Economic Benefits of the European High-Speed Rail Network

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Amid growing business opportunities and major social change, an extensive high-speed rail (HSR) network is being developed to link the main cities of the European Community. In addition to providing an alternative mode for intercity travel, the 24 000 km of new and upgraded HSR track will facilitate and support major social and economic change. A conventional economic evaluation of this network has been undertaken using a coarse, strategic multimode model and quantifying time and operating cost savings as measures of economic benefit. An enhanced method for evaluating the economic benefits of the European HSR network is described. The focus of the method is the additional benefits that would accrue to business travelers. A survey of European companies revealed additional economic impacts, not so far considered in the evaluation of the European HSR network, that are perceived and valued by business travelers. An approach is developed to value the additional impacts and to incorporate them into the conventional economic evaluation of the HSR network. The results suggest that the additional impacts are potentially a significant source of economic benefits. It is probable that the application of this approach would identify substantial benefits accruing to nonbusiness travelers too. This has important implications for how the European HSR network is evaluated and priorities are set for its implementation.

A study, "Socio Economic Impact of the European High Speed Rail (HSR) Network," was undertaken for the Transport Directorate (DGVII) of the European Commission during 1991–1992. The study was undertaken by a group of consultants led by Halcrow Fox and Associates and including PA-Cambridge Economic Consultants, Leeds University Institute for Transport Studies, and Accent Marketing and Research.

The purpose of the paper is to describe and discuss one of the important findings of the study—that there are expected to be large and important "extra" economic benefits attributable to the European HSR network, which are not incorporated in a conventional cost benefit analysis (CBA). This conclusion follows from an analysis of the opportunities created by HSR and a survey of the likely responses of European businesses.

EUROPE IN TRANSITION

Change, Uncertainty, and Opportunity

Europe was defined for this study as the 12 states of the European Community (EC). It represents one of the largest concentrations of population and wealth in the world, with a population of 330 million—the largest grouping after China and India, and an economic output equal to that of the United States.

Moreover, Europe is in transition. With the completion of the Single European Market (SEM) in 1992, European businesses will have undergone or face profound change:

- Many companies have been reappraising and changing their European branch plant structure. New production plants are being established closer to major markets, particularly markets where growth is expected to be most rapid. In some cases plant restructuring is reducing the number of plants to take advantage of scale economies.
- A geographical widening of suppliers is occurring, and new trading relationships are being established with much less reliance on indigenous suppliers. At the same time, the number of suppliers is being reduced, particularly where small firms are involved.
- Intensifying competition is giving a renewed impetus to the forging of transnational alliances, coalitions, acquisitions, and other forms of collaboration. In many cases relationships mature to become full mergers.

These trends will be strengthened by the expected development of a single financial system across Europe incorporating a common currency and a central European bank. Recent developments in Eastern Europe are already having a profound impact on the EC, and there is much uncertainty about the outcome. The future for Europe is, in summary, characterized by dynamic change, uncertainty, and opportunity.

Transport is at the heart of this transformation, impeding or facilitating the free exchange of goods and services and central to the prospects for environmental change, for better or worse. It is against this background that transport policy should be viewed.

HSR Operating Environment

The impact of HSR will depend substantially on the future socioeconomic environment and on the policy environment in which it operates. The study adopted a "best estimate" for the socioeconomic environment, with economic growth averaging 2 to 3 percent per year, an increasing response to the SEM, and urban restructuring trends leading, for example, to the relocation of some service activities in the central districts of the largest "world" cities and in attractive smaller

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cities with qualified work forces and good access to major metropolitan areas.

The main study analysis adopted a Pragmatic Policy scenario, consistent with the available demand forecasts and similar to recent or existing policy. In the scenario there is little attempt to manage road and air demand by pricing, and, increasingly, infrastructure provision fails to keep up with demand. Growing congestion by road and air are the result. In this scenario rail "takes the strain" in a situation that approaches crisis for all EC travelers.

The implications of a strong Policy-Led scenario are also analyzed. Here there is convergence of national fiscal, subsidy, and competition policies; transport tariffs/prices are set to reflect social—including environmental and congestion—costs, and private-sector resources are mobilized to increase infrastructure provision and develop services more responsive to demand. Here too rail takes the strain as road and air tariffs/prices rise relative to rail.

Table 1 gives the important impacts of these scenarios on tariffs and congestion levels on Europe's transport system.

EC Transport Policy

The interplay of EC and national policy influences Europe's transport sector. In recent years EC policy has taken great strides forward and provides the direction for future change. The commission has produced railway and civil aviation policies (*1*,*2*) and will shortly produce an overall transport policy document.

Railways

The main components of EC railway policy are as follows:

- Provision and access to the EC railway infrastructure: The freedom of access to national railway infrastructure should be offered to any authorized rail transport operator. International companies should have transit rights.
- Infrastructure ownership: Member states should authorize national undertakings to own and operate infrastructure under clear conditions. The railways should pay for facilities on a basis equivalent to other modes of transport.
- Railway undertakings: Member states should lay down the requirements for the continuation or establishment of authorized railway transport or infrastructure operators, in particular ensuring their autonomy, independent management, technical ability, and adequate financial structure.
- Public railway undertakings: Member states have to provide for the institutional, economic, and financial restructuring of existing public railway undertakings, creating the conditions for their adaptation to the new situation.
- Infrastructure development: The EC should examine how different financial instruments could contribute to the achievement of high-speed network projects.
- High-speed services: The EC should promote their international development (notably a network of major axes).

The result is intended to be an efficient railway system, responsive to consumer choice and breaking down the barriers to the exchange of goods and services.

Civil Aviation

There is uncertainty about the pace and content of future change, but a plausible scenario is as follows:

- Competition between airlines will increase. Hub/spoke airports and interlining will become more common.
- However, tariffs will probably not decrease in general. The efficiency gains from deregulation and privatization will be offset by several factors: value-added tax, which will be applied but has not been hitherto; duty-free subsidies to airports, which will be removed; environmental levies; higher

TABLE 1 Impact of Scenarios on Tariffs and Congestion Levels on the EC Transport System[a]

Market/Scenario	Impact on Tariff by: Rail	Air	Car	Impact on Congestion by: Rail	Air	Car
Business Travel						
- Pragmatic scenario	+10%	+10%	+ 25%	+5%	+25%	+45%
- Policy led scenario	+30%	+70%	+110%	°	-10%[b]	-20%[b]
Non-Business Travel						
- Pragmatic scenario	+10%	+10%	+25%	°	20%	+25%
- Policy led scenario	+30%	+50%	+70%	°	-20%[b]	-20%[b]

a relative to existing tariffs and congestion levels

b traffic generation will take up some of this 'spare capacity' landing charges for increasingly scarce landing slots; and increased security costs.

• There will be continuing substantial increases in demand. The increase has been 10 percent per year during the last 2 years.

• There are a number of possible constraints on future air transport growth. Air traffic control problems are not intractable and will not be a major problem once planned European improvements are in place. Runway and terminal capacity will be a very serious constraint on air transport growth. At the five or six main hub airports in Europe there will be substantial congestion, with pricing to allocate available slots.

• There is no evidence that city center airports (like London City) will develop. The demand is not there to provide a reasonable frequency except for a very few movements (London to Paris, Amsterdam, or Frankfurt, for example), and environmental controls will constrain this.

Demand Context

The introduction of HSR is taking place against a background of rapidly growing demand by all modes (Table 2).

Car dominates the interregional travel market in Europe, whereas air has only a small market share. A small modal shift from car to HSR will therefore increase HSR demand markedly, whereas a similar shift from air will have a much smaller impact.

Rail patronage is forecast to increase substantially by 2015: up 80 percent in the "base" and 140 percent with the complete HSR network. But in the absence of HSR the market share of rail will decline by around 30 percent. The introduction of HSR will preserve this market share at around the present level.

The economic importance of HSR depends on its impact on a small proportion of business travel. Experience in Europe from other sources helps understand the behavior of this market:

• Business travel by rail is closely related to the performance of the economy, typically with an elasticity with respect to gross domestic product of 1.5.

• The most important variable for HSR is the journey time elasticity. Whereas published evidence on the elasticity of interurban rail demand to journey time is limited, an elasticity of about −1.3 is typical.

• Whereas journey time is undoubtedly the most important variable affecting mode choice, business travelers' behavior is influenced by other factors, particularly frequency, through services, and reliability. Moreover, although it is sometimes said that prices do not matter to business travelers, and although this might be true of the travelers themselves, it is certainly not true for their companies or travel managers.

HSR IN EUROPE

The study looks forward 20 to 25 years to 2015, about the time the European HSR network is targeted for completion, and assesses how economic and social activity will be affected compared with a base situation in which no HSR lines are completed beyond those now under construction.

Base Network and Completed HSR Network

Figure 1 shows the HSR network that was proposed to the commission in the report of the high-level group (*3*). It also identifies the lines under construction that are incorporated in the base network for the study: Britain, London to Edinburgh; Spain, Madrid to Sevilla; France, Paris-Lille-Calais-Dover, Paris-Tours and Le Mans, and Paris-Lyon-Valence; Italy, Roma-Firenze; and Germany, Hannover-Kassel-Wurzburg, Mannheim-Stuttgart, Hamburg-Hannover, Hamburg-Bremen-Munster, Dusseldorf-Hannover, Dusseldorf-Kassel, Frankfurt-Fulda, and Frankfurt-Mannheim.

Already HSR has had a major impact in Europe. The Paris-Lyon TGV, running for 10 years, carries 90 percent of the

TABLE 2 Increase in EC Interregional Passenger Demand, 1987–2015[a] (millions of passengers) (*8*)

Mode	1987		2015 Base [b]			2015 Complete HSR [c]		
	No.	%	No.	%	% increase	No.	Network %	% increase
Car	2750	(79)	7650	(84)	+180	7400	(81)	+170
Bus	150	(4)	300	(3)	+100	300	(3)	+100
Air	150	(4)	400	(4)	+170	350	(4)	+130
Rail	450	(13)	800	(9)	+80	1100	(12)	+140
Total	3500	(100)	9150	(100)	+160	9150	(100)	+160

a Pragmatic Policy Scenario

b Defined as the complete HSR network excluding 14 cross-border 'missing links' (reference 3)

c Figures exclude traffic generated by the introduction of HSR.

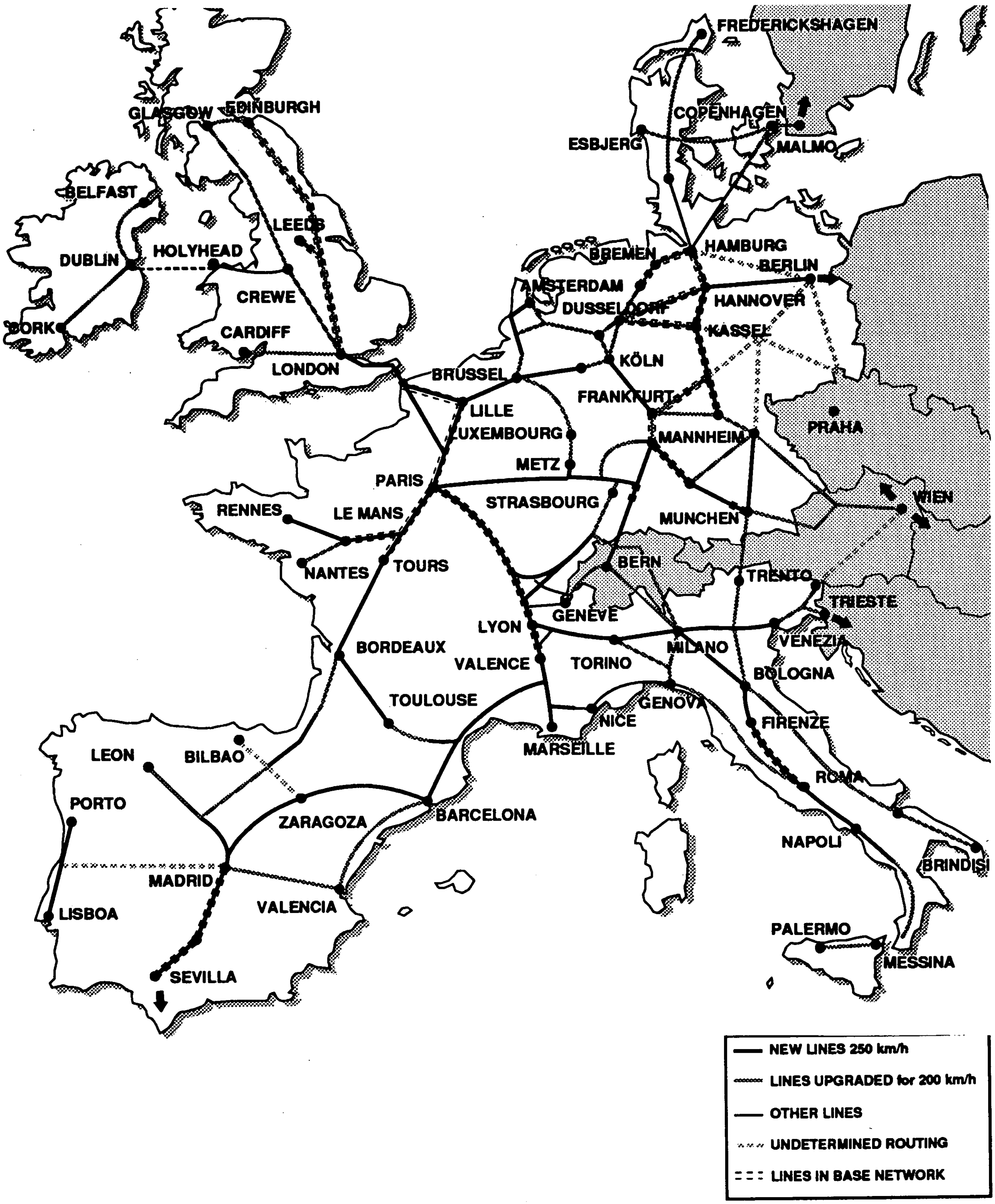

FIGURE 1 HSR network.

public transport market (air carries just 10 percent) and achieves the 427-km journey in just 2 hr. Half the trips were newly generated, one-third were air passengers, and one-sixth were car occupants.

The integrated European HSR system comprises a 24 000-km network, including 9000 km of new track and 15 000 km of upgraded track. It would permit international trains traveling at speeds between 200 and 350 km/hr to link Europe's major cities.

Technical Harmonization

In this study the fully integrated HSR network is assumed to be implemented, accommodating through-running services across all national frontiers. No operational constraints imposed by different rail technologies are assumed. This is a major assumption that deserves comment.

The Short Term

In the next 5 years or so the proliferation of different technologies in train control systems will move the national railways further away from technical harmonization. The implications for through running of international HSR services are that the next generation of rolling stock will need to be multivoltage and multisignaled.

In terms of types of high-speed service that will be offered, the diversity of on-board equipment required will almost certainly limit international services to a few key corridors where demand is sufficient to justify the expenditure and complexity of the train equipment. This is likely to be to the detriment of international services between provincial centers off the main high-speed trunk network.

Longer Term

In the longer term the trends toward greater integration and harmonization among Europe's industries and the forging of closer links between the peoples of Europe, coupled with congestion and capacity problems for competing modes, are expected to lead to a significant growth in both the volume and the geographical spread of demand for HSR travel. This should help provide the financial impetus toward achieving, if not full technical harmonization, at least a significant degree of harmonization, enabling high-speed trains from one country to operate over the tracks of another part of the EC.

In technical terms the main contribution to this is likely to be the trend toward greater portability of train control equipment, leading in time to the widespread use of radio-based on-board train signaling. By progressively freeing the railways from the need to install expensive cabling and trackside equipment when they expand their HSR network, high-speed services may be able to achieve greater market penetration at lower cost by using conventional tracks (subject to any other technology constraints). This may not become widespread for 15 to 20 years.

IMPACT OF HSR ON EUROPEAN BUSINESSES

Access to Business Opportunities

The results of accessibility analyses carried out for the study indicate that the completion of the HSR network would create significant new opportunities for individuals and organizations to participate in business activities. The opportunities, or accessibility benefits, are generated from two principal sources: (*a*) a reduction in journey times, particularly below certain critical thresholds, and (*b*) the linking of population centers within a single HSR network, thereby increasing the potential market area that can be served from a given location.

Journey Time Reductions

Benefits to businesses are most likely when day trips become possible, implying one-way door-to-door journey times of under 4.5 hr—typically 3 hr on the train in the case of rail travel, or 1 hr on the plane for air travel. HSR would bring about considerable reductions in rail journey times below this threshold, thereby creating new opportunities for day-return business trips.

Significant travel time reductions below the 4.5-hr threshold would take place on densely populated corridors throughout the EC, but this impact would be especially great in the "core" area of the Northern States (an area bordered by London, Amsterdam, Dusseldorf, Koln, Stuttgart, and Paris—see Figure 1).

Catchment Area Increase

The introduction of an integrated HSR network would result in very large increases in the urban population catchments of many European cities. Figure 2 shows the rail population catchment of cities within 4.5 hr (door-to-door) of travel by HSR.

Increases in population catchments would be particularly great in the core area of the Northern States. The population (and markets) accessible by HSR from major conurbations in this area would compare favorably with those currently reached by air within a similar 4.5-hr (day-return threshold) travel time.

The greatest relative change in accessibility due to HSR would take place in smaller cities (those with a population of around 1 million or less) rather than in the larger conurbations. For example, Strasbourg, which is located on the border of France and Germany (population 400,000), would experience a 540 percent growth in its rail population catchment from 6 million to 28 million.

There are two sources of these accessibility benefits: (*a*) smaller cities are not so well served by air, with few and infrequent flights, whereas HSR would provide a minimum 2-hr service frequency, and (*b*) the time required for access to and egress from the HSR network in smaller cities is very low, both in comparison with access times for airports and those of rail stations in major cities, hence door-to-door travel times are reduced.

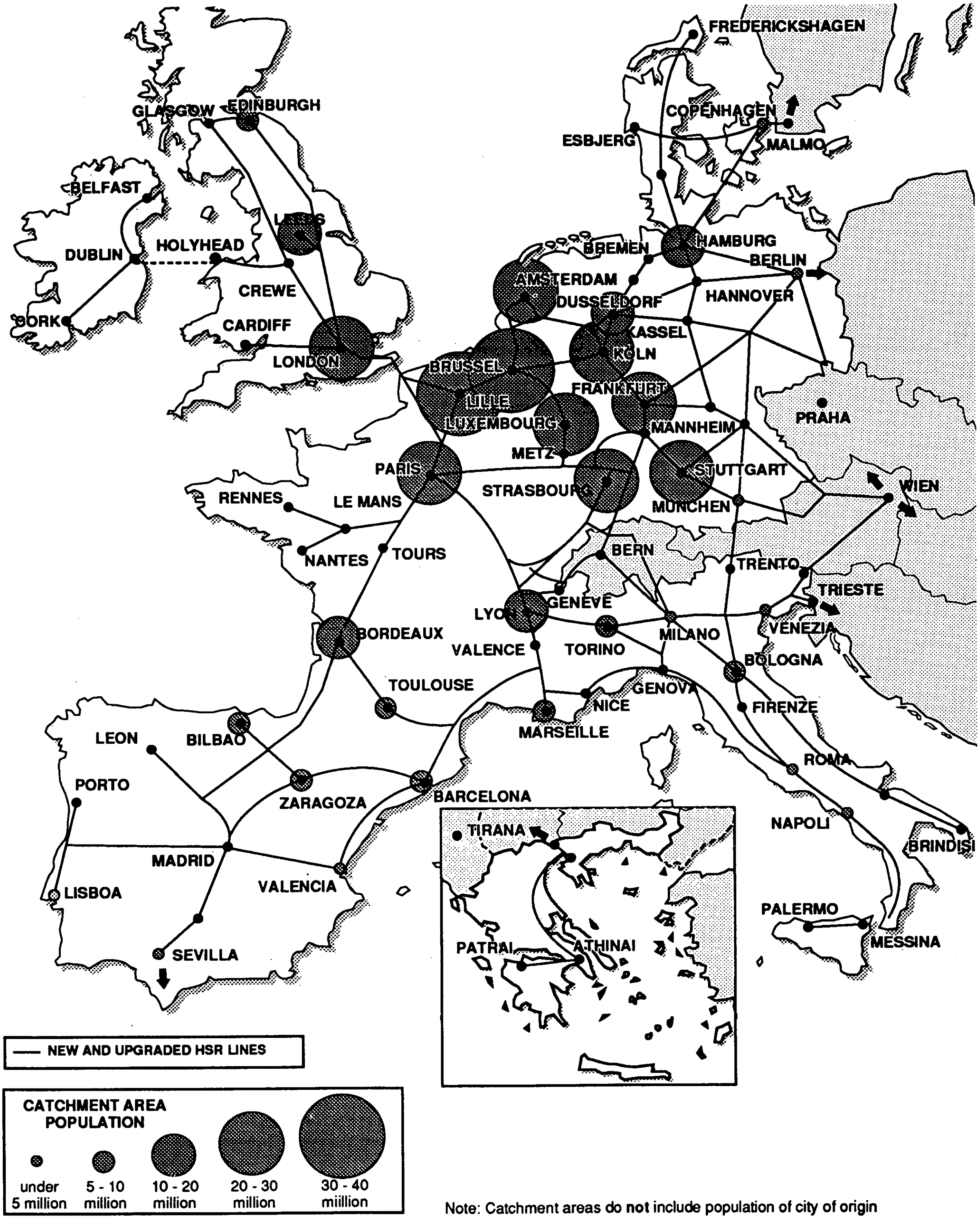

FIGURE 2 City population catchments within 4.5 hr of travel by HSR.

Changes in levels of accessibility indicate the extent to which new opportunities for business activities will emerge from the introduction of HSR. The extent to which European business travelers are likely to perceive and exploit such opportunities and the resultant economic benefits are described below.

Business Responses to HSR—Additional Sources of Economic Benefit

In-depth interviews were carried out with senior executives of more than 50 major European business corporations. In addition, postal questionnaires were distributed to more than 6,000 smaller enterprises. The results of these surveys have revealed the perceptions of business people toward travel by HSR and its potential benefits.

In particular, the surveys have identified impacts of HSR that have implications for business efficiency (that is, that reduce the opportunity cost of travel or for which a willingness to pay can be deduced).

Nine journey attributes have emerged from analysis of the survey results that would be perceived by business executives as either "relevant," "important," or "of critical importance" in the decision to travel by HSR. Clearly the benefits of HSR go well beyond the gains from higher speeds alone. In order of declining importance these are time saving (the most important), ability to make outward and return journeys on the same day, reliability, proximity of rail terminus to trip origin/destination (access time), service frequency, perceptions of safety, price, comfort, and opportunity for in-travel work.

Attributes that appear to have been formally included in the demand forecasts and conventional evaluation of the European HSR network are time savings and price (a determinant of demand, and a transfer payment in economic evaluation). That the impacts of the remaining attributes appear not to have been formally incorporated in demand forecasts or valued provides the basis for this paper. To the extent that these attributes result in increased demand (service frequency, access time, and the facility for day-return trips will each have this effect) and economic output, they should correctly be incorporated in economic evaluation. To the extent that large extra benefits result, they should be center-stage in decision making.

In-Travel Work Capacity

HSR will provide a comfortable, spacious, well-equipped, and undisturbed environment in which to work. The creation of greater opportunities for productive work while traveling will thus reduce the opportunity cost of travel for passengers who transfer to HSR. Figure 3 shows the hypothetical levels of work efficiency associated with different environments.

Whereas the levels remain to be empirically tested, Figure 3 illustrates the point that the work efficiency of HSR passengers is likely to be considerably higher than that of air, coach, and car travelers. It may well be higher than on conventional trains.

Furthermore, passengers who transfer from air and car to HSR not only benefit from improved work efficiency, but also from being able to work for a greater proportion of their journey. HSR passengers spend more time on board the vehicle and less time accessing the terminus and checking in than air travelers.

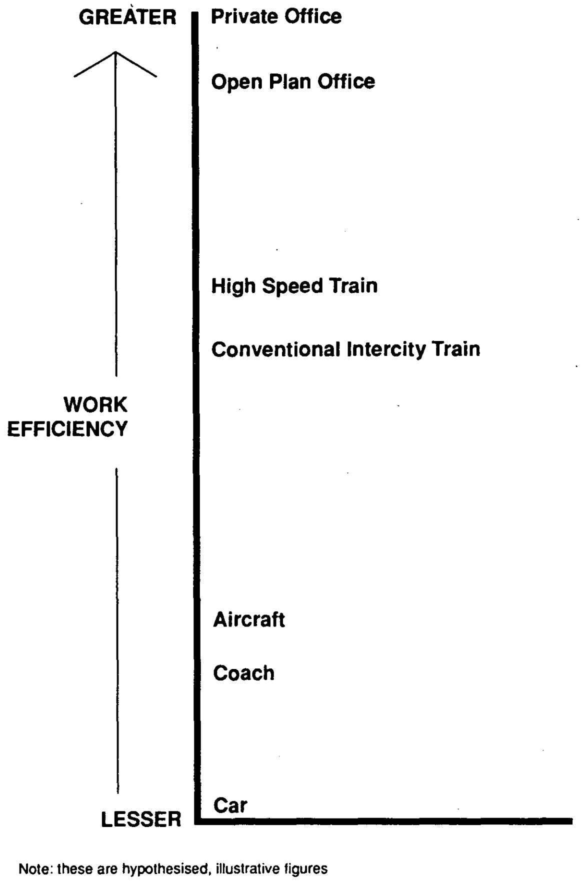

FIGURE 3 Working efficiency in different environments.

Another of the additional six attributes of HSR is increased comfort. This may have similar connotations for business travelers as the opportunity for in-travel work, and attempts to value each separately could result in double counting. In the absence of more detailed research, it is prudent to regard them as having the same efficiency impact.

Access Time Saving Between Plane/Train and Origin/Final Destination

HSR passengers spend most of their door-to-door journey on the train, whereas short-haul air travelers spend up to 75 percent of total travel time going to and from the airport; negotiating check-in, security, and various other procedures; and walking up to 1 mi through the airport terminal to the aircraft. Research has found that passengers place different values on an equivalent time saving, depending on whether it is saved while on board the main mode of travel (HSR train/plane) or while accessing the vehicle (walk/interchange/wait time, etc). This reflects the higher level of stress and reduced comfort associated with travel between the main transit mode and the trip origin or destination (*4*). Passengers who transfer from air to HSR will experience a significant benefit from a reduction in this total access, check-in, and wait time and are likely to be willing to pay a premium for the saving.

New Opportunities for Day-Return Trips

One of the main impacts of HSR will be to provide business travelers with the opportunity to make a return trip within a single day. In the absence of HSR, some would be compelled to make an overnight stay before completing their trip. Passengers who transfer from the car mode, together with existing rail travelers, all stand to gain.

The benefit to travelers is likely to go beyond that represented by the net travel time reduction (which is represented in a conventional CBA). By making a return trip within the same day, business travelers release the whole of the following day for alternative, productive activities and are able to spend the night at their home rather than in a hotel. There will be a willingness to pay for the utility gains from both impacts.

Higher Service Frequencies

The frequencies of HSR services are likely to be consistently high throughout the network, and a minimum headway of 2 hr is likely to be achieved throughout a 16-hr operational day. This contrasts with air services, which only achieve a comparable frequency on shuttle operations between major city pairs.

Service frequency affects business efficiency through changes in the defer time of travel, that is, the difference between the preferred and the scheduled travel time.

Greater Service Reliability

In 1989, 24 percent of short- and medium-haul flights in Europe were delayed by more than 15 min (*5*). This risk of delay represents a significant increase in the opportunity cost of air journeys to the business traveler. Moreover, it is unlikely that reliability of air services will improve, with projections by the Association of European Airlines suggesting that 11 of the 46 major airports in Europe will exceed their runway capacities and 17 their terminal design capacities by 2000 (*6*).

In contrast, HSR travelers should, because of the greater operational reliability of rail systems, experience no systematic service delays (i.e., more than 15 min) on a consistent basis. Hence, air passengers who transfer to HSR should experience significant benefits, both from real reductions in delay and from reduced risks of delay.

ECONOMIC BENEFITS OF HIGH SPEED RAIL

Conventional CBA

A conventional CBA of HSR in Europe has recently been carried out elsewhere on behalf of the European Commission. It considered the economic impact of constructing 14 key HSR lines across national borders, thereby linking the isolated national networks and forming a pan-European HSR system. The conventional CBA evaluated the following impacts: net travel time savings to travelers, operating cost savings to operators of the transport system, rolling-stock costs, and infrastructure capital costs. Standard economic values for unit travel time and operating cost savings were drawn from previous CBAs within Europe.

Demand forecasts were derived using a four-stage transportation model from which the diversion of passengers to HSR from other modes (car, bus, air, and conventional rail) could be estimated. The model also provided estimates of the total travel time and operating cost savings due to HSR.

Enhanced Evaluation

The conventional economic evaluation of the 14 international HSR links, outlined above, was repeated using an enhanced evaluation framework.

Identification of Impacts

The enhanced framework incorporates traditional economic impacts (travel time savings, operating cost savings, accident cost savings, and capital and maintenance costs) along with the five additional quality impacts experienced by business travelers. Table 3 summarizes them and describes the nature of the efficiency gain generated by each.

Prediction of Impacts

The enhanced evaluation has not involved new demand modeling. The prediction of the magnitude of the additional impacts on business travelers has relied entirely on the travel forecasts used in the conventional CBA. Relevant information was abstracted on the number of passengers who transfer from car, coach, and air to HSR following completion of the cross-border key links. It is likely that the data underestimate the true diversion to HSR because the five new quality impacts are not represented in the demand models.

Valuation of Impacts

The valuation of the additional economic impacts relies on somewhat less conventional techniques than those used in a traditional CBA of infrastructure investment. Whereas the valuation techniques used have a sound theoretical basis, the unit values do not always have the advantage of empirical validation. It has been necessary to make assumptions based largely on economic valuation research into domestic intercity or urban travel (*4,7*). Values are expressed in constant 1990 U.S. dollars, converted from Ecus at the rate of \$1 U.S. = 0.725 Ecu.

The following values of time, consistent with previous CBAs for the European Commission, have been used: work time,

TABLE 3 Additional Economic Impacts on Business Travelers

ECONOMIC IMPACT	BENEFITTING GROUPS	SOURCE OF BENEFIT	EFFICIENCY GAIN
(1) In-travel work capability	ex. car passengers ex. air passengers	Creation of greater opportunities for productive work whilst travelling	Reduced opportunity cost of travel
(2) Access time saving	ex. air passengers	The value of one hour saved travelling between home/office and plane/train is greater than a similar saving whilst on board the plane/train	Willingness to pay premium for a reduction in access time.
(3) New opportunities for Day Return trips	ex. car passengers ex. rail passengers	Reduction in journey times below the threshold that permits return trips within the same day	Willingness to pay to spend evening at home/whole of following day available for productive activities.
(4) Higher service frequencies	ex. air passengers	Significantly higher HSR frequencies on certain routes compared with air	Reduced opportunity cost of travel due to lower defer time.
(5) Greater service reliability	ex. air passengers	Greater reliability of scheduled HSR sercices compared with air	Reduced opportunity cost of travel due to lower risk of delay.

$39.70/hr; nonwork time, $9.90/hr. The approach to valuation is as follows.

For in-travel work capability,

- Benefits accrue to all business passengers who transfer from car and air (information currently available does not enable a firm conclusion to be drawn on whether existing rail passengers also benefit);
- The benefits arise from a combination of two factors: extra time during which work can be undertaken and higher productivity of work that is carried out;
- Car travelers benefit from 100 min work time per trip, air passengers by an extra 60 min (this recognizes that passengers spend a larger proportion of HSR journeys working and that the average in-vehicle time is longer on HSR trips); and
- The value of this additional in-travel work time is assumed to be $13.80/hr. This is a conservative estimate, which recognizes that whereas HSR passengers may achieve a high level of productive efficiency, the time "saved" may not necessarily be devoted to work activities. This would benefit from empirical clarification.

For access time savings,

- Benefits accrue to all business passengers who transfer from air;
- Access time savings take account of travel to the airport/HSR station, wait times, interchange and check-in times, and egress time from the airport/station to the final destination;
- Access time savings for each city are weighted by the city population in order to develop a mean time saving per person for each major urban center;
- The mean weighted access time saving between air and HSR is 51 min per trip; and
- The value of this saving is estimated to be $8.40/trip.

For opportunities for day-return journeys,

- Benefits accrue to business travelers who divert from car and to rail passengers;
- Estimates of the number of travelers to benefit are based on trip length distribution data, which identify rail journeys reduced below a 4.5-hr travel time threshold; and
- Valuation of the benefit considers the willingness to pay to spend an additional evening at home or to have a complete day in which to schedule business activities following the day-return trip (the net time saving is already included in the conventional CBA). A value equivalent to 4 hr of nonwork time (i.e., one evening) or 1 hr of work time, $39.70, is assumed.

For higher service frequencies,

- Benefits accrue to passengers diverted from air;
- 75 percent of these passengers are estimated to benefit from significantly higher frequencies than would be achieved on the alternative air services;
- Excluding air services between major cities, which enjoy relatively high frequencies, the mean frequency per air route is estimated as 2.5 flights per day. The associated mean defer time is 1 hr per flight; and
- The value of defer time is assumed to be the average value of work time previously used in studies for the commission ($39.70/hr). Thus the average benefit per passenger is $39.70/hr.

For greater service reliability,

- Benefits accrue to passengers who divert from air;
- 24 percent of air passengers are delayed by an assumed average of 25 min ("at least" 15 min) per trip; and
- The value of this delay, per passenger, amounts to $16.60.

Evaluation Results

The benefits from these five economic impacts are summarized in Table 4. Net Present Benefits (NPBs) are discounted over 30 years and are expressed in constant 1990 dollars.

The total additional efficiency benefits to business travelers amount to an extra U.S. $35.3 billion. This represents an increase in NPB over that of a traditional CBA of 25 percent.

When the additional business traveler benefits are combined with the results of the conventional CBA, the additional benefits more than double the NPV of the HSR network, and the benefit-cost ratio of the HSR network increases from 1.3 to 1.6.

Implications

These results have great significance for a number of reasons. First, they indicate that the economic benefits of HSR are much greater than was originally thought. Second, they demonstrate that these wider economic benefits can be quantified and evaluated in monetary terms. Third, they suggest a broader approach to the evaluation of HSR projects, which could be developed into a standard appraisal methodology for such schemes.

The additional efficiency benefits reflect a general improvement in the quality of travel. They are likely to have a direct economic impact on the performance of European businesses and their staff.

Furthermore, it is likely that they represent minimum levels of benefit. First, the extra impacts of HSR are not reflected in the models used to forecast travel demand, and a conservative approach to valuation has, in the absence of empirical evidence, been adopted. Second, it is likely that, following further research, additional economic benefits to various categories of leisure traveler could also be identified and valued.

Whereas the evaluation is based on sound theoretical principles, further empirical work is required to establish empirical values. Because the majority of additional benefits accrue from the ability to make a day-return trip and from in-travel work opportunities, priority should be given to researching these impacts.

CONCLUSIONS

The European HSR network is being planned and constructed in a period of great change and growing business opportunities. The success of HSR will, in part, be determined by the extent to which it exploits and supports these opportunities.

TABLE 4 Summary Economic Evaluation of the HSR Network

ECONOMIC IMPACTS (millions Ecus/$)	Costs/Benefits from traditional evaluation		Traditional Costs/Benefits + additional business traveller benefits	
	Ecus	$	Ecus	$
Travel Time Cost Savings (previous CBA)	84,000	116,000	84,000	116,000
Operating Cost Savings (previous CBA)	15,500	21,500	15,500	21,500
In-Travel Productive Time Benefits (New)	-	-	15,300	21,100
Access Time Savings Premium (New)	-	-	700	1,000
Day-Return Opportunity Benefits (New)	-	-	7,400	10,200
Service Frequency Gains (New)	-	-	2,500	2,500
Service Reliability Gains (New)	-	-	300	500
Infrastructure and Rolling Stock Costs (previous CBA)	(77,500)	(107,000)	(77,500)	(107,000)
Net Present Benefits (NPB)	99,500	137,500	125,700	172,800
Net Present Value (NPV)	22,000	30,500	48,200	65,800

All costs and benefits are discounted present values. Parentheses denote costs.

Completion of the network would create significant accessibility benefits for business travelers. Most important among these would be the many new opportunities to make return trips within 1 day, thus reducing the need for overnight stays.

The greatest relative impact of HSR is likely to occur in smaller cities rather than in the major metropolitan areas. These cities are less well served by air, with relatively few and infrequent flights, whereas the time required to access the HSR network is comparatively low.

Additional economic impacts of HSR that are not normally included within the investment appraisal of rail infrastructure have been identified. They are all perceived and valued by business travelers and relate to the enhanced quality of service provided by HSR. The addition of these new impacts to the travel time and operating cost savings estimated by a conventional CBA increases the NPB of the HSR network by 25 percent and doubles the NPV.

This finding has important implications. The CBAs of the European HSR network carried out to date, based on travel time and operating cost savings alone, are unlikely to be an appropriate basis for appraising the full range of impacts of this new transport mode. Rather these other, quality factors will improve decision making: in determining the value for money viability of HSR, in setting priorities for implementation, and in system specification and design.

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