Appendix 2

Review of the Economic Case for HS2

Prepared by Chris Castles and David Parish

Chris Castles

Chris Castles is a transport economist and former partner of PwC, where he led the firm's Transport Economics and Policy group for some 15 years. He began his career in transport planning working on cost/benefit analysis using transport network models. He joined Coopers & Lybrand where he carried out a wide range of international transport project appraisals for major port, rail, road and airport schemes. He has also undertaken various transport policy studies including studies on the structure of rail freight subsidy, competition within the rail industry, access arrangements and pricing for rail infrastructure, rail industry restructuring, airport slot allocation, pricing and competition studies.

He has been responsible for a number of reviews of major infrastructure projects including :

- a review for the Swiss Treasury of the Transalpine Rail Tunnels scheme,
- a review and monitoring of Eurotunnel for the banks to assist in the financial restructuring of the company,
- a review of the masterplan for the long term development of Rome airport,
- a mid-term review of a railway electrification project in New Zealand,
- advice to a bidder on business prospects and risks of the Channel Tunnel Rail Link concession,
- a review of forecasts prepared by another bidder for the Channel Tunnel Rail Link,
- a review of the implications of the proposed structure for the London Underground PPP,
- a review economic case for a new railway linking Pretoria and Johannesburg.

David Parish

David Parish is an economist and former partner of PwC who specialises in the evaluation of major infrastructure projects. He joined the Department for the Environment and Transport as an economist after university and worked on the development of the National Traffic Model, the forerunner of the methodology which the Department applies today in the project appraisal. His was responsible for the development of national traffic forecasts and their application in appraisal of highway projects. He was also involved in analysis of potential traffic transfers from road to rail, evaluation of the impact of higher energy prices on transport and a study of interactions between taxation and transport policy.

He joined Coopers & Lybrand as an economic consultant and participated extensively in a cost benefit analysis of the Channel Tunnel project. He also carried out a review of transport policy in Ireland and worked as a special adviser to the Irish government's parliamentary select committee on transport policy. Subsequently, he worked numerous international rail, road and port projects. Since retiring from PwC in 2002 he has carried out a range of independent consultancy projects. He acts from time to time as an adviser to the RAC Foundation and the Asian Development Bank. He recently advised the Campaign for Better Transport on financing issues associated with the Mersey Gateway project.

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Summary of Conclusions

1 We were commissioned by 51M to carry out a review of the Economic Case for the proposed high speed rail link between London and Birmingham, HS2. Our review covered only the transport user benefits which make up 80% of the quantified economic benefits in the appraisal published by the Government as part of its consultation on the project. Although we did not have access to the network models that were used to carry out the demand forecasts and to calculate the economic benefits, the information published was sufficient for us to understand the structure and method of analysis and the key assumptions that were used.

2 We found that the Economic Case for HS2 is deeply flawed. There are important weaknesses and errors in application of the methods and in the key assumptions made, including;

- An inappropriate 'do minimum' base case was used for comparison with the HS2 case. This led to an unrealistic base case scenario resulting in unnecessarily high levels of crowding, thus exaggerating the benefits of HS2;
- A different base case was used for the evaluation of alternative schemes to the HS2, thus preventing comparison of the results of the evaluation of alternatives with those of HS2 on a common basis. This had the effect of understating the relative benefits of the alternatives;
- Alternative strategies to HS2 that would involve much lower costs and risks were not considered thoroughly;
- Despite the above, the evaluation showed that the best alternative considered by DfT had a better economic return than HS2. Yet the Government appears to have ignored this result and has failed to explore an optimised alternative scheme that would involve much lower costs than HS2, would be much less risky and would provide the capacity needed at the time it is required;
- Out of date assumptions on the income elasticity of demand for forecasting rail demand were used, leading to the forecasts being substantially overstated;
- The forecasting period was extended well beyond the time frame for which the assumed relationships used in the demand forecasts could be considered stable;

- The benefits from overcrowding relief were overstated, as a result of the use of an unrealistic base case;
- There are doubts over the validity of the benefits from improved reliability with HS2;
- An incorrect value of working time for rail travellers was assumed, against known experience that people use their time of on trains productively;
- The large subsidy being proposed for HS2 has not been justified, nor has the full impact of increased subsidy on the existing network after the opening of HS2 been quantified or evaluated;
- Risk and uncertainty has not been taken properly into account throughout the analysis.
- The Economic Case is highly dependent on benefits which will not arise for over 30 to 40 years in the future thus heightening the risks and reducing the relevance of the project to current needs.

3 The economic case for the construction of a high speed rail link between London and the West Midlands is therefore flawed in a number of serious respects. Our review of the reports issued with the Government's consultation and other work on capacity and alternatives to HS2 submitted to the Transport Select Committee demonstrate that a much better and cheaper solution would be to provide additional capacity on the existing network to meet the increases in demand as they materialise. This is a far less risky and more cost effective solution. It does not involve committing some £18bn now to construct a new line that will not be available for use until 2025 on the strength of some very uncertain demand forecasts, in order to achieve benefits from faster rail journey times that have dubious economic value, most of which will not materialise for 30 or 40 years into the future.

4 The Government has launched its consultation on the basis of constructing the 'Y' network extending HS2 from Birmingham to Leeds and Manchester. It believes that the case for extending the HS2 beyond Birmingham will be stronger than the economic case for the London to Birmingham line alone. But the preliminary analysis it has produced to demonstrate this appears to be very crude and no details have been released so that it can be reviewed. The economic analysis that has been carried out for the London to Birmingham line, on which the indicative estimates for the Y network were based, is so weak that it seems very unlikely to be sufficiently improved when applied to the 'Y' network to justify committing well over £30bn.

5 Furthermore, there are serious doubts that the 'Y' network will be viable on purely operational grounds. It will require 18 trains per hour to be operated in the peak hours to meet the capacity requirements for the forecast traffic. This level of operating capacity has never been achieved on any high speed railway in the world; even ones that are totally self-contained. HS2 will not be self-contained and its capacity will be affected by imported

delays from the trains running into the HS2 system, along with other operational constraints.

6 As the debate has continued and more information has come available, the arguments against HS2 have multiplied. The claimed benefits to the wider economy of enabling faster travel in the narrow intercity travel market are largely illusory, or at best small. Expanding capacity across the existing rail network and targeted improvements to the road network would provide a far greater contribution to bridging the north-south divide and could be delivered much earlier. HS2 will not be environmentally beneficial. At best, it will be carbon neutral. It is expected to generate a great deal of additional traffic which in turn will generate more road trips at either end of the journey, thus increasing harm to the environment. This major new route will create noise, visual intrusion and serious severance effects across hundreds of miles of urban and rural areas.

7 Our analysis has shown the economic benefits to users are much less than claimed. We have shown that the traffic demand for HS2 is likely to be about 30% lower than forecast. The risks in the demand forecasts have been considerably increased by extending the forecasting period well beyond the time frame for which the assumptions used can be regarded as reliable. Furthermore, the crowding benefits that have been claimed only arise because an unrealistic base case for comparison has been used. If the scheme were compared with the optimised alternative developed by 51M, or with the RP2 alternative proposed by the DfT's own consultants, the crowding benefits would disappear. We have also found that the reliability benefits of HS2 have been overstated but it is difficult to estimate by how much. Finally, the benefits of faster rail journey times to business travellers are much less than has been assumed because they are based on the false assumption that time spent by business travellers is wasted and the assumed value of working times saved on trains is far too high.

8. The effect of these adjustments, and others arising from our review, on the results of the economic appraisal of HS2 are shown in Table 1. We would emphasise that these adjustments are not sensitivity tests but are our assessment of more realistic central assumptions for the evaluation. They show that there is no economic case for building HS2.

9 The BCR[1] from the Government's own transport user cost/benefits analysis is 1.6. The adjusted BCRs are approximations to the outcome of a full reappraisal but they give a

[1] [1] Following the practice of the Government we have used the term BCR, or benefit cost ratio in this report to present the results of the evaluation. But the term NBR, or net benefit ratio, is the more accurate terminology (see paragraphs 7.23 and 7.24). The BCR/NBR represents a measure of value for money for use of government subsidy. The scale of the BCR, or NBR, reported for HS2 should be judged in the light of an NBR of infinity for any non-subsidised, commercial project and also in comparison with the figures achieved for other projects in the transport sector which often achieve a BCR or NBR of more than 5. The BCR reported for HS2 is less than 2 which, for a revenue earning project to be operated on commercial lines, is low.

reasonable estimate of the impact of these proposed revisions. They do not include any adjustment to shorten the forecast period to within a reliable range, or for a reduction in the reliability benefits, although we believe these adjustments should be made. Neither do they allow for an increased level of risk over time by using a higher discount rate. A combination of any two of the reasonable adjustments shown in the table eliminates the case for HS2 and the combination of all of them has a massive effect.

10. We therefore believe that there is a need for an independent reappraisal of the HS2 scheme in the context of a wider policy and strategic framework for the transport network as a whole. This appraisal should correct the errors in the analysis, use more realistic assumptions and take proper account of risk and uncertainty and make a direct comparison of HS2 with the best alternative scheme to determine the optimal strategy for developing the WCML route.

Table 1 BCR After Adjustments to the Appraisal Assumptions

Adjustment to benefits	**Adjusted BCR from 1.6**
1 Reduce demand forecasts by 29%	1.1
2 Revised base case (no crowding)	1.4
3 Value working time at commuter rate	1.2
4 Operating life 40 years	1.3
Adjustment 2+3	0.9
Adjustment 1+ 2 +3	0.7
Adjustment 1+2+3+4	0.5

1 Making the Case for High Speed Rail in Britain

This Review

1.1 We were commissioned by 51M to carry out a review of the Economic Case for HS2 that has been presented as part of the Government's consultation on High Speed Rail. Our work has focussed on the analysis of the proposed high speed rail link between London and the West Midlands, since a full economic appraisal of this line has been carried out by HS2 Ltd for this link. The Government has launched a consultation on a broader 'Y' network, extending the line to Leeds and Manchester. However, an economic appraisal for this network has not yet been published and only some broad estimates have been prepared of the scale of the benefits and costs involved based on the London to Birmingham appraisal. A full economic appraisal of the 'Y' network is expected to be published towards the end of this year.

1.2 Our review of the benefits of the London to West Midlands link has been confined to the estimates of transport user benefits and the overall evaluation framework. Transport user benefits make up 80% of total benefits. We have not reviewed the capital and operating cost estimates that have been used in the appraisal of HS2. Neither have we reviewed the environmental impacts which have been the subject of other reviews. The non user, or wider economic, benefits that have been claimed for the project, have been the subject of a separate review for 51M by Professor Tomaney. We have drawn on other work commissioned by 51M to address the technical and operational aspects as they affect the operational capacity of HS2 and alternative ways in which rail capacity on or in the vicinity of the West Coast Mainline (WCML) route might be increased.

1.3 To set the context for our review, we start by summarising the way the policy for high speed rail in Britain has developed over time. Although this review is primarily a technical review of the economic case for HS2, we have commented on important policy issues in our report. The scale of the investment envisaged and its wider implications for the railway network makes it essential to consider these policy issues as part of any review of the evaluation of HS2. We start by considering how the HS2 policy came to be adopted by the Government.

Early Proposals for High Speed Rail Links in Britain

1.4 The first proposal to construct a new dedicated high speed railway linking London with the North of Britain was made by Virgin Trains to the Strategic Rail Authority (SRA) in 2000. At that time, the SRA was encouraging private sector train operators to make bold and imaginative proposals for the development of the railways. The SRA picked up the idea for high speed rail and carried out some preliminary work during 2000. In 2001, Virgin put forward its proposal for high speed rail on the East Coast Mainline in its bid to win the franchise, but this was rejected in favour of the bid from the incumbent operator GNER.

1. 5 Prior to these proposals, the idea of a high speed rail network for domestic rail services in Britain had not been considered seriously. Until rail privatisation, passenger demand on the railways had remained broadly level for the past 30 years. A case for making very large investments to increase railway capacity by building new lines for high speed rail services over the relatively short intercity routes in Britain did not exist. An exception was seen in the international Channel Tunnel Rail Link between London and the high speed rail network in France. The case for HS1, as it came to be known later, was built on the strength of demand forecasts developed using methods similar to those used for the appraisal of HS2. The forecasts for HS1 later proved to be wildly optimistic by a factor of about 3.

1.6 The prospects for growth in rail travel changed after rail privatisation which brought new investment, particularly in rolling stock, into the industry, together with new commercial management, improvements in service quality and marketing innovations. These factors, together with increases in personal incomes and deterioration in the competitive position of road transport, led to sustained growth in rail passenger demand after 1996, particularly for long distance journeys. The number of journeys on long distance rail services nearly doubled between 1995 and 2008. Growth in rail demand was encouraged by incentives within the franchise contracts for train operators to fill the train capacity available by price differentiation using yield management techniques to encourage demand in the off peak periods.

1.7 In the same period from 1995, growth in **total** long distance travel by **all modes** of transport grew slowly until 2003 and has since remained broadly constant. Statistical analysis has been used to try to explain the growth in rail demand against the pattern of the growth in the total market. However, indicators of rail service quality and competitiveness are not readily available to be included in this analysis. Therefore it is difficult to distinguish and separate the various influences on rail demand, including rising incomes, changes in the structure of demand and changes in the relative competitiveness and attractiveness of rail travel. The primary driver of demand growth that is used in forecasting demand for rail travel are income and relative prices, using estimates of income elasticity of demand[2] and

[2] The ratio of the growth in demand to the growth in incomes causing demand growth.

the price elasticity of demand. The estimates used for forecasting demand have been revised several times in response to changing evidence. However, income and price changes have not been the only factors causing the rapid growth in rail demand since privatisation, and uncertainty over the long term stability of these relationships over time adds considerably to the risks in the forecasts.

1.8 In August 2001, the SRA appointed the consultants Atkins to carry out a study of the case for building high speed rail links in Britain. The study was completed in January 2003 and made a case in favour of a new dedicated high speed rail network, starting with a link from London to the West Midlands. Atkins forecast that growth in demand for rail travel would continue over the long term, particularly on the long distance strategic routes, based on the new relationships between rail travel and future growth in incomes. They concluded that limitations on the ability to increase capacity on the existing rail and road networks would make the construction of a new high speed rail network a better option. The average rate of growth of rail traffic forecast by Atkins on the strategic west coast mainline route was 3.6% per annum over 30 years, leading to an expected tripling of demand on the route and a rise in the average train load factor from 36% to 81% by 2031, given current rail and road capacity levels.

1.9 After completion of the study, proponents of the scheme continued to press the case for building a high speed railway. Greengauge 21 was founded in 2006 by Jim Steer, the former Director of Strategy at the Strategic Rail Authority and Julie Mills, who had led the Atkins study. It is a non-profit public interest company which promotes the case for high speed rail. It has published various forecasting and evaluation studies to make the case for high speed rail.

1.10 In the same year, 2006, the Eddington Transport Study was published. This study was commissioned by the Treasury and the Department for Transport (DfT) to investigate the long term relationship between transport and productivity in the UK. This study proposed a different set of priorities for the development of the UK's transport sector. It warned against concentrating scarce investment resources on large scale schemes serving particular parts of the country. It demonstrated that much better economic returns and more beneficial impacts on the wider economy could be achieved by investment in a range of smaller schemes balanced across the transport sector. By this means, increases in capacity could be achieved sooner, in line with rising demand and at lower risk than providing large lumpy additions to capacity based on uncertain growth forecasts.

Government Support for the High Speed Rail Project

1.11 Support for high speed rail received a major boost about two years later when Lord Adonis became Minister of State, and later Secretary of State, for Transport. Lord Adonis' enthusiasm for high speed rail was apparent, seemingly driven by examples in other

countries like Japan and France that had established successful high speed rail networks, albeit in very different economic geographies to that in Britain and with the benefit of large initial capital subsidies. He set up HS2 Limited as a government owned company in January 2009 with a remit to consider the case for building a high speed rail network in Britain.

1.12 The institutional rationale for establishing HS2 Ltd as a government owned company at such an early stage in the consideration of the case for high speed rail is not clear. HS2 Ltd insists that it is not a project promoter aiming to make the case for HS2. Rather it describes its task as evaluating the merits of the case for HS2. However, its ability to carry out an objective and balanced evaluation is undermined by its focus on HS2 as the only solution it has considered to meet the capacity requirements on the intercity rail network. The consideration of alternative solutions was carried out separately and later by the Department for Transport (DfT) and has had lower priority, less attention and fewer resources. The fact that HS2 Ltd is examining only one solution has been a crucial weakness in the way the economic case for HS2 has been evaluated by government. The case for building HS2 is clearly a major policy question that needs to be considered in the context of all the reasonable options for addressing the capacity issues at stake.

1.13 HS2 Ltd appointed Atkins to carry out its analytical work, based on the DfT's standard NATA methodology and framework for transport project evaluations. HS2 Ltd published its first report on the business case for the London to the West Midlands link of the HS2 in December 2009. The report refers to work carried out by both Network Rail and Greengauge 21 on high speed rail and to having 'kept in close touch' with these organisations during the evaluation. Since the same parties were involved in earlier work, it was unlikely that HS2 Ltd's work would bring a fresh perspective to the evaluation of the project. HS2 Ltd issued its first business case for the London to Birmingham link in December 2009. It broadly agreed with the earlier report that rail passenger demand growth would result in average load factors exceeding 80% on the WCML by 2033, based on a very similar rate of growth in rail traffic that had been forecast seven years earlier. HS2 Ltd's cost/benefit appraisal resulted in a NATA net benefit/cost ratio of 2.4, including only transport user benefits and 2.7 when wider economic benefits were also included.

1.14 The Conservative and Liberal Democratic Parties declared their support for high speed rail in the run up to the general election, mirroring Labour's commitment to the project. The Coalition Government then made an early commitment to HS2 in the coalition agreement. The political appeal of HS2 is evident. It appears to be an environmentally friendly, bold strategic investment in a high technology solution to the nation's long term transport needs; and one that has been adopted by a number of other leading nations. By reducing travel time by rail between London and city centres in the north of England it might somehow bridge the 'North-South divide'. However, none of these propositions had been properly tested at the time the political commitments were made to the project.

High Speed Rail Consultation

1.15 Now that the work within government on the evaluation has progressed there are growing doubts that the evidence produced by the studies carried out by the Government supports the claims that have been made for the HS2. The economic returns shown by the latest evaluation prepared by HS2 Ltd are relatively low. It will be broadly carbon neutral and it will impose significant environmental costs on the landscape from its visual, noise impacts and severance effects. It will divert very little traffic from road and it will not reduce the number of flights out of London. The wider economic and strategic benefits that have been claimed for the project have not been demonstrated by analysis. Nor will the proposed links to Heathrow, or to HS1, be viable or practical. The Labour party is now re-evaluating its commitment in the light of the new circumstances and outlook for the economy.

1.16 The Government launched a consultation on HS2 and issued a large number of documents in support, including a revised and updated 'Economic Case for HS2' prepared by HS2 Ltd. This new appraisal includes an initial indicative evaluation of a 'Y' network, which would extend the network to Leeds and Manchester from Birmingham, bringing the costs of the proposed HS2 project to some £30 billion in present value terms, and much higher in nominal terms. This indicative appraisal of the 'Y' network is, however, too broad brush to provide a basis for decision taking and the Government intend to issue a full appraisal of the 'Y' by the end of the year. We have therefore concentrated on the analysis of the economic case for the London to the West Midlands link for our review, on which the estimates for the Y network have been based.

Revisions to the Economic Case for HS2

1.17 Since the initial evaluation carried out by HS2 Ltd in December 2009 and its update in March 2010, there have been a number of significant changes in the economic prospects and the assumptions underpinning the evaluation of HS2 which are summarised below and in Table 1.1:

- Prospects for economic growth are lower and the future has become less certain as the world economy continues to struggle with issues of insecure sovereign and private debt and low consumer confidence;
- The demand forecasts have been adjusted to recognise the Government's policy of increasing rail fares by RPI+3% for the next three years. Thereafter they assume a continuation of the policy of increasing rail fares by RPI+1%;
- Errors in Atkin's modelling work, which had resulted in the earlier demand forecasts being inflated, have been corrected and other adjustments made to the modelling;

- Significant reductions in the cost estimates were made. Some of these were related to the reductions in the rate of growth in demand so the timing of rolling stock purchases changed accordingly;
- Various changes were made in the appraisal accounting framework.

Table 1.1 Effect on the Net Value of the Benefits of HS2 from Changes in the Evaluations March 2010 v February 2011

Net Effect of changes in costs	+ £2,397m
Net Effect of changes in demand forecasts	-£4,633m
Net Effect of changes in modelling	- £4,515m
Net Effect changes in the appraisal methods	+£264m
Total Impact on Present Value of Net Benefits	**-£6,487m**

1.18 The scale of the changes on the results of the appraisal is significant, reducing the benefit of HS2 by nearly a third of the current estimate of the benefits. It raises questions about the robustness of the analysis that has been carried out. The new demand forecasts were reduced by about 30% compared to the earlier figures. The main rationale for a new high speed rail line had been that high forecasts of demand required significant increases in capacity that could not be achieved economically on the existing network. Faced with these reductions in the forecasts of demand, HS2 Ltd decided to extend the period of the forecast by a further 10 years to 2043 before applying an assumed 'cap' on demand. The timing of the 'cap' had already been extended 7 years beyond that recommended in the DfT's NATA guidelines, to 2033 in the earlier appraisals. This further extension of the forecasting period for the most recent evaluation is well outside the secure time frame for the NATA demand forecasting methodology and was a major departure from the DfT's own guidance.

1.19 The evaluation period used for evaluating the net benefits of HS2 is very long, extending 60 years beyond the planned opening date for the project of 2025. HS2 Ltd's latest evaluation shows the NATA cost/benefit ratio at 1.6, down substantially on 2.4 found in the 2009 evaluation. However, this analysis is heavily dependent on the inclusion of benefits in the period between 40 to 80 years into the future which account for over half the benefits, which greatly increases the risks and uncertainties of the economic case of the project. The evaluation of the project has not treated the issue of risk in a systematic fashion. There is no estimation of the probability range for key variables and the sensitivity tests that have been carried out are inadequate to reveal the impact of key uncertainties.

Thus the evaluation of HS2 has not learned the lessons from international experience of similar large scale infrastructure projects which failed to evaluate the impact of risk on investment decisions.

1.20 Work carried out by Atkins for the Department for Transport on alternatives to HS2 has demonstrated that the capacity of the existing network can be increased to meet growing demand for the foreseeable future. This work has been reviewed in other work commissioned by 51M referred to in paragraph 1.2 which has demonstrated that the Atkins' proposals are not the most optimal way of increasing capacity on the existing network. Much more can be achieved, at lower cost, by lengthening and reconfiguring trains and making full use of the capacity available, as well as new capacity in the pipeline of committed improvements. This work has demonstrated that the capacity for standard class seating on the West Coast Mainline (WCML) can be more than tripled from the 2008 base that was used for HS2 Ltd's analysis at relatively low cost. Thus there is a serious question over the need for HS2.

1.21 Apart from capacity requirements, the second key justification for building a high speed rail network is that it would provide faster journey times and hence save travel time for users. DfT have used a conventional approach to estimating the economic value of time savings which relies on the assumption that time spent travelling in working time is unproductive. This is a reasonable assumption for car travel, for which these estimates were first developed. But DfT has now acknowledged that it is not a sound assumption for rail travel in working time for business users, since it is evident that they do work on trains. DfT have recognised that the estimation of these benefits is erroneous and that to estimate the true value of time savings for business travellers requires more research and analysis.

1.22 There are therefore good reasons to carry out a review of the work that has been done to evaluate this large and costly project. With expenditure in prospect of £30 billion or more, including £750 million on preparatory work to be spent in the next 5 years during a period of unusual austerity, it is right to examine the economic case rigorously.

2 Economic Evaluation of HS2 London to Birmingham

2.1 The primary reason for the Government adopting the policy of building HS2 is to meet the rail capacity needs for future growth in rail traffic on the West Coast Mainline corridor (WCML) corridor. In addition, HS2 will provide the benefits of much faster train journeys between London and Birmingham and, later, to points further north. In order to evaluate whether building HS2 is a sound economic decision, the benefits expected to transport users from providing rail capacity in this form, and the faster journey times that will result, must be analysed and quantified in monetary terms and compared with the additional costs that will be incurred in constructing and operating HS2. This analysis must include the impact on users of other parts of the rail network and the net cost and revenue changes on the rest of the network. In addition, there will be a number of wider impacts of a large project such is this on the regional and national economy and on the environment. Our review is confined to the transport user benefits which make up about 80% of the total quantified benefits in the Government's appraisal.

Key Inputs to the Economic Evaluation

2.2 A set of network transport models was developed by HS2 Ltd to forecast demand on rail and other modes and to analyse the likely amount of traffic that would use HS2. These models were also used to quantify transport user benefits. The information provided for the consultation does not enable the detailed assumptions and operations of these models to be reviewed. Nor were the disaggregated outputs available in a suitable form to examine the plausibility of the analysis at the detailed level.

2.3 The models have used standard network modelling techniques and the assumptions in them have been mainly drawn from the DfT's webTAG modules and Passenger Demand Forecasting Handbook (PDFH), developed by the Association of Train Operating Companies. WebTAG is publically available on DfT's website but PDFH is commercially confidential. PDFH includes a great deal of research on the structure and trends in the railway market and the factors influencing the development of the market. The fact that this document is not publicly available when it contains some of the key material to evaluate the methods

and assumptions used to justify the expenditure of large amounts of public money on railway investment appears anomalous. We understand that a Freedom of Information request has been submitted to release this document to the public and we would strongly support this request in the interests of transparency and sound analysis.

2.4 The network models used for this evaluation are complex and they have the characteristics of a 'black box' in that any errors within them are hard to detect, even by those using them. Inevitably there will have been elements of judgement deployed at the detailed level in developing and using these models. The significance of these judgements is not entirely transparent to the outside reviewer. Without access to the models and the detailed outputs it is not possible for an independent review such as this to check the validity of all the results. To illustrate the point, an error was found by HS2 Ltd after a model audit in the Station Access Model due to the incorrect weighting of the access times to city centre stations. This had a substantial effect on the results of the forecasts published in 2010. Errors such as this are common in the course of this kind of modelling and can lead to significant changes in the results.

2.5 Nevertheless, most of the key assumptions and the framework and methodology of the analysis are clear from the published documents. We were also able to discuss elements of the appraisal with DfT and HS2 Ltd. We submitted a request for information but we were later referred back to public documents which did not contain all the information requested.

Components of the Economic Evaluation

2.6 The economic evaluation of HS2 requires a number of key elements:

- The development of a suitable base case describing the scenario without HS2, to be compared with the expected outcomes if HS2 is built;
- Forecasts of demand for both the base case and the HS2 case, including the changes in demand across the broader transport networks;
- Identification of the individual impacts of HS2 and quantification of the benefits and costs and revenue effects arising in the base year and at the end of the forecast period;
- Estimation of the time stream of capital and operating costs of the railway under each of the two cases over the project life;
- Deciding the cost benefit accounting framework to identify costs and benefits to the relevant parties (Government, transport users, private providers and the wider society) and making appropriate adjustments, for instance in the treatment of indirect taxes;
- Discounting the time stream of costs, benefits and revenue effects over the project life to present values using appropriate discount rates.

- Sensitivity tests on key assumptions to examine the vulnerability of the case to risk and uncertainty.

2.8 The issues relating to the base case for comparison of HS2 are discussed in Section 3, which also considers the issue of the justification for the large subsidy envisaged for constructing HS2. The forecasts of demand are discussed in Section 4. Transport user benefits are covered in Section 5 focussing on the value of time. Section 6 discusses the evaluation of alternatives to HS2. Section 7 covers a range of other issues including the treatment of risk and uncertainty, sensitivity tests, the impact on the rest of the rail network, the project evaluation period and the discounting of costs and benefits as well as the accounting framework and presentation of the results. Section 8 presents our conclusions.

2.9 As noted earlier, we have not addressed any of the issues relating to the estimation of capital and operating costs. However, we note that recommended guidance on the treatment of optimism bias in the estimation of costs has been adopted. Neither have we examined the impacts on non-users, including the estimates that have been made of wider economic benefits and the effects on the environment.

3 Base Case for Comparison with HS2

3.1 To determine the benefits and costs of HS2, the outcomes from building the HS2 must be compared with what would happen if it were not built. Thus a critical part of any economic evaluation is to decide what the base case without the project would be. If an unrealistic base case is chosen it can invalidate the economic appraisal. There are two common ways that an unrealistic base case might be developed in an appraisal of HS2, by:

- assuming that excessively high costs would need to be incurred on the existing infrastructure if the HS2 were not built, thus understating the effective net additional costs of a decision to build the HS2, or
- assuming that too little will be done to expand capacity on the existing network if HS2 were not built, with the result that the network would become so congested that costs to the users become very high. The apparent benefits of HS2 in relieving this congestion will then be higher than if a more realistic base case were chosen.

3.2 The evaluation that has been carried out has mainly fallen into the second of these traps. DfT has carried out a separate evaluation of alternatives to HS2. In the evaluation of the alternatives for the London to Birmingham route, they have compared these alternatives to a different base case to that used for the HS2 evaluation, thus invalidating the comparison of HS2 with the alternatives. We also understand that the same allowance for optimism bias has been used in the cost estimates for the alternatives as for HS2. Since there is very much less uncertainty over the costs of implementing the investment to increase capacity on the existing line than for building a new line with a technology new to Britain, this clearly falls into the first trap. In our view a direct comparison should be made between the option of building HS2 with the best alternative. This would give the clearest analysis of the relative merits of two real options for developing the route.

Government Project Appraisal Guidelines

3.3 The economic case for HS2 which has been developed by HS2 Ltd and the Department for Transport follows guidance prepared by the Treasury in the Green Book on Appraisal and Evaluation in Central Government and by the Department for Transport in its New Approach to Appraisal (NATA). NATA implements the Green Book for transport schemes. The approach is explained in webTAG, a set of web pages which is publicly available on the DfT's web site. The DfT has recently announced that NATA is to be dropped. However, we understand that the methodology used by HS2 Ltd is consistent with the latest guidance and

that the detailed methodologies and assumptions set out in webTAG will be retained and used for economic evaluation.

3.4 In general, we consider that the appraisal of HS2 has followed this guidance properly. However, in four key areas we consider that there are shortcomings where the standards of the Green Book and NATA have not been met. These are:-

- The timing of the arbitrary cap placed on the demand forecasts, (see Section 4),
- The use of a "do minimum" case as a base case in the appraisal of HS2,
- The failure to use the same base case in appraising HS2 and the alternatives to HS2 for the London to West Midlands link,
- The failure to look at a sufficiently wide range of options in the appraisal.

The Do-Minimum Case

3.5 Both the Green Book and NATA lay great stress on the "do minimum" case. The Green Book insists that it should always be considered and "*carried forward in the shortlist, to act as a check against more interventionist action.*" WebTAG amplifies this guidance for transport schemes stating that "*The 'do-nothing' scenario generally makes little sense as the datum against which the options are compared because it is very rare for there to be no changes at all to the present system in the pipeline. The most usual basis for the assessment of options is the 'do minimum' in which only committed changes are added to the existing system. These 'committed' changes, which may apply to public transport and parking as well as roads and traffic management, should be limited to those schemes to which a genuine commitment has been made from which it would be difficult to withdraw. This includes projects for which tenders have been invited or let and projects to which Ministers have given a firm commitment (for example, road schemes in the Targeted Programme of Improvements).*"

3.6 For the vast majority of small and medium scale schemes which are appraised using the Green Book and webTAG the "do minimum" will provide a suitable base case against which to evaluate proposed actions. However, for a major scheme, such as HS2, which will not be available for some 15 years and will have a very long project life thereafter, the "do minimum" is no more realistic as a base case than the "do nothing." It is inconceivable that any government, faced with further rapid increases in demand on the route from London to Birmingham, would fail to provide additional seating capacity and permit very high levels of overcrowding to develop for many decades into the future.

3.7 This possibility is recognised in both the Green Book and webTAG, albeit in slightly different ways. The Green Book states that "*The term 'Base Case' is sometimes used to refer to the 'do minimum' option, but it is not used in this way in the Green Book.*" WebTAG says that "*The do-minimum should also include minor changes which can be expected to be*

carried out as conditions deteriorate - signalisation of busy priority junctions, for example." In both cases the authors clearly recognise that the do-minimum should not be used as a reference case for evaluations where it is clearly unrealistic. Neither the Green Book or webTAG fully address all the issues concerning the appraisal of mega projects such as HS2.

3.8 The do minimum case that has been used to compare the HS2 scheme has assumed that only the committed project to lengthen 31 of the 52 Pendolino trains operating on the WCML from 9 to 11 cars would be carried out and this would remain the case for the whole of the 60 year project life to 2092. We assume that the evaluation included allowance for the costs of replacing the units when needed over the project life, or that annual leasing costs for rolling stock have been used throughout.

3.9 With the restricted capacity implied by this do minimum case, the amount of crowding that will be forecast before HS2 opens and in subsequent years grows continuously to very high levels. This, in turn, results in high apparent levels of benefit being attributed to HS2 by relieving this artificial level of congestion. What should have been done was to allow for further capacity increments on existing routes in the base case in order to prevent high and unrealistic levels of overcrowding being forecast during the evaluation period.

3.10 It is certain that the benefits of HS2 have been exaggerated as a result of this error. An arbitrary cap has been applied to the demand forecasts at the point that rail traffic is forecast to double. In the initial evaluation, released by HS2 Ltd at the beginning of 2010, traffic was forecast to double by 2033. In the latest forecasts this doubling is not expected to occur until 2043. This arbitrary cap on base demand growth has ensured that the capacity of HS2 is forecast to be fully utilised at around the time base traffic has doubled and the traffic with HS2, including additional diverted and newly generated traffic, will have tripled. It also allows a limit to be placed on the effect of excessive overcrowding in the do-minimum case to prevent the modelling of the overcrowding function becoming unstable, as would be the case at very high train load factors. The adoption of a cap on demand at this critical point potentially enables the results of the evaluation to be 'backward engineered' by setting the cap on the forecasts to match the capacity provision available on HS2 and to limit the effect of excessive crowding in the modelling.

3.11 Combining this distortion in reality with the very long operating life of 60 years assumed for HS2, together with the low discount rate now adopted in Treasury guidance[3], has created a high degree of arbitrariness in the results of the evaluation.

The Two Base Cases

[3] 3.5% for the first 30 years and 3.0% for the remainder of the appraisal period, with a further drop to 2.5% 75 years from the current year ie 45 years into the appraisal period of HS2.

3.12 In any cost benefit study it is vital to compare all alternatives against the same base case. The Green Book states that "*Each option is then appraised by establishing a Base Case."* The report produced by HS2 Limited does not examine any alternatives but a separate report by Atkins for DfT has examined a number of alternatives involving a series of improvements to the West Coast Main Line (See Section 6). In carrying out this work Atkins used a different, and in our opinion much more realistic, base case which envisaged the lengthening of the **whole fleet** of Pendolino units and some other minor improvements in order to address overcrowding. DfT informed us that this was due to unspecified difficulties in modelling the original base case that was used for the HS2 evaluation.

3.13 As a result of this difference in the two base cases, the results of the Atkins study of alternatives and the HS2 appraisal for the West Midlands link are not comparable. The enhancement of the base case in the analysis of alternatives will probably have resulted in depressing the benefit cost ratio of the alternatives. This is because the lengthening of the additional trains in the fleet assumed in the enhanced base case would reduce the difference in train load factors, and hence the crowding relief, with the alternatives case. Nevertheless, the most attractive alternative, RP2, achieved a BCR of 1.9 for transport user benefits which exceeds the BCR of 1.6 for HS2. Given this superior result for the alternative to HS2, it is unclear why the Government has not put more emphasis on identifying and evaluating the best alternative option to HS2 which would be both very much cheaper and could be implemented sooner, with less risk and in line with demand growth as it materialises.

3.14 According to other work commissioned by 51M there are also other distortions in the analysis. Some infrastructure costs in the Stafford area were included in the base case for the evaluation of the alternatives but were excluded from the do minimum for the HS2 evaluation. This has created another inconsistency in relative favour of HS2 over the alternatives. Furthermore, some of the costs that have been included in the preferred alternative scheme, RP2, are not necessary, or not attributable, to the relevant WCML services.

3.15 The DfT also released another Atkins report for the consultation entitled 'Strategic Alternatives to the Proposed 'Y' Network', in anticipation of the completion of the evaluation of the HS2 'Y' network. It appears that the base case for this analysis will be consistent with the evaluation of the Y network when it is released.

Failure to Look at Other Options and to Justify Subsidy Requirements

3.16 Both the HS2 study and the Atkins review of alternatives look at HS2 on a 'predict and provide' basis and lay exclusive emphasis on the benefit cost ratio of the investments which they are reviewing. However, this is against the advice given in webTAG which states that "*the BCR is of limited value where projects (road user charging, for example) result in*

significant revenues accruing to the Broad Transport Budget (for national or local government) such that the Present Value of Costs (PVC) becomes negative." For projects with significant revenue the appraisal should never separate the issue of investment from the issue of pricing.

3.17 However, the evaluation of HS2 does not make any attempt to examine the proposed level of fares on the existing lines, prior to considering the need for investment. Infrastructure industries, like railways, tend to require large lumpy investments to expand capacity when certain operating limits are reached. The normal economic pricing policy in such industries is to adopt long run marginal cost pricing principles[4]. There has been no public policy discussion of the role of such pricing principles in the context of the HS2 investment. A pricing policy based on these principles would optimise the timing for investment in capacity and would ensure that all efficient incremental investment options were carried out before considering providing the huge increment in capacity being considered with HS2. This pricing policy ensures that the user pay principal operates and investment is only carried out when users are willing to pay for it over the long run.

3.18 Any subsidy that may be provided needs to be justified on the basis of the economic benefits generated, over and above those that can be achieved without providing the subsidy. There is no evidence that this analysis has been carried out, or that the policy issues relating to subsidy have been considered. Furthermore, although the option of premium pricing for the much faster HS2 services was discussed it was not carried forward into the analysis as a potential means of reducing the level of subsidy required for HS2.

3.19 Without justification it has been assumed that a very large capital subsidy should be provided to build HS2. We understand that HS2 is expected to operate without subsidy at the operating level. However this may depend on how competition operates with services on the existing network. The Government may be forced to require the regulator to restrict competition to avoid diversion of traffic back onto the existing line. Government policy in the past, prior to privatisation, has been to provide no subsidy for intercity rail services since this sector is competitive with road and other modes and can operate profitably using the normal classic services. Therefore, there needs to be a clear justification as to why the Government should commit such a large subsidy in order to provide fast rail services to the small part of the transport market represented by city centre to city centre travel. Since the average income of intercity rail travellers is considerably higher than that of the average

[4] Long run marginal cost prices are set at the level of the forward looking total costs of providing the additional capacity needed to meet forecast growth over the next investment increment. This may imply a significant rise in prices towards the time that capacity limits are being reached when a major increment of investment is needed. The impact of higher prices on demand may, in turn, dampen demand and delay or obviate the need for investment, thus improving economic efficiency. On the other hand, if smaller increments of capacity can be provided efficiently it will allow lower prices and a smoother and more efficient profile of investment.

taxpayer and a high proportion are business travellers, this is an important policy questions that needs to be addressed.

3.20 The Green Book takes a firm view on pricing issues stating that "*Government policy is generally to set charges for goods and services sold commercially at market prices, and normally to recover full costs for monopoly services, (including the cost of capital as defined in the Treasury Fees and Charges Guide).*" This is not the approach that has been taken to the HS2 review and any appraisal of HS2 should explain why the Green Book guidance has not been followed.

3.21 The appraisals by HS2 Ltd and by Atkins disregard the possibility of managing demand more effectively in a scenario without HS2, so that some traffic is moved from the peak to off peak. This policy has been recommended to the DfT by the Public Accounts Committee which said that "*The current round of planning relied heavily on buying extra carriages and on extending platforms to accommodate longer trains but this approach cannot go on indefinitely. Clearly, alternatives must be found to meet the capacity challenge in the future. The Department should vigorously pursue and promote smart ticketing and other demand management techniques to reduce the inefficiencies of overcrowding in peak hours and underused rolling stock at other times.*" The recently published McNulty review of value for money in the railways also placed great emphasis on the use of pricing and yield management to achieve better use of railway assets and to reduce costs. The imperative of reducing carbon emissions would also suggest that DfT should focus on improving capacity utilisation on trains. However, no allowance has been made for policies of this sort in appraising HS2. Instead the sole focus is on investment.

3.22 The Green Book stresses the importance of looking at a wide range of options when considering a project such as HS2. It states: "*For a major programme, a wide range should be considered before short-listing for detailed appraisal. Both new and current policies, programmes and projects should be included as options."* By focusing only on investment options and giving much greater prominence to the HS2 option over the alternatives, the economic appraisal of HS2 has fallen short of the standards expected in the Green Book.

4 Demand Forecasts for the HS2, London – West Midlands

Experience of Forecasting on Rail Projects

4.1 The track record of traffic forecasting for major rail projects is poor, both in the UK and internationally. Bent Flyvbjerg and a group of colleagues at the University of Aalborg and elsewhere have carried out research over many years into major transport infrastructure projects (ie projects costing over US$100 million)[5]. They have established a data base of international projects and found evidence of systematic bias in the forecasting of costs, benefits and risks. Optimism bias tends to influence, not just demand forecasts, but the entire project appraisal process. Among their key findings are:-

- Average cost overruns were 44.7% for 58 rail projects, 33.8% for 33 bridge and tunnel projects and 20.4% for 167 road projects, with over 90% of projects experiencing an overrun.
- Rail passenger traffic forecasts for 25 projects showed actual traffic was on average only 51.4% of the traffic forecasted.
- By contrast, in 183 road projects, traffic was under-estimated by an average of 9.5%.
- The inaccuracy of demand forecasts is found across the five continents and fourteen countries covered by the data base and forecasting accuracy has not improved over the thirty year period which the study covers.
- The errors in road traffic forecasts may be due to technical failings but other errors are best explained by psychological and political-economic factors, which may be influenced by public sentiment in favour of rail investment.

4.2 Two major rail projects in Britain are included in the Flyvbjerg data base, the Channel Tunnel and the subsequent associated rail link from London to the tunnel. They both illustrate the way these biases develop in the process of decision taking.

4.3 The Channel Tunnel traffic forecasts were prepared on behalf of a large international consortium of lending banks which provided finance for the project. They appointed traffic and revenue consultants (TRC) and also an independent reviewer of the demand forecasts. The TRC produced annual updates of their forecasts over the more than 10 year project preparation and construction period and these were independently reviewed. The annual

[5] Policy and Planning for Large Infrastructure Projects: Problems, Causes, Cures published in Environment and Planning B: Planning and Design 2007, volume 34, pages 578 - 597

independent review never deviated by more than 5% from the TRC's forecasts in its assessment of their validity. The main focus of the review tended to be on macro economic factors rather than factors related to competition that proved to be the most decisive.

4.4 TheTRC used well established transport planning techniques and models for forecasting demand and revenue although, arguably, these were poorly suited for preparing reliable forecasts for a commercial rail shuttle link in the competitive cross channel market. The Channel Tunnel forecasts failed to anticipate the competitive response of the ferries to the opening of the Channel Tunnel and Eurotunnel quickly fell into financial difficulties because its revenue was only half the expected level.

4.5 The need for a rail link to strengthen the Channel Tunnel was debated for many years during the planning stage, but was delayed by uncertainty over its funding and viability. It eventually went through a competitive bidding process as a privately funded project using the revenue stream from the Eurostar trains that had already been purchased by British Railways and SNCF. The bid was won by the London and Continental Railway consortium. They relied on demand forecasts produced using transport planning methodologies that were very similar to those that have been used for HS2. These rely on estimates of consumer responses to new service levels on the railway and to future changes in income and price that are expressed as elasticity of demand assumptions. These forecasts anticipated that demand would now have reached about 25 million passengers, whereas actual traffic has grown only slowly and has now reached around 9 million, nearly 15 years after the original forecasts.

4.6 When LCR failed the government appointed advisers to review the forecasts in 2001. By then there was a political predilection to provide a government funded rescue of LCR, rather than to leave the risks with the private sector, as had been done with Eurotunnel. The forecasts underpinning the financial rescue agreement with the Government proved no more reliable than the original forecasts and, despite reassurances that there was a very low risk of it happening, the risk came back to the Government. HS1 has recently been sold for £2.1 billion, well below its construction costs of £5 billion. A large proportion of the loss has been borne by the taxpayer on the basis of unrealistic demand forecasts.

4.7 The shortcomings in the estimation of project costs have been recognised by the DfT for many years. A report[6] prepared by Flyvbjerg in association with Cowi was published by the DfT in June 2004 and sets out guidance on how to make allowance for optimism bias in project costs by building in a contingency margin to cost estimates. These procedures have been adopted by the DfT and an allowance for optimism bias is incorporated in the cost

[6] Procedures for Dealing with Optimism Bias in Transport Planning: Guidance Document prepared by Bent Flyvbjerg in association with Cowi and published by the Department for Transport in June 2004

estimates for HS2. However, no provision has been adopted for optimism bias in the preparation of rail traffic forecasts.

Demand Forecasts for HS2

4.8 The main source of assumptions for the baseline forecasts for HS2 is the Passenger Demand Forecasting Handbook (PDFH). The PDFH is produced by the organisations in the rail industry, managed by Association of Train Operating Companies, and contains the industry's standard approach to demand forecasting. The PDFH is not publicly available, despite freedom of information requests for its publication. Consequently this review has had to rely on the information on the forecasting methodology which is available on webTAG, in the reports on the HS2 project and in the background documents to the 2007 Rail White Paper[7].

4.9 The PDFH is not sufficient to provide full forecast data on its own as the project appraisal has to analyse the effects on demand and costs across transport networks to examine route and modal choice decisions, as well as aggregate traffic levels. PDFH is therefore combined with four other models in order to establish detailed forecasts by route and mode. These models are:-

- A long distance model which covers trips by road and air as well as rail and identifies potential diversion of trips between the three modes.
- Two shorter distance models which examine in particular rail travel in the South and the Midlands regions. The models assess the impact on passengers on the classic network if HS2 is built and the potential for using released capacity for regional and local services.
- A model which looks at the Heathrow market for passengers wishing to access international flights.
- A station choice model which identifies how passengers in London and Birmingham would choose to access both HS2 and classic rail services.

4.10 The forecasts which these models produced are summarised in Table 4.1 below. This shows that base underlying growth in all long distance rail travel in Britain is forecast to increase by 96% from 2008 to 2043, a rate of 1.9% per annum. On the section of WCML, north of Milton Keynes, for which HS2 Ltd provided consistent numbers, the growth is expected to be 127%, or 2.4% per annum. The faster journey times and improved service

[7] http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/about/strategy/whitepapers/whitepapercm7176/railwhitepapersupportingdocs/nmfdemands.pdf

levels of HS2 is expected to generate substantial new traffic demand, as well as to divert traffic from air, road and classic rail services, leading to a further increase to 209%, more than tripling the traffic on the WCML over levels in 2008 by 2043. Average daily traffic on the WCML is forecast to rise from 50,000[8] trips per day in 2008 to about 100,000 trips per day in 2043 under baseline demand growth. Some 88,000 trips in 2043 are forecast to transfer to HS2 from classic rail (including the Chiltern Line) and an additional 48,000 trips per day on HS2 will be new rail trips, either newly generated, or diverted from air and road., giving total daily traffic on HS2 of 138,000 trips per day. Some 22,000 trips per day will remain on WCML classic services.

Table 4.1 Total long distance domestic trips

	Increase 2008 to 2043	Average annual rate
Total long distance rail (over 100 miles)	96%	1.9%
WCML (north of Milton Keynes) without HS2	127%	2.4%
HS2/WCML with HS2 phase 1	209%	
Domestic air	128%	2.4%
Car	54%	1.2%
Total long distance without HS2 (all modes)	66%	1.5%

4.11 The impact of taking account of route specific and network effects of HS2 using the network models is therefore to increase demand forecasts well above the baseline growth rates suggested by PDFH. Against expected overall growth in long distance rail travel of 96%, demand growth forecast for on the classic rail and HS2 combined is expected to more than triple. The increments in demand over underlying demand on the WCML and on HS2 which are derived from the network models seem high. The composition of demand on HS2 is summarised in Table 4.2 The lack of transparency in the network models discussed in paragraphs 2.2 to 2.4 prevents a close examination of the reasons for these large

[8] There are inconsistencies in the base demand figures that create some confusion in the figures. This is apparently due to reallocation of traffic between the Chiltern Line and the WCML. The growth rates given in Table 8.1 are therefore based on the figures north of Milton Keynes and the volume figures are south of Milton Keynes which represent the highest traffic loads.

increments over base demand growth. However, it should be noted that the do minimum case adopted by HS2 implies high levels of overcrowding on the WCML before HS2 opens. The impact will be to divert traffic away from rail in the do minimum case and hence the level of traffic diversion from road and air would probably be lower if there were a more realistic do minimum case (although total traffic levels would be the same).Given the record of these models in previous rail forecasting exercises, referred to earlier, the assumptions within them, their operation and their detailed results merit an external and independent review before reliance can be placed on these results.

Table 4.2 Source of Demand on HS2 London – West Midlands

Source of demand	% of Total
Switch from classic rail	**65%**
New trips	**22%**
Shift from air	**6%**
Shift from road	**7%**

Source: HS2 Ltd model

4.13 With regard to the background growth in demand, it is worth noting that the basis for the underlying growth in air transport demand has potentially been inflated because it is based on latent, or unconstrained, demand on domestic air services that would arise if the airport capacity needed to meet it were available. In fact, with the cancellation of the third runway at Heathrow, airport capacity constraints will continue to suppress supply of domestic air services, particularly where rail travel is an option. Whilst it can be argued that this latent demand represents demand that would be available if air service capacity were available, it is likely that at least some of this demand is already represented in the growth forecasts on other modes.

4.14 Our key concern with the traffic forecasts is not that they are demonstrably too high. All forecasts are uncertain. There are clearly alternative possible interpretations for the available data and the treatment of risk and uncertainty on a project of this sort should take account of the large range of possible outcomes for the forecasts. The forecasts produced by HS2 Ltd have tended to adopt assumptions that would put them at the top of the range of possible outcomes. The best academic research, for example carried out by Mark Wardman and Joyce Dargay, also produce quite high estimates of income elasticity similar to those used in the latest PDFH. However, HS2 Ltd has used an earlier version of PDFH which adopts even higher income elasticities of demand. Furthermore, HS2 Ltd has extended the range for which the PDFH assumptions are regarded as likely to remain stable well beyond the time boundary recommended in its own guidance.

Application of PDFH Income Elasticities of Demand

4.15 The baseline forecasts used by HS2 Ltd are produced using the PDFH 4.1 version. However, there is a more recent version, PDFH 5, based on more recent research which recommends lower income elasticities of demand, particularly for long distance journeys. The academic research referred to earlier uses income elasticities more closely aligned to the new version PDFH5. According to webTAG, the model for forecasting underlying rail demand takes account of a range of exogenous variables to produce its forecasts, in addition to income. These include GDP, employment, population, car ownership, and costs and journey times by car, bus and air. It also takes account of a range of endogenous variables which include fares, journey time by rail, performance and non timetable related service quality. The forecasts are sensitive to all these variables, but they are particularly sensitive to the income variable.

4.16 PDFH 4.1 assumes that rail demand is sensitive to both income and to journey length. PDFH 5 has suggested lower and more realistic elasticities but the evaluation of HS2 has continued to be based on the out of date assumptions in PDFH 4.1. A comparison of the figures is in the table below:-

	PDFH 4.1	**PDFH 5**
To London	2.00 + 0.0032 per mile	1.9
From London	0.84 + 0.0032 per mile	0.9

4.17 The elasticity of demand over a 100 mile journey to London according to PDFH 4.1 is 2.32 compared to 1.9 using PDFH 5. Over a 400 mile journey from Scotland to London, the PDFH elasticity is 3.28 v 1.9. Thus the elasticities in PDFH 4.1 become highly implausible for longer journeys because of the distance term. Using PDFH 5 elasticities, rather than the out of date figures in PDFH 4.1, is estimated would reduce the demand forecasts for HS2 by about 29%. Making the simplistic assumption that user benefits would fall pro rate to traffic levels[9] the impact would be to **reduce the user BCR from 1.6 to 1.1, or below.**

'Capping' the Demand Forecasts

4.18 DfT's guidance, set out in NATA, for carrying out scheme appraisal is to cap demand forecasts in 2026. The reason is that there is considerable uncertainty as to whether the relationships between the variables used for forecasting rail demand will remain stable in

[9] In practice, the relationship between user benefits and traffic levels is likely to be non linear and lower traffic is likely to result in a more than proportional fall in benefits. This appears to be borne out by the sensitivity tests carried out by HS2 Ltd, see paragraph 7.12.

the long term. For projects, such as the acquisition of rolling stock, demand forecasts up to 2026 are all that is usually required. However, for a very long term project such as HS2, which will not even open until 2026, DfT decided it was appropriate to extend the forecasting period by extrapolating the same relationships between rail demand, income and other variables. During the first appraisal of HS2, carried out in 2010, the forecasting period was therefore extended to 2033. Demand was expected to double by this date. This increased the level of risk in the forecasts given the uncertainty over the stability of the relationships particularly between demand and income which have changed considerably over the past 30 years or more, and may well change again in the future.

4.19 Now, with the revised forecasts in the latest evaluation, the forecasts of base rail demand fell substantially. These forecasts used lower GDP growth assumptions and recognised the Government's policy to increase rail prices by RPI + 3% for the next 3 years and by RPI+1% thereafter. If DfT had used these new forecasts capped at 2033, as before, the economic case for HS2 would have disappeared. Instead, DfT decided to extend the forecast period out a further ten years to 2043, by which time the base demand was again forecast to double. The evaluation of HS2 has therefore been based on an arbitrary assumed target for a doubling of underlying rail demand on WCML on the section south of Milton Keynes and the task of the forecasting process has been to determine when that doubling of traffic might occur. To make that estimate DfT has had to assume that the relationship between rail demand and income growth will remain unchanged for the next 30 years.

4.20 While the forecasts would then be more realistic, we consider that there would still be a strong risk of overestimation in the forecasts for two main reasons. First there is evidence of saturation in the demand for long distance travel overall. Total long distance journeys by all modes have stayed at broadly a constant level since 2003, while long distance car journeys have fallen over that period. If the market overall is saturated, it is unsafe to assume that the railway can attract an increasing proportion of journeys over the next 30 years in the narrow segment of the market represented by city centre to city centre to city centre travel, particularly because rail already has a large share in this market.

4.21 Second, the forecasts make no assessment or allowance for changes in habits and tastes and of the potential of disruptive technologies which may reduce the necessity for some travel, and in particular business travel. We believe video technology could disrupt the travel market significantly over the next twenty years and there will be a rapid growth in technological alternatives to travel. In appendix 1 we discuss the potential for video conferencing to illustrate one significant risk to the 'business as usual' assumption underlying the forecasts for HS2.

4.22 Over the past fifteen years the number of long distance (over fifty miles) trips taken in the UK has reached a plateau. This matches common sense expectations, since everyone has a limit on the amount of time they can spend travelling. However, within this total there

has been a shift away from road and air travel and towards rail. There are several possible explanations for the growth in rail travel compared to other modes. One is the changes in the rail industry that have accompanied privatisation, with franchisees making far greater efforts to attract passengers through incentive fares and other initiatives. A second possible explanation is the development of wireless technology, which means that time spent on trains can now be used productively. A third is the surge in investment which followed privatisation and led to improved service levels. A fourth is the growing congestion on the road network and in airports which has diverted some travellers to rail. A fifth is the growth in incomes over this period, which has attracted more passengers to the trains. The relative importance of these factors is crucial to the traffic forecasts used for HS2 and the estimation of a likely saturation level. If the main explanation for growth in rail traffic is changes in the attractiveness of rail relative to other modes in a saturated travel market then the level of demand for rail travel is likely to plateau shortly. However, if rising incomes is the key determinant of demand growth then rail traffic levels may continue to grow.

4.23 The situation over the past fifteen years is in sharp contrast to the period before rail privatisation. At that time, rail travel was broadly static while demand grew rapidly on other modes and in particular car. Income was also rising over this period. This strongly suggests that factors other than income are playing a significant role.

4.24 The Government is also alert to the possibilities. The recent White Paper on local transport stated that: “As well as considering packages of sustainable transport measures, consideration should be given to not travelling at all. Information and communications technology now provides the means to reduce or remove the need to travel in a number of situations, and can have a number of benefits, to the economy and to the environment.” Some 22% of trips on HS2 are expected to come from newly generated trips that would not have otherwise taken place and these are clearly the sort of marginal trip that might be avoided.

4.25 Subsequently the DfT has begun a consultation exercise on alternatives to travel, stating that: “For the first time...not travelling is an element within the Ministerial portfolio.” The consultation references options: “ranging from teleconferencing, videoconferencing and web-conferencing, to working flexible hours, and working remotely.” This consultation shows that government recognises the possibilities of substitutes to long distance travel, but it has taken no account of them in making its forecasts of demand for HS2.

Conclusions

4.26 The Transport Select Committee investigated the failure of the Channel Tunnel Rail Link in 2006. These were primarily the failure to evaluate the impact of low cost air carriers and the unrealistic elacticities of demand used to forecast passenger responses to Eurostar’s

services. The Committee's reported that '*The Department told us that it has now learned from all this experience, and that the next time it considered undertaking a major transport project, it would factor more severe downside assumptions into its business case analysis'*. It is difficult to reconcile this statement with the work that has been done presented by the Government to justify HS2.

4.27 The White Paper "Delivering a Sustainable Railway" concluded that: *"Forecasts have been wrong before, and any strategy that tried to build a rigid investment programme based on fixed long-term forecasts would inevitably be wrong again."* This is precisely what HS2 has done. There is therefore a strong likelihood that the traffic forecasts for HS2 are too high and at the very least it should be admitted that the forecasts are highly uncertain and subject to a high margin of error. The most appropriate strategy for providing capacity in such an uncertain forecasting environment is an incremental one which builds up capacity slowly as needs develop. Instead the HS2 project has followed the familiar path of an ambitious, attractive and visionary project that has been enthusiastically promoted as the desired solution, rather than being objectively appraised against alternative policies and strategies.

4.28 It appears that the Government has been slower than the private sector to learn the lessons implicit in the inherent unreliability of the forecasting techniques applied for railway projects. The Department has not followed its own advice in the planning of HS2. It has relied on the same forecasting methods and assumptions and has not taken account of the risk in these forecasts in evaluating a full range of options for providing the capacity needed on the West Coast Mainline. Instead, it has focussed on one solution, high speed rail, and has then adopted an approach to the evaluation which discouraged an integrated and balanced examination of all the options.

4.29 We consider that the forecasts produced to justify the HS2 project do not have a high probability of being achieved. At a minimum we suggest that the forecasts should be modified to alter the income elasticities from the PDFH 4.1 figures to the PDFH 5 figures which are now recommended, which will reduce demand by 29% and the user BCR to 1.1 or less. We also consider that the saturation level of demand is likely to be reached well before 2043. The department's advice in NATA is to cap demand after fifteen years. We consider that there are sound reasons for this which apply to HS2 as much as to other projects. There is already evidence of saturation and it is unrealistic to project continuously rising demand at the same rate beyond fifteen years. If the cap on the forecast demand were applied earlier in 2033 as in the previous evaluation the BCR would fall fell below 1.

5 Benefits to Transport Users from HS2

Summary of User Benefits

5.1 The central part of an economic evaluation is to identify and quantify the benefits of the scheme. Table 5.1 summarises the results of the HS2 evaluation for the individual categories of user benefit, expressed in total present value terms over the project life. Total user benefits have been estimated at £17.9 billion, before adjustments for the effect of indirect taxes. The figures show that:

- Rail journey time savings make up 41% of the benefits. These are the result of the higher speeds and shorter journey times offered by HS2;
- Improved reliability of services are expected with the dedicated track for the new HS2 services, providing 13% of the benefits;
- A further 15% of the benefits will come from reduced crowding on journeys formerly taken on classic rail services;
- Other rail user impacts include increased service frequency, reduced time spent at interchanges and improved station access time. They make up 20% of benefits;
- Decongestion due to diversion of traffic from the roads and other impacts, such as reduced road accidents and road noise, make up the remaining 12%.

Table 5.1 Benefits of HS2 (London – W. Midlands) to Transport Users

(£ million, 2009 present values)

Benefit category	Business	Other users	Total
Rail Journey time savings	5,700	1,700	7,300
Improved Rail Reliability	1,800	500	2,300
Reduced Rail Crowding	700	1,900	2,600
Other Rail User Impacts	1,700	1,800	3,500
Road Decongestion	1,200	600	1,800
Other impacts (road accidents, air quality, road noise and HSI link)	--	--	400

Total Benefits			**17,900**

Source HS2 Ltd model analysis

5.2 The user benefits are calculated using the network models developed for the demand forecasts. Interpretation and scrutiny of the results is limited by the same constraints of lack of transparency within these complex models that were noted earlier. It is therefore not possible to question the magnitudes of the individual category of benefits without being able to examine the disaggregated results. For instance, the level of road decongestion benefits appears high in comparison with the amount of traffic diverted from road to HS2. Only 7% of HS2 traffic is from road leading to just a 1% fall in motorway traffic. Yet road decongestion generates 10% of the benefits. But the reason for this cannot be investigated without access to much more detailed information. We can however, review the key assumptions driving the analysis and the most important assumption is the value of time of transport users.

Benefits from Relief of Crowding

5.3 The scale of the benefits from relief of crowding must be interpreted in the context of the artificially constrained do minimum case used to derive them. Had a realistic do minimum been used the crowding benefits would have been all but eliminated. As discussed in Section 6, additional capacity can be provided on the existing network, at low cost, to meet all the forecast demand without the need for crowding. Eliminating crowding benefits would reduce total benefits to £15.3bn.

5.4 Indeed, a realistic do minimum case would provide additional capacity **before** the earliest date at which HS2 could come into operation. Whereas in the HS2 case the Government will be reluctant to spend money to relieve congestion in the period before 2025 in anticipation that HS2 will eventually solve the problem because any investment in additional capacity on the existing line will be made redundant. There would therefore be **additional congestion** in the period to 2025 in the case where HS2 is built compared to the do minimum case which in turn would lead to additional disbenefits of train crowding prior to opening HS2. This would occur at the beginning of the evaluation period when the effect of discounting over time is low.

5.5 If it were assumed that the effect of additional crowding prior to the opening of HS2 in 2025 would generate, say, £1bn of disbenefits and if the unnecessary crowding created by the artificial do minimum is eliminated, the effect would be to **reduce the user benefit BCR it from 1.6 to about 1.3.**

Reliability Improvement Benefits

5.6 There are severe doubts over the scale of the reliability benefits claimed for HS2, particularly in the longer term with the extensions to create the 'Y' network. Improved reliability of high speed rail services has been demonstrated where there is a completely self contained system that does not import delay from the rest of the network The Tokyo-Osaka Shinkansen is famed for its reliability while operating high capacity services of up to 14 trains per hour at the peak. This is achieved on a dedicated, self contained, linear system operated under the disciplined management and organisational culture of Japan. The maximum capacity of the French system is 12 train per hour.

5.7 HS2 will not be a self contained system and imported delays from the classic network are inevitable. These will increase as capacity utilisation on the system is increased. The capacity required to carry the forecast demand for the Y network requires operation at the full claimed capacity of 18 trains per hour during peak periods. However the feasibility of achieving this is unproven and highly doubtful. No high speed rail system has achieved this level of utilisation and HS2 Ltd has not explained how it can be achieved. In addition, the 'Y' will be heavily exposed to imported delays from trains connecting through the classic network since 6 of the planned 18 trains per hour will connect between the two networks.

5.8 There are therefore strong doubts about the estimates of reliability benefits for HS2. The existing classic system can be operated well within its capacity limits even with the forecast increase in traffic using the initiatives described by Atkins in the RP2 scheme, or even more effectively by the optimised alternative developed for 51M. Where necessary, infrastructure improvements can be made at a modest level of cost to relieve pinch point constraints.

Faster Journey Time Benefits - Value of Time

5.9 The key assumption underpinning the estimates of benefits from transport investment projects is the values of time savings for the various categories of journey purpose. These values have been used to estimate the economic benefits from journey time savings. They have also been used in the quantification of most of the other transport user benefits shown in Table 5.1. The benefits from improved reliability of train services, reductions in crowding on trains and changes to service frequencies are evaluated using parameters based on the value of time. Only the small items of benefits, 'other impacts,' are not derived from the values of time. The value of time assumptions are therefore the most critical element of the HS2 project appraisal.

5.10 The appraisal has used the standard values of time recommended by webTAG which have been supported by extensive research over the years. The recommended value of time for rail commuters is £6.52 per hour and for other non working time travellers it is £5.77 per hour. For people travelling by rail in working times the recommended value of time is £48.64 per hour. Only two categories of journey purpose have been used for the analysis,

leisure trips and business trips taken in working time. However, the commuter value of time has been used to value the effects on business travellers of crowded trains. The reason is that relief of crowding affects the welfare of the traveller as an individual but it does not affect his employer, whereas time spent travelling is assumed to be a cost to the employer

5.11 The non working values of time are standard average values used for transport economic appraisal. These are not 'behavioural values' based on willingness to pay principles. Behavioural values will reflect the income of travellers. The Government has chosen to use a common value of non working time for economic appraisals to avoid transport investment decisions being biased towards higher income users in non working time.

The Value of Working Time on Trains

5.12 The value of time of rail business passengers travelling in working time is intended to measure the average costs to employers of their time, on the assumption that this represents the average of the marginal rates of productivity of those employees. The cost to employers is the average hourly rate of pay, plus a 24.1% mark up for non-wage costs paid by the employers. Excluding the mark up, implies that business travellers are estimated to earn an average rate of £39.19 per hour.

5.13 This value is critical because the benefits calculated using this rate make up 51% of total user benefits, although business travellers are estimated to form only 30% of rail users of the HS2 services. Assuming a 40 hour week and 45 working weeks in the year, this implies an annual average pay rate of about £70,000 in 2009 values. This appears high and it is unclear whether it is strongly supported by research on the earnings of the average rail traveller in this specific market for intercity services. We understand the estimate is derived from the National Travel Survey data.

5.14 If business travellers using intercity rail services are indeed drawn from therelatively small group of people who enjoy this level of average income, it is unlikely that this high average income will be sustained in real terms over time. If the market is to grow at the rate forecast, the composition of rail business travellers will be diluted by more people at the lower end of the income range and the average income of the group will gradually move towards mean income levels for business travellers. It is unlikely that the demand forecasts for business travel by rail will be met just by increased frequency of travel by the high income group currently represented.

5.15 The appraisal of HS2 assumes that time saved on business travel provides an economic benefit equivalent to the cost to the employers of the business travellers' time, because the time saved can be used productively at work. The implication is that business traveller's time is unproductive while sitting in trains. This is clearly not the case, since, with

modern technology, there are ample opportunities to work on trains and the facilities are likely to improve further in future. In their latest evaluation, HS2 Ltd has now recognised this, but they have not changed this critical assumption in their analysis.

5.16 It has long been recognised in the literature that this assumption is likely to be false. As long ago as 1977 Hencher developed a formula to identify the factors that would influence the value of travel time savings:

$$VBTT = [(1 - r - pq)\,MP + MPF\,] + [\,(1 - r)\,VW + rVL\}$$

Employer value Employee value

Where, VBTT = value of savings in business travel time

MP = marginal product of labour

MPF = extra output due to reduced (travel) fatigue.

VW = value to employee of work time at the workplace relative to travel time

VL = value to employee of leisure time relative to travel time

r = proportion of travel time saved used for leisure

p = proportion of travel time saved at the expense of work done while travelling

q = relative productivity of work done while travelling relative to time at the workplace.

5.17 The formula acknowledges a range of factors that can influence the value of working time spent travelling, including the business traveller's own preferences. One of these factors, 'p,' recognises that people may work productively while travelling. An attempt was made by an academic group from the Institute of Transport Studies to apply the Henscher formula using data from the last large scale national value of time study in the UK (Hague Consulting Group et al 1999). The data was based on stated preference surveys where travellers were faced with questions concerning travel choices they might make under certain circumstances. It only covered road transport users and the questions asked were unlikely to reveal all the subtleties implied by the Henscher formula. It was found that the Henscher formula was too data hungry to establish meaningful values. The authors were inclined to use hypothetical arguments to speculate that most of the variables would tend to zero for road users, leaving MP, the marginal product of labour, as reflected in employer's costs, as the remaining variable.

5.18 Whilst that conclusion may be a fair approximation for road users, it is most unlikely to apply to intercity rail travellers in working time. It is evident that many business travellers do work on trains and thus their time is not wasted, as assumed in the evaluation. In the last HS2 evaluation published with the consultation, the DfT has now recognised this flaw in the reasoning that at least some of business traveller's time on trains is used productively, reading, using computers and communicating. Indeed, this is one of the reasons business people use trains rather than cars and explains the high share of rail in the city centre to city centre travel market. If this is so, time saved on train journeys cannot be valued as though it were wasted.

5.19 The consequence is that there is a question mark over a substantial portion of the benefits of HS2. There is a lack of research or empirical evidence to determine an accurate estimate of the true economic value of working time spent on intercity trains. However, an *a priori* argument can be made that the value of time of business travellers should be reduced to the personal values of time of non-working time. Since virtually all business travellers have the opportunity to work on trains if they choose to, it is erroneous to value time savings on rail as though travelling by rail **prevents them working**. Clearly, most could work if they wanted to and, if they choose not to, it is for a reason. Perhaps they are in fact using their own leisure time in 'out of hours' travelling, or, perhaps they are refreshing their thoughts for the tasks ahead. There are many reasons why people do not work 100% of the time, just as they do not do so in the office.

5.20 If it were assumed that business travellers' time in trains should be valued at the same rate as commuters the total user benefits would fall to £13.0bn and the **user BCR would fall from 1.6 to 1.2**. Combining this adjustment with the overstatement of crowding benefits **reduces the BCR to 0.9.**

Response of DfT to the Issue of VoT of Working Time

5.21 The DfT has sought to address this dilemma by suggesting that if business people do work on trains then they could not work on crowded trains. Therefore the disbenefits of business travellers being prevented from working on crowded trains in the do minimum case should be valued at the full working time value of time to allow for this loss of productive work. They also point to evidence that some business travellers choose to travel by air to save time rather than use trains, which suggests that business travellers do in fact value savings in travel time. We would challenge this response on a number of grounds.

5.22 Business travellers tend to pay premium fares in order to ensure they do get a seat. Any sensible yield management system will ensure that this continues to be the case in the future, even if average load factors increase. Thus business travellers will continue to be able to work on crowded trains in the future. It is possible that conditions will become more

uncomfortable over time, particularly with the artificially constrained do minimum base case that has been used in HS2 Ltd's appraisal.

5.23 In practice, the crowding benefits arise only because the evaluation has used an unrealistic do minimum comparator with the HS2 case. If a realistic alternative were used there would be few crowding benefits since the alternative scheme on the classic network would have sufficient capacity to avoid crowding. In this case, the only benefit of HS2 will be the faster journeys it offers. The effect of reflecting these more realistic assumptions is to reduce the BCR to about 1.

5.24 Whilst it is true that some business travellers do choose the fastest mode of travel, these are a self selecting group who happen to have a high value of time. Other business traveller choose rail because of the benefits of comfort and convenience it offers and the opportunities to do productive work.

5.25 It is probable that rail already has a large proportion of the relevant market for business travel. These are the business travellers who can access the main railway stations served by intercity services and prefer to use the train rather than the car or other modes for long distance journeys between city centres. This would explain why the estimates of car travellers who are expected to divert to HS2 services only make up 7% of the demand forecast to use HS2, despite the large reduction in train journey time offered by HS2. It is because travellers in any transport submarket have very specific characteristics that any estimate of value of time should be tailored to the specific market served. The use of average values of time struck over a wide diversity of markets is likely to be misleading and not reflect either the specific user type variation of values of time, or the mode specific factors influencing it.

5.26 Finally, if the logic of treating business time on trains as wasted is now recognised as invalid, then the basis for the evaluation that has been carried out is flawed and must be rethought, researched and reanalysed. Furthermore, the logic of the traffic forecasts also needs to be revisited now that DfT have realised this flaw in the rationale for their methodology. The fact that many business people do use their time productively on trains will be reflected in their current choice of rail over road or air. To an extent this preference will be calibrated into the logic of the transport model's mode choice functions and the estimates of generalised costs. But these may need to be revisited with different behavioural values of time.

5.27 HS2 Ltd recognises there is a lack of evidence for the values of time used in their evaluation and state that ' *There is not currently any robust or agreed basis for adjusting values'.* If this is the case then no robust case for building HS2 has been developed.

6 Options for Meeting Capacity Requirements

Economic Evaluation of Alternatives to HS2

6.1 In the original Atkins study in 2003 the main justification for building HS2 was that capacity on the existing line could not be increased cost effectively to meet the growth in demand expected at the time. However, the Government appears to have given relatively little attention or resources to investigating this claim by examining options for increasing capacity to meet demand using the existing rail network. In 2010 the Government commissioned Atkins to carry out a study of alternatives to HS2 which examined a number of options. This study was updated in February 2011 using revised forecasts of demand. The study considered a number of options, or 'packages,' of investment initiatives including:

- Additional train frequencies with some supporting infrastructure enhancements (RP2) ;
- Building on RP2 by providing additional capacity on the Chiltern line to enable some fast London to Birmingham trains to be diverted from WCML, thus releasing capacity for other services (RP3);
- Building on RP3 with further upgrades on the Chiltern line to reduce London-Birmingham journey times (RP4);
- Again, building on RP4 by providing additional capacity between Birmingham and Stafford to enable the diversion of some services from the north west to be diverted onto the Chiltern Line (RP5).

Table 6.1 Costs of the Rail Package Alternatives Considered

(present values £m)

Rail package	Capital Cost	Initial rolling stock purchase	Total
RP2	3,619	1,142	4,761
RP3	12,272	1,477	13,749
RP4	14,892	1,559	16,451
RP5	19,466	1,955	21,421

6.2 All of the options were designed to provide the capacity needed to meet the forecast traffic. However, the costs of the different packages vary widely. RP2 is very much cheaper than all the other options. The difference in costs with the other packages varies from a factor of 2.9 and 4.5. Yet the difference in the improvement in London to Birmingham journey times between each of the options is relatively small. RP2 gives an improvement of 12 minutes on an 85 minute journey time. RP3 improves this by only 2 minutes and RP4 and

RP5 improves on RP3 by another 6/7minutes.With these modest improvements, it is not surprising that RP2 gave a much better BCR than any of the other packages. The BCR for RP2 was 1.9, while the BCR for the other packages were all less than I and hence they were found to be not economically viable. The fact that the BCR of RP2 is superior to the 1.6 found for HS2 has not featured in the arguments on the merits of HS2 presented by the Government. We believe that a more balanced approach to evaluating options for expanding rail capacity on the route is required.

6.3 It is questionable why so much work was devoted to costing infrastructure enhancements that achieved few additional benefits, rather than investigating a more optimised alternative strategy based on increasing train size and capacity. This strategy would increase capacity flexibly and in line with demand growth as it materialised. That would seem always to have provided a more attractive option. However, in the context of examining alternatives to the expenditure of £18bn on HS2 to accommodate the same level of underlying demand, it is perhaps not surprising that the consultants considered significant infrastructure investment might have been needed.

6.4 In Section 3, we have described how the evaluation of the alternatives carried out by Atkins used a different do minimum comparator case for the evaluation of the alternatives from that used for the evaluation of HS2. The do minimum case used for the evaluation of these alternatives to HS2 assumed that **the whole existing fleet** of 52 Pendolino trains would be lengthened from 9 to 11 cars. Whereas the evaluation of HS2 assumed that only the committed project to **lengthen 31 trains** would be carried out in the absence of the HS2**.** This inconsistency invalidates the comparison of the BCR of the HS2 with those found for the alternatives. The fact that the BCR for RP2 is better than for HS2, despite this inconsistency in the base case, only emphasises even more that the alternative scheme to HS2 requires proper investigation..

6.5 The effect of this inconsistency in the base case was to improve the capacity of this enhanced do minimum case used for the evaluation of the alternatives compared to the different do minimum used to evaluate HS2. Clearly the incremental benefits of the alternatives would be lowered by this enhanced base case compared to the result if a consistent approach had been adopted. We were told by DfT that the reason this inconsistency arose was that there were difficulties in modelling the do minimum case in the way it had been done for the HS2 evaluation. The nature of the difficulties was not explained and we can only speculate as to the cause. It may have been that the crowding function in the model became unstable at high load factors with the original, unrealistically constrained, do minimum. However, that would not explain why similar difficulties were not found when the separate modelling for the do minimum case for the evaluation of HS2 was carried out.

6.6 The second way the analysis has been distorted was that no attempt appears to have been made to optimise the timing of the provision of the capacity in line with the growth in demand. All the new capacity is assumed to be provided in 2025, for consistency with the expected opening of the HS2 with which the alternative is being indirectly compared. However, this is not a valid way of evaluating the alternatives because it fails to reflect one of the main comparative benefits of a strategy of using the existing network i.e. that capacity can be expanded more closely in line with demand and avoid over- or under-capacity. Nevertheless, despite these potential biases against the alternatives in the evaluation, RP2 still achieved a substantially better user BCR than HS2, 1.9 v 1.6. This indicates that HS2 would achieve a BCR lower than 1, if it were compared with RP2 directly by using this scheme as the base case for comparison.

6.7 The HS2 strategy, by contrast, will result in growing congestion on the railway for the next 15 years before HS2 is opened. Then there will be massive over provision of infrastructure capacity resulting in very high unit costs of providing rail capacity. This is against the whole thrust of the proposals of the McNulty review which argues for improving asset utilisation as a key driver of cost reductions. Consequently, the level of rail subsidy will be increased beyond the already high levels that are caused by the excessively high cost base of Britain's rail industry. An optimised alternative strategy would, by contrast, be wholly consistent with McNulty and will help drive down costs on the railways.

6.8 There also appears to be other inconsistencies in the evaluation of HS2 and RP2. Some infrastructure expenditure in the Manchester and Stafford areas appears to have been assumed to have been carried out for other reasons in the evaluation of HS2, although it is included in the costs of RP2. This will have caused additional bias against the alternative options. In addition, according to other analysis presented by 51M, about a third (£1.36bn) of the infrastructure expenditure included in RP2 is not necessary to achieve the relevant objectives of the scheme.

6.9 All these factors will have depressed the estimated BCR of the evaluation of RP2. In our view, there needs to be a more thorough and consistent evaluation of alternatives for providing capacity on the WCML than has been carried out by the Government so far.

6.10 Network Rail spent about £9 billion on the recently completed the upgrade of the WCML and it is essential that this investment is fully utilised before considering the next huge investment in the line. The McNulty review has concluded that the cost of providing railway services in the UK are about 40% higher than comparable railways and that there is scope to reduce costs by 30%. High infrastructure costs and low train utilisation are major factors in these high costs. Only by making much more effective use of existing assets can the targets for reducing rail costs set out by McNulty be achieved. The evaluation of alternatives to HS2 needs to focus on options that are based on lengthening of the trains in the first instance, to make the best use of the capacity that is available. This is the most cost

effective means of expanding capacity and this approach gives the best means of matching capacity with increasing demand.

Optimised Alternative

6.11 An analysis has been carried out for 51M to investigate whether there are more cost effective alternatives to increasing the capacity of the WCML to meet growth in demand. This has concluded that there is potential for increasing capacity on the WCML by 215% by a range of incremental initiatives that could be introduced progressively in line with growth in demand. The background forecast demand on the WCML is for a doubling of traffic (102%) by 2043. Thus a tripling of the capacity on the existing line would be more than adequate to meet forecast traffic in the foreseeable future. To date, no commentator has demonstrated that this finding is incorrect and such criticism as has been made has simply tried to obfuscate the arguments. The hierarchy of options to expand capacity include:

- Increasing the capacity on the Chiltern Line between Birmingham and London using the "Evergreen 3" upgrade, to be completed in September this year. This will deliver comparable journey times to the WCML route (90 minutes to Marylebone compared with 84 minutes to Euston), and the Chiltern Line directly serves important catchment areas such as Solihull, Warwick and Leamington Spa.
- Reconfiguration of rolling stock to increase seat capacity, particularly the conversion of some underutilised first class carriages to standard class;
- More effective demand management to control peak demand;
- Operation of longer trains, without major infrastructure works;
- Selected infrastructure works to address critical bottlenecks;
- Major infrastructure works.

6.12 A summary of the cumulative impact on standard class seating capacity of applying this strategy of incremental enhancement of capacity is given below:

- The introduction of the current timetable following the completion of the WCML upgrade has in itself increased capacity by 38% over the 2008 timetable that was used as HS2 Ltd's base case.
- The committed lengthening of 31 of the Pendolino fleet will achieve a further increase of capacity to 79%;
- Additional services are planned in 2013 which will increase capacity to 92% over the 2008 base.

- If 25% of the first class carriages were reconfigured to standard class the capacity increment would reach 127%, allowing for the increased seat capacity and higher load factors in standard class. This should be able to be achieved without loss of revenue using yield management techniques.
- A further large increment of capacity to 181% over the base case could be achieved by introducing 12 car sets, except to Liverpool where infrastructure constraints prevent this.
- Additional services equivalent to 34 trains daily could be introduced if some targeted infrastructure investment costing about £2.06 billion were carried out. This would enable capacity to be increased to 215%.
- In addition to the capacity increases on WCML summarised above, Evergreen 3 would enable a capacity increasebetween London and Birmingham by providing longer trains to Birmingham via the Chiltern line.

6.13 The effectiveness of increased capacity will be undermined if growth in demand is disproportionally concentrated in times of peak demand. Peak demand management is an essential feature of all forms of transport on busy routes. Otherwise the costs of providing capacity to meet very high levels of demand in just a few hours of the day becomes prohibitive, with low average utilisation factors for the assets used. Some degree of peak demand is inevitable. It is the size of the peak relative to the shoulder and off peak periods that is critical. Most of the current peak demand on the WCML is caused by the fare structure, particularly on the trains from Euston just after 7.00pm when Saver tickets become valid. As pointed out by the McNulty review, greater sophistication in yield management techniques is needed, including selective use of fully reserved trains, in the future to bring down the costs of rail travel.

6.14 The report for 51m demonstrates that these interventions to enhance the capacity of the existing WCML are not complex and would not involve the kind of disruption that took place during the recently completed upgrade of WCML. They are the logical extensions of that major upgrade which are needed to make effective use of the infrastructure capacity that has already been provided and so reduce unit costs on the railway.

6.15 We therefore propose that an optimised strategy for enhancing the capacity of the WCML is developed on the basis of these initiatives. This strategy would need to take account of the needs of all traffic and not just intercity and would include freight. Once an optimised alternative scheme is identified it should be evaluated directly with the HS2 project and not just with some do minimum comparator. In this way the true comparative benefits of HS2 against a strategy based on utilising the existing network can be determined on a consistent basis.

7 Other Elements of the Economic Evaluation

7.1 There are a number of other key elements of the economic evaluation of HS2 that need to be considered:

- The impact of HS2 on the rest of the network:
- The treatment of risk and uncertainty in the evaluation,
- The effect of the assumed project life and discount rates.
- The accounting framework for the appraisal and the presentation of the results

Impact of HS2 on the Rest of the Network

7.2 The network models used for the demand forecasts and the economic evaluation of HS2 have the advantage that they enable a systematic and, normally, consistent approach to analysing and evaluating the total impact on demand and user benefits across the networks represented in the models. The networks represented in the Planet Long Distance model included the trunk road network, relevant domestic air services, the existing classic rail network and HS2. The station access models included more detailed local transport networks. The validity of the outputs of the network models depends, amongst other things, on how accurately the transport services on the networks are represented. Inevitably, some approximations are needed to represent the variety and complexity of train services. The models are neither simulation models, able to represent service characteristics at a detailed level, nor are they business models able to estimate the impact on costs, demand, revenues and subsidy requirements from changes in the level of demand.

7.3 The main objective of the models is to forecast demand and they are designed mainly for this purpose. This places severe limitations on the extent to which they are able to evaluate the impact on the business economics of the classic rail network which will be affected by the diversion of a large proportion of its traffic to HS2. The consequential impact of this loss of traffic is difficult to foresee so far into the future. The initial impact will be to reduce drastically the traffic on the existing London to Birmingham classic intercity services, leading to a withdrawal of many of these services to match capacity closer to demand. There will then be opportunities to develop a new schedule of services. The effects are likely to involve both winners and losers. The withdrawal of services is likely to reduce the frequency or eliminate, the services that stop en route between the main city centre terminals, since they depend for their viability on the base intercity demand.

7.4 The Government has said that new services will be introduced to use the capacity releases on the classic network. However, these are likely to be the least profitable services

and to need the most subsidy, otherwise they would already exist. The result will inevitably be a large increase in the subsidy requirements on the existing classic network. This has been the experience of all other high speed rail services. The provision of a sudden large increment in capacity leads to redundant capacity on the existing infrastructure. Existing services become unprofitable and have to be withdrawn, or subsidy increased. Any new services introduced will require higher subsidy, since they are likely to be the most financially unattractive. Infrastructure costs remain broadly the same because the infrastructure must continue to be maintained.

7.5 The analysis that has been carried out by HS2 Ltd has not estimated the impact on subsidy on the classic network. It has calculated the net impact of new revenue from HS2 less the loss of revenue from the classic intercity services. And it has made allowance for the cost savings from services withdrawn from the classic network. But no business model of the classic network has been developed to allow the profitability and subsidy needs of the services that will be operated on it after HS2 to be analysed. This is a serious omission in the analysis. If the additional annual subsidy requirements were added to the capital subsidy for HS2 it would inevitably show the BCR to be much lower.

7.6 An attempt was made by HS2 Ltd to represent a notional set of services that might operate on the classic network when HS2 is opened in order to estimate changes in demand in the 'with HS2' case. But to estimate the viability of the services remaining and new services introduced requires estimates of demand and revenue on each of the services, and the costs of operation and the overall cost of fixed infrastructure. A business model is required and the existing network models cannot be adapted to that task. It might be argued that the case for increasing subsidy on the existing network will be determined at the time on a case by case basis according to the net benefits of the services provided. But much of the additional subsidy that will be needed will have been because HS2 has reduced the utilisation of the assets on the existing network. Therefore this increase in the annual subsidy should be attributed to HS2.

7.7 It is not possible to make a meaningful estimate of the level of this additional annual subsidy requirement on the classic network. But if, for illustration, it amounted to, say, 5% of the present annual subsidy for the whole network, or £100m pa, to achieve the desired level of service on the classic network, this would be equivalent to a £2.6bn increase in the present value of subsidy requirements over the project life. In practice, given the pressure to compensate for the loss of classic services after HS2 is opened, the total increase in subsidy requirements on the classic network could be considerably higher, depending on policy decisions. There may be an argument about how much is attributable to HS2 if the subsidy can be justified in its own right. Nevertheless, building the HS2 will take the Government the opposite way it wants to go with respect to the level of annual subsidy required to support Britain's railways.

Treatment of Risk and Uncertainty

7.8 The appraisal that has been carried out of HS2 is very weak with regard to the treatment of risk and uncertainty. The risks associated with the HS2 policy are manifold and cannot be covered comprehensively here. The project requires a huge commitment of resources to be spent on a project that will not be ready for operation for at least 15 years. There are major technology risks, particularly associated with the feasibility of achieving the capacity requirement of 18 trains per hour on HS2 that will be required for the 'Y' network to be feasible. This has not been achieved on any HS network in the world and is reminiscent of the undelivered promise of new signalling capability on the recent upgrade of the same WCML route.

7.9 By the time HS2 is ready for use after 2025, there could be many changes in economic conditions and travel demand patterns, as technology and tastes change. As we will discuss later, the case for the project is highly dependent on benefits that will not arise until more than 40 years into the future. Thus the time profile of the estimated benefits and costs represent substantial risks in themselves. The relatively low discount rates recommended by the Treasury for project appraisal do not take account of time related risk. There is therefore a case for considering using a supplement on the discount rates for this purpose. We recognise that increasing the discount rate is not an effective way of dealing with all project risks, but it can take account of time related uncertainty for projects that have very long project lives. As with much else in this form of analysis, it is a judgement as to where any addition to the discount rate should be set.

7.10 Perhaps, the strongest argument for a more thorough treatment of the risks associated with the project is that HS2 is not needed. There is plenty of capacity available on the existing line to be able to carry three times the current levels of traffic. One of the main arguments made for HS2 when it was first considered was that capacity could not be expanded sufficiently and cost effectively on the existing line. This is clearly not the case.

7.11 If there is no argument for HS2 on the ground of capacity needs, we have also shown in Section 5 that the benefits of faster travel are very questionable in both economic and environmental policy terms. HS2 will take the Government further from the 'Green Agenda' by generating a large increase in travel demand which will involve not just rail travel, but also additional travel by road associated with more rail journeys.

7.12 With this range of risks it is surprising that the HS2 evaluation is so weak in this area. It relies on a number of sensitivity tests which fail to reflect the extent of uncertainty over key variables. The sensitivity tests chosen involve adjustments to specific assumptions, mainly

affecting the demand forecasts. The test undertaken by HS2 Ltd are summarised below against an expected user BCR of 1.6:

- Extending the forecasts for five more years to 2048 raises the BCR to 2.0;
- Stopping growth in demand at 2026 reduces the BCR to 0.7;
- Increasing the rate of growth in demand so that the 'cap' is reached in 2033 raises the BCR to 1.9;
- Slowing the rate of growth in demand from 1.4% pa to 1.1% pa so that cap is reached in 2055 would reduce the BCR to 1.3;
- Reducing the rate of growth in very long distance trips (to Scotland) reduces the BCR to 1.3;
- Assuming no further growth in both long distance car and air demand beyond 2008 reduces the BCR to 1.4;
- Higher carbon trading prices leading to a 37% increase in air fares by 2043 would increase the BCR to 1.8 (NB This relatively high increment is probably due to the questionable use of latent demand for air travel in the evaluation, rather than actual capacity constrained growth);
- Higher fuel duty to increase prices by 50% by 2043 would increase the BCR to 2.4. This large increase is mainly due to the impact on the underlying rail demand of higher petrol prices for cars;
- Rail price increases at the rate of RPI+2%, rather than RPI+1% would reduce demand by 24% and reduces the BCR to 0.9;
- Halving the value of time for business travellers would, under DfT's assumptions, have little impact.

7.13 However, this last test, relating to the value of working time, is based on the erroneous argument that the effect would be offset by business travellers being unable to work on crowded trains (see Section 5) The assumption that premium fare business travellers would not find a seat would be an unusual outcome from any normal commercial yield management system. If it true, it would certainly demonstrate the flaws in the do minimum case that creates such an artificial scenario. With a realistic do minimum, there would be very little crowding for business travellers.

7.14 The sensitivity tests carried out do not reflect the range of uncertainty in the key variables. And they do not reflect the combination of risks that face this project. Sensitivity tests are a quite 'rough and ready' way to deal with risk and uncertainty in project appraisal. The process of dealing with risk should start at the beginning of the process when alternative strategies for dealing with the basic need for the project are considered. A shortage of capacity on the WCML can be addressed by a range of much lower risk measures, long before there is a need to consider building a complete new railway to substitute for an existing line that has just had £9bn spent on upgrading it. It may be this

mindset in the rail industry that has led to costs in the rail industry in Britain being 40% higher than in comparable countries.

7.15 The first recourse to a situation of excess demand for any product is normally to consider raising the price. If the users are currently not paying the full cost of the service and are, on average, relatively rich, as is the case on the WCML, that would seem to be a valid policy response. To an extent the Government are now doing this by the current policy of increasing rail prices by RPI+3% for the next three years. But a more targeted increase on peak loaded trains on the WCML is likely to make a substantial impact on the problem of crowding and apparent capacity shortages.

7.16 We recognise that the economist's suggestion of raising prices, even peak prices, is never popular politically in the public services (although commercial air services appear to be able to price according to the strength of demand). However, in the case of the WCML, peak pricing may only be needed to a relatively limited extent in order to shift the sharpest peaks causing the most problems. Furthermore, the capacity limits on the WCML have not been reached. Substantial increases in capacity can be achieved by incremental investment in higher capacity trains and other low cost initiatives.

7.17 The combination of peak pricing and incremental capacity increases in line with demand is a much lower risk strategy than building a complete new high speed railway. Therefore this option should have been the first to be considered at the early policymaking stage. At the time, Eddington was urging exactly this approach. Instead, the assumption was made that high speed rail was the solution needed and the analysis has followed this conclusion. Only later was work commissioned on the alternatives and this has been narrowly based and inadequate for such a major strategic decision.

7.18 Risk and uncertainty should be taken into consideration throughout the policymaking and appraisal process and not tagged on at the end in sensitivity tests alone. The probability range of uncertainty should be recognised in all the key variables. There is a case for the use of Monte Carlo techniques to recognise the impact of combinations of risks amongst a range of key variables, especially in the demand forecasting process. Thus, rather than acknowledging each risk separately, the distribution of probability around the mean can be used to analyse the combined impact of a number of risks to different key variables. However, the adoption of such techniques is difficult in practice because it is hard to judge the probability distribution of key variables and some risks are correlated and would require extensive analysis to take into account the interrelationships involved.

7.19 Where there is a likelihood of optimism bias, it should be taken into account. Optimism bias has been allowed for in the estimation of costs but not in the demand forecasting for HS2. There may have been optimism bias in other parts of the evaluation in the choices made. The choices made of the base case tended to favour the case for HS2.

Similarly the use of the cap on demand at a level of a doubling of underlying demand has allowed the whole benefits of HS2 at broadly its full capacity to be carried forward over the following 40 years of the project life. Whilst we believe that the detailed analytical work on the project has been carried out diligently and objectively by HS2 Ltd, their focus on investigating the case for high speed rail, rather than finding an optimal solution to capacity constraints on WCML may have influenced the approach adopted at key junctures.

Project Life and Discounting

7.20 The operating life for HS2 that has been used in the cost/benefit analysis is unusually long, extending 60 years beyond 2025. It is clear that railways are capable of being operating for very long periods, providing a proper allowance is made for maintenance, renewal and full replacement of assets at appropriate times. But, when looking so far into the future, there is an arguable risk of obsolescence. The assumption of a long operating life favours the case for HS2, particularly in combination with the low discount rates in Treasury guidance[10]. The way the evaluation has been carried out by allowing traffic demand to increase to the point when the capacity of HS2 will be broadly fully utilised, and hence the benefits are at the maximum level, and then projecting these benefits forward another 40 years with real income growth allowance and a low discount rate will tend to overstate the total benefits. At least an allowance for growing risk over time should be considered, possibly by adding a risk allowance to the discount rate. Approximately half the benefits will occur after 2043 between 30 and 75 years using these assumptions. If the project life were shortened by 20 years it would reduce the benefits by approximately 18% reducing the BCR to 1.3.

The Appraisal Accounting Framework

7.21 The appraisal of HS2 places great emphasis on the Benefit Cost Ratio (BCR) or Net Benefit Ratio (NBR) of the project (the two terms are used interchangeably). This is the ratio of the **net** costs of the project to the **gross** benefits. The net costs are calculated by calculating the gross costs of providing the service and then deducting the amounts that are collected in fare revenue. This approach works well for the majority of transport projects where there is no revenue and the ratio will help to identify those projects that generate the greatest benefits for the investment of a given amount of public funds. It is methodologically unsound for projects that have significant revenue and this is recognised by the DfT. WebTAG states that "*the BCR is of limited value where projects (road user*

[10] 3.5% for the first 30 years and 3.0% for the remainder of the appraisal period, with a further drop to 2.5% 75 years from the current year ie 45 years into the appraisal period of HS2.

charging, for example) result in significant revenues accruing to the Broad Transport Budget (for national or local government) such that the Present Value of Costs (PVC) becomes negative."

7.22 This is an important methodological point. For a commercial project that is expected to earn revenue, the BCR would normally be infinite as there would not be any subsidy from the public sector to bear. For HS2 the central estimate of the BCR is 1.6 without wider economic benefits. This is a very low figure for a revenue earning project. A better way of looking at the figures is to calculate the Benefit Cost Ratio, in the way the term has been conventionally used in cost/benefit analysis, by comparing the gross costs with the gross benefits (ie including the revenue line in with the benefits). On this basis, on HS2's own figures, the true BCR is 1.26 against an NBR of 1.6.

8 Conclusions

8.1 The economic case for the construction of a high speed rail link between London and the West Midlands is flawed in a number of serious respects. Our review of the reports issued with the Government's consultation and other work carried out by 51m demonstrates that a much better solution would be to provide additional capacity on the existing network to meet the increases in demand as they materialise. This is a far less risky and more cost effective solution. It does not involve committing some £18bn now to construct a new line that will not be available for use until 2025 on the strength of some very uncertain demand forecasts, to achieve benefits from faster rail journey times that have dubious economic value, most of which will not materialise for 30 or 40 years into the future.

8.2 The Government has launched its consultation on the basis of constructing the 'Y' network of high speed rail links, not just the London to Birmingham link. It believes that the case for extending the HS2 beyond Birmingham to Leeds and Manchester to create the 'Y' network will be stronger than the economic case for the link to Birmingham. But the preliminary analysis it has produced to demonstrate this appears to be very crude and no details have been released so that it can be reviewed. The economic analysis that has been carried out for the London to Birmingham link is so weak that it seems unlikely to be sufficiently improved when applied to the 'Y' network to justify committing well over £30bn.

8.3 Furthermore, there are serious doubts that this scheme will be viable on purely operational grounds. The 'Y' network will require 18 trains per hour to be operated to meet the capacity requirements in the peak for the forecast traffic. This capacity has never been achieved on any high speed railway in the world; even ones that are totally self contained. HS2 will not be self contained and capacity and reliability will be affected by imported delays from the trains running into the HS2 system, along with other operational constraints, are likely to make this scheme inoperable at the planned peak capacity level.

8.4 As the debate has continued and more information has come available, the arguments against HS2 have multiplied. The claimed benefits to the wider economy of enabling faster travel in the narrow intercity travel market are largely illusory, or at best small. Expanding capacity across the existing rail network and targeted improvements to the road network would provide a far greater contribution to bridging the north-south divide and could be delivered much earlier. HS2 will not be environmentally beneficial. At best, it will be carbon neutral. It is expected to generate a great deal of additional traffic which in turn will generate more road trips at either end of the journey, to harm the environment. This major new route will create noise, visual intrusion and serious severance effects across hundreds of miles of urban and rural areas.

8.5 Our analysis has shown the economic benefits to users are much less than claimed. We have shown that the traffic demand for HS2 is likely to be at least 29% lower than forecast. The risks in the demand forecasts have been considerably increased by extending the forecasting period well beyond the time frame for which the assumptions used can be regarded as reliable. Furthermore, the crowding benefits that have been claimed only arise because an unrealistic base case for comparison has been used. If the scheme were compared with the optimised alternative proposed by 51M, or with the RP2 alternative proposed by the DfT's own consultants, the crowding benefits would disappear. We have also indicated that the reliability benefits of HS2 have been overstated but it is difficult to estimate by how much. Finally, the benefits of faster rail journey times to business travellers are much less than has been assumed because working time spent of trains is not wasted as the current evaluation assumes.

8.6 The effect of these adjustments, and others arising from our review, on the results of the economic appraisal of HS2 are shown in Table 8.1. We would emphasise that these adjustments are not sensitivity tests but are our assessment of more realistic central assumptions to the evaluation. They show that there is no economic case for building HS2. The BCR from the Government's own transport user cost/benefit analysis is 1.6. The adjusted BCRs are approximations to the outcome of a full reappraisal but they give a reasonable estimate of the impact of these proposed revisions. They do not include any adjustment to shorten the forecast period to within the reliable range or for a reduction in the reliability benefits, although we believe these adjustments should be made in a reappraisal of the scheme. Neither do they allow for an increased level of risk over time by using a higher discount rate, as discussed in paragraph 7.21. A combination of any two of the reasonable adjustments shown in the table eliminates the case for HS2 and the combination of all of them has a massive effect.

Table 8.1 BCR After Adjustments to the Appraisal Assumptions

Adjustment to benefits	**Adjusted BCR from 1.6**
1 Reduce demand forecasts by 29%	1.1
2 Revised base case (no crowding)	1.4
3 Value working time at commuter rate	1.2
4 Operating life 40 years	1.3
Adjustment 2+3	0.9
Adjustment 1+ 2 +3	0.7
Adjustment 1+2+3+4	0.5

Appendix 1

Potential for Video Conferencing as a Substitute for Business Travel

1 Video conferencing and the wider use of the internet have been touted as an alternative to business travel for the past twenty years. However, it is difficult to see significant impacts so far on levels of business travel as a result of these technologies. In fact it is quite possible that internet technologies have encouraged additional business travel as companies and entrepreneurs look further afield for customers, suppliers and contacts.

2 The main take up of the equipment to date has therefore been in large international companies which can afford the costs and see significant savings in international air travel as a result. Indeed, the equipment is often marketed as an alternative to air travel. Technology companies, keen to be seen to practice what they preach to customers, have also been in the vanguard. The rate of take up has been considerably higher in the United States than in Europe.

3 There are a number of reasons why use of video conferencing has not become mainstream:-

(a) High cost of equipment.

(b) Technical complexity of the equipment, so that it was not user friendly but often required a dedicated technician to be on hand to support its operation.

(c) Lack of eye contact between participants, disjointed conversations and general poor feel of the meeting.

(d) Limited number of companies with multiple international locations that could obtain the network benefits of the technology.

(e) Difficulty of linking more than two locations in a single video conference.

4 However, those companies which have adopted the technology see significant benefits. The two main manufacturers of video conferencing equipment, Cisco and Hewlett Packard, both moved quickly to take advantage of its potential. Cisco reduced its annual travel budget from US$ 740 million to US$ 240 million. Hewlett Packard reduced its travel budget by 30%. Other technology companies have also reported significant benefits. Microsoft reported an initial annual saving of US$90 million. In the UK, BT reported savings of £135 million in travel costs in 2006/07, with almost a million face to face meetings replaced. Easynet achieved a 20% cost reduction in travel costs and achieved cost recovery on its investment in less than a year.

5 The use of video conferencing is not restricted exclusively to technology companies. Multinationals such as Procter and Gamble and Deloitte have both adopted the technology and reported benefits. But a recent survey by Easynet reported that two thirds of European businesses have not considered video conferencing, even though 87% could see the potential for saving money. Key concerns were the cost of the technology and the lack of personal touch in meetings. Moreover, some businesses that had adopted the technology were not using it to the full potential.

6 The scope for significantly greater market penetration is clear and there a number of reasons to expect it to be achieved in the next decade. They include:-

(a) The costs of using video conferencing are falling steadily as both IT equipment and communications become progressively cheaper. The application of Moore's law, whereby the number of transistors on a chip doubles every 10 months to two years as the cost halves is having a significant impact on the cost of new installations.

(b) As increasing numbers of companies adopt the technology, the network benefits of becoming a user increase. This is supplemented by the growing numbers of service providers who offer video conferencing facilities for short term hire.

(c) Improvements in ease of use of the equipment and in the "feel" of video conferences. More modern video conferencing facilities give a better feeling of being in a normal meeting, such that the term video-presence is often used to describe them. There is far better eye contact with other users and participants can be based in multiple locations.

(d) Pressure on companies to reduce their carbon footprint. Most companies which have adopted the technology emphasise the reduction in carbon emissions alongside financial savings.

(e) Changing procedures in companies for approving travel. In some cases companies now review travel requests more searchingly to assess whether video or audio conferencing can be used instead.

(f) The continuing search for productivity gains and the needs of regular business travellers, who often prefer the new technology to the pressures of continuous travel.

7 The main application of video conferencing at present is in the business market. However, its use is spreading into the leisure market. The recent acquisition by Microsoft of Skype is said to have been heavily influenced by Skype's video conferencing capability. Young people are now the fastest growing group of Skype users and activities such as having a virtual drink with friends is becoming more common. In the longer term, this will have

knock on effects in the business market, since users who have become familiar with the technology while they are at school will have no difficulty adapting to its use in the world of business.