IRPF: la tarifa y las deducciones"
Autor: Rafael Salas
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Autores: Adolfo Corrales y David Taguas
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Autores: Ismael Fernández y Miguel Sebastián
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Autores: César Molinas, Fernando C. Ballabriga, Eudald Canadell Alvaro Escribano, Elias López, Luis Manzanedo, Ricardo Mestre, Miguel Sebastián y David Taguas
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Autores: Oscar Bajo y Simón Sosvilla
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Autores: Antonio Carrascosa y Luis Sastre.
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Autor: José Antonio Nieves de la Flor.
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Autores: Leandro Prados de la Escosura, Teresa Dabán y Jorge Sanz.
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Autores: Javier Andrés y José E. Boscá.
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Autores: Luis González Calbet, Angel Sánchez y David Taguas.
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Número: D-1994-004
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63.- Título: "Fondos Comunitarios en España: Regionalización y análisis de su incidencia
Autores: Mª Dolores Correa, Ana Fanlo, Juan Manzanedo y Santiago Santillán
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