The Case for High Speed Rail

An update

John Preston
December 2010

RAC Foundation

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RAC Foundation
89–91 Pall Mall
London
SW1Y 5HS

Tel no: 020 7747 3445

www.racfoundation.org

Registered Charity No. 1002705

This report has been prepared for the RAC Foundation by Professor John Preston of the Transportation Research Group, School of Civil Engineering and the Environment, University of Southampton. The report content is the view of the author and does not necessarily represent the views of the RAC Foundation.

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Abstract

This paper was commissioned by the RAC Foundation in May 2010 to examine three pieces of evidence published in March 2010 concerning the case for High Speed Rail (HSR) in Britain. It builds on earlier work commissioned from the author and published in October 2009 to provide a rapid review of emerging evidence on the case for HSR. The aim of this paper is, in the light of this new evidence, to update the earlier paper, in particular with respect to: (i) the economic benefits and costs; (ii) the financial liability for the public purse; (iii) net carbon savings; and (iv) planning issues.

It finds that there is an economic case for HSR from London to Birmingham (HS2), and beyond to Leeds and Manchester, but that this is dependent on assumptions concerning the long-term growth in demand for long-distance rail passenger traffic. However, mid-scale improvements to existing road and rail infrastructure may provide better economic returns and these should be further investigated. There does not appear to be an economic case for a direct link to either Heathrow or to the international services provided by HS1 (the Channel Tunnel Rail Link).

It also finds that HSR costs are exceptionally high in the UK and hence, despite relatively high levels of demand, substantial subsidy is required. For the HS2 scheme between London and Birmingham, this support would be around £12 billion (2009 prices), which is to say around two-thirds of the capital costs. How this funding is delivered remains to be determined. There may be some scope to reduce costs and increase revenue from the HS2 scheme, but this could be at the expense of social returns.

The paper confirms earlier work that found that HSR has modest environmental and wider economic benefits, over and above the mainstream transport benefits. It also confirms that building an HSR line is a major enterprise which would take around eleven years, whilst the HS2 proposals are strongly linked to Crossrail, which is scheduled to be completed in 2017. The earliest that HS2 might be completed is 2026. Planning may be complicated by the proposals to abolish the Infrastructure Planning Commission.

1. Introduction

This paper was commissioned by the RAC Foundation in May 2010 to examine three pieces of evidence published in March 2010 concerning the case for High Speed Rail (HSR) in Britain.

These were:

- The Command Paper (Cm7827) on HSR, published by the Department for Transport (DfT) and running to some 152 pages.

- A report to Government entitled *High Speed Rail: London to the West Midlands and Beyond* that was produced by High Speed Two Limited (HS2 Ltd), an independent body established in January 2009 to develop a new HSR line between London and the West Midlands and to consider the case for HSR services linking London, northern England and Scotland. The main report was published in 11 parts, running to some 247 pages. In addition, a set of 13 supporting documents was produced. The creation of these documents involved panels of some 25 experts and consultation with some 200 interested parties.

- A series of four reports produced by the engineering consultancy Atkins and commissioned by the DfT as part of the High Speed 2 Strategic Alternatives Study.

This paper builds on earlier work commissioned from the author by the RAC Foundation and published in October 2009 to provide a rapid review of emerging evidence on the case for HSR. This earlier work included consideration of the DfT's *New Line Capacity Study*, undertaken in July 2007 but not published until April 2009, Network Rail's New Lines Programme, published in August 2009; and Greengauge 21's studies on an HSR strategy for Britain published in September 2009.

The aim of this paper is, in the light of this new evidence, to update the earlier paper, in particular with respect to:

- the economic benefits and costs;
- the financial liability for the public purse;
- net carbon savings; and
- planning issues.

These issues will be dealt with in subsequent sections. However, before this is done it will be useful to restate the main findings of the series of reports published in March 2010. HS2 Ltd have developed detailed recommendations for a high speed route between London Euston and a new terminal station in Birmingham (at Fazeley Street), with interchange stations in London at Old Oak Common (for connections to Crossrail, Heathrow Express and the Great Western Main Line) and in Birmingham, adjacent to the existing International station. The high speed line will be extended north of Birmingham to connect with the West Coast Main Line (WCML) at Lichfield. This would allow the use of HS2 by classic-compatible services from Manchester, Liverpool and Scotland.

A two-track line will be built with maximum operating speeds of 400 kilometres per hour (kph), although the initial top speed would be 360 kph. The line would be built to the continental GC loading gauge[1], thus permitting double-deck operation. As HS2 will be used exclusively by high speed passenger trains, 18 train paths per hour will be possible, although only up to 11 paths would be used initially, with 'headroom' for a further 3 in the peak, and 10 paths being used off-peak. In addition, HS2 will be designed to accommodate train lengths of 400 metres (essentially double train sets), with capacity for 1,100 passengers. The terminal at Euston would require ten new platforms, whilst the terminal at Birmingham Fazeley Street would require six platforms. The Birmingham Interchange station would involve four platforms and a car park of some 7,000 spaces. The Crossrail Interchange at Old Oak Common would involve six platforms on HS2 and eight platforms on the classic rail network. A rolling stock depot would be located at Washwood Heath in Birmingham and an infrastructure depot near Brackley (Northamptonshire).

Very detailed plans for high capacity, high speed infrastructure have thus been drawn up, although there could be concerns that the scheme has been gold-plated in engineering terms. In particular, the proposed infrastructure would not be used to its full potential (in terms of both speed and capacity) at opening, although there would be scope for future service improvements.

A huge number of options have been assessed against engineering, sustainability and economic criteria, with three being examined in detail. Maps for over 50 sections of the preferred route have been produced. In addition, 27 possible options for the central London terminal were examined, along with 11 possible sites for a station serving Heathrow, 17 options for serving central Birmingham and 10 locations for serving the outer West Midlands. The scope for intermediate stations was also examined, with detailed studies at three locations (Aylesbury, Bicester and Milton Keynes) but an economic case for such stops could not be made.

Two issues were only partly resolved – whether Heathrow Airport should be served directly by HS2 (either by a loop or a spur) and whether there should a direct rail link (single or double track) between HS2 and HS1; given the relatively sparse traffic, the assumption is that neither would be provided. The then Secretary of State, Lord Adonis, commissioned Lord Mawhinney in March 2010 to investigate HSR access to Heathrow. This commission was confirmed by the new Secretary of State (Phillip Hammond) in May and the report was presented in July. This report argued that there was not a case for a link to Heathrow Airport until the high speed network was extended to Leeds and Manchester, but that when the HS2 between London and Birmingham is built, appropriate junction engineering works should be included to make it possible to provide a loop serving the Heathrow Central Terminal. However, the report also recommends that serious consideration be given to making Old Oak Common the initial London terminal, despite the fact that HS2's modelling work suggests that two-thirds of London traffic would use Euston and forecasts the

1 This has a height of 4,650 mm compared to the GB standard of 3,965 mm.

likely congestion of connecting public transport modes at Old Oak Common if this were to be the London terminus.

If a rail link is to be built between HS1 and HS2 it is recommended that it should be double track at conventional speed, between Old Oak Common and Camden Road East Junction. This would have an estimated cost in excess of £1 billion. The Mawhinney Report states that ‘It makes sense if possible to create a seamless link between H1 and HS2’ (paragraph 63), but it is also acknowledged that further work is required.

The proposed HS2 service would result in a journey time of 49 minutes between London Euston and Birmingham Fazeley Street, by comparison with the current journey time of around 82 minutes (Euston to New Street) – a station-to-station speed increase of around 67%. The journey time between Birmingham Interchange and Old Oak Common would be 31 minutes, which has formed the basis of the Command Paper’s claim of journey times between London and Birmingham of around 30 minutes. Services to the north using HS2 would benefit from time savings of around 30 minutes.

The basic off-peak service pattern assumes three services between London and Birmingham, three between London and Manchester, two between London and Liverpool and one between London and Glasgow (HS2, 2010: 148). An additional service in the peaks between London and Preston is proposed, along with supplementation of the London–Birmingham service.

The provision of HS2 would allow a recasting of the WCML timetable. In particular, this would allow additional services for the Milton Keynes South Midlands Growth Area. For example, it is proposed that Milton Keynes would receive up to eight non-stop services to London in the peak hour, with five further stopping services, and enhanced services northwards, these being to Crewe, Glasgow, Liverpool and Manchester (Technical Appendix, pp. 14–21).

Detailed rail demand modelling has been undertaken using the PLANET model (the DfT strategic rail demand forecasting model). It should be noted that HSR has not been modelled as a new mode, but as an incremental improvement to the existing rail system. Without HS2, around 106,000 long-distance passengers are forecast to be using the southern part of the WCML per day in 2033. By contrast, the southern section of the HS2 route is forecast to be carrying 145,000 passengers per day, with a reduction of 84,000 passengers on the baseline classic network.[2] Of these, around 54,000 HS2 trips per day would be to/from the Birmingham stations (37%), with the balance coming from further north. Around 30% of travel would be for business. Some 57% of journeys would switch from classic rail, 8% would be from air, 8% from car and 27% would be generated. HS2 would thus have a higher level of abstraction from rail and a lower level of abstraction from road and, even more so, air than the other HSR schemes shown in Table 1.

Table 1: Diversion factors resulting from introduction of HSR

Route	Paris–Lyons[1] 430 km	Madrid–Seville[2] 471 km	Madrid–Barc'a[3] 630 km	Thalys[4]	Eurostar[4]
% HST traffic generated from	1980 to 1985	1991 to 1996 forecast	Before HSR' to 'After HSR'	Range not given	Range not given
Induced	29	50	20	11	20
Road	11	6	10	34	19
Conventional rail	40	20	10	47	12
Air	20	24	60	8	49

Note: * All Paris–Lyon's 'after' rail travel is presumed to be by HST (i.e. none by conventional rail following introduction of HST), since the alternative journey time is approx. five hours compared with approx. two hours by HST.

Sources: [1]Bonnafous (1987) [2]de Rus & Inglada (1997) [3]Coto-Millán et al. (2007) [4]Segal (2006) quoted in Preston (2009)

It should be noted that this is a relatively high level of demand, equating to almost 44 million passengers per annum (assuming an annualisation factor of 300 – see Demand Analysis Report, p. 90). This would appear to be comfortably above the social break-even figure of 9 million (but for a 500 km route – the preferred HS2 route 3 is 175 km)[3] developed by de Rus and Nash (2009: 66). Gourvish (2010) reports that in 1992 there were 23 million rail passengers between Paris and Lyon (some eleven years after the introduction

2 This implies 22,000 still using WCML with HS2 and classic rail usage on the corridor totalling 167,000, an increase of around 57%.

3 This is to a common point near Birmingham (HS2, 2010: 99). The distance from Euston to the connection with WCML is estimated to be 189 km, whilst the entire HS2 build is 205 km.

of TGV services). The Command Paper (p. 38) notes that there are 150 million rail passengers per annum between Tokyo and Osaka.

High speed routes beyond Birmingham have also been considered, albeit at a much less detailed level than the London–Birmingham route, with three broad networks considered: the ‘inverse A’, the ‘reverse S’ and the ‘reverse E’. This strategic analysis indicated that the inverse A performed best, a variant of which (the ‘Y network’) was subject to further analysis. This would involve two branches, one to Manchester and the other to Leeds, with intermediate stations on the latter in the East Midlands and in South Yorkshire. This would lead to rail journeys from London to Leeds reducing by one hour (from 140 to 80 minutes). Journey times from Manchester to London would also be 80 minutes, compared with the current 128. However, HS2 would reduce the journey time between London and Manchester to around 100 minutes, so the journey time reduction for the extension to Manchester would only be 20%, compared with a reduction of over 40% for Leeds. The inverse A network was forecast to be used by around 440,000 passengers per day in 2033, of which 219,000 would be to/from London. Total annual usage of the inverse A network would thus be around 132 million – a figure comparable with the Tokaido Shinkansen. It is estimated that compared with HS2, a Manchester branch would lead to an increase in London-based traffic of a little over 9,000 trips per day, whereas the Leeds branch would lead to an increase of some 70,000 trips per day.[4] The Manchester branch would also stimulate around 7,400 non-London daily trips, with the figure for the Leeds branch being around 19,000.

4 This would suggest London traffic up from 140,000 to 214,000 per day as a result of the Leeds and Manchester extensions – an increase of 56%.

2. The Economic Benefits and Costs of HSR

The HS2 studies have contributed further evidence on the economics of HSR in Britain, and this is now reviewed in three sections. In section 2.1, costs are examined, then in section 2.2 benefits are examined, before in section 2.3 the interplay of costs and benefits is considered.

2.1 Costs

The Command Paper (p. 68) indicates that the costs for the 128 miles (205 km) of HS2 route between London and Birmingham would be between £15.8 billion and £17.4 billion, whilst the 335 mile (536 km) Y-shaped network would cost a total of around £30 billion (2009 prices). This suggests high unit costs of around £77 million to £85 million per km for HS2, compared with around £53 million per km for the Leeds/ Manchester extensions. The higher unit costs for HS2 reflect the greater burden of the terminals and the greater proportion of tunnelling.

Rolling stock costs are given as £472 million for 16 HS captive sets (with a risk provision of 18%) and £2,363 million for 45 HS classic-compatible sets (with a 40% risk provision). A maintenance cost of £2.80 per km has been assumed for HS captive trains and £3.50 for the classic-compatible sets. Energy consumption has been estimated at £2.80 per km.

For the extensions to Manchester and Leeds some simple unit rates per km were used for route over flat terrain (£11 million), over undulating terrain (£17.5 million), through urban areas (£25 million) and in tunnel (£80 million). For stations, costs of £150 million for a two-platform through station and £240 million for a four-platform terminal station were used. An appraisal optimism uplift of 66% was used.

These costs are much higher than many other HS schemes (see, for example, Campos & de Rus, 2009). Comparisons with two schemes in France, two in Germany and one each in Italy and Spain, undertaken by BSL Management Consultants for HS2 Ltd, indicated that, when adjusting for urban approaches and tunnelling, unit construction costs in the UK appeared to be double those in mainland Europe. A number of reasons were given for this. Construction in Europe tended to be undertaken as a rolling programme which leads to economies of experience whereas in the UK, HS1 (which was used as the basis for HS2 costs) was a one-off project that required more direct supervision. It was also speculated that the more prescriptive approach to transposition of EU legislation in the UK has led to increased costs. Multiple subcontracting was also thought to be cost inflating as each commercial layer adds overheads and profit margins, whilst the complexity of the necessary contractual arrangements requires large external project management teams. The addition of an optimism bias element may also create self-fulfilling project price inflation.

2.2 Benefits

The HS2 scheme is expected to generate benefits of some £32 billion (Present Value) and net revenue of almost £15 billion over sixty years. Over 85% of benefits come from traditional transport user benefits such as time savings, crowding relief and reliability improvements. Of these transport user benefits around £2.5 billion (slightly less than 10%) are due to reliability improvements (HS2 Demand Model Analysis: 157). It is estimated that HS2 generates an average benefit of £8 per trip (HS2, 2010: 174).[5]

5 From the Demand Model Analysis Report (p. 39) and the Model Development Report (p. 65), and given that 30% of traffic is for business, an average appraisal value of time of around 25 pence per minute can be inferred. This suggests that the average benefit is equivalent to a time saving of around 32 minutes.

Of these transport user benefits, more than £20 billion accrue to HS2 passengers (mainly due to improved journey times), up to £4 billion accrue to passengers on the classic line (due to reduced overcrowding and increased frequency) and £2 billion to road users (due to reduced congestion – for example, traffic on the southern section of the M1 is forecast to fall by around 2%). It should be noted that 61% of the transport user benefits accrue to business users (who only make up 30% of passengers), reflecting the higher values of time for this group (which can be up to seven times higher than the values for leisure travellers).

The other main source of benefits is related to the wider economy, with agglomeration benefits and the reduction in imperfect competition in the business sector, which when taken together are estimated to lead to benefits of £3.6 billion. There are also some small positive impacts related to accidents, air quality and noise, but these only amount to less than £100 million.

The extension to Manchester is forecast to have incremental transport user benefits of £8.1 billion, whilst the corresponding figure for the Leeds extension is £30.4 billion.

2.3 Interplay of Costs and Benefits

The findings of the HS2 studies add to the considerable evidence from ex ante appraisals of HSR in Britain (National Audit Office, 2001; Atkins, 2003; Atkins, 2008; Preston et al., 2009; Network Rail, 2009; Greengauge 21, 2009). Some of the key findings of these reports are summarised in Table 2.

Table 2: Reported Benefit Cost Ratios (BCRs) of recent HSR studies in Britain

	Source	Description	BCR
Full Networks	Atkins, 2003		2.0
	Atkins, 2008		2.0
	Network Rail, 2009	Option 1.4.1	1.8
	Greengauge 21, 2009		3.5
Individual Lines	Atkins, 2003[1]	London–West Midlands	2.1
	Atkins, 2008	East Coast	2.5
		West Coast	1.5
	Network Rail, 2009	London–Manchester	0.9
	Greengauge 21, 2009	HS NW Phase 1[2]	2.9
		HS NE Phase 1[3]	2.0

[1] As reported by de Rus and Nash (2009) [2] London–Manchester [3] London–Newcastle

Source: Preston (2009)

Table 3 summarises the results from the HS2 studies. It should be noted that the results for the HS2 route from London to Birmingham are not strictly comparable to those for the Manchester and Leeds extensions, as the former has been analysed to a much greater degree of detail than the latter. However, it can be see that the HS2 line with a BCR of 2.4 is consistent with previous estimates for individual lines, albeit towards the top end. It should be noted that the BCR of HS2 plus the Manchester extension is also around 2.4, slightly lower than the 2.9 estimated by Greengauge 21 (2009) for their HS NW Phase 1. A feature of the HS2 long-term strategic analysis is the very strong economic performance of an extension to Leeds, which is estimated as having a BCR of around 25. As a result, the provisional BCR of the Y-shaped network is around 4, which is higher than any of the previous estimates for a full network.

It should be noted that the net benefits in Table 3 refer to transport user benefits only. For HS2, the benefits from wider economic impacts are estimated to be worth £3.6 billion, increasing benefits by 12% and raising the BCR to 2.7.

Table 3: Appraisal results of HS2 studies (£ million, PV 2009 prices)

	HS2	Manchester Extension	Leeds Extension	Full Network
Net Benefits	28,700	8,100	30,300	67,100
Net Costs	11,900	3,700	1,200	16,800
BCR	2.4	2.2	25	4.0
NPV*	16,800	4,400	29,100	50,300

Note: figures for Manchester and Leeds extensions from HS2 Demand Model Analysis (pp. 131 & 133)

* Net Present Value

There appears to be a case for HSR investment but these results are predicated on continued growth in the demand for long-distance rail travel of around 3.3% per annum up to 2033 (after which the market is assumed to be saturated).[6] However, if this assumed growth reduces by around a half, then the BCR of HS2 falls to a value of around one (HS2, 2010: 187), illustrating the importance of this assumption. Similarly if background growth of 3.3% per annum only lasted up to 2022, then the BCR of HS2 would fall to a value of around one. Latest Office of Rail Regulation (ORR) data indicate that year-on-year growth in the long-distance rail market was 3.7% if comparing 2009/10 with 2008/9, and 9.3% if comparing Quarter 1 2010/11 with Quarter 1 2009/10. This suggests that this market has been relatively recession-proof.

6 This assumed growth period is longer than that of the DfT, whose standard practice is to cap demand from 2026 onwards.

This contrasts with the London and South East market, which reduced by 1.8% between 2008/9 and 2009/10, but with some signs of a recovery as demand has increased by 2.4% between Quarter 1 2009/10 and Quarter 1 2010/11.

An important issue in appraisal relates to the definition of the base case (do-minimum) and alternative (do-something-else) scenarios. This issue was investigated by Atkins, who examined alternative investments in classic rail and in road. Their findings are summarised in Table 4.

Table 4: Economic summary statistics for alternatives to HS2 (£ million, 2009 price)

	Rail package 2	Road package 2	Both
PVB	7,349	5,136	12,485
PVC	2,025	1,403	3,428
BCR	3.6	3.7	3.6
NPV	5,325	3,732	9,057

Source: Strategic Outline Case (pp. 58 & 63). PVB = Present Value of Benefits, PVC = Present Value of Costs. The rail package assumes rolling stock treated as a capital cost. If rolling stock is leased, the BCR reduces to 2.8. Note also that road package 2 corresponds to the mid-scale road package in the Command Paper (p. 51). The mid-scale rail package in the Command Paper is based on Atkins' rail package 2A, which involved the reinstatement of additional journey time (of around three minutes for London to Manchester via Wilmslow) to assist recovery from delays and incidents. The Command Paper also assumes rolling stock is leased, resulting in a BCR of 2.2.

Rail package 2 involves increases in frequencies on the WCML through a series of infrastructure improvements including a Stafford bypass, three new platforms at London Euston and Manchester Piccadilly, four-tracking (Attleborough–Brinklow, Beechwood Tunnel–Stechford), grade separation (between Cheddington and Leighton Buzzard and at Ardwick) and speed improvements in the Northampton area. Road package 2 involves the wide spread adoption of hard shoulder running (255 miles), plus some widening of the M42 and M25 (34 miles). The impacts of the road packages were modelled using the National Transport Model.

It can be seen from Table 4 that both the road and rail improvements have BCRs in excess of those for HS2 in Table 3. Given budget constraints, strict interpretation of these results would suggest that these schemes should be implemented before the HS2 project and that they should be included in the base case against which HS2 is appraised. However, both the road and rail packages are enhancements of existing infrastructure, and there may be concerns that disruption costs are underestimated. The Command Paper (p. 50) notes that the WCML upgrade took almost a decade to complete, and the costs involved payments of more than £500 million to train operating companies in compensation for the disruption caused.[7] There appears to be little governmental appetite for a further WCML upgrade.

The Command Paper also notes that the mid-scale rail upgrade package would only provide journey time improvements of around ten minutes (but see the footnote to Table 4 above) and a maximum potential rail capacity increase of around 50%. The mid-scale road improvement provides a potential road capacity increase of 20% and journey time improvements of around two to four minutes. By contrast, a new HSR line is estimated to increase rail capacity by more than 200% and reduce journey times by 35 minutes, and thus has advantages in terms of connectivity. From Table 3, it can be seen that the NPV of HS2 is £16.8 billion, whilst from Table 4 it can be seen that the combined NPV of rail package 2 and road package 2 (which are not strictly additive) is around £9.1 billion. This reduces to around £7.5 billion if rail package 2 is replaced by 2A (as in the Command Paper). These calculations are only indicative, but suggest that a mid-scale improvement of existing infrastructure could achieve around half the net economic benefits of HS2.

7 The provision in HS2 for such payments is £174m but this also includes possession/isolation costs.

3. The Financial Liability for the Public Purse

Gourvish (2010: 25) notes that the Japanese Tokaido and the French Sud-Est HSR schemes were not subsidised and appear to be successful in financial terms. For example, for the latter, the capital investment was fully amortised after twelve years.

Despite higher traffic levels than TGV Sud-Est, this does not appear to be the case for HS2. Table 3 indicates that government support of around £11.9 billion would be required, representing around two-thirds of the capital costs of £17.8 billion. For the full Y network, government support might increase to £16.8 billion out of total capital costs of £29 billion (58%). These findings are broadly in line with earlier studies (Network Rail, 2009; Greengauge 21, 2009).

One possible source of funding might come from the proceeds of the sale of HS1 (Speech by Environment Secretary Caroline Spelman, 1 September 2010), which has an estimated value of £2 billion.

4. Net Carbon Savings and Environmental Impacts

The HS2 studies confirm that HSR has a relatively modest impact on carbon. HS2 carbon dioxide (CO_2) mean emissions are estimated at 19.7 million tonnes, whilst the mean estimates are that there will be reductions of 0.9 million tonnes for classic rail, 0.2 million tonnes for car and 23.2 million tonnes for air. This gives a mean estimate of a reduction of 4.6 million tonnes but a range is given from a decrease of 25 million tonnes to an increase of 26.6 million. This should be compared with UK CO_2 emissions of 528 million tonnes in 2010, with 139 million tonnes from the transport sector. The variation in the estimates is largely related to assumptions concerning the likely response of airlines to HS2 (and the extent to which flights are withdrawn) and the carbon intensity of electricity generation (the central case is based on the assumption that this will not reduce below 0.385 kgCO_2 per kWh). It should be noted that these calculations assume a relatively high HS2 load factor of 60%.

The total embedded carbon cost of construction, based on the main bulk construction materials, has been estimated at 1.2 million tonnes CO_2. This suggests that construction only accounts for 6% of carbon costs. This is lower than the estimates of Booz Allen and Hamilton (2007), who suggest a figure of around 26%, and Network Rail (2009d, Figure 3.1) who estimate a figure of 18% (but based on a CO_2-equivalent estimate of greenhouse gases). ADEME et al. (2009) have undertaken detailed life cycle carbon cost calculations for the Rhine Rhone TGV that indicate that only 53% of carbon costs are associated with traction energy, but this reflects the low carbon intensity of French electricity.

Other environmental impacts are dealt with in less detail by the HS2 studies. Noise and vibration is an important issue. Some 350 dwellings would experience high noise levels and a much larger number would experience some increase. Some 9,400 houses located over tunnel sections could experience vibration impacts. Some of these impacts will be reduced by mitigation measures, with ancillary items including £215 million primarily for environmental mitigation – out of total costs of £16.5 billion (only 1.3% of costs). However, many other cost items will play a mitigation role. Other studies (such as Temple, 2007) suggest up to 10% of construction costs may be related to environmental mitigation measures.

Although the route has been chosen to minimise environmental impacts (and work on this is ongoing), there would be important impacts on landscape, townscape, biodiversity and water courses. The HS2 route goes through the Chilterns, an Area of Outstanding Natural Beauty, and measures are planned to mitigate the potential adverse impacts of this nationally protected landscape, with 37% of the route through this area in tunnels. There would be a need to for property demolition, particularly around Euston and Old Oak Common (affecting some 260 dwellings in total). An Exceptional Hardship Scheme has been established to fund compensation.

Although internationally designated habitats and sites are avoided by the route, there are some nationally protected sites that are affected, including Ufton Fields SSSI (Site of Special Scientific Interest) near Leamington Spa. There will be some impact on watercourses, with short diversion of the Rivers Colne, Cole, Tame and Rea, and some potential impact on aquifers in the Colne Valley, and between Brackley and Kenilworth. Some 17 km of the route will be built in high-risk flood areas. However, HS2 concluded that these non-monetised impacts are unlikely to be large enough to alter the conclusion that the scheme would deliver high value for money.

5. Planning Issues

Although HS2 is not being primarily advocated as a spatial planning tool, there will be some regeneration benefits, particularly in Birmingham Eastside (linked to Fazeley Street), Park Royal (linked to Old Oak Common) and the London Borough of Camden (linked to Euston). The capacity released on the WCML will assist in the development of the Milton Keynes South Midlands Growth Area where 225,000 new houses and 200,000 new jobs are planned over the next ten years.

Work by Graham and Melo (2010) shows that although economic theory does not preclude the existence of agglomeration benefits across inter-regional distances, the empirical evidence suggests that these may be very small, at least in relative terms. For example, a transport investment that directly affects 25% of long-distance rail trips by increasing speeds by 25% might increase the output of affected areas by 0.0006% (or £8.29 million per annum). Even if the transport investment affects 50% of long-distance rail trips and has a 50% increase in speeds, the increase in output is only 0.0022% (or £31.6 million per annum). Given the likely measurement errors with such calculations, it would seem sensible to underplay the wider economic impacts of HSR. The schemes will have also have some direct economic benefits. For example, over the seven years of construction, there would be some 10,000 jobs created as a result.

The planning of HS2 appears to be linked to Crossrail. Construction would not start until Crossrail was completed in 2017. This would allow both human and financial resources to switch to HS2. An average annual rate of expenditure during construction of £2 billion would be commensurate with Crossrail and other major projects such as the Olympic Park. The highest spend for HS2 in a single year is estimated to be £3.9 billion.

The Command Paper (pp. 138–140) gives some indicative timelines, assuming the use of a single Hybrid Bill, as used by Crossrail, HS1 and the Dartford Crossing. Following consultation, an initial mobilisation phase would involve two years, construction would be six and a half years, and testing and commissioning would take a further two years. With this timetable it should be possible for a London-to-Birmingham line to open by the end of 2026. However, following the election of a new government in May 2010, the initial consultation phase has already been extended by around six months.

HS2 Ltd recommends a largely public sector funding approach, with an arm's length sponsoring body similar to the Olympic Delivery Authority. A single infrastructure company is also recommended to control the operations and maintenance of HS2. It is believed that HS2 is too big to be a single public-private partnership PPP – the total value of all PPPs in the UK in 2008 was £6.5 billion, approximately a third of HS2's capital costs. Multiple PPPs are thought to be too complex; the Dutch Hogesnelheidslijn Zuid, which used such a model, commenced operations two years later than planned. There could be developer contributions towards station sites, whilst newbuild sites such as those in Birmingham could be delivered by 'Design, Build, Finance and Maintain' PPPs. Such PPPs could also be used to deliver the depots and rolling stock. A recent report by Ross et al. (2010) suggests that HSR should commence with a £6 billion scheme that runs from Birmingham Airport to Old Oak Common and which could be funded by a Special Purpose Vehicle, whilst the Mawhinney Review (paragraph 29) appears sympathetic to a PPP approach. The method of delivery is likely to be a political bone of contention. Another issue will be the durability of the Planning Act 2008 and the Infrastructure Planning Commission that it established.

6. Conclusions

The HS2 reports have provided some clarity with respect to the case for HSR in Britain. A detailed route has been determined between London and Birmingham and this has permitted more detailed service planning and hence a more detailed estimation of costs and benefits than has hitherto been the case. There has also been some important multi-modal analysis. Although there have been some changes since publication, not least the cancellation of the third runway at Heathrow, these still constitute the most authoritative set of reports on HSR in Britain to date.

The HS2 reports confirm the findings of earlier studies that there appears to be a case for HSR between London and Birmingham, and beyond to Leeds and Manchester, whilst the cases for a service to Heathrow and for an international link between HS1 and HS2 are much weaker. The extension to Leeds appears particularly justifiable.

The HS2 reports confirm that HSR is an expensive technology and appears to be particularly so in the UK, due to the country's built-up nature, the resultant high land costs, and its high environmental and other regulatory standards. The work that Infrastructure UK plans to undertake to understand and reduce the high costs of civil engineering projects will be important. There may be scope for cost engineering the HS2 proposals with respect to some features of the scheme design.

The HS2 reports also confirm that the main benefits of HSR are the generalised cost savings that accrue to existing rail passengers, to passengers that have been abstracted from air, and to road and generated passengers. These benefits will be mainly in the form of time savings, but may also be related to improved levels of comfort, principally due to reduced crowding. There will be benefits for users of classic lines as capacity is released, but these benefits are only likely to represent a maximum of 14% of transport user benefits.

Another important source of benefits is net revenue. Implementation of the 'user pays' principle would improve financial performance, but at the expense of social performance. How revenue yield techniques might work on HSR services, and the extent to which they would attract users from across the social spectrum, remain important issues. Other unresolved issues include the extent to which there will be price competition from rival conventional train services, the track access charging regime that will be applied, and the extent of competition from other modes, particularly air and coach.

The HS2 evidence confirms that HSR can grow the rail market by a factor of around two, although this growth will be less for shorter distance trips. The main sources of demand are from classic rail and from brand new trips, with abstraction from air and particularly from road more limited. However, the evidence also highlights the importance of the assumptions concerning continued growth of long-distance passenger rail traffic. If this growth is reduced below 3.3% per annum then the case for HSR could be delayed. If it stalls completely, the case for HSR will disappear.

The HS2 studies indicate that HSR can have some positive wider economic impacts, but that these are relatively modest and do not make much difference at the margins. The same can be said for the impacts of HSR on accidents and the environment.

The multimodal studies that have accompanied the HS2 proposals have shown that new classic rail can not give better social returns than HS2, but it also suggests that mid-scale improvements to existing road and rail infrastructure could give better returns than HS2. If this is really the case, these schemes should be implemented first and included in the base case against which HS2 is appraised.

The HS2 reports also highlight planning and funding issues that will need to be resolved, although here the political dimension may be more important than the economic. Particular issues will involve the scope for involving PPPs, and the replacement of the Infrastructure Planning Commission.

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89–91 Pall Mall
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SW1Y 5HS

Tel no: 020 7747 3445
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