COMPETITION IN RAIL PASSENGER SERVICES: THE CASE FOR A HSR LINE

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Abstract

This paper presents a model where the entry of a new train operator in an HSR line is evaluated in terms of the changes in prices, service levels, profits and consumer surplus. We develop a theoretical model based on a deterministic utility function and, in a subsequent step, the model is calibrated using actual data from two Spanish HSR lines. The model is simulated assuming two alternative regimes, depending on the behavior of the rail operator. Under the public scenario, the rail operator will maximize the social welfare, while under the private scenario the rail operator will maximize profits; competitors behave as profit maximizers. Our model shows that whether entry is profitable depends on the amount of new traffic that the new operator can generate. If it is sufficiently high then entry will be beneficial both in terms of consumer surplus and social welfare (public scenario) or just in welfare terms (private scenario). But if it is not then the mixed duopoly produces the highest levels of consumer surplus and social welfare. Our results reveal that in the current situation there is a high and inefficient level of train services. A lower combination of prices and service levels would reduce the economic losses and significantly improve both consumer surplus and social welfare (without entry). If privatization of the rail industry is promoted, there will be a transfer of surplus from consumers to operators, with a net reduction in social welfare by around 15% in both corridors with respect to the current situation.

Keywords: passenger transport, infrastructure, high speed lines, competence.
JEL Classification: L11, D47, H54, R42, R48

1 Introduction

In the last twenty years many countries have invested large amounts of resources in new High Speed Rail lines. These new services have notably changed the market shares and conditions in the routes where these services have been implemented. In particular, Preston (2009) points out that in Europe in 2008, there were 5,600 km of high speed lines in operation. And using UIC data, foresights indicate that by 2025 China will have 9,138 km of high speed line in place or planned, followed by Spain (7,105), France (6,654), Japan (6,073) and Germany (3,658).

However, the economic crisis is provoking a dramatic change,and some of these planning investments are being reconsidered. Then it is not only necessary to make a more precise assessment of the whole costs and benefits, but also to introduce better management systems to allow for a more efficient exploitation of the HSR lines. Recently, the Spanish Government announced plans to introduce private equity and private operators in the passenger rail system, including the HSR lines. These policy changes are also aimed at designing better formulas to finance the investment plans in the agenda. Our paper will analyze the potential effects that a new rail operator can provoke into an HSR line market and the viability of the infrastructure. Recent papers have estimated social break-even traffic levels for HSR investments (de Rus and Nash, 2009, de Rus and Nombela, 2007). Assuming some sensible values on different parameters, these works estimate that the break-even first year demand, for a 500 km route, is about 6 million passengers per year, but Nash (2009) rises this figure up to around 9 million. These figures are relatively high and question many of the current and future HSR investments.

There are few works than consider the internal competition within the rail passenger markets. Preston et al. (1999) estimate a demand-cost model based on a specific software (the PRAISE model) designed to predict the effect of competition between operators, by simulating the decisions on a sample of individuals. Johnson and Whelan (2003) and Glass (2003) also elaborate a demand-cost model to assess potential on-track competition within the rail market in UK. But their analysis is focused on intra-modal competition and do not take into account the strategic reactions of transport firms under any change in the market conditions. The main result is that only scenarios of "cream skimming" and "fare and cost reductions" are generally feasible with competition. In contrast, Ivaldi and Vibes (2008)consider a simulation model, based on game theory, to analyze inter and intra-modal competition in the passenger transport industry. They focus on the changes in the market shares and the impacts on users from different changes in the structural market conditions (like the introduction of a new train operator or a low cost airline). They conclude that the entry of low cost operators can notably increase the levels of consumer surplus. Also Adler et al. (2010) modeled competition between rail and air on a number of Trans European Network corridors where investment in high speed rail is either underway or proposed, using a game theory model to compute Nash equilibria. They assumed competition between low cost and conventional airlines but not competition within the rail mode.

A recent paper by Jonhson and Nash (2012) uses an improved version of the PRAISE software to model open access competition on an HSR international route. 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 loss of social welfare. Particularly, entry is only feasible if it leads to a notable cost reduction and additional traffic is generated. Therefore their main conclusion is whether wouldn't it be better to franchise the services instead of allowing the entry of a new operator.

Our paper will develop an IO model where strategic interaction among the different transport operators will be taken into account. We assume that there is internal and external competition in the HSR services and, additionally, track access fees are optimally set in the model by a regulator. In particular, we wish to analyze how the presence of a new HSR operator can affect the market conditions, modifying industry profitability, consumer surplus and social welfare. To this end a model will be defined based on a deterministic utility function. It is assumed that transport operators compete in prices and frequencies, and that fees for the use of rail and air infrastructures affect the model too. Finally a calibration of the model using actual data from the Spanish HSR services between Madrid-Valencia and Madrid-Seville will be undertaken.

The next section will describe the main features of the theoretical model. Section 3 will present the calibration and simulation process and report the main results of the analysis. Finally we conclude with some remarks and policy recommendations.

2 The Model

In order to achieve these objectives, we define a model where we assume a typical transport market between two cities. In this market there is an existing HSR service that competes with an air transport service. Firstly we are going to analyze the duopoly case.

2.1 The duopoly case

Asumming that there is one air carrier competing with the HSR service, the utility function of a representative user is given by (in a similar way to Dixit and Stiglitz, 1977):

$$U = y + \alpha_r Q_r + \alpha_a Q_a - \frac{1}{2}(b_r Q_r^2 + b_a Q_a^2 + 2d Q_r Q_a)$$

where y, Q_r and Q_a denote other income different from transport, passenger traffic by rail and air, respectively. Parameter d measures the degree of substitutability between modes. The constant α_r is equal to $a_r - \delta_r(T/n_r)$, where a_r is the maximum willingness to pay for travelling by rail (plus value of time), n_r denotes the frequency of rail transport, and δ_r stands for the users' disutility for not travelling in the desired service. The constant $\alpha_a = a_a - \delta_a(T/n_a)$, where a_a is the maximum willingness to pay for travelling by plane and n_a denotes the frequency of air transport. Note that T stands for the available time period that operators have to schedule their services. Maximization of U subject to the budget contraint yields a system of inverse demand functions. Inverting the system we have that:

$$\begin{aligned} Q_r &= \frac{a_r b_a - a_a d}{b_r b_a - d^2} + \frac{d}{b_r b_a - d^2} p_a - \frac{b_a}{b_r b_a - d^2} p_r - \frac{d\delta_a}{b_r b_a - d^2}\frac{T}{n_r} + \frac{d\delta_r}{b_r b_a - d^2}\frac{T}{n_a} \\ Q_a &= \frac{a_a b_r - a_r d}{b_r b_a - d^2} + \frac{d}{b_r b_a - d^2} p_r - \frac{b_r}{b_r b_a - d^2} p_a - \frac{d\delta_r}{b_r b_a - d^2}\frac{T}{n_a} + \frac{d\delta_a}{b_r b_a - d^2}\frac{T}{n_r} \end{aligned}$$

so that higher frequency in one mode enhances the demand for that mode whereas it decreases with more frequency by the competing mode.

Each transport operator incurs constant marginal costs c_r and c_a (operational costs per passenger), and there is an access fee, g_r and g_a, per service that is paid to the infrastructure operator.

Under these assumptions, we are going to consider two alternative scenarios. Firstly, we assume the private duopoly scenario. So each transport operator maximizes profit by first choosing frequencies and then prices; decisions are simultaneous at each stage. As usual, the game is solved by backward induction. In the last stage of the game, firms solve

$$\begin{aligned} \max_{p_r} \pi_r &= (p_r - c_r)Q_r - c_r n_r - g_r n_r \\ \max_{p_a} \pi_r &= (p_a - c_a)Q_a - c_a n_a - g_a n_a \end{aligned}$$

Solving $\partial\pi_r/\partial p_r = 0$ and $\partial\pi_a/\partial p_a = 0$,we get - prices are strategic complements- as a function of the maximum willingness to pay for travelling in either mode and frequencies:

$$p_r^* = f(\underset{+}{a_r},\ \underset{+}{a_a},\ \underset{+}{n_r},\ \underset{-}{n_a})$$

$$p_a^* = f(\underset{+}{a_a},\ \underset{+}{a_r},\ \underset{+}{n_a},\ \underset{-}{n_r})$$

The signs report the relationships with prices. And then, substituing the equilibriums prices, and solving $\partial\pi_r/\partial n_r = 0$ and $\partial\pi_a/\partial n_a = 0$ we obtain:

$$n_r^* = f(\underset{+}{a_r},\ \underset{-}{a_a},\ \underset{-}{g_r},\ \underset{+}{g_a})$$

$$n_a^* = f(\underset{-}{a_a},\ \underset{+}{a_r},\ \underset{-}{g_a},\ \underset{+}{g_r})$$

Alternatively we asume a different scenario where the rail operator maximizes social welfare (defined as the sum of operators' profits and consumer surplus), while the air operator keeps maximizing profits. This is referred to as a mixed duopoly. As before we assume, that each transport operator chooses frequencies in the first stage and prices in the second. Then solving $\partial SW/\partial p_r = 0$ and $\partial\pi_a/\partial p_a = 0$ one gets

$$p_r^{MD} = f(\underset{+}{a_r},\ \underset{+}{a_a},\ \underset{+}{n_r},\ \underset{+}{n_a})$$

$$p_a^{MD} = f(\underset{+}{a_a},\ \underset{+}{a_r},\ \underset{+}{n_a},\ \underset{+}{n_r})$$

And the equilibrium for frequencies:

$$n_r^{MD} = f(\underset{+}{a_r},\ \underset{+}{a_a},\ \underset{-}{g_r},\ \underset{+}{g_a})$$

$$n_a^{MD} = f(\underset{+}{a_a},\ \underset{+}{a_r},\ \underset{-}{g_a},\ \underset{+}{g_r})$$

2.2 Entry of a new train operator

Now we assume that there is a new train operator competing in the HSR service. Then the utility function is rearranged in the following way:

$$U = y + \alpha_1 Q_{r1} + \alpha_2 Q_{r2} + \beta Q_a - \frac{1}{2}(b_r Q_{r1}^2 + b_r Q_{r2}^2 + b_a Q_a^2) - d(Q_{r1}Q_a + Q_{r2}Q_a + Q_{r1}Q_{r2})$$

where α_{r1} is equal to $a_r - \delta_r(T/n_{r1}), \alpha_{r2}$ is equal to $a_r - \delta_r(T/n_{r2})$ and α_a is equal to $a_a - \delta_a(T/n_a)$.As we did before, consumer equilibrium behaviour yields the following direct demand equations:

$$\begin{array}{rl} Q_{r1} = f(a_{r1}, & a_{r2}, a_a, p_{r1}, p_{r2}, p_a, n_{r1}, n_{r2}, n_a) \\ & + \; - \; - \; - \; + \; + \; + \; - \; - \\ Q_{r2} = f(a_{r1}, & a_{r2}, a_a, p_{r1}, p_{r2}, p_a, n_{r1}, n_{r2}, n_a) \\ & - \; + \; - \; + \; - \; + \; - \; + \; - \\ Q_a = f(a_{r1}, & a_{r2}, a_a, p_{r1}, p_{r2}, p_a, n_{r1}, n_{r2}, n_a) \\ & - \; - \; + \; + \; + \; - \; - \; - \; + \end{array}$$

Note that we have a triopoly situation, and again two alternative scenarios are distinguished. In the first scenario, the three operators maximize profits. Then, we obtain the equilibrium prices (and comparative statics) as follows:

$$\begin{array}{rl} p^*_{r1} = f(a_{r1}, & a_{r2}, a_a, n_{r1}, n_{r2}, n_a) \\ & + \; + \; + \; + \; - \; - \\ p^*_{r1} = f(a_{r1}, & a_{r2}, a_a, n_{r1}, n_{r2}, n_a) \\ & + \; + \; + \; - \; + \; - \\ p^*_a = f(a_{r1}, & a_{r2}, a_a, n_{r1}, n_{r2}, n_a) \\ & + \; + \; + \; - \; - \; + \end{array}$$

And then we obtain the expressions for equilibrium frequencies:

$$\begin{array}{rl} n^*_{r1} = f(a_{r1}, & a_{r2}, a_a, g_r, g_a) \\ & + \; - \; - \; - \; + \\ n^*_{r2} = f(a_{r1}, & a_{r2}, a_a, g_r, g_a) \\ & - \; + \; - \; - \; + \end{array}$$

$$n_a^* = f(a_{r1}, a_{r2},\ a_a,\ g_r,\ g_a)$$
$$\qquad - \quad - \quad + \quad + \quad -$$

Proceeding in the same manner, prices and frequencies are obtained under the mixed triopoly situation, with the corresponding comparative statics. The former rail operator keeps maximizing social welfare, and both the rail entrant and the air operator maximize profits.

3 An empirical application

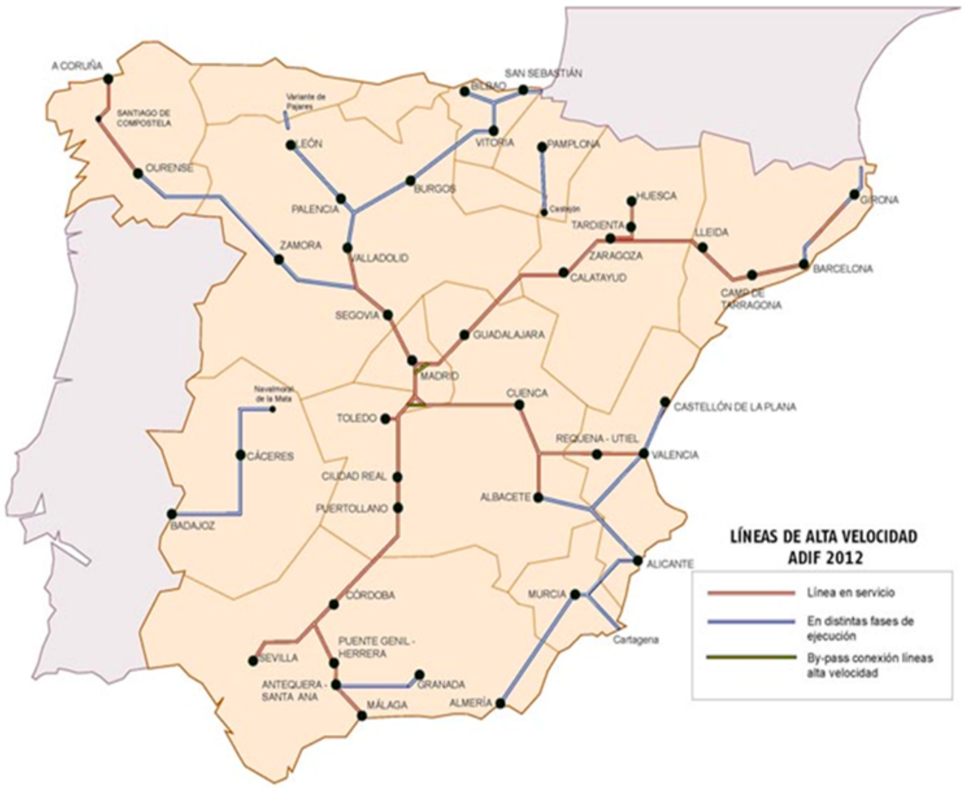
Our following step in the analysis will be to carry out a simulation using actual data. This analysis allows us to obtain additional numerical results to the analytical ones obtained in the theoretical section. In particular we are going to employ actual data from two HSR lines: the HSR between Madrid and Valencia and the HSR between Madrid and Seville. Figure 1 presents a map with the main HSR lines in Spain. Besides these two lines, there is an additional high speed line between Madrid and Barcelona. We have opted for simulating only the lines of Valencia and Seville, because these fit very well to the features of the model. Currently there is only one operator in the rail and the air market, and then the initial situation replicates the duopoly case shown in the previous section.

In order to simulate the model we have to employ actual data for both corridors:

Table 1.Some data for Madrid-Valencia and Madrid-Sevilla HSR corridors

	Madrid-Valencia	Madrid-Sevilla
Traffic point to point per year	1925000	2140942
Rest of internal traffic per year	448000	656298
Total passengers per year	2373000	2797240
Total passenger-km per year	1182975000	1234806492
Average km per passager	371	441
Average revenue per passenger (€)	75	88
Train services per day and direction	15	17
Air services per day and direction	5	5

Figure 1 HSR Corridors in Spain 1



Note that we can interpret the coefficients multiplying to rail and air prices and the intervals between rail and air services in the direct demand equations as the marginal effect of each one of these explanatory variables on the traffic demand. We can find estimates for these elasticities in previous papers by Martín and Nombela (2008), and Álvarez et al (2009).[1] The considered values are the following:

	Own-price elasticity	Cross-price elasticity	Own elast. time between services	Cross elast. time between services
Rail	-0.632	0.120	-0.232	0.028
Air	-1.016	0.120	-0.196	0.010

Then we can define a system of five equations in five unknowns ($b_r, b_a, \delta_r, \delta_a$ and d) as follows:

[1] These estimates are aggregate estimates for interurban traffic. There are no individual estimates for each corridor.

$$\frac{b_a}{b_r b_a - d^2} \frac{\overline{p_r}}{\overline{q_r}} = 0.632$$
$$\frac{d}{b_r b_a - d^2} \frac{\overline{p_a}}{\overline{q_r}} = 0.12$$
$$\frac{b_r}{b_r b_a - d^2} \frac{\overline{p_a}}{\overline{q_a}} = 1.016$$
$$\frac{d\delta_r}{b_r b_a - d^2} \frac{\frac{T}{\overline{n_r}}}{\overline{q_r}} = 0.232$$
$$\frac{d\delta_a}{b_r b_a - d^2} \frac{\frac{T}{\overline{n_a}}}{\overline{q_r}} = 0.028$$

Values for $\overline{p_r}$, $\overline{q_r}, \overline{p_a}, \overline{q_a}, \overline{n_r}$ and $\overline{n_a}$ are taken from the values observed in these variables in 2011 (see table 1). Additionally we need estimates for the parameters a_r and a_a.Given the values obtained for the previous parameters, and knowing the traffic levels for both corridors, the estimates for a_r and a_a can be easily recovered (making use of the equilibrium expressions obtained in the previous section). In particular, the estimates used in the simulation are the following:

	$Madrid - Valencia$	$Madrid - Sevilla$
b_r	0.060	0.059
b_a	0.195	0.268
d	0.008	0.007
δ_r	44.38	55.55
δ_a	45.11	72.91
a_r	339.39	369.13
a_a	388.91	497.34

These values are also employed to simulate the triopoly scenario.

Next, cost parameters are necessary in the calibration process. We assume a linear cost function in the following way:

$$TC_{ri} = (c_r + g_r)n_{ri}, \text{ where } i\text{=1, 2}$$
$$TC_a = (c_a + g_a)n_a$$

The parameter c_r for the train operating costs were taken from the work by de Rus and Nash (2009). The value c_a was borrowed from the paper by Swan and Adler (2006) who provide estimates for the airplane operation costs. And finally values for g_r and g_a were obtained from the operators themselves. The values expressed in euros per train or airplane are the following:

	$Madrid - Valencia$	$Madrid - Sevilla$
c_r	18707	22739
g_r	1400	1400
c_a	11000	12666
g_a	1200	1200

Next, we proceed to solve the game as explained before in the theoretical model. Firstly, we calibrate the duopoly situation under two hypothetical scenarios. Under the mixed duopoly we assume that the rail operator maximizes the social welfare (the profits plus the consumer surplus), meanwhile under the private duopoly air and rail operators are maximizing profits competing in prices. Futhermore, we assume a break–even constraint in the mixed duopoly scenario. This implies that profits and consumer welfare are weighted in a different way with the objective that rail profits in the mixed duopoly approach zero. The social welfare function in the duopoly situation is expressed as follows:

$SW = \Phi\ (\pi_r + \pi_a) + CS$, where $CS = (y + \alpha_r Q_r + \alpha_a Q_a - \frac{1}{2}(b_r Q_r^2 + b_a Q_a^2 + 2dQ_r Q_a)) - (p_r q_r + p_a q_a)$

In particular, $\Phi > 1$, and takes different values in order ensure non-negative profits in any mixed scenario that we simulate.

Tables 2a and 2b show the results for the Madrid-Valencia and Madrid-Seville routes, respectively.

The first column in both tables shows the base case, where we have introduced the values for the existing situation in the market using the data for prices and level of frequencies in 2011 for the rail and air transport operators. The second column reports the mixed duopoly under the break-even constraint. The third column shows the results of a private duopoly, and hence, these results can be interpreted as the result of a privatization process. And the fourth and fifth columns simulate the results of entry of a new rail operator in the mixed and the private duopoly cases. Note that, in italics and small letters, we provide the relative variation of the simulated results with respect to the current situation.

We must note that tables 2a and 2b provide similar results for Madrid-Valencia and Madrid-Seville. The mixed duopoly would lead to a 22% reduction in the number of train services in both corridors and a rail prices decrease by 23%. This result would allow to eliminate the operating current losses in both corridors. Besides, the mixed duopoly would produce a 22% increase in social welfare produced mainly by the increase in consumer surplus by 14%. But air bussiness would not be economically viable in Madrid-Seville. The third column shows the result of the private duopoly, i. e., the result of a theoretical privatization. Train and air price would rise by 72% and 18% in Madrid -Valencia, and by 58% and 33% in Madrid-Seville. There would be a notable reduction of the number of trains in both corridors (40%), but the number of flights would increase by 22% and 37% in both corridors. These results provoke a significant consumer surplus decrease (around 50% in both corridors), outweighted by a notable increase in the profits for the train and air operators, resulting in a net decrease in social welfare by 14 and 16% for Madrid-Valencia and Madrid-Seville, respectively.

The fourth and fifth columns in tables 2a and 2b show the results when a new train operator enters the market. Assuming the values obtained in the previous calibration for the utility function and using them for calibrating the equations in section 2.2, both columns show the results when a new HSR operator enters the market under the mixed and the private scenarios, respectively. Note that the approximation we use (the Dixit-Stiglitz utility approach) implies that entry will generate an increase in total market size. In particular, total rail traffic increases by 68% and 20%, respectively, with respect to the base case in the Madrid-Valencia route, and by 47% and 12% in the Madrid-Seville route. In the case of the mixed scenario, the new entrant results in a reduction of the incumbent price by 19% in Madrid-Valencia and by 18% in Madrid-Seville. The number of train services would increase by 32% in both corridors. These results provoke a significant increase in rail profitability, and entry is clearly profitable specially in the Madrid-Valencia corridor. Consumer surplus and social welfare would also increase by 37% and 61%, respectively, in both corridors. But air would not be profitable. Regarding the private scenario, rail price will increase by 59% and 40% in Madrid-Valencia and Madrid-Seville, respectively, and the total number of rail services will increase by 20% in both corridors. Altogether this would imply a decrease in consumer surplus by 17% in both corridors, but the bigger increase in the rail profitability in Madrid-Valencia would finally lead to a social welfare improvement in this corridor.

In order to reduce the effects of the total traffic generated by entry in the Dixit-Stiglitz approach, we have reduced the value of parameter a_r in the model equations. We lower this value by 10%, assuming then a decrease in the willingnes to pay for the train service, and then the global increase in the train service will be lower. Tables 3a and 3b present the results under this assumption for Madrid-Valencia and Madrid-Seville, respectively. As in table 1, columns 2 and 3 present the results of the mixed and private scenario when there is an entrant in the HSR market. Columns 4 and 5 present the results of the same scenarios but assuming that the entrant produces with lower costs (the entrant is considered 25% more efficient in the provision of services than the incumbent). Finally, column 6 assumes that the incumbent in the private scenario also reduces its costs by 12.5%. In this case, the results for both corridors present slight differences. In Madrid-Valencia, under these assumption and without efficiency gains, entry in the mixed and private scenario will provoke a 29% increase in rail traffic, but the air traffic would be basically the same. In the Madrid-Seville corridor there would be an increase by 11% and 14% for the rail and the air traffic respectively.[2]In both corridors, the entry of a new rail operator in the mixed duopoly would be economically profitable with respect to the current situation. In Madrid-Valencia the social welfare would be practically the same than the obtained in the base case, but in Madrid-Seville there would be a welfare loss by 11%. In the private scenario, there would be a notable decrease in consumer surplus in both corridors (by 37% and 35% in Madrid-Valencia and Madrid-Seville) but there would be an improvement in rail profitability finally resulting in a net decrease in social welfare by 16% and 23%, respectively.

The fourth column in tables 3a and 3b show the results of the mixed scenario when the entrant produces with 25% lower costs than the incumbent . The results are similar to the ones obtained when there are no efficiency gains. But these lower costs for the entrant produce a higher profitability and a higher level of consumer surplus, improving the level of social welfare with respect to the situation where there are no efficiency gains. In particular, social welfare improves by 10% and 3%, respectively, in Madrid-Valencia and Madrid-Seville with respect to the current situation. The fifth colum present the results in tables 3a and 3b to extend the results when the entrant's efficiency gains occur in the private scenario. Now there is an improvement in terms of profits and consumer surplus in both corridors with respect to the private scenario without efficiency gains, but there is a decrease in social welfare by 6% and 9% with respect to the current situation . Finally the last column presents the results when the incumbent produces also with lower costs (the costs are reduced by 12.5%). In this case, the social welfare levels in the current situation are basically recovered in both corridors.

[2]Recent data obtained from the competition between the incumbet (Trenitalia) and the new entrant (NTV) in the HSR between Milano and Naples (produced during the last eight months of 2012) show that the entry of this new company provoked an increase by 17% in the total air traffic. This increase was produced despite the severe economic crisis of this period.

Tables 4a and 4b report the results assuming that the incumbent and the entrant are not symmetric. In the previous simulations the entrant can enter the market with the same size of the incumbent and then, they split the market in equal conditions. But it seems more realistic that the entrant be of a smaller size, and then will enjoy a lower market share. To do this, we modify the constant in the utility function in this way: $\alpha_1 = \lambda_1 a_r - \delta_r \frac{T}{n_{r1}}, \alpha_2 = \lambda_2 a_r - \delta_r \frac{T}{n_{r2}}$, where $\lambda_1 = 0.925$ and $\lambda_2 = 0.75$. Then we repeat the same earlier exercises. The most outstanding results are that now the entrant offers fewer trains but with lower prices, and that, in any case the entrant cannot obtain non-negative profits. Also the results are worst in terms of consumer surplus and social welfare in comparison with the symmetric case. Obviously the profitability levels and consumer surplus improve when the entrant and the incumbent can operate with fewer costs. This result is interesting, because it shows that the entry of the new operator produced with a smaller size than the incumbent will be hardly effective and viable.

4 Conclusions

This paper has presented a model where the entry of a new train operator in an HSR line is evaluated in terms of the changes in prices, service levels, profits and consumer surplus. Firstly we have developed a theoretical model based on a deterministic utility function. In order to provide more specific results a calibration model was employed using actual data from two Spanish HSR lines: Madrid-Valencia and Madrid-Seville.

We have simulated the model assuming two alternative regimes, depending on the objective function of the rail operator. Under the public scenario, the rail operator maximizes social welfare, while under the private scenario the rail operator maximizes profits. Our model has shown that successful entry depends on the amount of new traffic that the new operator can generate. If this new traffic is sufficiently high then entry will be beneficial in terms of consumer surplus and social welfare. But if the generated traffic is low, then the mixed duopoly produces the highest levels of consumer surplus and social welfare. Our results also show that in the current situation there is a high and inefficient level of train services. A lower combination of prices and level of train services would reduce the economic losses and significantly improve both consumer surplus and social welfare (without entry). If privatization of the rail industry is promoted, there will be a transfer of surplus from consumers to operators, with a net reduction in social welfare by around 15% in both corridors with respect to the current situation.

In the eventuality that entry of a new rail operator is promoted, the highest levels of social welfare and consumer surplus are produced in the mixed scenarios. If the entrant has lower costs, then there will arise significant increases in social welfare and consumer surplus. In the private scenario, with low levels of new traffic, it can lead to similar levels of social welfare to the current situation as long as the efficiency gains are generalized to the entrant and the rail incumbent. When we simulate an asymmetric case, that is, where the incumbent has a bigger size than the entrant, entry is not economically viable and the losses in social welfare may be important. Then if the entry process were promoted, the size of the entrant should be similar to the incumbent's size.

References

[1] Adler, N., E.Pels and C. Nash (2010).“High-speed rail and air transport competition: Game engineering as tool for cost-benefit analysis”.Transportation Research Part B: Methodological, Volume 44, Issue 7, 812-833.

[2] Alvarez San-Jaime, O., P. Cantos-Sanchez, R. Moner-Colonques and J. J. Sempere-Monerris (2009). "Alternative Pricing Regimes in Interurban Passenger Transport with Externalities and Modal Competition". Regional Science and Urban Economics 39, 128–137

[3] Dixit, A. and J. E. Stiglitz (1977). "Monopolistic competition and optimum product diversity". American Economic Review 67, 297-308

[4] Glass, A. (2003). “An Assessment of the Desirability of On-Track Competition: The Ipswich-London route”.Institute of Transport Studies, University of Leeds.

[5] Ivaldi, M. and C. Vibes, (2008), "Price Competition in the Intercity Passenger Transport Market: A Simulation Model", *Journal of Transport Economics and Policy*, vol. 42, n. 2, May 2008.

[6] Johnson, D. and G. Whelan (2003).“Modelling the Impact of Alternative Fare Structures”. Institute of Transport Studies, University of Leeds.

[7] Johnson, D. and C. Nash (2012).“Competition and the provision of rail passenger services: A simulation exercise”. Journal of Rail Transport Planning and Management, Volume 2, 14-22

[8] Martin J. C. and G. Nombela (2008). "Impacto de los nuevos trenes AVE sobre la movilidad". Revista de Economía Aplicada 47, 5-23

[9] Nash, C. (2009). “When to invest in high-speed rail links and networks?”.Discussion Paper 2009-16 OECD/ITF, 2009.

[10] Preston J. et al. (1999,) “The Case for High Speed Rail:A review of recent evidence”. Report # 09/128 for the Royal Automobile Club Foundation.

[11] Preston, J., Wardman, M., Whelan, G., (1999). “An analysis of the potential for on-track competition in the British passenger rail industry”. Journal of Transport Economics and Policy 33, 77–94

[12] de Rus G. and C. Nash (2009). “ In what circumstances is investment in HSR worthwhile?” in G. de Rus, ed, Economic Analysis of High Speed Rail in Europe, Fundación BBVA, Madrid.

[13] de Rus, G. and G. Nombela (2007).“Is investment in HSR socially profitable?”.*Journal of Transport Economics and Policy*, 41, 1, 3-23.

[14] Swan, W. and N. Adler (2006). "Aircraft trip cost parameters: a function of stage lenght and seat capacity". *Transportation Research Part E,* 42, 2, 105-115

Tables

Table 2a. Madrid-Valencia (initial case)

	Current situation	Mixed duopoly	Private duopoly	Mixed+entrant	Private+entrant
Train price (inc.)	75	58	129	61	119
	1	*0,77*	*1,72*	*0,81*	*1,59*
Train price (entr)				114	119
Air price	110	122	130	114	120
	1	*1,11*	*1,18*	*1,04*	*1,09*
# trains inc.	15	11,71	8,97	11,25	8,67
	1	*0,78*	*0,60*		
# trains entr.				8,50	8,67
# trains (aggreg.)	15	11,71	8,97	19,75	17,34
	1	*0,78*	*0,60*	*1,32*	*1,16*
# flights	5	5,9	6,08	5,71	5,85
	1	*1,18*	*1,22*	*1,14*	*1,17*
Train inc. Traffic	3150	3723	2203	3373	2065
	1	*1,18*	*0,70*		
Train entr. Traffic				1967	2065
Total train traffic	3150	3723	2203	5340	3794
	1	*1,18*	*0,70*	*1,70*	*1,20*
Air traffic	616	628	667	588	618
	1	*1,02*	*1,08*	*0,95*	*1,00*
Profits incumbent	-29198	456	122392	430	89228
Profits entrant				69517	89228
Profits air	6808	4865	12473	-2720	2907
Consumer surplus	410611	467005	198509	560722	342708
	1	*1,14*	*0,48*	*1,37*	*0,83*
Welfare	388221	472326	333374	627949	524071
	1	*1,22*	*0,86*	*1,62*	*1,35*

Table 2b. Madrid-Sevilla (initial case)

	Current	Mixed duopoly	Private duopoly	Mixed+entrant	Private+entrant
Train price (inc.)	88	68	139	72	123
	1	*0,77*	*1,58*	*0,82*	*1,40*
Train price (entr)				122	123
Air price	120	152	160	142	149
	1	*1,27*	*1,33*	*1,18*	*1,24*
# trains inc.	16	12,43	9,64	11,91	8,40
	1	*0,78*	*0,60*		
# trains entr.				9,14	8,40
# trains (aggreg.)	16	12,43	9,64	21,05	16,80
	1	*0,78*	*0,60*	*1,32*	*1,05*
# flights	5	6,69	6,86	6,49	6,64
	1	*1,34*	*1,37*	*1,30*	*1,33*
Train inc. Traffic	3831	3915	2370	3518	2139
	1	*1,02*	*0,62*		
Train entr. Traffic				2119	2139
Total train traffic	3831	3915	2370	5638	4278
	1	*1,02*	*0,62*	*1,47*	*1,12*
Air traffic	490	567	597	534	561
	1	*1,16*	*1,22*	*1,09*	*1,14*
Profits incumbent	-23198	685	124381	116	52638
Profits entrant				65008	52638
Profits air	-10468	-6715	598	-14039	-8329
Consumer surplus	446986	511015	223792	615076	365186
	1	*1,14*	*0,50*	*1,38*	*0,82*
Welfare	413320	504985	348771	666161	462133
	1	*1,22*	*0,84*	*1,61*	*1,12*

Table 3a. Madrid-Valencia: symmetric case (with low induced traffic)

	Current	Mixed + entry	Private + entry	Mixed + entr (entr l. c.)	Priv + entr (entr l. c.)	Priv + entr (entr & inc. l. c.)
Train price inc.	75	70	100	71	108	103
	1	*0,93*	*1,33*	*0,95*	*1,44*	*1,37*
Train price entr.		97	100	103	108	107
Air price	110	120	123	119	123	123
	1	*1,09*	*1,12*	*1,08*	*1,12*	*1,12*
# trains inc.	15	9,68	7,94	9,64	8,26	8,56
	1					
# trains entr.		7,84	7,94	9,25	9,27	9,35
# trains (aggreg.)	15	17,52	15,88	18,89	17,53	17,91
	1	*1,17*	*1,06*	*1,26*	*1,17*	*1,19*
# flights	5	5,85	5,93	5,84	5,93	5,91
	1	*1,17*	*1,19*	*1,17*	*1,19*	*1,18*
Train traffic inc.	3150	2510	1736	2486	1643	1781
	1					
Train traffic entr.		1676	1736	1789	1881	1841
Total train traffic	3150	4186	3472	4275	3524	3622
	1	*1,29*	*1,07*	*1,32*	*1,08*	*1,11*
Air traffic	616	618	636	615	637	632
	1	*1,00*	*1,03*	*1,00*	*1,03*	*1,03*
Profits inc.	-29198	457	29965	205	27313	46082
Profits entr.		20093	29965	56285	67542	65851
Profits air	6808	2636	6086	2217	5833	5356
Consum surplus	410611	359654	258509	369522	265562	276424
	1	*0,88*	*0,63*	*0,90*	*0,65*	*0,67*
Welfare	388221	382840	324525	428229	366250	393713
	1	*0,99*	*0,84*	*1,10*	*0,94*	*1,01*

Table 3b. Madrid-Sevilla: symmetric case (with low induced traffic)

	Current	Mixed + entry	Private + entry	Mixed + entr (entr l. c.)	Priv + entr (entr l. c.)	Priv + entr (entr & inc. l.c.)
Train price inc.	88	85	106	86	106	109
	1	*0,97*	*1,20*	*0,98*	*1,20*	*1,24*
Train price entr.		104	106	112	114	114
Air price	120	149	152	149	154	151
	1	*1,24*	*1,27*	*1,24*	*1,28*	*1,26*
# trains inc.	16	9,90	8,51	9,85	8,48	9,19
	1					
# trains entr.		8,43	8,51	9,99	10,07	10,06
# trains (aggreg.)	16	18,33	17,02	19,84	18,55	19,25
	1	*1,15*	*1,06*	*1,24*	*1,16*	*1,20*
# flights	5	6,65	6,71	6,64	6,88	6,69
	1	*1,33*	*1,34*	*1,33*	*1,38*	*1,34*
Train traffic inc.	3831	2455	1851	2429	1840	1906
	1					
Train traffic entr.		1804	1851	1939	1982	1978
Total train traffic	3831	4259	3702	4368	3822	3884
	1	*1,11*	*0,97*	*1,14*	*1,00*	*1,01*
Air traffic	490	561	572	560	578	569
	1	*1,14*	*1,17*	*1,14*	*1,18*	*1,16*
Profits inc.	-23198	-159	17211	-550	15286	37487
Profits entr.		8957	17211	54843	63359	62508
Profits air	-10468	-8248	-5826	-8715	-6407	-6618
Consum surplus	446986	367957	288363	381260	305193	311371
	1	*0,82*	*0,65*	*0,85*	*0,68*	*0,70*
Welfare	413320	368507	316959	426838	377431	404748
	1	*0,89*	*0,77*	*1,03*	*0,91*	*0,98*

Table 4a. Madrid-Valencia: asymmetric case

	Current	Mixed + entry	Private + entry	Mixed + entr (entr l. c.)	Priv + entr (entr l. c.)	Priv + entr (entr & inc. l.c.)
Train price inc.	75	65	109	66	107	111
	1	*0,87*	*1,45*	*0,88*	*1,43*	*1,48*
Train price entr.		58	65	69	74	74
Air price	110	121	125	121	125	125
	1	*1,10*	*1,14*	*1,10*	*1,14*	*1,14*
# trains inc.	15	10,38	8,26	10,32	8,23	8,88
	1					
# trains entr.		6,06	6,36	7,54	7,79	7,77
# trains (aggreg.)	15	16,44	14,62	17,86	16,02	16,65
	1	*1,10*	*0,97*	*1,19*	*1,07*	*1,11*
# flights	5	5,88	5,99	5,87	5,97	5,96
	1	*1,18*	*1,20*	*1,17*	*1,19*	*1,19*
Train traffic inc.	3150	2910	1877	2870	1863	1914
	1					
Train traffic entr.		1002	1114	1189	1278	1274
Total train traffic	3150	3912	2991	4059	3141	3188
	1	*1,24*	*0,95*	*1,29*	*1,00*	*1,01*
Air traffic	616	625	648	621	644	643
	1	*1,01*	*1,05*	*1,01*	*1,05*	*1,04*
Profits inc.	-29198	218	53559	415	51261	69450
Profits entr.		-52185	-44032	-23336	-14066	-14548
Profits air	6808	3948	8476	3245	7721	7493
Consum surplus	410611	360139	231269	369295	225888	231679
	1	*0,88*	*0,56*	*0,90*	*0,55*	*0,56*
Welfare	388221	312120	249272	349619	270804	294074
	1	*0,80*	*0,64*	*0,90*	*0,70*	*0,76*

Table 4b. Madrid-Sevilla: asymmetric case

	Current	Mixed + entry	Private + entry	Mixed + entr (entr l. c.)	Priv + entr (entr l. c.)	Priv+entr (entr & inc. l.c.)
Train price inc.	88	69	119	69	119	122
	1	*0,78*	*1,35*	*0,78*	*1,35*	*1,39*
Train price entr.		65	72	76	82	82
Air price	120	157	161	155	160	161
	1	*1,31*	*1,34*	*1,29*	*1,33*	*1,34*
# trains inc.	17	12,31	9,72	12,24	9,69	10,44
	1					
# trains entr.		7,21	7,56	8,9	9,2	9,18
# trains (aggreg.)	17	19,52	17,28	21,14	18,89	19,62
	1	*1,15*	*1,02*	*1,24*	*1,11*	*1,15*
# flights	5	7,24	7,36	7,22	7,33	7,45
	1	*1,45*	*1,47*	*1,44*	*1,47*	*1,49*
Train traffic inc.	3831	3265	2073	3220	2059	2113
	1					
Train traffic entr.		1129	1253	1322	1424	1418
Total train traffic	3831	4394	3326	4542	3483	3531
	1	*1,15*	*0,87*	*1,19*	*0,91*	*0,92*
Air traffic	490	585	604	581	601	605
	1	*1,19*	*1,23*	*1,19*	*1,23*	*1,23*
Profits inc.	-23198	36	70805	482	68173	89489
Profits entr.		-57568	-46990	-23440	-11532	-12151
Profits air	-10468	2694	7568	2035	6843	6598
Consum surplus	446986	444522	277929	454839	271561	279127
	1	*0,99*	*0,62*	*1,02*	*0,61*	*0,62*
Welfare	413320	389684	309312	433916	335045	363063
	1	*0,94*	*0,75*	*1,05*	*0,81*	*0,88*