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Cost-benefit analysis of the high-speed train in Spain

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Abstract. The high-speed train is a technological break-through in passenger transport which has allowed to increase railways share in modal split in medium range distances, competing with road and air transport. The first high-speed link in Spain was launched in April 1992, with high success according to occupancy rates and public opinion of its quality, safety and impact on regional development. The Madrid-Sevilla corridor includes several routes (commuting, long-distance and services provided using high-speed infrastructure but with *Talgo* technology). In this paper, an *ex post* cost-benefit analysis is carried out from demand and cost data available and under several assumptions about the life span of the project, growth hypothesis, time and accident values, and with a social discount rate of 6% in real terms. Economic evaluation of the project shows that the Spanish high-speed train project should have not been carried out in 1987 in that particular corridor.

1. Introduction

The historical decline of railways as the main way of transport for passengers and freight is in contrast with the popularity of the new railway technology known as "high-speed". This new technology consists of a special infrastructure and trains that allow to run passengers' convoys at speeds

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over 250 km per hour. For medium distances, these trains are presumed to have an advantage with respect to road and air transport.

The high-speed train (HST) has achieved the joint support of a number of agents: users who value his speed and comfort; the EU Commission, which contemplates HST as a new form of European integration (see Commission, 1990); railways operators, which regard it as a leap forward in a social environment highly critic to their deficits; and finally, industrial producers of railway equipment for commercial reasons.

The main drawback of HST in corridors of low traffic density is its high sunk cost. Infrastructure (generally not compatible with freight transport) is more expensive than that required by conventional railways, and its use is associated with decreasing average costs.

In Europe, the high speed train will absorb an important volume of public funds in the next years. Railways administrations are planning to build 30 000 km of railways track for high speed in the next 25 years. In Spain, in addition to the existent Madrid-Sevilla line, the Master Plan of Infrastructure of the Spanish Government contemplates the construction of the route Madrid-Barcelona-French border and the “Basque-Y” (lines Vitoria-Bilbao, Vitoria-San Sebastián, and a common segment). This part of the corridor will link the Spanish high-speed railway with the French HST through Irún. Track costs of the line Madrid-Sevilla are approximately 900 million pesetas of 1993 per kilometer.

Nash (1991) calls for a careful assessment of cost and benefits of high-speed train proposals. Based on the evidence of demand response to speed changes (Fowkes, Nash and Whiteing, 1985; Owen and Philips, 1987; Bonnafous, 1987; Marks, Fowkes and Nash, 1986), development benefits (Bonnafous, 1987) and environmental effects (Fields and Walker, 1982; Hughes, 1990), Nash concludes that there is too little evidence about the true costs and benefits of high-speed train proposals. Environmental and development benefits appear unconvincing. Nash concludes that time savings, accident cost savings and a reduced need for new infrastructure in alternative modes are the main sources of benefits from the introduction of the high-speed train. The net benefit of new proposals can be expected to be positive in the network of major European middle distance markets but “proposals to build entirely new infrastructure to more peripheral areas where extra capacity is not needed anyway should be looked at with much greater skepticism” (Nash, 1991).

In this paper, an economic evaluation of the Madrid-Sevilla corridor is carried out[1]. At present, operating revenues are far from covering total costs. Nevertheless, social benefits derived from the high-speed train cannot be reduced to revenues obtained from the service operation. The interest of

[1] The routes included in the cost-benefit analysis are: links between Madrid-Sevilla, Córdoba, Ciudad Real, Puertollano, Málaga, Cádiz and Huelva; Córdoba-Sevilla, Ciudad Real and Puertollano; Sevilla-Ciudad Real and Puertollano; and Ciudad Real-Puertollano. Destinations not serviced by high-speed trains, namely Málaga, Cádiz and Huelva, are included because *Talgo* services use part of the HST track. The technology used by *Talgo* trains allows to reach relatively high speeds compared to conventional trains, although much inferior to HST speeds.

carrying out an *ex-post* economic evaluation of the HST is the information that it can provide for other HST projects of the European Union. The link Madrid-Sevilla has the value of a trial for future decisions of investment in high-speed trains.

In Sect. 2 of this paper, the characteristics of the corridor are described, considering the changes caused by the introduction of the HST. Costs and benefits of the HST are described in Sect. 3. In Sect. 4, the methodology used for the estimation of benefits is discussed. Costs, benefits and the social profitability of the HST are estimated and sensitivity tests are carried out. The main conclusions are presented in Sect. 5.

2. The Madrid-Sevilla corridor: basic data

The construction of high-speed infrastructure in Spain was carried out between 1987 and 1993. The Spanish high-speed train (AVE) started its operations in April 1992, with a demand highly influenced by the Universal Exhibition held at Sevilla in 1992 (EXPO) and the pricing policy applied by RENFE (see Table 1). Current price reductions of 30% for the journey Madrid-Sevilla and 50% for Madrid-Ciudad Real were introduced in order to offset the effects of the demand decrease after the closure of EXPO (October 1992).

These low prices have induced high-load factors for HST: 84% in trains between Madrid and Sevilla, and 62% in commuter services. Prices leading to these occupancy rates are far from allowing the company to break-even. For long distance services, operating costs and part of capital depreciation are roughly covered, but, for commuter services, prices are below average

Table 1. Average revenue of the HST (Pesetas/passenger-km)

		Long distance	Index	Commuter	Index
1992	April	19.32	100	19.31	100
	June	19.84	102.7	19.48	100.9
	August	18.22	94.3	18.16	94
	October	17.94	92.9	11.37	58.9
	November	14.26	73.8	9.66	50
1993	January	14.02	72.6	9.57	49.6
	March	14.36	74.3	9.35	48.4
	June	14.21	73.6	9.39	48.6
	September	14.20	73.5	9.34	48.4
	December	14.55	75.3	9.35	48.4
1994	January	15.07	78.0	9.65	50
	April	16.28	84.3	10.74	55.6
	September	16.41	84.9	11.05	57.2
	December	16.30	84.4	10.62	55

Source: RENFE

Table 2. Distances and average journey time by transport modes

O-D	Distances (km)				Journey time			
	Conventional train	HST	Road	Air	Car	Bus	Conventional train	HST
Madrid-Sevilla	565	471	538	50′	5 h 20′	6 h 30′	5 h 55′	2 h 30′
Madrid-Málaga	627	513	544	55′	5 h 40′	7 h 15′	6 h 50′	4 h 40′
Madrid-Huelva	675	581	632	–	6 h 20′	7 h 50′	7 h 40′	4 h 30′
Madrid-Cádiz	727	624	663	55′	6 h 30′	8 h 10′	7 h 45′	5 h 00′
Madrid-Ciudad Real	255	171	190	–	2 h 05′	2 h 30′	1 h 55′	51′
Madrid-Puertollano	293	210	228	–	2 h 35′	3 h 00′	2 h 45′	1 h 10′
Madrid-Córdoba	442	321	400	–	3 h 55′	5 h 00′	4 h 25′	1 h 45′

Source: Transport operators

Table 3. Prices by transport modes (1995 pesetas)

O-D	Air	Car[a]	Bus	Conventional train		HST	
				First class	Second class	Business	Tourist
Madrid-Sevilla	13 450	8 098	2560	8 537	5864	11 700	8500
Madrid-Málaga	16 200	8 439	3000	10 462	6783	11 000	7400
Madrid-Huelva	–	9 513	3045	10 814	6898	11 100	7300
Madrid-Cádiz	13 950	10 119	2905	13 170	8921	13 300	8800
Madrid-C. Real	–	2 799	1200	3 247	1852	2 200	2600
Madrid-Puertollano	–	3 395	1400	4 428	1919	3 000	2700
Madrid-Córdoba	–	5 980	1945	7 241	3720	8 500	6200

Source: Transport operators
[a] Estimated from SETEC (1993)

variable costs. Tables 2 and 3 display journey times and prices for different transport modes and for the main origin-destination links of the Madrid-Sevilla corridor.

Considering the values of time[2] employed by the Department of Transport (MOPT, 1991) the HST is the transport mode with the lowest generalized cost in most cases, although it is not the fastest mode. Air transport is the fastest mode in the Madrid-Sevilla corridor, even after accounting for access and waiting times. The advantage of the HST with respect to air transport appears when tariffs of both modes are compared.

These differences in the generalized costs have provoked a dramatic change in the respective shares of transport modes, with the train as the main way of transport instead of the car as it used to be in the past. As Table 4 shows, the bus has lost some passengers while plane and conventional train have suffered dramatic reductions in their use.

[2] Values of time (in pesetas of 1993) per hour: car, 758; conventional train, 1633; bus, 408; air transport, 3208.

Table 4. Modal split in the line Madrid-Sevilla (Thousands of passengers)

Transport mode	Without HST (1991)	(%)	With HST (1996 forecast)	(%)
HST	–	–	1438.2	41.3
Car	1436.4	52.0	1407.4	40.5
Conventional train	392.3	14.2	96.4	2.8
Air transport	694.4	25.1	352.2	10.1
Bus	239.2	8.7	182.9	5.3
Total	2762.3	100	3477.1	100

3. Costs and benefits of the HST

The costs and benefits of the high-speed train can be classified as follows:

- Costs and revenues of the construction and operation of the project.
- Variation in costs and revenues of other transport operators.
- Time savings for HST users.
- Time savings for road users due to the reduction of traffic congestion.
- Changes in quality of service.
- Reduction of traffic accidents.
- Regional economic development.
- Environmental impact.

This paper is concerned with the estimation of the costs and benefits listed above, except the last two. The empirical evidence suggests that transport infrastructure is only a necessary condition for economic development. It is difficult to accept that HST changes substantially the basic parameters of the South region of Spain in order to promote economic development of Sevilla and Andalucía. Nash (1991) points out that high-speed trains do not affect freight transport and studies carried out for the Paris-Lyon line (Bonnafous, 1987) only detect marginal changes in industrial location. Hall and Hass-Klau (1985) consider the impact of railway investment in urban structure of German and British main cities, specially in their economic aspects, without finding any significant effect.

In Alvarez and Herce (1993) an estimation of the regional effects of high speed is carried out, concluding that "... with all relevant objections ... the regions that obtain the most benefits during the construction of the projects would be those that are placed in the group of regions with self-sustained growth (Madrid, Navarra, Aragón and Cataluña) ... and developing regions like Valencia or industrialized ones like País Vasco".

Regarding the macroeconomics effects of the projected Madrid-Barcelona HST, the outcomes estimated in Alvarez and Herce (1993), show a negative balance: the generated employment would be higher (13 000 additional jobs) if the investment were allocated to road infrastructure. If trains and electric equipment were made with Spanish technology, 35 000 additional jobs would be generated. Although there would be a positive effect on gross private domestic investment, significant negative effects could be expected on inflation, balance of payments and public deficit.

The environmental impact of the HST is not clear either. HST projects involve the use of large areas of land, its infrastructure and trains create a barrier effect in the territory and produce noise, air pollution and landscape intrusion. Noise and air pollution per passenger-km are smaller than in the case of road transport. However HST uses electric power, which is an energy also obtained in part from fuel. Moreover, the energy consumption increases in a higher proportion than the rise in speed. In practice, the balance depends on traffic deviation from other modes of transport that are more contaminating and the ways in which the electricity is obtained.

Regarding the impact of the Madrid-Sevilla HST on other transport operators, the main effects which must be considered are those on air transport (Iberia and airports), on conventional railways and on road transport (buses, cars and road network).

For air transport between Madrid and Sevilla, the introduction of the HST has induced a demand downshift of 50%, diminishing the load factor and flight frequency. Moreover, traffic losses in air routes between Madrid-Málaga and Madrid-Jerez (around 20%) have to be added. Given the importance of this effect, it seems clear that the HST impact on Iberia must be accounted for.

The use of airports has also been affected by the introduction of the HST. The Sevilla airport has suffered a reduction of 25% in its use, as Madrid-Sevilla represented 50% of airport traffic. The economic consequences of this reduction have been aggravated by the investments which were carried out in the airport of Sevilla in order to accommodate the peak of demand induced by the exhibition EXPO-92.

For conventional railway transport, RENFE has also been affected by the introduction of the new product. The Madrid-Sevilla, Madrid-Málaga and Madrid-Córdoba links were amongst the main twenty lines of the company. Conventional trains have lost the major part of their traffic in this corridor, therefore an efficient solution might be to consider the closure of the conventional infrastructure. However, the impossibility of carrying goods on the new infrastructure makes this scenario unfeasible.

The impact on bus transport has been the following. In long distance services, both products are hardly substitutes at current prices. In commuter services, and taking into account the low prices introduced by RENFE, bus operators are certainly affected by HST.

In the case of the road network, the introduction of HST has induced a considerable reduction in car use (see Table 4). This traffic reduction generates economic benefits derived from time savings, reduction in car-operating costs and accidents. Savings in maintenance and repair costs, consequence of a lower use of the network, are practically negligible since traffic reduction does not affect freight transport. Road network maintenance expenditures depend basically on the number of heavy vehicles which use the roads and, more precisely, on the load per axle.

The main benefits obtained from HST are: 1) time savings obtained when users shift from slower transport modes, and 2) total gains from newly generated traffic. In the following section, an explanation of the methodology used and the estimation of these benefits are presented.

It has been argued that one of the benefits of HST has been the increase of land value in Ciudad Real. Nevertheless, this benefit is a consequence of the improvement in accessibility to this city, which is already accounted in the reduction of travel time between Madrid and Ciudad Real. To include this effect in the analysis would lead to double accounting, therefore we do not consider it.

4. Economic evaluation of HST

In order to evaluate the economic effects of HST, it is required first to have an estimation of the demand for the period which is going to be considered for the analysis. To obtain this estimate, surveys carried out by RENFE in the Madrid-Sevilla corridor have been consulted, and real data of HST for the period 1992–1994 and four months of 1995 have been used. Additional information was supplied by Iberia, RENFE and bus companies operating in the corridor. The main components of the demand (generated and deviated traffic) have been obtained for each market segment (commuters, long distance and *Talgo*) and each transport mode.

In Coto, Inglada and Baños (1995), an elasticity of demand with respect to GDP of 1.25 is reported. Using this result and Spanish evidence on demand behaviour in conventional train and bus services, the evolution of demand for the next 30 years (40 years in the sensitivity analysis) is estimated assuming that the Spanish GDP will grow from 1997 onwards at a rate of 2.5% and that HST fares will not be reduced below average variable costs.

Using this demand estimation, the social profitability of the HST is obtained considering the costs and benefits described in the previous section. Benefits of the HST are obtained from 1992 onwards, after the starting of the service. Costs and benefit present values are obtained with a 6% social discount rate[3]. The evaluation is carried out at 1987 prices, since it was in that date when the HST project was initiated.

The HST costs have a fixed component (infrastructure), semi-fixed (trains) and variable (operating costs). In this paper it is considered that prices (net of tax) of the infrastructure, trains and operating costs, measure opportunity costs except in the case of labour (Dodgson and Forrest, 1988).

HST infrastructure was built between 1987 and 1993, with a cost (including taxes) of 500 billion pesetas of 1996. The technical lifetime of the project is 45 years (MOPT, 1991) and HST benefits are mainly obtained from time savings and generated traffic. The methodology used for the benefit evaluation is a generalization of the analysis carried out in Dodgson

[3] This social discount rate has been used by the Department of Transport in other infrastructure projects in Spain.

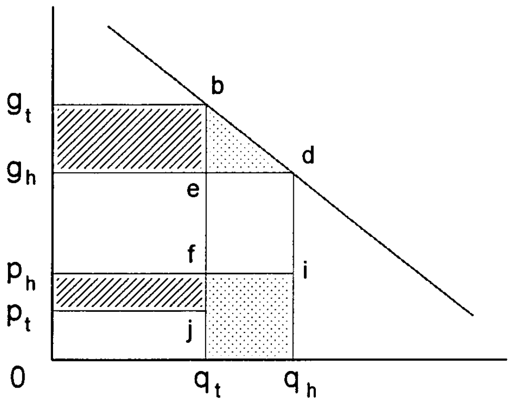

Fig. 1. HST benefits (train and bus users)

(1984). For users of bus and conventional train, Fig. 1 shows, for a particular distance, the reduction of the generalized cost of travel, as a result of the introduction of the HST.

We consider the case of train passengers (the argument is similar for bus passengers). The initial generalized cost of the train (g_t) composed by the train fare (p_t) and the value of total journey time (g_t-p_t) falls to g_h, which is the generalized travel cost of HST. The derived benefits from this reduction in generalized cost can be expressed as:

$$(g_t-g_h)q_t+1/2(g_t-g_h)(q_h-q_t)+p_hq_h-p_tq_t+C_t-C_h$$

These benefits are equivalent to the shaded areas in Fig. 1, from which the net cost of obtaining such benefits must be subtracted: the introduction of HST (C_h) and savings derived from the closure of conventional train services (C_t).

This procedure can be simplified when it is considered that gross benefits of the diverted traffic (q_t), are the time savings due to the introduction of a faster transport mode. Then, it is only necessary to calculate the reduction in access and travel times and to multiply it by the value of time (area $beg_tg_h+fjp_hp_t$). The social benefit of generated traffic (q_h-q_t) is represented by the area under the demand function (bdq_hq_t) excluding the area (edif) which represents the travel time spent. The area (fiq_hq_t) is computed from revenues, and the triangle (bde), dividing by two the difference in generalized costs of generated traffic.

The measurement of benefits of journeys deviated from car to HST (see Fig. 2) can be obtained through the following expression:

$$(g_c-g_h)q_c+1/2(g_c-g_h)(q_h-q_c)+p_hq_h$$

The approach used here is to measure the saving of real resources from deviated traffic which is represented in Fig. 2 (areas $beg_cg_h+fjp_hc_c$), plus the saving in the operating costs of car journeys (area oc_cjq_c). If car were the only alternative to high speed, the costs of HST introduction should be

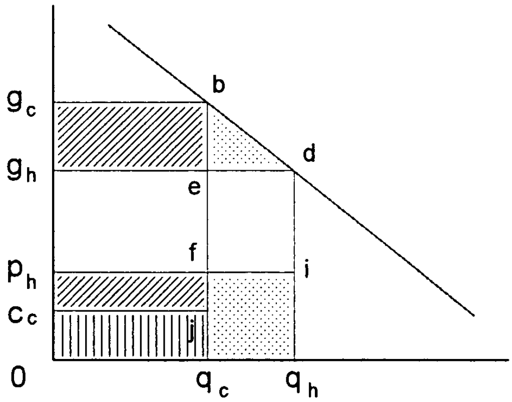

Fig. 2. HST benefits (car users)

added. Nevertheless, as there are several modes, it is necessary to do it only once to avoid double accounting.

The estimation of savings in operating costs (area oc_cjq_c) has been carried out considering maintenance costs, fuel and lubricant consumption, the wearing out of tires and half of car depreciation (SETEC, 1993).

Deviated traffic from road to HST reduces the risk of accidents, since the exposure to this risk of remaining vehicles is reduced. There is no concluding evidence about the relationship between the number of accidents and the traffic volume (Carbajo, 1991). This paper uses known elasticities of accidents with respect to traffic volume (see Fridstrom et al., 1992), and monetary values of the Department of Transport: death (25 million pesetas), injuries (3.3 million pesetas), accidents without deaths (509 000 pesetas) and accidents without injuries (68 000 pesetas).

Another benefit of HST is the reduction in road congestion. Using a previously estimated relationship between speed, average traffic flows and the capacity of the road (Transportation Research Board, 1985), the average annual speeds for every section have been estimated, taking as a reference the traffic structure from vehicle accounting at kilometer 267 on the N-IV road (Las Navas de Tolosa), which is approximately the intermediate point of the Madrid-Sevilla route.

Let us consider now the case of air transport. Although it may seem that this transport mode is not substantially different from the cases of bus and conventional train, there is a key aspect which must be explicitly considered.

Figure 3 considers a scenario in which society does not save time with the shift of passengers from air transport to the HST. The generalized cost of the air transport passengers (g_a) goes down to g_h with the introduction of the HST, causing an increase in the demand from q_a to q_h. The explanation of why the result may be negative is found in the saving of resources: air transport is faster than HST, including access and waiting time. Figure 3 shows how for deviated journeys (q_a) society loses the difference between the areas (fjp_ap_h) and (beg_ag_h): an increase of the resources employed (total value of the time) in doing the same journeys. Again, it is necessary to in-

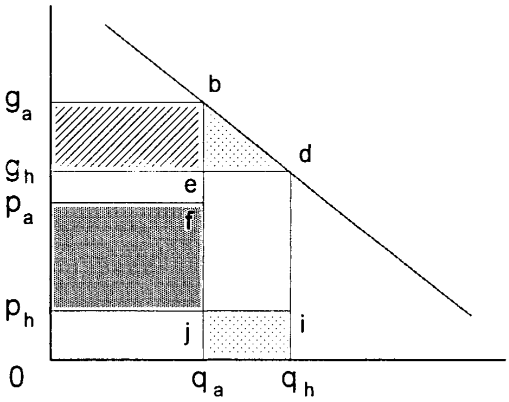

Fig. 3. Benefit of HST (air transport passengers)

clude the benefit of generated traffic (areas bde+jiq_hq_a) and the savings derived from flight service closures.

Users of air transport change to a slower mode of transport because they are compensated by lower prices ($p_h<p_a$) for the increase in total journey time $(g_h–p_h)>(g_a–p_a)$.

The benefits and costs of the introduction of HST in Spain are summarized in Table 5 (see Tables 6 and 7 in the Appendix). The outcome is negative and mounts to 258 billion pesetas of 1987, using a social discount rate of 6%. Table 5 shows the sensitivity of results to different assumptions: life of the project (40 years); shadow pricing of labour; increase of 25% in generalized costs of car, train and bus; GDP growing at a 3% rate. The shadow pricing of labour has been estimated as follows: labour accounts for 25% of HST infrastructure costs. It has been considered that half of that labour is voluntary unemployed and wages are included net of taxes. The other half is assumed as structural unemployment and the price applied is net of taxes and unemployed benefits. As it can be appreciated, changes in the resultant NPV and the structure of benefits under the different hypotheses do not modify the main findings of this paper.

A simple financial analysis of the project shows a NPV of –314 billion pesetas of 1987, which indicates that an economic evaluation of HST, considering all social costs and benefits, reveals an 18% improvement on its performance. As Table 5 shows, the main source of benefits of the HST is generated traffic (44% of the total benefits of the project).

Benefits of deviated traffic are not limited to time savings (22.5%). The reduction in operating cost in other transport modes is also important. The shift to HST of journeys by car reaches 8.9% of the total benefits; cost savings from railway and air transport yield benefits of 9.4 and 9.6% respectively. The savings in bus operator casts are not significant. Benefits from the reduction in congestion and accidents are only 4.6%.

The internal rate of return (IRR) is close to zero. It is worth noticing that, even in the case of a high IRR, other alternative projects should have been evaluated (for instance, railway track of Spanish gauge with *Talgo* trains at higher speed).

Table 5. Benefits of high-speed train in Spain (millions of 1987 pesetas)

	Social benefit of HST[a]	GDP growth rate (3%)	Project life (40 years)	Shadow prices for labour	Increase of 25% in generalized costs of car, train and bus
Costs					
Infrastructure	–237761	–237761	–237761	–200575	–237761
Residual value	17636	18546	5816	17636	17636
Trains	–58128	–61003	–61700	–58128	–58128
Maintenance	–41410	–41410	–45022	–41410	–41410
Operation	–135265	–140575	–155516	–135265	–135265
Time savings of (deviated traffric):					
– Conventional train	37665	39950	44582	37665	55119
– Car	4617	4898	5469	4617	9779
– Bus	1958	2079	2321	1958	2867
– Air transport	0	0	0	0	0
Generated traffic	86718	92080	102951	86718	92703
Costs reductions in:					
– Conventional train	18505	19629	21906	18505	18505
– Air transport	19020	20157	22460	19020	19020
– Bus	1680	1783	1990	1680	1680
– Operating costs of cars	17412	18471	20618	17412	17412
– Congestion	4896	6284	7486	4896	4896
– Accidents	4128	4363	4867	4128	4128
Net present value of HST	–258329	–252509	–259533	–221143	–228819

[a] Project life (30 years), GDP growth (2.5%), social discount rate (6%)

It has been argued that the link of the Spanish high-speed rail with the European HST network would improve, in a significant way, the social profitability of the project. However, journey times in high-speed trains from Sevilla and Madrid to the main European cities are too long to dispute the hegemony of air transport in long-distance journeys (De Rus, 1992).

5. Conclusions

In this paper a cost-benefit analysis of the HST in Spain is carried out based on the best available information about demand and cost with data provided by RENFE and other transport operators, and with the values of time and accidents used by the Spanish Department of Transport.

In order to estimate the demand increase, it has been assumed that GDP grows at a 2.5% per year during the lifetime of the project (30 years). Estimated benefits have been tested with a sensitivity analysis extending the life span of the project to 40 years, raising the GDP growth rate to 3%, using shadow prices for labour and increasing generalized costs of train, car and bus in a 25% to allow for differences in quality. The results obtained suggest that the introduction of the HST in Spain was not justified in economic terms in 1987 in the chosen corridor.

In the Master Plan of Infrastructures of the Spanish Government, new high-speed lines are planned for the next years. The conclusions of this work suggest that the new projects should be seriously evaluated. In particular, a major effort should be made to undertake demand analysis to lay the foundations of sound traffic forecasting for future projects. Finally, the importance of time savings in HST projects justifies a major research effort in the estimation of the value of time for different types of travellers and different transport modes, in order to improve the socio-economic evaluation of transport projects.

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Appendix

Table 6. Benefits of the HST (net of taxes) (millions pesetas of 1987)

Year	Time savings from deviated traffic				Generated traffic	Cost savings				Cost savings in road		Total
	Car	Railway	Air transport	Bus		Car	Railway	Air transport	Bus	Congestion	Accidents	
1992	164.1	1 264.8	0.0	58.5	2 746.1	601.6	609.6	901.0	50.7	72.0	119.5	6 587.9
1993	284.1	2 386.0	0.0	118.9	4 497.4	1 047.5	1 155.0	1 301.5	102.4	128.9	245.9	11 267.6
1994	292.9	2 544.0	0.0	129.1	5 188.3	1 141.0	1 262.4	1 271.9	111.3	154.7	267.4	12 363.0
1995	317.2	2 658.9	0.0	138.2	5 898.7	1 245.1	1 310.5	1 321.8	118.6	185.6	291.6	13 486.1
1996	341.1	2 770.0	0.0	145.0	6 500.7	1 284.0	1 361.8	1 377.6	124.3	221.2	313.1	14 438.8
1997	351.7	2 856.5	0.0	149.6	6 703.9	1 324.1	1 404.4	1 420.7	128.2	237.2	322.2	14 898.4
1998	362.7	2 945.8	0.0	154.3	6 913.4	1 365.5	1 448.2	1 465.0	132.2	254.4	331.7	15 373.2
1999	374.0	3 037.8	0.0	159.1	7 129.4	1 408.2	1 493.5	1 510.8	136.3	273.1	341.4	15 863.7
2000	385.7	3 132.8	0.0	164.0	7 352.2	1 452.2	1 540.2	1 558.0	140.6	293.4	351.3	16 370.4
2001	397.8	3 230.7	0.0	169.2	7 582.0	1 497.6	1 588.3	1 606.7	145.0	315.5	361.6	16 894.3
2002	410.2	3 331.6	0.0	174.5	7 818.9	1 544.4	1 637.9	1 656.9	149.5	339.4	372.2	17 435.6
2003	423.0	3 435.7	0.0	179.9	8 063.3	1 592.6	1 689.1	1 708.7	154.2	365.5	383.1	17 995.2
2004	436.2	3 543.1	0.0	185.5	8 315.2	1 642.4	1 741.9	1 762.1	159.0	394.1	394.3	18 573.9
2005	449.9	3 653.8	0.0	191.3	8 575.1	1 693.7	1 796.3	1 817.2	164.0	425.3	405.9	19 172.5
2006	463.9	3 768.0	0.0	197.3	8 843.1	1 746.6	1 852.5	1 874.0	169.1	459.4	417.8	19 791.7
2007	478.4	3 885.8	0.0	203.5	9 119.4	1 801.2	1 910.4	1 932.5	174.4	496.8	430.1	20 432.5
2008	493.4	4 007.2	0.0	209.8	9 404.4	1 857.5	1 970.1	1 992.9	179.8	537.8	442.7	21 095.6
2009	508.8	4 132.4	0.0	216.4	9 698.3	1 915.6	2 031.6	2 055.2	185.4	582.8	455.7	21 782.2
2010	524.7	4 261.6	0.0	223.2	10 001.3	1 985.4	2 095.1	2 119.4	191.2	632.3	469.0	22 493.3
2011	541.1	4 394.7	0.0	230.1	10 313.9	2 037.2	2 160.6	2 185.7	197.2	686.6	482.8	23 229.9
2012	558.0	4 532.1	0.0	237.3	10 636.2	2 100.8	2 228.1	2 254.0	203.4	746.4	497.0	23 993.3
2013	575.4	4 673.7	0.0	244.7	10 968.6	2 166.5	2 297.7	2 324.4	209.7	811.4	511.6	24 783.8
2014	593.4	4 819.7	0.0	252.4	11 311.3	2 234.2	2 369.5	2 397.0	216.3	882.1	526.6	25 602.6
2015	612.0	4 970.4	0.0	260.3	11 664.8	2 304.0	2 443.6	2 471.9	223.0	959.0	542.1	26 451.1
2016	631.1	5 125.7	0.0	268.4	12 029.4	2 376.0	2 520.0	2 549.2	230.0	1 042.7	558.0	27 330.4
2017	650.8	5 285.9	0.0	276.8	12 405.3	2 405.2	2 598.7	2 628.9	237.2	1 133.7	574.4	28 241.8
2018	671.2	5 451.1	0.0	285.4	12 792.9	2 526.8	2 679.9	2 711.0	244.6	1 232.7	591.3	29 186.9
2019	692.1	5 621.4	0.0	294.4	13 192.7	2 605.8	2 763.7	2 795.7	252.3	1 340.4	608.7	30 167.1
2020	713.8	5 797.1	0.0	303.6	13 605.0	2 687.2	2 850.0	2 883.1	260.1	1 457.5	626.6	31 183.9
2021	736.1	5 978.2	0.0	313.0	14 030.1	2 771.2	2 939.1	2 973.2	268.3	1 585.0	645.1	32 239.3
2022	759.1	6 165.0	0.0	322.8	14 468.6	2 857.8	3 030.9	3 066.1	276.7	1 723.6	664.1	33 334.7
Total	15 194.0	123 661.5	0.0	6456.4	287 770.0	57 253.8	60 780.7	61 894.3	5534.9	19 970.5	13 544.8	652 060.9

Table 7. Costs of HST (net of taxes) (millions pesetas of 1987)

Year	Infrastructure	Infrastructure maintenance	Trains	Operating costs	Salvage value	Total costs
1987	12 035.9	0.0	0.0	0.0	0.0	12 035.9
1988	28 223.0	0.0	0.0	0.0	0.0	28 223.0
1989	44 174.7	0.0	5 217.1	0.0	0.0	49 391.8
1990	69 078.7	0.0	420.9	0.0	0.0	69 499.6
1991	72 177.0	0.0	22 915.4	0.0	0.0	95 092.4
1992	31 474.6	3 041.6	18 810.8	6 958.7	0.0	60 285.7
1993	29 922.2	4 055.4	6 670.8	9 228.9	0.0	49 877.3
1994	0.0	3 971.2	0.0	9 638.3	0.0	13 609.5
1995	0.0	3 772.7	1 857.2	10 262.8	0.0	15 892.7
1996	0.0	3 772.7	1 857.2	10 671.7	0.0	16 301.6
1997	0.0	3 772.7	1 857.2	10 908.8	0.0	16 538.7
1998	0.0	3 772.7	0.0	11 151.3	0.0	14 924.0
1999	0.0	3 772.7	1 857.2	11 399.2	0.0	17 029.1
2000	0.0	3 772.7	0.0	11 652.5	0.0	15 425.2
2001	0.0	3 772.7	1 857.2	11 911.5	0.0	17 541.4
2002	0.0	3 772.7	0.0	12 176.3	0.0	15 949.0
2003	0.0	3 772.7	1 857.2	12 446.9	0.0	18 076.8
2004	0.0	3 772.7	1 857.2	12 723.6	0.0	18 353.5
2005	0.0	3 772.7	0.0	13 006.4	0.0	16 779.1
2006	0.0	3 772.7	1 857.2	13 295.5	0.0	18 925.4
2007	0.0	3 772.7	1 857.2	13 591.0	0.0	19 220.9
2008	0.0	3 772.7	0.0	13 893.0	0.0	17 665.7
2009	0.0	3 772.7	1 857.2	14 201.8	0.0	19 831.7
2010	0.0	3 772.7	2 286.3	14 517.5	0.0	20 576.5
2011	0.0	3 772.7	1 857.2	14 840.2	0.0	20 470.1
2012	0.0	3 772.7	1 857.2	15 170.0	0.0	20 799.9
2013	0.0	3 772.7	0.0	15 507.2	0.0	19 279.9
2014	0.0	3 772.7	1 857.2	15 851.9	0.0	21 481.8
2015	0.0	3 772.7	1 857.2	16 204.2	0.0	21 834.1
2016	0.0	3 772.7	2 715.4	16 564.4	0.0	23 052.5
2017	0.0	3 772.7	1 857.2	16 932.5	0.0	22 562.4
2018	0.0	3 772.7	16 004.1	17 308.9	0.0	37 085.7
2019	0.0	3 772.7	3 714.4	17 693.6	0.0	25 180.7
2020	0.0	3 772.7	4 572.6	18 086.9	0.0	26 432.2
2021	0.0	3 772.7	4 143.5	18 488.9	0.0	26 405.1
2022	0.0	3 772.7	4 143.5	18 899.8	–135 550.5	–108 743.5
Total	287 086.1	116 703.8	119 472.8	425 184.2	–135 550.5	812 896.4