3. THE MARKET FOR HIGH SPEED RAIL

Introduction

3.1 It was clear from the country case studies undertaken for this project that the potential market justification for high speed rail has, historically, been stronger in some other countries than in Britain. This section evaluates the impact of differences in the transport market on the case for high-speed rail in each country. Key factors, which are discussed in detail, are:

- The distances between population centres: high speed rail offers an advantage for journeys over medium distances but relatively little incremental benefit over either very long or very short distances;
- The competitiveness of other transport modes, including the conventional rail network;
- Demand and capacity: many countries have built high-speed rail lines as much for reasons of capacity as for reasons of speed (securing incremental passengers rather than journey time savings for existing passengers). The benefits of new construction will be greatest when this new capacity can be highly utilised early on – particularly when relatively high discount rates are used; and
- Population distribution: the distribution of population around city centres relative to more distant suburbs, will affect the potential benefits of high speed rail.

Journey times and distance

3.2 High-speed rail enables journeys over medium distances to be made quickly. However, it offers relatively little advantage for either very short or very long journeys:

- For shorter journeys, even conventional rail is faster than air travel for door-to-door journeys, and high-speed rail offers little incremental advantage because of the need to accelerate to the maximum speed. In fact, journeys via high speed train may be slower than via conventional train, because high speed trains often have to serve new stations that are less well-located; and
- For long journeys, air is faster and the proportionate impact that high-speed rail can make to the pre-existing air/rail journey time distances is smaller.

3.3 The exact range of journeys over which high speed rail is competitive, at least in terms of journey time, clearly varies depending on assumptions about time required for station and airport access, check in, etc. With the recent emerge of a dynamic aviation market in Europe, longer-term projections as to total air journey times are becoming less easy to predict with confidence. The market advantage of rail also varies dependent on the speed and reliability of each mode – in particular, whilst 300km/h is fairly typical for high speed rail operation worldwide, conventional rail speeds vary significantly between routes. However, this shows that, in general:
• for journeys of less than about 150km, high speed rail offers little advantage over conventional rail and may, depending on the location of stations, be less convenient for most passengers;
• for journeys of approximately 150-400km, rail is faster than air travel even if there is no high speed line, and high-speed rail will instead serve to make that advantage more robust;
• for journeys of more than 400km, high speed is necessary for rail to become the fastest mode and thereby make significant mode switches realistic; and
• for journeys of more than about 800km, even with dedicated high-speed infrastructure available for the entire route, air travel is faster. The competitive rail markets become more niche-focused (night services, car transport services, etc).

FIGURE 3.1 COMPETITIVE ADVANTAGE OF HIGH SPEED RAIL

3.4 The case studies demonstrated that there is a strong correlation between whether countries have extensive high speed rail networks (either in service or under construction) and whether they have significant population centres that are distances apart that makes high speed rail a competitive transport option:
• In France, distances are ideal for high-speed rail. The majority of journeys are to/from Paris; 8 out of the 9 other major cities are more than 400km away; and all except Nice are within 800km.
• In Spain, distances are also ideal for high-speed rail. The largest city, Madrid, is in the centre of the country and other major cities are generally on or near the coast, 400-600km away.
• In Japan, many key cities, such as Osaka, Nagoya, Kobe and Kyoto, are also in the range of distances from Tokyo for which high speed rail is the most competitive mode;
• In Germany and Italy, there are a number of cities in the range of distances for which high speed rail is necessary for rail to be competitive, but many other cities are sufficiently close together that high speed rail offers little advantage; and

• In Australia, the biggest cities are generally so far apart that high-speed rail could not be competitive, although with 350km/h technology, a link from Sydney to Melbourne could in principle be possible.

**Competitiveness of other transport modes**

*Conventional rail network*

3.5 The above analysis was based on a ‘typical’ conventional rail network, assuming that conventional rail would be able to sustain a standard operating speed of 130km/h plus some time for acceleration/deceleration. However, the quality of conventional rail routes varies significantly between countries, and between different routes within the same country.

3.6 The figure below illustrates the effect this has on the potential market for high speed rail, by showing the total journey time advantage that high speed rail offers passengers over the fastest alternative mode, depending on the distance travelled:

• With a typical rail operating speed of 130km/h – which is fairly representative of many main line routes around Europe, and is also fairly appropriate for the West Coast Main Line in Britain – high speed rail offers a maximum benefit of 45-50 minutes’ saving, for distances of around 350-400km (such as London to Preston or Paris to Brussels).

• Where the standard speed that conventional rail can operate at is closer to 100km/h – more representative of Spain or England south of London – high speed rail can offer journey time advantages of 1 hour or more over all other modes, and therefore could offer benefits for shorter journeys.

• Where the standard speed that conventional rail can operate at is 160km/h, such as the East Coast Main Line in Britain, the maximum journey time advantage offered by high speed rail is about 35 minutes for journeys in the region of 450km, such as London to Newcastle.

**FIGURE 3.2 JOURNEY TIME ADVANTAGE OF HIGH SPEED RAIL**
3.7 This is a very simplified indicator of the speed benefit of high-speed rail. Where it is possible for high speed rail to use existing city centre stations – as the SRA proposes for a high speed line in the UK in most cases – or for there to be more than one station in/around major cities (as for conventional rail on many routes), the potential benefit of high speed rail is greater. In addition, although high-speed rail is not significantly faster than air travel for some journeys, the overall journey may still be preferable for passengers. For example, on the Paris to Marseille route, at the upper limit of the distance range over which rail can be competitive with air, rail has nonetheless captured 60% of the market, despite air travel offering a wider range of travel options (in terms of airports served).

3.8 A better conventional rail network also offers some advantages for high-speed rail construction. Where the conventional network has enough capacity for existing approaches to city centres to be used, construction costs are significantly reduced because much less tunnelling is required. In France, Germany and Italy, it has been possible to use existing routes in this way to gain access to key termini. In Spain and Japan, the poor quality of the existing rail network, and in particular the use of a different gauge, has increased the total cost of high speed rail construction, because it has been necessary to create new routes into city centres. If Australia were to construct a high speed rail line, it would also need to build new routes on the approaches to major cities.

3.9 In the Britain, it is likely that significant work would be required on the final approaches to key cities, and the costs of this work would increase if the peaks for long distance and commuter traffic overlapped, if these were to share the same tracks.

5 The use of existing stations may increase the time required for acceleration to high speed, although in practice the effect of this would be minimal.
However, as the main routes north of London are relatively good, it would probably not be necessary to build new routes into the centre of London, as has been needed for the construction of CTRL. Overall, the relatively good quality of the British rail network north of London would be of benefit in high speed rail construction, because it would allow high speed trains to provide fast services beyond the core new route. The high speed line itself would be used to bypass a number of the key capacity constraints on the existing network.

*Other transport modes*

3.10 The competitive strength of other transport modes also varies significantly between the case study countries.

3.11 Over long distances, the main competitor for high speed rail is air, and the recent development of low cost airlines presents a serious challenge to rail operators, many of whom have historically faced little pressure to contain their costs. All of the case study countries have significant domestic air networks but in France in particular, high domestic air fares, which have been sustainable as a result of limited competition, probably have increased the demand for high speed rail travel. Where low cost airlines have recently begun to compete against high speed trains – for example on the Paris-Cologne route and some routes in Japan – they have reduced rail’s market share significantly. A high speed rail line in Britain would probably face more intense price competition from airlines than high speed rail lines in the other case study countries.

3.12 However, capacity constraints at British airports, particularly those in southeast England, may reduce the intensity of this competition over time – depending on whether how much, if any, additional runway capacity is provided. In contrast, it is likely that high speed rail lines in other countries will face more competition from air transport. Although it is sometimes argued that high speed trains can only mitigate a tiny proportion of air travel growth, because they cannot serve most air destinations, this is rather misleading: many passengers (primarily holidaymakers) chose their destinations in part on the basis of the cost and convenience of travel, so they may chose destinations accessible by rail or road if air travel is too expensive or inconvenient.

3.13 Our research did not show a clear relationship between car ownership and the construction of high speed rail routes. Car ownership in France, for example, is higher than in Britain. However, there was some relationship between high speed rail construction and the extent to which road tolls are levied. The two countries with the largest high speed rail networks (France and Japan) are also the countries that levy the highest motorway tolls. Tolls are also levied in Italy, but at a lower rate, and in Spain,

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6 Traffic between Paris and Cologne on Thalys, the high speed rail operator, fell 14% after the entry of Germanwings, a low cost airline.
but on a smaller proportion of roads. In Germany, Britain and Australia, motorway tolls are generally not levied.

3.14 This discussion illustrates how the case for high-speed rail can be substantially enhanced or undermined by policy changes affecting other modes some time after the rail investment commitment is made. Clearly, tolling Britain’s motorways could (but need not) alter their users’ generalised costs, and thereby strengthen the case for rail alternatives in Britain. If runway capacity in the South East is constrained by Government decisions, the response of the aviation industry in coming years will be affected by future European and UK policy on issues such as slot allocation, airport charges, traffic distribution rules, and the economic structure, ownership and regulation of BAA plc. It will also be affected by future developments in the low cost carriers’ business models, which have transformed the benefits and risks of regional aviation in last decade.

**Demand and capacity**

3.15 High speed rail offers very high passenger capacity. Signalling systems can usually handle a train approximately every 4-5 minutes; with up to 1,000 seats per train, on a double TGV Duplex unit, a high speed rail line can, in theory, carry the same number of passengers as a Boeing 737 every 45 seconds, or three parallel motorways. High speed trains in Japan have even higher capacity (up to 1,600 seats per train). Therefore, for a country to realise the maximum benefits of investment in high speed rail, not only must there be demand for journeys over a particular range of distances, but that demand must be very large.

3.16 It was also clear from the international case studies that a key reason that many countries have constructed high speed rail lines has been to provide extra capacity, rather than speed. Capacity was the main justification for construction of the world’s first high speed rail lines, from Tokyo to Osaka and Paris to Lyon. Capacity continues to be the main reason for Italy to construct high speed lines; on some routes, such as Rome to Naples, the gain in speed will be relatively small. The construction of high speed lines provides additional capacity for many different types of trains, not just fast InterCity trains, because it frees capacity on the conventional routes for freight and regional passenger services. For example, in Britain, the opening of CTRL Phase 1 has enabled some expansion of domestic trains on the conventional line from London to south and east Kent, because Eurostar trains have been transferred to dedicated track.

3.17 Within Europe, the full theoretical capacity of high speed rail lines, which is typically 120-160 trains per direction per day, is never used, although capacity is often fully utilised during peak periods. However, the viability of a high-speed rail route is clearly dependent on there being sufficient demand to use a significant proportion of the available capacity. The figure below shows the trains per day operated on a number of key European high-speed lines. All routes handle at least 30 trains per
direction per day and most handle 50-100. The Shinkansen routes in Japan also carry very heavy traffic, with up to 10 trains per direction per hour.

**FIGURE 3.3 TRAINS PER DIRECTION PER DAY ON HIGH SPEED LINES**

3.18 In terms of the capacity benefits of high-speed rail, the case for construction of high speed rail in Britain now appears strong. Britain should be able to utilise a very high proportion of the capacity on at least the southern part of a high speed line (from London to the Midlands); in fact, the SRA’s analysis shows that if the high speed line served both the northeast and the northwest, the southern part of the line would be capacity constrained in the medium term. It is likely that capacity utilisation on the northern sections would be lower. It is interesting to note that the case for construction in Britain on grounds of capacity would have been much weaker in the 1970s and 1980s, when other European countries were planning their first high speed rail lines, because there was much more spare capacity available on the conventional rail network at that stage.

**Combined analysis of the potential demand and benefit**

3.19 As discussed above, the key benefit of high-speed rail is its ability to move a large number of people quickly over medium distances. This section evaluates the combined effect of these factors in the case study countries.

3.20 The figure below compares an estimate of the potential demand for rail on the five potentially biggest routes of at least 200km, in Britain and the other six case study countries, transposed onto a graph demonstrating where high-speed rail offers a significant potential journey time advantage. Potential demand, shown on the vertical axis, is used here as an indicator of the potential benefits of the high speed line. The assessment of demand has been based on a simple gravity model that we have developed but which we have not sought to calibrate; although we would not expect this to predict demand on any individual route accurately, it should indicate the potential magnitude of demand in each case.
3.21 The use of a gravity model is a very simple method of comparing demand for travel between routes in different countries and ignores the fact that there are many more complicated factors driving travel demand. However, this does confirm that, of the case study countries, the potential demand for high speed rail travel is likely to be greatest in France and Japan. At least on the basis of this analysis, there appear to be a number of potential routes in Britain, but the case is rather less strong than in France or Japan.

Distribution of population

Population density

3.22 All types of rail – conventional and high speed – are better at serving markets where demand is located densely around key nodes. High speed rail can serve a higher proportion of the potential market in countries such as Spain or France with densely populated cities than in countries such as Australia or the USA, where most of the urban population lives in lightly populated suburbs. In contrast, high speed rail construction tends to be less politically controversial and expensive in countries where the areas between major cities are lightly populated.

3.23 The figure below compares the case study countries. The blue bars above the axis show the population density of the five largest cities in each country; the purple bars show the population density of the country as a whole. The combined bar provides a simplified guide to the suitability of a country for high speed rail – the higher this is, the more the economic geography is “friendly” to high-speed rail. This demonstrates
that population densities are more suitable for high speed rail in France or Spain than in Germany or Britain, and that in Japan, while high-speed infrastructure is costly and disruptive (relative to Britain) its demand benefits are significantly higher.

**FIGURE 3.5 POPULATION DENSITY**

![Population Density Diagram](image)

*Location of main population centres*

3.24 As discussed above, high speed rail lines can provide very high capacity and the benefits of investment will be greater if this capacity can be well utilised. It would be very unusual for there to be such great demand for travel between two individual cities that a dedicated high speed line can be justified: the line must also be able to handle passengers to/from other cities, either along or beyond the core route. The case for construction of high speed lines is likely to be stronger if population is located in corridors that can be served by a single line.

3.25 The distribution of population in some countries, particularly France and Italy, has enabled maximum use to be made of high-speed rail investment. For example, when the Paris to Lyon TGV line was constructed, it was possible, using branches and the conventional rail network, also to serve many other destinations including Lausanne, Geneva, Marseille, Nice and Montpellier; the same route now also carries trains to/from Brussels and (in the summer) London. Italy’s ‘long and thin’ nature means that the Rome to Florence high speed line is of benefit to journeys between a large number of different cities, not just these two. Similar benefits arise in Japan.

3.26 In contrast, in Germany, the distribution of population in a large number of medium sized or small cities that are dispersed around the country means that few long sections of line have very high traffic; as a result, it has not been possible to get the same utilisation from high speed rail investment there. Similar issues apply in Spain and
Australia. The distribution of population in Britain, along a ‘long and thin’ country, would enable a high speed railway to serve a relatively high proportion of the population.

Conclusion

3.27 Our analysis of the benefits of, and market for, high speed rail shows that high speed rail provides travel time benefits for trips of at least 150-200km and up to 800km; and that the benefits are greatest for journeys of 300-550km. High speed rail may offer benefits for slightly shorter journeys if the stations it serves are as well located as the conventional rail stations. However, our country case studies showed that countries have constructed high speed railways for reasons of expanding capacity as much as improving journey times. Separation of high speed InterCity services from regional passenger and freight trains offers a significant improvement in capacity.

3.28 Our analysis shows that the market conditions for high speed rail to be successful are met in Japan and France more than the other case study countries, and in this context it is perhaps not surprising that these countries have invested more in high speed rail than the others. The population densities in France and Spain are more conducive to high speed rail development than in the other countries, and the distribution of population centres along corridors in Japan, Italy, Britain and to an extent France but not Germany, Spain or Australia is conducive to high speed development.

3.29 If a high speed line was to be constructed in Britain, securing the benefits from expanding capacity would be an essential part of the overall investment case – perhaps as much as improved journey times. In this respect, the case for construction of a high speed line in Britain is now much better than it would have been 20 years ago, when there was more spare capacity on the conventional rail network.