HS2 Phase Two
West Midlands to Crewe
Economic Case

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Department for Transport

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Preface

This document presents our advice to the Government on the economic case for accelerating the building of part of the Phase Two route from the West Midlands to Crewe, so that we are able to open that stage of the High Speed Two (HS2) network six years earlier than planned, in 2027.

It is one of a suite of documents that sets out the case for accelerating the building of HS2 to Crewe whilst continuing with the overall plan to build the whole HS2 network by 2033. It should be read in conjunction with the Phase 2a strategic case and the Phase Two Command Paper "High Speed Two: East and West - The next steps to Crewe and beyond".[1] These publications summarise the vision for HS2, and provide an update on our plans.

In 2013, HS2 Ltd published the Economic Case for the whole HS2 network. At that point the Government's intention was that Phase One would be built and operational by 2026 and Phase Two seven years later in 2033. In March 2014, the Chairman of HS2 Ltd, Sir David Higgins, published his report 'HS2 Plus'. In it he proposed that "the Government should accelerate Phase Two as soon as possible to take the line 43 miles further north than planned in Phase One, six years earlier than planned".

The aim of this Economic Case is to set out the costs and benefits of accelerating delivery of the section from the West Midlands to Crewe known in this report as Phase 2a, and so to bring some of the benefits of HS2 to the north sooner. This Economic Case provides:

- an update on the costs and benefits of the full HS2 network which the section between the West Midlands and Crewe helps to deliver (referenced in this report as "the full network");
- the value of bringing forward the opening of the additional high speed route to Crewe by six years from 2033 to 2027 (referenced in this report as "The case for acceleration of Phase 2a"); and
- the economic case for building the section of high speed route from the West Midlands to Crewe in its own right (referenced in this report as "Phase 2a as an increment to Phase One").

The Economic Case analysis has been carried out in accordance with HM Treasury's Green Book and the Department for Transport (DfT) Web Based Transport Analysis Guidance (WebTAG). In line with that guidance, our analytical framework continues to be based on "social cost benefit analysis", which attempts to place a monetary value on as many impacts as possible.

HS2 is a unique proposal in that its scale and complexity pushes at the boundaries of standard appraisal practice. The October 2013 Economic Case presented our thinking on how we could extend and improve the appraisal of an infrastructure investment of this size. Since the 2013 Economic Case, we have continued to develop our appraisal methodologies and this Economic Case sets out where and how we have developed our approach since 2013.

[1] Available on www.gov.uk

1 Executive summary

1.1 Overview

1.1.1 Phase One of HS2, due to open in 2026, will see a new high speed line constructed from Euston to north of Birmingham, where it will rejoin the existing West Coast Main Line (WCML). Current proposals are for Phase Two to open in 2033, which will extend the line north and east to join the WCML south of Wigan and the East Coast Main Line (ECML) near York. HS2 will add much-needed additional track capacity to the north–south routes of our railway system, creating opportunities to improve the frequency and reliability of rail services for towns and cities, both on and off the HS2 network.

1.1.2 This document presents an updated analysis of the economic case for HS2. It is the first substantive update to the analysis since the October 2013 Economic Case supporting the Phase One hybrid Bill, and the Phase Two consultation.

1.1.3 This Economic Case supports the Strategic Outline Business Case (SOBC) for the accelerated delivery of a 37-mile section of the Phase Two route between the West Midlands and Crewe (Phase 2a). Accelerating delivery of this section will deliver faster journeys from London to Manchester, Crewe, Liverpool, Preston, Warrington, Wigan and Glasgow. Building faster to Crewe means that the North West and Scotland will see more of the benefits of HS2 earlier.

1.1.4 HS2 is a large undertaking, with significant upfront capital investment but with benefits that will accrue for generations to come. The sheer size of the project, and the longevity of its impacts, magnify the opportunities and risks of investment. It is not possible to forecast far into the future without a degree of uncertainty, and we have therefore continued to focus our economic analysis on understanding the range of possible outcomes, rather than simply providing a single benefit cost ratio (BCR).

1.2 The economic appraisal

1.2.1 Guidance on how to assess the costs and benefits of transport infrastructure projects is set out in DfT's appraisal guidance. As part of this analysis, the costs and benefits are compared against each other to generate the BCR – i.e. the value of benefits (inc wider economic benefits) that would result from every £1 that the scheme costs.

1.2.2 This assessment captures the costs, benefits and changes in revenues for the whole of the rail network – not just those associated with the HS2 infrastructure. This includes the costs of both constructing and operating the railway. The benefits include lower levels of overcrowding on both HS2 and standard rail services, and quicker, more frequent and more reliable journeys for passengers. These costs and benefits are appraised over a 67-year period for the full network, from 2026 (the opening of Phase One) to 2093 (60 years after the opening of the full Y network in 2033).

1.2.3 Since the last Economic Case, we have undertaken a number of updates in the modelling, a combination of updates to our demand forecasts and updates reflecting the changes in the rail network. We have also updated the base costs. These cost

updates continue to make the assumption that the construction costs increase in line with general price inflation (i.e. the GDP deflator) for our reference case. Construction inflation (and growth in other project-specific costs) since 2011 has been higher than background inflation and this may continue over the next 5 years. This was recognised in the spending review to create a project-specific inflation rate. The implications of this higher project-specific inflation rate on the results are discussed in this Economic Case as a sensitivity test.

1.2.4 Overall the BCR spread for the full network reference case with the addition of Phase 2a is now higher than the 2013 Economic Case, with a greater proportion of results, 95%, returning a high value for money and a point estimate BCR of 2.5. This means HS2 continues to provide a robust and high value for money as shown in Figure 1.

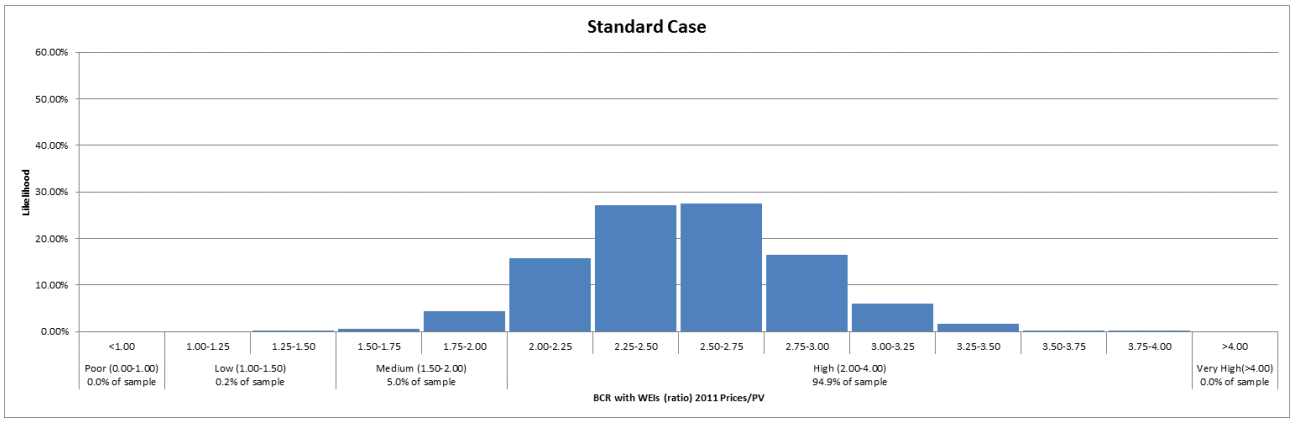


Figure 1: The BCR spread for the full network of HS2 including the acceleration of the Phase 2a section

1.2.5 The impact of assuming that construction costs increase at a project-specific inflation rate up to the year 2020/21 is to increase overall costs and lower the value for money of the scheme. However, the full network still provides a high value for money in 72% of cases, and provides a point estimate BCR of 2.2, only slightly lower than the October 2013 Economic Case.

1.2.6 In this Economic Case, we have also assessed the costs and benefits of accelerating the West Midlands to Crewe route section (Phase 2a). The acceleration of this route is financially positive over the appraisal period, and while there is a slight cost increase in the short term to deliver an additional hybrid Bill to accelerate Phase 2a, there are significant benefits and revenue over the six years between its construction and the construction of the remainder of Phase Two. A BCR cannot therefore be calculated, as the costs net of additional revenues (i.e. the denominator) are negative. We therefore conclude that the acceleration of the Phase 2a route section provides very high value for money, while also improving the value for money of the full HS2 network.

1.2.7 This piece of infrastructure also has to be assessed on its own merits. For this we have looked at the benefits, revenue and costs of the route over those provided by the Phase One scheme, and this is termed the Phase 2a incremental case. To do this we looked at the benefits and revenue using the same train service specification (TSS) as Phase One. This means that our assessment of the Phase 2a increment is a conservative one as the Phase One TSS has been created to support both the Phase

One scheme and to allow a clear route to the full network TSS. Even with this assessment, we see that the reference case for the Phase 2a increment remains a positive one, as shown in Figure 2, with a 63% chance of the scheme returning at least a medium value for money and a point estimate BCR of 1.6.

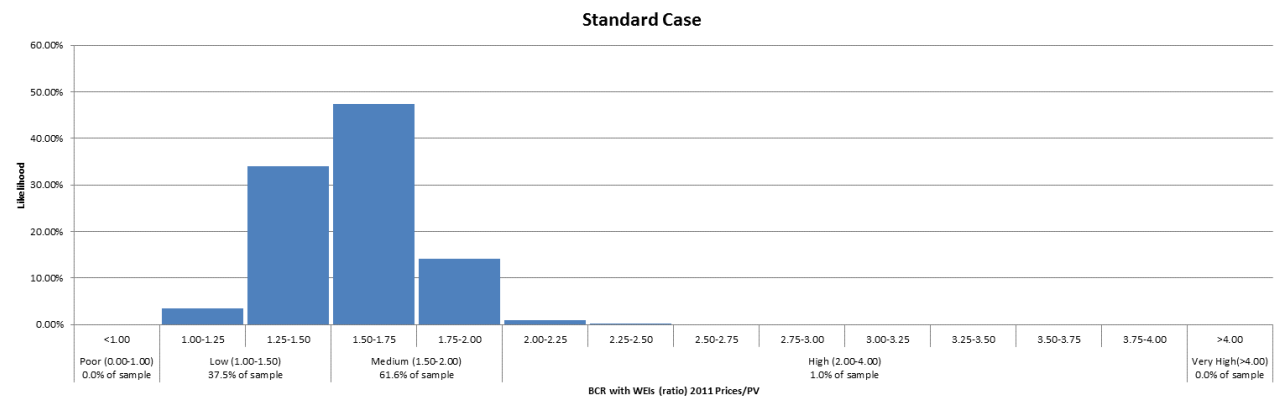


Figure 2: The BCR spread for the Phase 2a incremental case

1.2.8 The impact of assuming higher project-specific cost inflation for the Phase 2a increment is also to lower the value for money. It now provides just over a 7% chance of having a BCR with at least a medium value for money, compared to a 63% change when inflation is in line with the GDP deflator, and a point estimate BCR of 1.3.

1.2.9 We believe these assessments of the case for HS2 to be conservative due to a number of factors, such as the use of a mechanism to stop the level of demand increasing indefinitely, but also the fact that none of our modelling assumes any change in the land use near HS2 stations. Some of the implications of these are investigated in the next section looking at uncertainties.

1.3 Understanding the uncertainties

1.3.1 Although we try to understand and quantify a proportion of the risks and uncertainties in our range of BCRs, some cannot be easily understood in this way. For these, we look at specific scenarios to understand the impact on the case for the scheme. There are four areas in particular that we look at using scenarios: demand cap assumptions, fares, values of time and costs. Each of these are discussed in turn.

Demand cap

1.3.2 One of the key assumptions which drives the BCR we calculate is the amount of demand that we forecast to occur for rail travel in future years. In our reference case, demand growth stops once it has reached a defined level, and the year when that occurs becomes our demand cap. For this economic case, the year when this occurs is 2037, only four years after the opening of Phase Two. More than that, against a backdrop of forecast increases in population, we implicitly assume that the number of rail trips per person actually reduces after 2037.

1.3.3 We have therefore looked at a number of variations in the demand cap. We have looked at the implications of having both a higher and lower amount of demand in the

cap (effectively meaning the cap occurs in a different year). We have also looked at the implications of retaining growth in demand in line with population increases beyond the demand cap year. These changes to the treatment of the demand cap have the potential to significantly improve the business case for the scheme. For example, moving the demand cap to 2044 to accommodate increasing demand by 20% increases the chance that the full network delivers a very high value for money (BCR >4.0) from 0% in the reference case to 35%. Allowing demand to increase in line with population after the demand cap year also produces a significant increase in the scheme BCR, with a 98% chance of at least high value for money.

Fares

1.3.4 Also affecting the economic case is the overall assumption on future fares across the rail network. This affects the economic case for the scheme primarily through the impact on the revenue that the scheme would produce. However, fares also interact with the demand cap, as evidence tells us that lower fares would produce stronger demand growth and therefore the demand cap would be reached earlier.

1.3.5 We have focused our analysis on scenarios where the fares growth is assumed to be lower than in the reference case, taking into account the impacts on demand. A scenario where fares grow in line with RPI inflation over all years of the appraisal without any changes to the demand cap reduces the BCR of HS2 by around 0.4. This reduction in the BCR is partly due to hitting the demand cap significantly earlier. Maintaining a year in which demand is capped, as in the standard case (2037), and applying lower fares assumptions increases the BCR of the full network giving a 99% chance of providing high value for money.

Values of time

1.3.6 Our reference case uses values of time for all passengers that are consistent with current DfT WebTAG guidance. Since the previous Economic Case, the DfT has conducted a significant amount of primary research into values of travel time. This research has been released alongside a consultation to inform future updates to WebTAG. Applying these new values of time to the appraisal of the HS2 scheme leads to a slightly higher BCR for the full network, as the benefits for the scheme increase by around 5% for the full network. However, adopting the alternative values of time has a smaller impact on the incremental case for Phase 2a.

Costs

1.3.7 The HS2 Economic Case uses operating costs that include an allowance for optimism bias in line with Treasury and DfT guidance. Investigating the impact of higher rates of optimism bias in operating costs still delivers a 99% chance of the full network returning a medium or high value for money.

1.4 Impacts on the wider economy

1.4.1 In addition to estimating direct transport user benefits in our analysis, we have also considered the additional wider economic impacts of Phase 2a. These wider impacts are not insignificant. We estimate the benefit value of these for the full network (with

Phase 2a) to be around a fifth of total benefits. Of these, more than half are due to agglomeration benefits that reflect improved opportunity for business, supplies and workers located in different areas of the country to interact with one another.

2 Introduction

2.1 Scope and purpose of this document

2.1.1 This document sets out HS2 Ltd's advice to the Government on the economic case for Phase 2a of HS2. It is published alongside the SOBC for Phase 2a, setting out the five cases for the scheme (Economic, Strategic, Commercial, Management and Financial). These together set out the complete rationale for building the HS2 route to Crewe six years earlier than originally planned.

2.1.2 Phase 2a is defined as the section of the western leg of Phase Two of HS2 that extends for 37 miles from the end of the Phase One network at Fradley to Crewe. At the Northern end, the Phase 2a high speed network connects with the WCML south of Crewe. North of this junction with the WCML, the high speed track continues to a tunnel portal south of Crewe that will enable the route to be developed for the remaining parts of Phase Two in line with the proposals put out to consultation in 2013. Phase 2a includes an infrastructure maintenance depot located in the Basford area south of Crewe. The alignment is largely consistent with the route that was consulted in 2013, with some route refinements made in response to the consultation, or to reflect lessons learned from the development of the Phase One design.

2.1.3 This Economic Case analyses the potential value for money of the proposed Phase 2a of the HS2 scheme, building the HS2 network between the West Midlands and Crewe so that it opens just one year after Phase One, in 2027.

2.1.4 It does not consider the value for money of alternatives. A separate Rail Alternatives report has been prepared that considers alternatives to the scheme analysed in this Economic Case.

2.1.5 This Economic Case informs part of the Government's SOBC for Phase 2a of HS2. The SOBC stage of developing a major project outlines a high-level indicative view on what the project is intended to deliver, the benefits of this, and costs in delivering the project. The project will move through the business case development stages until a Full Business Case is produced to support a final investment decision. The scope, costs and schedule of the scheme will be refined during this development process to provide greater confidence in the scheme's value for money. Therefore, at this SOBC stage, assumptions and modelling inputs including the scheme design and train service specification (TSS) are indicative. These indicative assumptions reflect our current best assessment of the Phase 2a scheme and are designed to provide Government with sufficient confidence about the intentions and outputs of the project to proceed beyond the SOBC stage.

2.2 Document structure

2.2.1 This document is structured as follows:

- Chapter 3 gives an overview of our approach to economic appraisal and summarises what has been changed or updated in the modelling framework

since the October 2013 Economic Case;

- Chapter 4 sets out the economic appraisal using the standard approach and assumptions;
- Chapter 5 examines the impact of changing key assumptions on the Economic Case;
- Chapter 6 sets out how some of the limitations of the standard appraisal framework and wider economic impacts;
- Appendix 1 sets out the modelling approach using the PLANET Framework Model (PFM);
- Appendix 2 sets out the scheme service patterns assumed for modelling purposes;
- Appendix 3 has more detail on cost assumptions;
- Appendix 4 sets out more detail on the benefits and the calculation of the BCR;
- Appendix 5 reports transport impacts from the standard case;
- Appendix 6 reports point estimate BCRs for the following scenarios:
  - standard case;
  - higher levels of demand: Demand cap 20% higher; and
  - alternative values of time; and
- Appendix 7 sets out examples of the journey times used in this Economic Case.

2.3 Supporting documentation

2.3.1 For more information on certain aspects of the analysis, this economic case should be read in conjunction with other reports. These include:

- PLANET Framework Model (PFM V5.2) – Model Description;
- risk analysis for the HS2 Economic Case – Technical documentation;
- assumptions report: PLANET Framework Model Version 5.2;
- summary of the key changes to the Economic Case Since October 2013;
- audit of development of the PLANET Framework Model versions 4.3 to 5.2 and use for the HS2 Phase 2a SOBC;
- Model Development Report: PLANET Framework Model version 4.3 – 5.2; and
- Atkins Model Development report, PFMv4.3 to PFMv5.2: Updating the Exogenous Forecasts.

3 Our analytical framework

3.1 Overview and our approach to economic appraisal

3.1.1 In October 2013, the Economic Case for HS2 Phase One and the full HS2 network was published in advance of the depositing of the Phase One hybrid Bill[2]. That Economic Case, and the associated documents published at that time, set out extensive details of our modelling approach and methodology. Since that Economic Case, we have continued to review and update our appraisal methodology and modelling framework to further enhance our ability to assess the impact of HS2 on the UK.

3.1.2 Rather than repeat all the information published in the October 2013 Economic Case, this chapter gives brief details of our approach to economic appraisal and the key changes we have made to our methodology since the October 2013 Economic Case.

3.1.3 We would suggest that readers interested in the details of our modelling and appraisal techniques read this Economic Case in conjunction with the supporting documentation referenced in Section 2.3.

3.2 Route and design

3.2.1 The capital costs for the Phase 2a scheme reflect the current design being used to assess the route decision and support the decision to progress a separate hybrid Bill. The capital costs for the full network reflects the scheme as presented as part of the route design in the engineering reports produced by HS2 Ltd. There have been updates to the design of the route including:

- responding to consultation responses;
- reflecting lessons learnt from the development of the Phase One route; and
- reflecting technical requirements to address issues like highways and watercourse clearances.

3.3 Demand forecasts

3.3.1 Our forecast of the number of passengers expected to travel on HS2 remains a central element of the economic case. Since 2013, we have updated our approach to forecasting demand in order to incorporate:

- changing external factors, such as revised assumptions on economic growth from the Office for Budget Responsibility (OBR);
- the latest evidence on how rail demand changes in response to economic growth, as set out in WebTAG guidance; and
- the latest government policy on rail fares, reflecting the commitment to

[2] The Economic Case for HS2, October 2013, available at https://www.gov.uk/government/organisations/high-speed-two-limited

maintain rail fares at 0% above RPI for the duration of this parliament.

3.4 Updates to the modelling approach

3.4.1 The transport impacts in this economic case continue to be forecast using a computer model called the PLANET Framework Model (PFM). HS2 Ltd continues to make updates and enhancements to the model, and the evidence underpinning it, in order to improve the accuracy of our forecasts. Since 2013, the primary updates to the model cover an update to both the method and the data used to model the increased reliability of HS2 services. These changes update the underlying data on network performance to use data from Network Rail's Paladin Data Extract and Reporting System[3], update the HS2 reliability assumptions and change the method to one that can be more easily applied in a coherent way across the whole HS2 network.

3.5 Updates to the without HS2 baseline

3.5.1 The without HS2 baseline (or "Do-Minimum") against which HS2 is compared has been updated to reflect recent changes in franchise commitments and updates to the high-level outputs specification for the period 2014–2019 (and some beyond this point). In particular, the updated Do-Minimum has updated the WCML timetable to reflect the current timetable, including the through running services from London to Scotland via Birmingham and the conversion of a first class carriage to standard class. It has also updated the ECML to reflect the Intercity Express Programme services and the latest franchise specification including services to Lincoln and Middlesbrough. Further updates have also been provided to the Midland Mainline, and London Midland services.

3.5.2 The service specifications assumed to have been implemented by 2026 in the model rely on a number of schemes that are or may be affected by the review of Network Rail's investment programme by Sir Peter Hendy. The service assumptions also do not reflect the recent decision from the Office of Road and Rail regarding the Great North Western Railway application.

3.6 HS2 service patterns

3.6.1 Phase 2a is assumed to have the same HS2 service pattern as Phase One. This means that we assume the same number of services, and stopping pattern, as presented in the October 2013 Economic Case, but in the period 2027 to 2033 some services gain the benefit of a 13 minute reduced journey time by using the new high speed section of track. No further rolling stock would be required between 2027 and 2033 in addition to what is planned for Phase One. Using the Phase One TSS as set out for modelling purposes in the 2013 consultation, the following HS2 services would take advantage of that journey time saving:

- the London to Glasgow service;

[3] Paladin Data Extract and Reporting System: a versatile train performance measurement facility producing analysis reports focusing on train performance and delay attribution.

- the London to Preston service;
- the London to Liverpool stopping at Crewe, Runcorn and Liverpool; and
- two of the three London to Manchester services (the third Manchester service is assumed to route via, but not stop at, Stoke).

3.6.2 Our base proposal is to accelerate delivery of one aspect of the Phase Two route: the route between Fradley and Crewe (Phase 2a). Our economic appraisal of this "base acceleration case" proposition then applies a conservative set of assumptions. The above TSS allows for consistent operations with Phase One, but we recognise that an optimised TSS could deliver further benefits. We then assume that the Phase Two TSS (as set out for modelling purposes in the 2013 consultation) will be implemented when the full HS2 network is delivered in 2033.

3.6.3 We have explored through sensitivity tests whether further benefits could be achieved by varying the TSS – for example, routing all three of the Manchester-London services via Crewe so all services benefit from some of the journey time saving of Phase 2a. Full details of the service patterns can be found in Appendix 2.

3.7 Cost estimation

3.7.1 Costs used in the BCR analysis include: construction costs; rolling stock costs; depot costs; infrastructure renewal costs and operating costs of the railway infrastructure and trains required for the HS2 project (including savings to services on the existing National Rail network that will be replaced or amended following the introduction of HS2 passenger service).

3.8 Use of risk analysis

3.8.1 This Economic Case continues the practice initiated in the October 2013 Economic Case to report probabilities and distributions for the scenarios covered rather than just point estimate BCRs. The modelling for the risk analysis has been updated in line with the rest of the modelling framework and has also extended the risk analysis to fully include variations in the wider economic impacts.

4 Reference case results

4.1 Introduction

4.1.1 This chapter sets out the economic appraisal of the three core scenarios covered by this economic case, deploying a specific set of assumptions for projecting costs and benefits into the future. This is called the "reference case". The reference case set out in this chapter is supplemented by a section illustrating some potential additional enhancements and alternative service patterns that may unlock additional benefits from Phase 2a with appropriate additional investment.

4.1.2 The previous economic appraisal of HS2 assessed the case using a range of different scenarios (futures) to better understand the robustness of the case to different assumptions. This method of assessment enables better understanding of the resilience of the case. This economic case continues to present the case using that approach.

4.1.3 The reference case assumed in this chapter makes the same set of assumptions regarding cost growth increasing in line with general price inflation (i.e. the GDP deflator), as used in the previous (October 2013) Economic Case. Construction inflation (and growth in other project-specific costs) since 2011 has been higher than background inflation, and this may continue over the next five years. This was recognised in the spending review to create a project-specific inflation rate. We will continue to keep the treatment of project-specific inflation and other changes to the BCR methodology under review. For this Economic Case, we present the impact of a project-specific inflation rate that is higher than general inflation in Section 4.6 after the reference case is presented. Although the addition of this project-specific inflation reduces the scheme BCRs, it does not materially affect the value for money of the full HS2 network, or the case for the acceleration of Phase 2a.

4.2 Core scenarios

4.2.1 This chapter sets out:

- an update to the costs and benefits of the full HS2 network incorporating the acceleration of the route between the West Midlands and Crewe (the full network);
- the value of bringing forward the opening of the additional high speed route to Crewe by six years from 2033 to 2027 (the acceleration of Phase 2a);
- the economic case for building the additional incremental section of high speed route from the West Midlands to Crewe in its own right (Phase 2a as an increment to Phase One); and
- the impact that assuming a project-specific inflation rate would have on the value for money of the scheme.

All benefits and BCRs in this chapter include wider economic benefits.

4.3 Risk versus uncertainty analysis

4.3.1 When projecting costs and benefits into the future, assumptions have to be made about a number of unknowns. There are unknowns about future levels of demand, people's future willingness to pay for high speed rail travel, and hence revenues. There are also risks in the estimation of costs.

4.3.2 In this document, unknowns have been classified into 'risks' and 'uncertainties'.

4.3.3 The term 'risk' is used for unknowns for which it is possible to derive a statistically robust understanding of the likelihood of different values occurring. For example, the OBR produces a short-run central estimate of growth which we use for the standard point-estimate of the BCR. The OBR also produces a range of different GDP outcomes over the next five years, and attaches its best understanding of likelihood to those different outcomes over that period.

4.3.4 Where the likelihood of different values can be quantified in this way, we have used established statistical techniques to analyse the impact of many of these factors, acting together, on the returns on investment, and hence determine the likelihood of different levels of return.

4.3.5 This approach relies on the definition of probability distributions of possible values for key factors, and the repeated simulation of the impact of different combinations of those factors on the outcomes in question. A key advantage of such an approach is that it guards against excessive weight being placed on extreme outcomes that would require the coincidence of a set of unlikely events to occur.

4.3.6 For our analysis, 'uncertainties' are defined as unknowns for which there is not a statistically based understanding of the likelihood of different values occurring. In some instances, this may be because there is no statistically robust evidence; in other instances, there may be competing theories on how a value should be derived.

4.3.7 For this Economic Case, such uncertainties have been analysed as discrete scenarios, and for each scenario, a risk analysis is conducted to give a distribution of outcomes.

Table 1 sets out the key factors that have been analysed with a) risk analysis and b) scenario tests.

Variables explored as part of risk analysis	**Variables explored through alternative scenarios**
Short- and long-term economic growth (GDP) which feeds into: • projections of demand and revenue; and • valuation of time savings and other impacts.	When and/or at what level the growth in long-distance rail demand is capped.
The value placed on time savings by leisure travellers and commuters.	The value placed on time savings by businesses, and new values of time.

Variables explored as part of risk analysis	Variables explored through alternative scenarios
The sensitivity of demand projections to economic growth and level of fares.	Rail fares assumptions for the network.
How sensitive leisure and commuter travellers' valuation of time is to the growth in GDP.	Operating cost optimism bias assumptions.
Rolling stock costs for Phases One and Two using the quantified risk assessment work undertaken by HS2 Ltd.	Construction cost inflation.

Table 1: Variables examined through risk analysis and scenario tests

4.4 Reference case risk analysis

4.4.1 This section presents risk analysis results for the reference case. The factors presented in the left-hand column of Table 1 above are allowed to vary in the risk analysis according to their statistical distributions.

4.4.2 The point-estimate BCRs for Phase 2a and the full HS2 network with and without the acceleration are reported in Appendix 6.

The full network

4.4.3 Figure 3 presents the results for the standard case risk analysis for the full network incorporating the acceleration of Phase 2a. The chart shows the relative probability of different levels of BCR, mapped against DfT's value for money categories. For the factors included in the risk analysis, which include economic growth and variations in the value of time for commuting and leisure passengers, the value for money of the full network continues to be strongly weighted towards the higher value for money categories.

4.4.4 The chart shows an almost 95% chance of having a BCR with wider economic impacts of greater than 2. The chart also shows that there is a very low risk (for the factors analysed) of the scheme yielding 'low' value for money; around a 1 in a 500 chance.

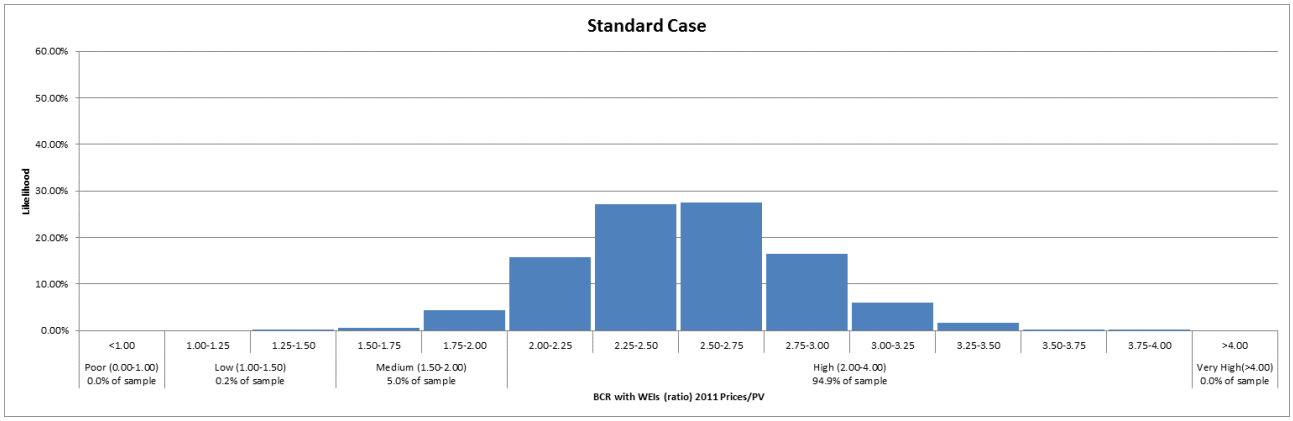


Figure 3: Results of analysis for full network BCR

4.4.5 This cannot be directly compared to the previous Economic Case in 2013 as that Economic Case did not incorporate Phase 2a as a distinct segment of the network. The TSSs used can be found in Appendix 2.

The acceleration of Phase 2a

4.4.6 Table 2 presents the additional benefits, revenue and costs of bringing forward the opening of the high speed route from the West Midlands to Crewe by six years from 2033 to 2027. The acceleration of Phase 2a adds benefits to the overall full network by delivering part of the full HS2 journey time savings earlier. The acceleration of Phase 2a also delivers a cost saving in appraisal terms compared to delivering the Phase Two network in a single stage in 2033. The acceleration leads to a modest increase in operating costs, and the need for an additional hybrid Bill leads to a small increase in undiscounted construction costs. However, the acceleration of Phase 2a leads to a reprofiling of construction costs over time. As future costs are discounted back into a present value for inclusion in the BCR, this reprofiling reduces the present value of construction costs by £268 million.

4.4.7 The cost savings in present value terms, combined with an increase in revenues from accelerating the Phase 2a network by six years, mean that the scheme is financially positive over the appraisal period. A BCR is intended to compare the benefits to society of a scheme relative to the cost to Government of that particular proposal. In the case of acceleration, the revenue generated outweighs the small capital and operating cost. A BCR therefore cannot be calculated, as the scheme is financially positive and there are no net costs against which the scale of benefits can be compared. No risk analysis has therefore been conducted, due to the fact that we cannot calculate a BCR.

£m 2011 prices present value (PV)	
Transport user benefits (business)	£279m
Transport user benefits (other)	£90m
Other benefits	-£5m
Loss of indirect taxes	-£30m
Net transport benefits	£333m
WEIs	£62m
Net benefits including WEIs	£394m
Capital cost	£-268m
Operating costs	£25m
Revenues	£346m
Net costs to Government	-£589m

Table 2: The acceleration of Phase 2a – benefits, revenue and costs

4.4.8 Figure 4 shows the difference in construction cost profile for the accelerated full network against the standard full network. This shows both the undiscounted construction cost profile (blue line) and the discounted construction cost profile we have used in the appraisal (red line)[4].

4.4.9 In the graph, the costs of delivering the route section from the West Midlands to Crewe are brought forward and are discounted less than in the standard full network case. These can be seen, for example, through an increase in costs in 2023/24 relative to the standard full network. However, construction of the other sections of Phase Two, which represent a significantly larger cost, is assumed to start later based on timescales for Royal Assent for a second hybrid Bill. The main construction works for the remainder of Phase Two are assumed to start in 2025/26 in the accelerated full network scenario, whereas in the standard full network scenario, works would have been a couple of years into progress by this point.

4.4.10 This means there are significantly lower construction costs around 2025/26 in the accelerated case, and these costs materialise later with higher costs for all years from 2027/28 onwards. The delay in these costs means that they are more heavily discounted and for a longer period. As a result, the present value of construction costs is lower for the accelerated network than for the standard full network.

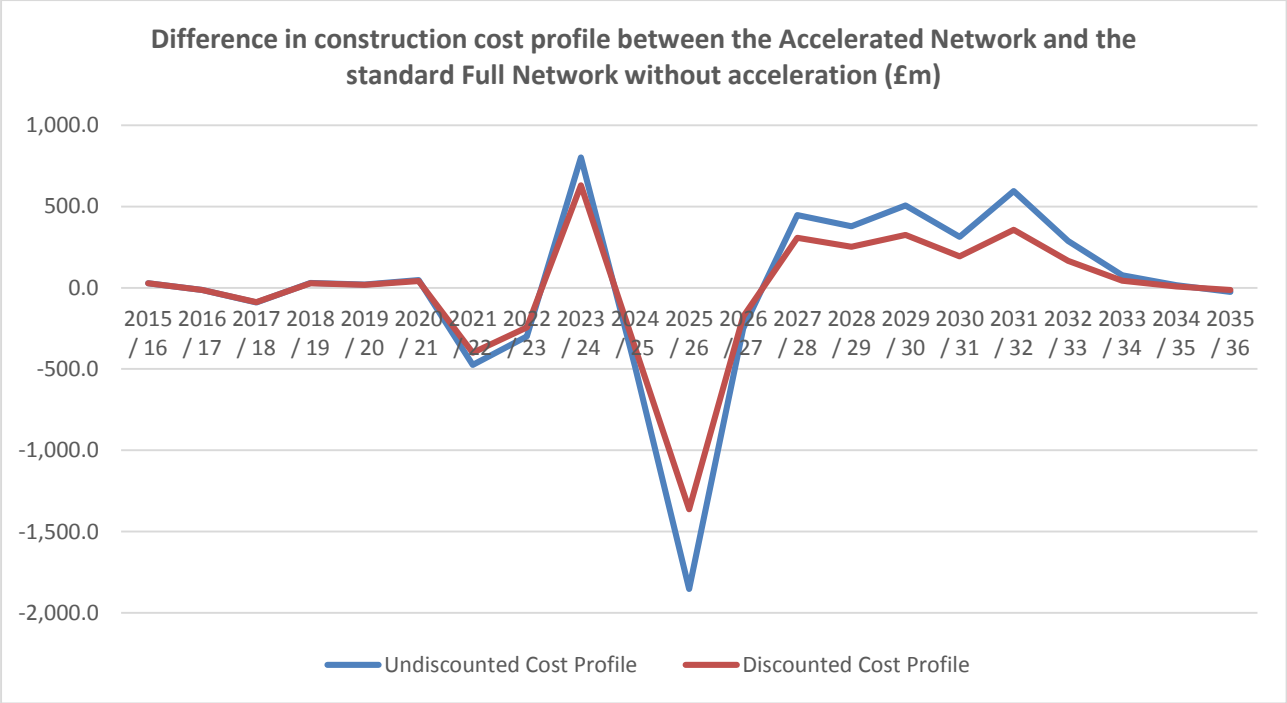


Figure 4: Difference in spend profile between the accelerated full network and the full network without acceleration

[4] To convert the construction cost profile into appraisal terms, the costs are discounted to a present value to reflect that people prefer to consume goods and services now rather than in the future, and they are converted into market prices to reflect indirect taxes to ensure the same unit of account is used as when assessing benefits. These concepts are described further in TAG Unit A1-1.

Phase 2a as an increment on Phase One

4.4.11 This test considers the benefits, costs and revenue of the Phase 2a scheme over that of the Phase One network. For the purposes of this appraisal we assume the same service specification as Phase One. For the incremental case, this is an assumption applied to enable consistent comparison with the other scenarios discussed above.

4.4.12 Figure 5 shows the results for the Phase 2a incremental risk analysis as a chart. It shows the relative probability of different levels of BCR against the value for money categories.

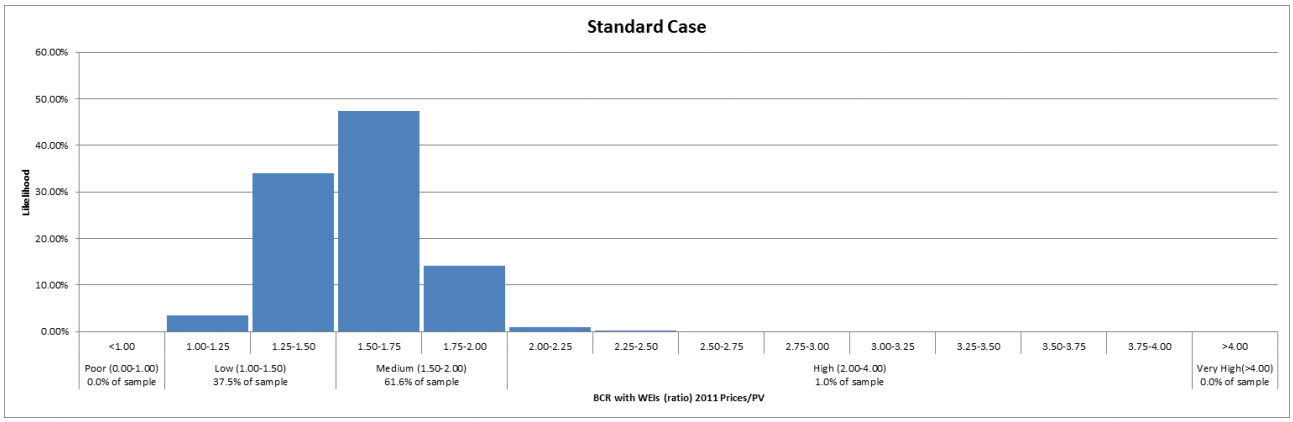


Figure 5: Results of analysis for Phase 2a as an increment on Phase One BCR

4.4.13 For the factors included in the risk analysis, the value for money of the scheme is weighted around the medium and low value for money categories, with just over a 63% chance of the Phase 2a scheme as an increment having a BCR with wider economic impacts of greater than 1.5 (at least medium value for money).

4.4.14 The assumptions for this analysis are particularly important. For the acceleration of Phase 2a, we assume that the TSS run for Phase 2a evolves into the TSS for the full network in 2033 (when the full network becomes operational). For Phase 2a as an increment on Phase One, we assume the Phase One TSS runs throughout the 60-year appraisal period. This is a conservative assumption. If a decision was taken not to deliver the rest of Phase Two, there would likely be scope to reconfigure the TSS to deliver an optimised stopping pattern.

4.5 Phase 2a alternative service patterns

4.5.1 Not building the remainder of the Phase Two network beyond Phase 2a would potentially allow alternative TSSs to be run that may provide greater benefits. We now look at the impact of variant service patterns on overall benefits and revenue and compare these to our incremental standard case. These serve to show that there are potentially further benefits possible from the incremental Phase 2a scheme in addition to the benefits presented in this Economic Case.

Manchester services routing

4.5.2 The standard case assumes the same service pattern and routing as Phase One, with two out of three hourly HS2 services to Manchester routed via, but not stopping at,

Crewe and using the additional HS2 infrastructure. The third of the hourly HS2 services to Manchester would not take advantage of the journey time improvements on offer from the additional Phase 2a infrastructure. We have looked at the impact on benefits and revenue for Phase 2a as an increment over Phase One, were this third service to be rerouted via Crewe. However, due to possible congestion on the line between Crewe and Manchester, a pathing allowance may be required. For the purposes of this test that pathing allowance has been assumed, as a conservative assumption, to be four minutes. This pathing allowance therefore reduces the journey time saving for Manchester services using the Phase 2a infrastructure from 13 minutes to nine minutes[5]. We have allowed for additional infrastructure cost, which may be required for this routing, of £200m including contingency (2011 prices). Table 3 shows the changes in benefits and revenue resulting from this re-routing of the third hourly Manchester service. As can be seen from the table, overall this would increase the BCR for Phase 2a as an increment.

£m 2011 prices present value (PV)	Phase 2a standard case	Phase 2a Manchester reroute	Difference
Transport user benefits	£1,978m	£2,123m	£145m
Other benefits	£5m	£5m	£0m
Loss of indirect taxes	-£117m	-£125m	-£8m
Wider economic benefits	£366m	£377m	£11m
Net transport benefits	£2,227m	£2,375m	£148m
Construction costs	£2,677m	£2,824m	£147m
Operating costs	£122m	£122m	£0m
Revenues	£1,376m	£1,490m	£114m
BCR	1.56	1.63	0.07

Table 3: Benefits and revenue changes from a Manchester service rerouting

Additional intermediate stops

4.5.3 As a further measure, additional stops could be put on HS2 train services, such as additional calls at Crewe to provide additional connectivity to the wider North West and Wales. In particular, we have looked at the impact of adding additional stops on one of the three HS2 trains per hour to Manchester and on the hourly HS2 London to Scotland service.

4.5.4 This uses the TSS set out in Appendix 2 but with the additional stops on the two services detailed above. This TSS provides benefits over the standard case as shown in Table 4, which shows the benefits and revenue for the incremental case a result of this

[5] All non-Manchester services still save 13 minutes over their Phase One journey times

altered stopping pattern. For this test, we do not calculate a BCR, as the requirements on the level of infrastructure (if any) and the associated capital costs are not fully understood at this time.

£m 2011 prices present value (PV)	Phase 2a standard case	Phase 2a additional stops at Crewe	Difference
Transport user benefits	£1,978m	£2,280m	£302m
Other benefits	£5m	£7m	£2m
Loss of indirect taxes	-£117m	-£141m	-£25m
Net transport benefits	£1,866m	£2,144m	£279m
Revenues	£1,376m	£1,627	£252m

(note: some numbers may not sum due to rounding)

Table 4: Benefits and revenue impacts from additional stops at Crewe

4.5.5 If this type of service pattern were used during the period 2027 to 2033, further issues would need to be resolved. In particular, the full network service pattern from 2033 onwards does not have calls at Crewe on the Manchester and Scotland services. To manage this, one of the following would need to occur:

- additional calls at Crewe removed from 2033 onwards (i.e. a temporary increase in number of HS2 services stopping at Crewe, for 6 years only);
- retention of the additional calls at Crewe from 2033 onwards, which would lead to those services which call having slower journey times compared to current journey time assumptions for the full network. On current designs for the HS2 alignment, this would significantly reduce benefits for the full network, because services calling at Crewe cannot rejoin the HS2 network to continue north to Manchester and Scotland. These services would therefore have to remain on the classic WCML north of Crewe in this scenario.
- provision of further infrastructure to create a Crewe hub that would allow HS2 services to call at Crewe and then continue their journey north along the HS2 line. Creating the hub would entail some level of cost.

4.5.6 We intend to undertake further work as part of the next stage of development for the Phase 2a business case and Crewe hub development (being led by Network Rail) to identify how further calls at Crewe could be accommodated, and what that would mean for costs and benefits for the scheme as a whole.

4.6 Impact of project-specific cost inflation

4.6.1 The reference case presented in this Economic Case assumes that the costs for the HS2 scheme increase in line with the general rate of inflation. We now consider the

implications for value for money of assuming that costs grow in line with a higher rate of project-specific inflation until 2020/21.

4.6.2 The project-specific inflation included here is an estimate of the higher construction inflation that the project may incur going forwards to 2020/21. Construction inflation since 2011 has been higher than background inflation, and this may continue over the next five years.

4.6.3 This project-specific inflation rate would increase the overall capital cost (discounted and in 2011 prices) by just under 12% for the full network. Figure 6 shows the BCR range with this construction cost assumption.

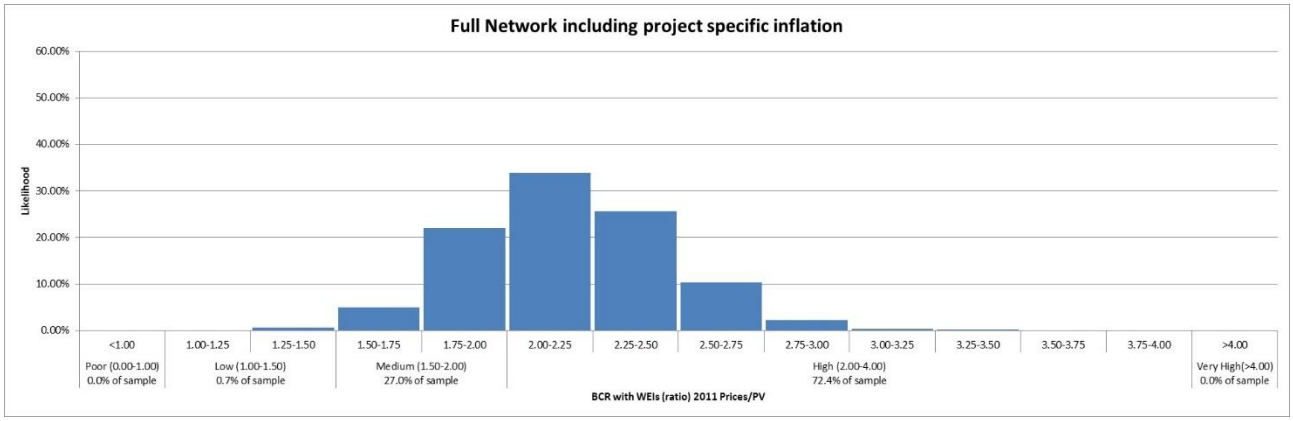


Figure 6: Full network including Phase 2a BCR spread with project-specific inflation included

4.6.4 Figure 6 shows the BCR spread for the full network with the Phase 2a acceleration and the project-specific inflation rate. This sensitivity provides a point BCR estimate of 2.2 and still provides at least a high value for money in 72% of cases.

4.6.5 The response of the range of BCRs for the Phase 2a increment to assuming higher project-specific inflation is a bit more noticeable, as shown in Figure 7. The incremental case now has just over a 7% chance of having a BCR with at least a medium value for money, compared to a 63% chance when inflation is in line with the GDP deflator. It represents poor value for money in 2% of cases, with a point estimate BCR of 1.3. However, as mentioned in the reference case analysis, this is a conservative assessment of the incremental case. The service pattern is not designed to produce the highest level of benefits in the incremental case; rather, it is designed to move seamlessly into the full network TSS.

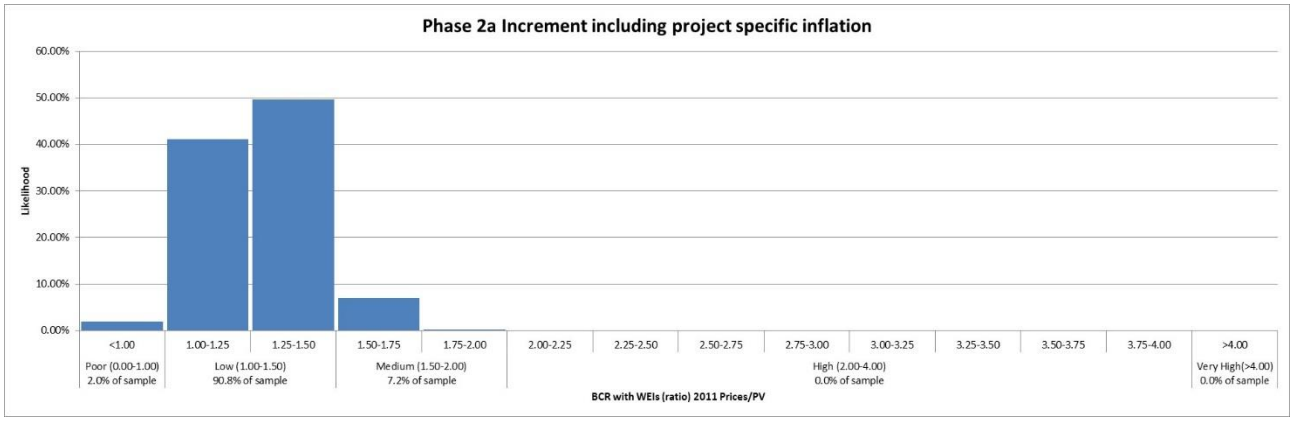


Figure 7: The Phase 2a incremental case including project-specific inflation

4.7 Conclusions

4.7.1 This chapter shows that the standard economic appraisal for the full network including the acceleration of the route between the West Midlands and Crewe continues to be weighted towards higher value for money categories. This is resilient to varying a wide variety of important inputs into the case. It also demonstrates a strong case for accelerating the scheme as part of the full network, as it enables benefits from that element of the HS2 infrastructure to be brought forward.

4.7.2 The scenarios looking at alternative service pattern options suggest the potential to realise further benefits in both the acceleration case and the incremental case. A full assessment of value of money in these scenarios requires developing our understanding of the level of infrastructure investment required. The work looking at the optimal infrastructure and TSS for the incremental case is at an early level, and further work to understand the implications on the business case may be required.

4.7.3 A sensitivity analysis that includes project-specific inflation in construction costs produces lower BCRs than under the reference case. These reductions, however, do not materially affect the case for the full network of HS2, or the case for acceleration.

5 Impact of alternative assumptions

5.1 Introduction

5.1.1 There are a number of variables that can have a significant impact on the economic case for HS2. In particular, these include the rate of growth of demand, level of demand, fares, cost and optimism bias assumptions, and the value of time. This section looks at each of these key variables and examines the sensitivities of the case to changes in these variables.

5.2 Impact of long-term demand assumptions

5.2.1 The rate of demand growth, and the ultimate level of demand assumed, has a significant impact on the economic case for HS2. A range of possible demand scenarios have therefore been tested for this SOBC.

5.2.2 Our standard approach to forecasting demand growth remains as set out in the 2013 Economic Case. Guidance on the relationships between rail demand growth and other economic factors is set out in WebTAG and is, in large part, based on the rail industry's Passenger Demand Forecasting Handbook (PDFH). In line with updates to WebTAG, our analysis now draws many of its parameters from the most recent version of the handbook – PDFH5.1.

5.2.3 However, this analysis is conducted on the basis of the demand being capped in a specific year. This demand cap prevents the benefits and revenue from increasing as a result of additional passenger demand after this point. This approach was originally based on previous advice in WebTAG guidance that stated "it is not reasonable to expect rail demand to grow indefinitely and therefore benefit streams and revenues (and therefore demand) should be held constant after a given period of time". As in previous iterations of the economic case, that date has been set according to the year in which the number of rail journeys greater than 100 miles nationwide reaches a certain level. This approach for the economic case for HS2 has been agreed with DfT, as HS2 is a long-term infrastructure project and it is therefore in accordance with the DfT's wider approach to appraising rail projects.

5.2.4 In the modelling to support this update, this level of demand would be reached in 2037, four years after the opening of Phase Two.[6] The demand growth seen in these forecasts could be considered conservative. If we look at the rate of long-distance demand growth since our models base year of 2010, we see an average annual growth rate of 3.3%; however, HS2's growth forecasts show an average growth rate of 2.2%.

5.2.5 Figure 8 shows how the current data on rail growth is currently outpacing our forecasts.

[6] The previous October 2013 Economic Case saw the same level of demand reached in 2036.

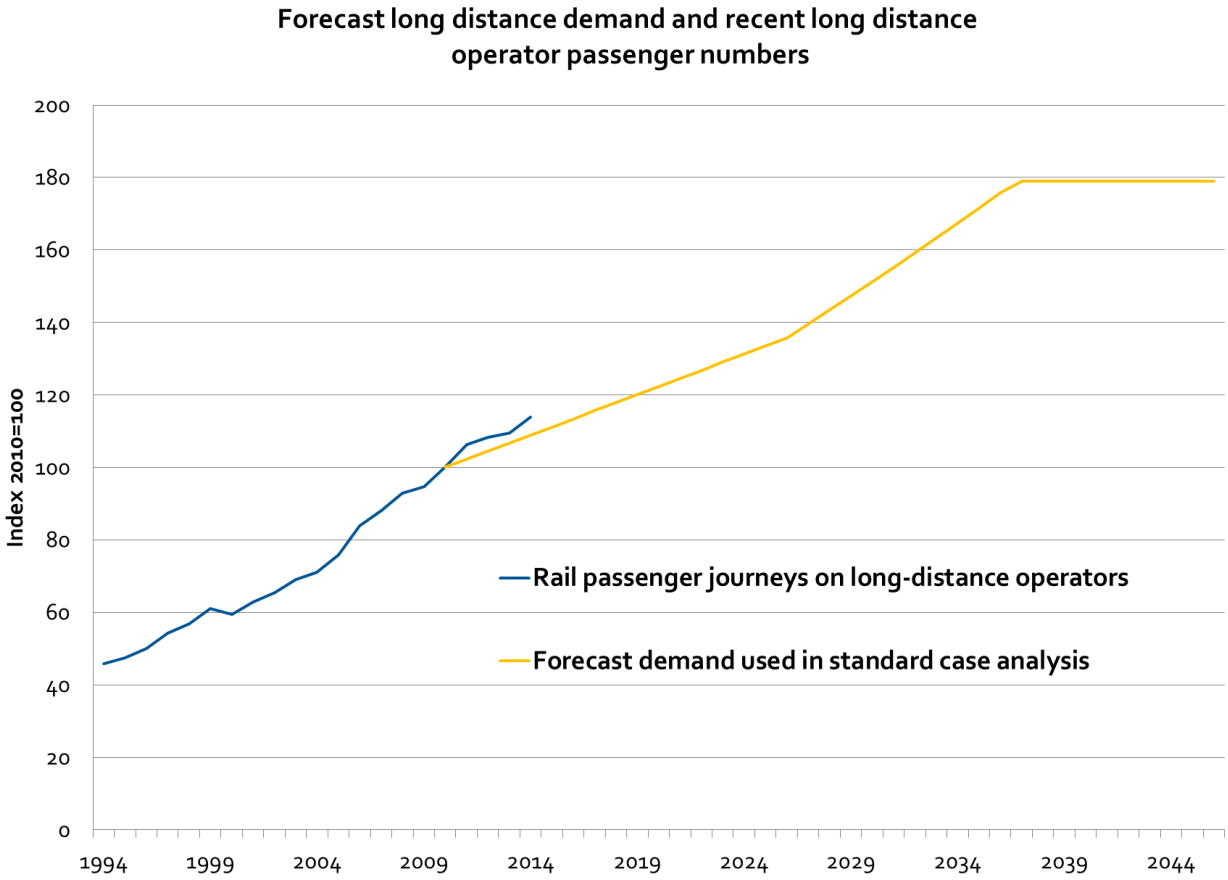


Figure 8: Recent trend for growth in journeys on long-distance operators' services compared to our forecast for future rail journeys over 100 miles without HS2

5.2.6 The next section of the document looks at the impact of changing the demand cap to understand the risks and opportunities around the value for money of the scheme.

Higher levels of demand

5.2.7 Figure 9 shows how the BCR for the full network with the acceleration of the West Midlands to Crewe route section responds to relaxing the demand cap. In particular, it shows the impact of increasing by 20% the level of demand which defines the cap year: the demand cap year would move out to 2044 (still only 11 years after the opening of the full network), and the point estimate of the BCR would increase to 3.8. The scheme now also has a 99.9% chance of providing high or very high value for money compared to 95% for the standard case.

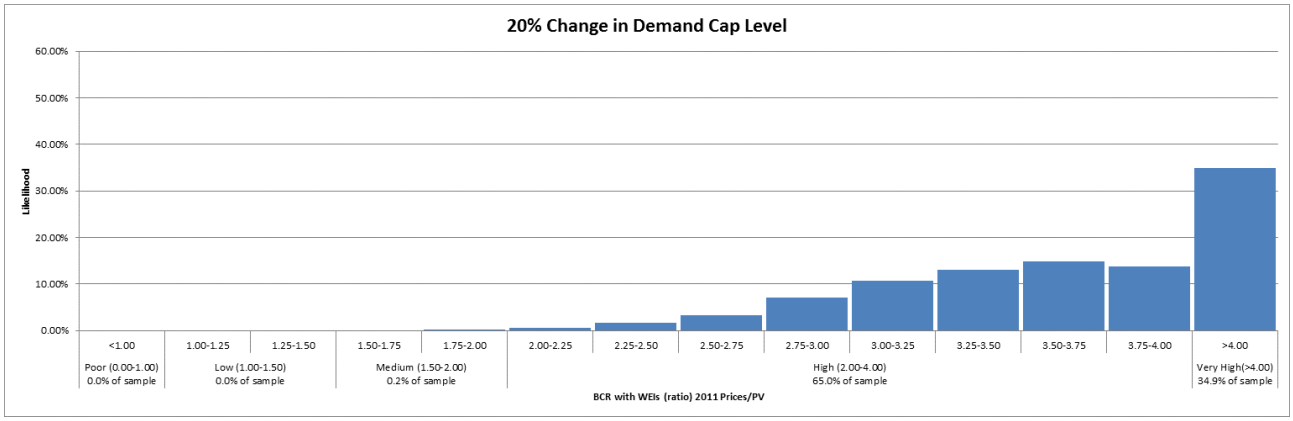


Figure 9: Impact on the full network BCR of increasing the level of demand by 20%

5.2.8 This increase in scheme BCR only provides an increase in the level of demand for 11 years after the opening of the full Phase Two. After that point, as in the standard case, the benefits and revenue are held constant.

5.2.9 In the same way, we have looked at the implication of the same increase in demand levels for the incremental case for the West Midlands to Crewe route. Here the scheme BCR increases and it now has a 90% chance of providing at least medium value for money.

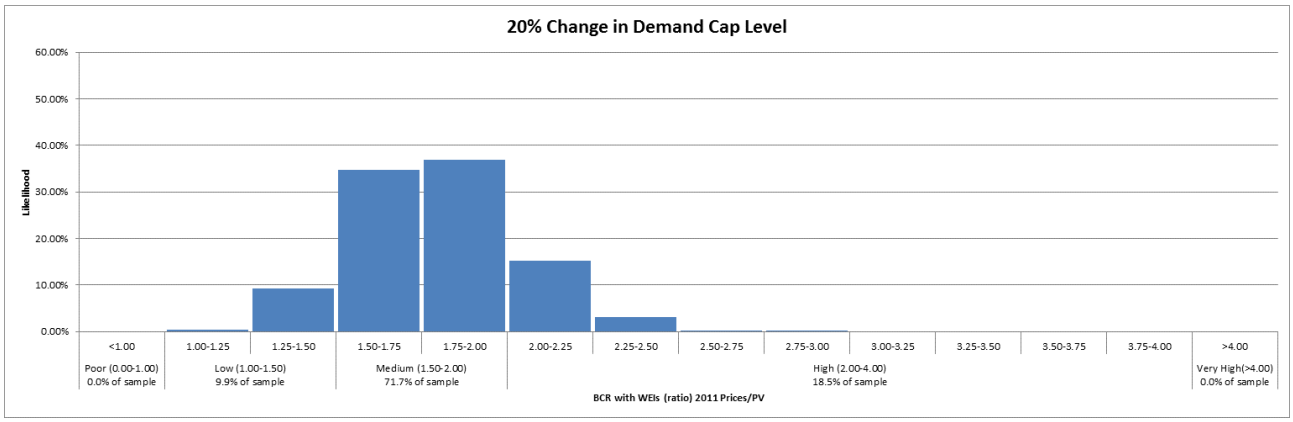


Figure 10: Impact on the incremental BCR of increasing the level of demand by 20%

5.2.10 As can be seen in Figure 10, the incremental case shows a different type of response to the increase in demand compared to the response seen for the full network. The response of the incremental case to changes in our key risk analysis variables appears to be much more muted. There are two elements at work here. The first is that the quantity of rolling stock does not change when compared to Phase One, meaning there is less variation from costs. In addition, the change in the demand cap is applied to both the Phase One scheme on a standalone basis, and to the combined Phase One and Phase 2a schemes. As a result, the impact of changing the demand cap on the difference between these two schemes (the increment) is naturally lower.

Alternatives to the demand cap

5.2.11 Our view is that the current demand cap in the standard case could be leading to conservative estimates of the return on investment in HS2. Given the uncertainty

associated with setting a demand cap and the lack of available evidence on market saturation, we have therefore looked at two alternative approaches to the demand cap.

5.2.12 In the first approach, the country is predicted to continue to see growth in population throughout the appraisal period even after the demand cap occurs. This growth would still give rise to a growth in demand purely from the impact of there being more people who want to travel. In fact, without this growth assumption, the reference case is implicitly assuming that the number of trips per person falls after the demand cap as population continues to grow in all other areas of the forecasts. We have therefore looked at the impact of assuming that demand continues to grow in line with these population assumptions. This is shown in Figure 11.

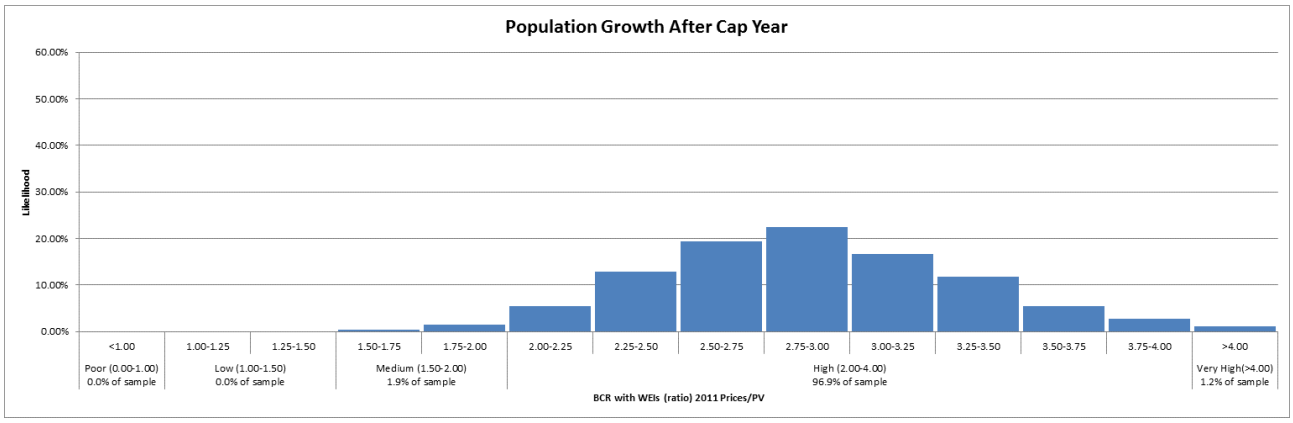


Figure 11: Impact on the full network of increasing demand in line with population increases after the demand cap year

5.2.13 We see that the value for the money of the scheme would rise from the standard case, as the additional demand provides an increase in benefits and revenue. The point estimate BCR would increase to 2.9, and there is now a 98% chance of the scheme providing at least high value for money.

5.2.14 The second approach we have considered covers what might happen if we were to consider a market saturation approach similar to that used in aviation forecasts instead of the fixed or population-only growth. Our October 2013 Economic Case looked in detail at this and the approach taken here is the same. The results are very similar, with the higher demand significantly increasing the economic case for HS2. This means the full network would have a 63% chance of having a very high value for money. The incremental case under a market saturation scenario also provides a significantly higher estimated BCR for the scheme of over 1.9, with an 87% chance of providing at least medium value for money.

5.2.15 In reality, it is impossible to predict with any certainty when long-distance rail market saturation might occur. Figure 12 shows an analysis of how many long-distance journeys per year the average GB household would effectively be making under some of these different cap year assumptions, and it does not suggest that the levels of demand that have been tested are implausible.

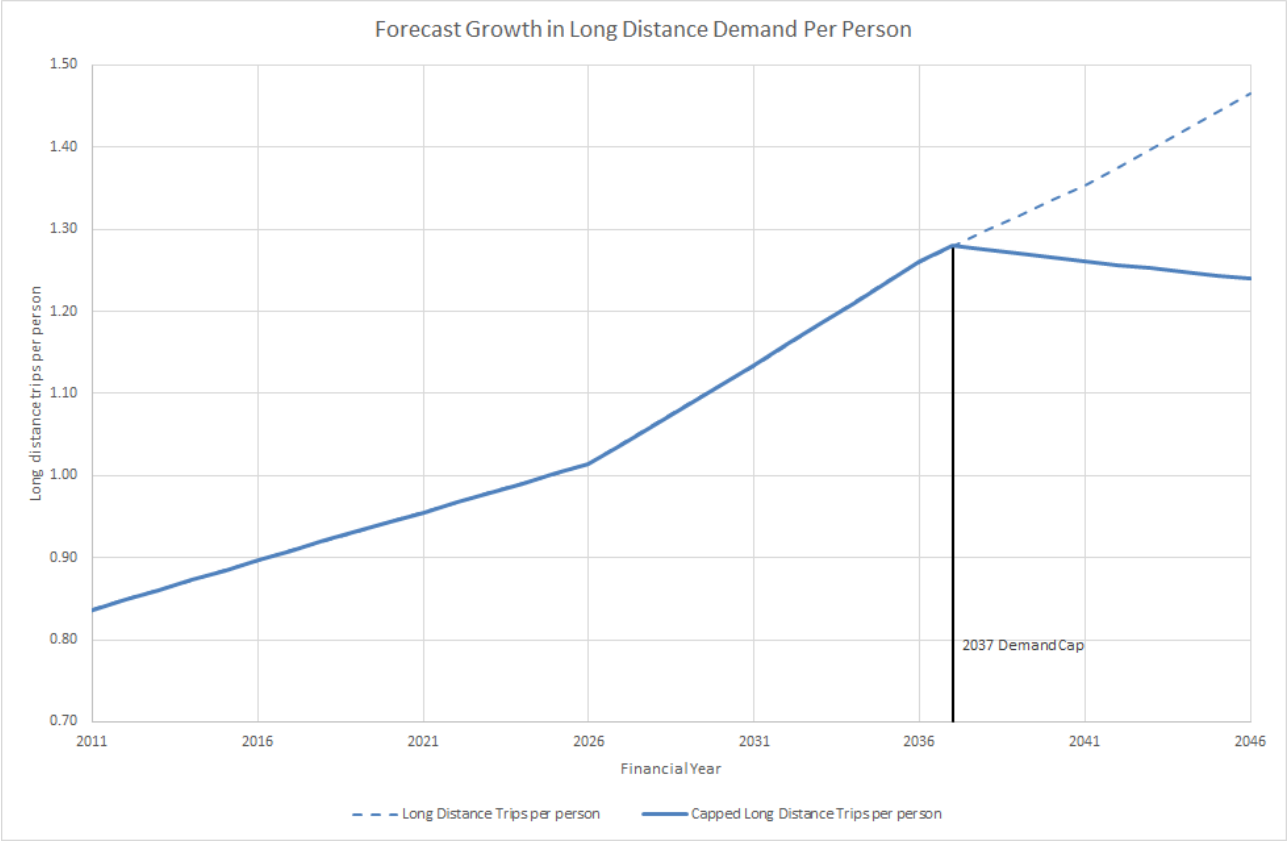


Figure 12: Forecast growth in long-distance trips per person

Lower levels of demand

5.2.16 Although our view is that the demand cap provides a conservative view of the level of demand as discussed in section 5.2.4, we do still need to understand what would be the impact were there to be lower demand than currently forecast. We have therefore also looked at scenarios where demand is capped at a lower level than in the standard case. Figure 13 shows the impact of a 20% lower demand cap on the full network, which would be reached in 2027. The value for money of the scheme is much lower, but the expected BCR of the full network would still be just over 1.6.

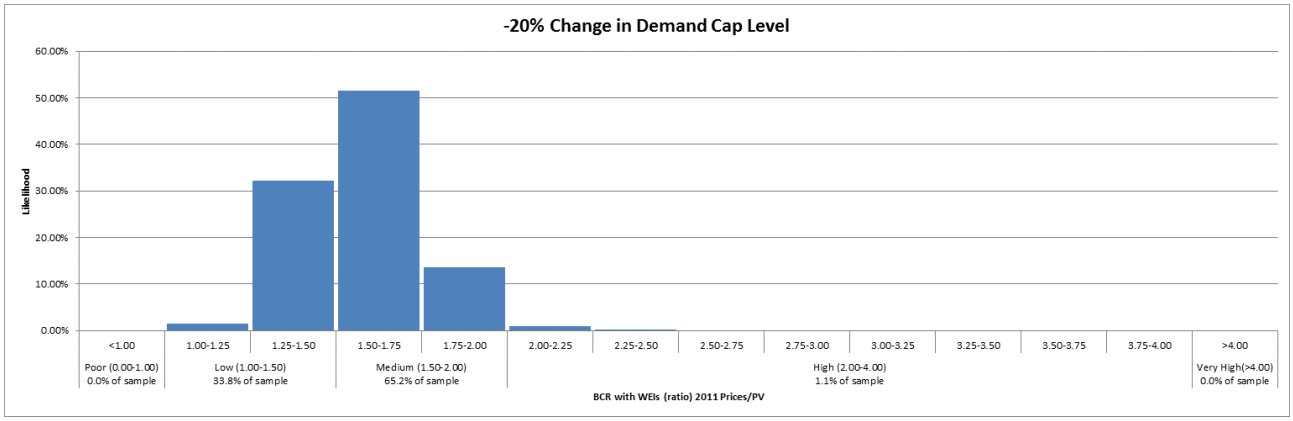


Figure 13: Impact on the full network (with acceleration) BCR of decreasing the demand cap by 20%

5.2.17 A similar decrease in the BCR range can be seen for the incremental case, though as already discussed in the context of higher levels of demand, the fact that this is an increment on an already existing scheme means that the overall impact is dampened as shown in Figure 14.

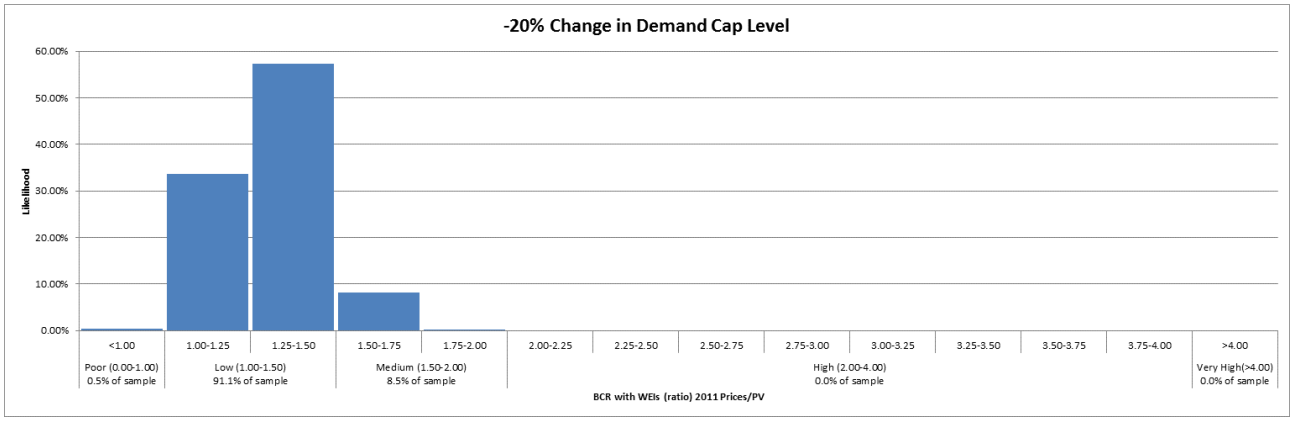


Figure 14: Impact on the incremental BCR of decreasing the demand cap by 20%

5.3 Impact of fares policy assumptions

5.3.1 Another key assumption in the Economic Case is related to the impact of the fares policy assumption as this is a key component of the likely revenue returned from the scheme. In this section we look at the impact of fares assumptions. In particular, we look at what would happen to the case for HS2 were the current policy of no real-terms fare increases (fares remain at 0% increase above RPI) extended outwards after the current parliament. This provides quite a conservative assumption in terms of how the demand cap performs, in this case the fixed demand cap will move to 2032. This occurs because increasing fares act as a brake on increasing demand and therefore lowering fares leads to quicker demand growth and the demand cap being reached earlier, one year before the opening year of Phase Two. Figure 15 shows the impact of the low fares on the BCR.

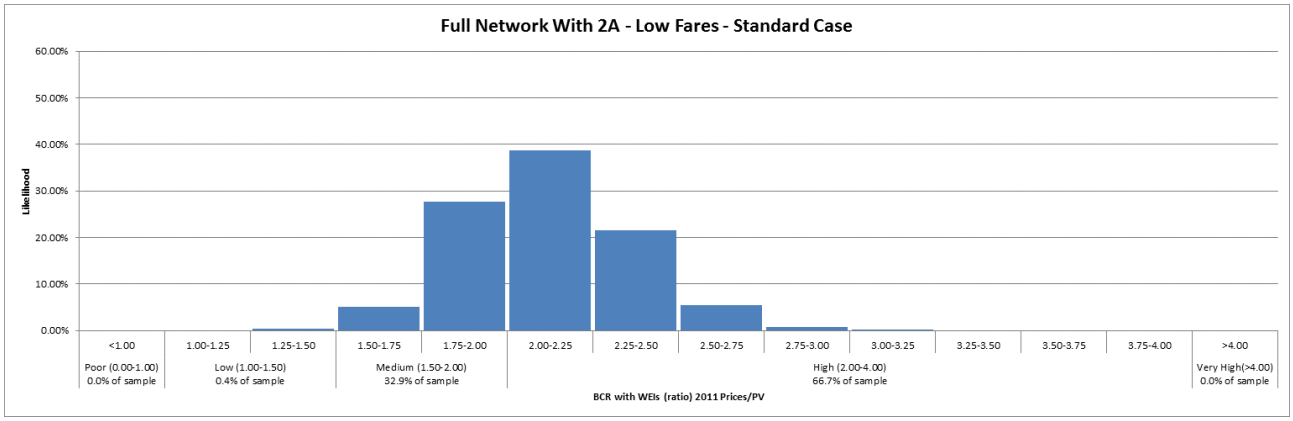


Figure 15: Full network with acceleration – low fares test

5.3.2 The low fares assumption would reduce the BCR of HS2 by around 0.4, due to the lower revenue associated with RPI+0% fare growth. However, as already discussed in the paragraph above, demand grows at a faster rate and therefore the demand cap is reached earlier. This earlier demand cap both means a similar level of benefits occur sooner, which leads to a slight increase in benefits overall due to lower levels of discounting, and also slight changes in the distribution of demand across the country, which can have a variable impact depending on the geographical location of the changes.

5.3.3 Similar to the impact of changing the demand cap, the impact on the incremental case for Phase 2a is somewhat muted in comparison to the change in the overall network. Figure 16 shows that the overall BCR would reduce slightly as a result of the lower fares with there now being a 67% chance of high value for money.

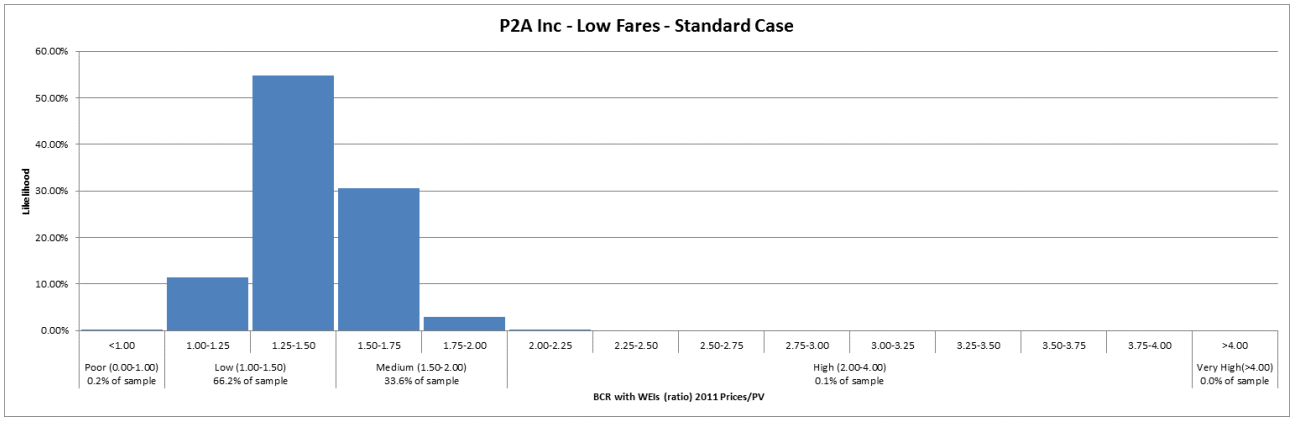


Figure 16: Phase 2a incremental – low fares test

5.3.4 The interaction of the demand cap with fares levels means that these results are difficult to interpret. If we look instead at a higher demand cap level, the impact on the BCR of the low fares assumption becomes clearer. Figure 17 shows the BCR range for a scenario with low fares and an increase in demand of 15%. This gives a demand cap year of 2037 (the same year as for the standard case). Now the expected BCR of the scheme is 2.8, with a 99% chance of providing a high value for money case.

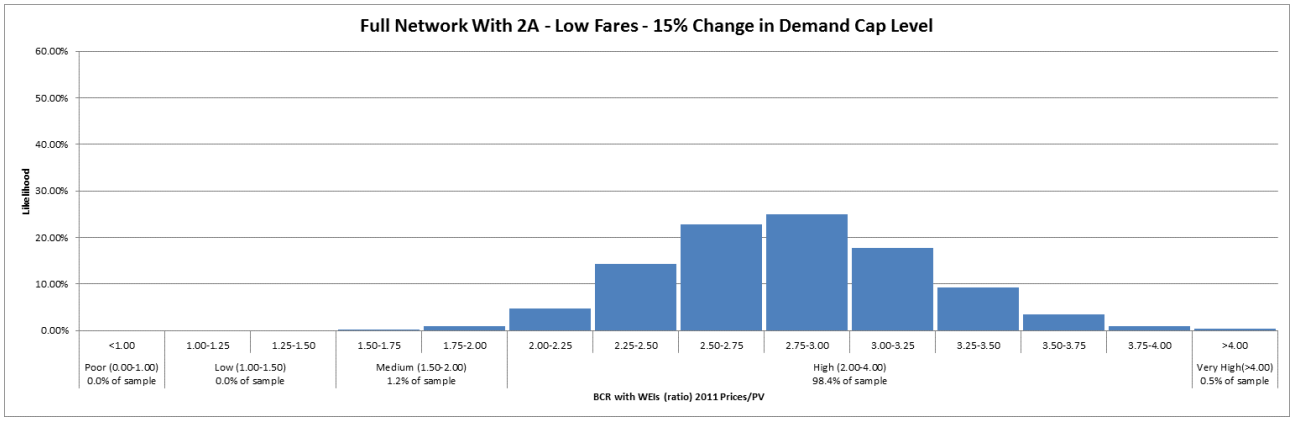


Figure 17: Low fares test with 15% increase in demand equivalent to 2037 demand cap

5.4 Impact of alternative values of time

5.4.1 All of the analysis in this Economic Case is based on the techniques set out in the DfT's WebTAG transport appraisal guidance. The standard approach to transport cost benefit analysis, as specified in WebTAG, requires a monetary valuation to be placed on the impacts that an investment will have on the travelling experience of transport users.

5.4.2 Most of these impacts are first expressed in units of time e.g. time spent travelling or time spent in crowded conditions, and are then converted in the analysis into units of money so that the benefits can be compared to the costs of the investment. This conversion is achieved with a set of 'values of time' that correspond to different aspects of journey time.

5.4.3 A user's journey purpose has a particularly strong influence on the values of time, with studies showing that people travelling in the course of their work are generally willing to pay considerably more to save elements of their travel time, than people travelling for their own ends. This distinction is particularly important for the cost benefit analysis of HS2, as our network is designed to provide for rapid journeys between city centres, and is therefore likely to carry a relatively high proportion of business travellers.

5.4.4 The values of time assumed for passengers who use HS2 is a significant driver for the level of benefits from the scheme and therefore it is important to understand the impact of alternative assumptions for this key input.

5.4.5 DfT has recently commissioned and published a significant piece of work looking to fully re-estimate new values of time for all three journey purposes (business, commuting and leisure) on the basis of new up to date surveys, sampling and modelling techniques[7]. This work has produced new values of time with the recommended use providing new national commuting and leisure values of time, with the business value of time being split into three distance bands. In addition to new

[7] https://www.gov.uk/government/collections/transport-appraisal-and-strategic-modelling-tasm-research-reports#valuing-journey-improvements

values of time, the work has also produced error bounds which we have used in the risk analysis. The outputs of this work have not been included in the reference case, as a consultation is currently being conducted on the implementation of the recommended values in WebTAG guidance.

5.4.6 We start by considering the impact of these new values of time as recommended. Figure 18 shows the BCR profile of these new values of time.

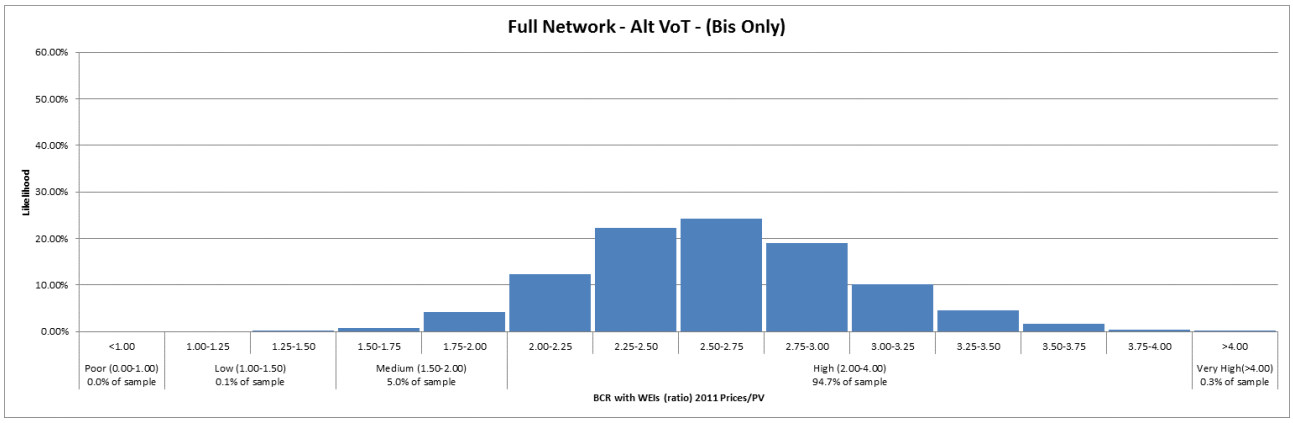


Figure 18: Value of time – business distance segmentation only – full network with Phase 2a

5.4.7 As we can see from this diagram showing the full network, the new values of time have a fairly limited but positive impact on the BCR spread for the scheme with a general increase of around 5% in the transport user benefits. The BCR is also spread slightly further due to the additional information around sampling errors being incorporated into the modelling. A similar impact is seen with the incremental case, although it is difficult to see differences in the BCR spread compared to the standard case (Figure 19 below).

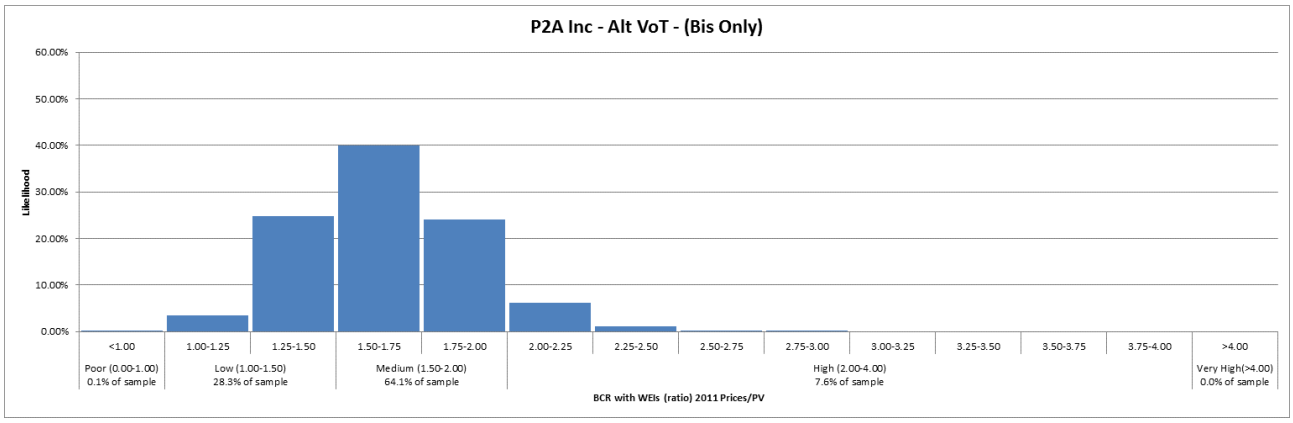


Figure 19: Value of time – business distance segmentation only – incremental Phase 2a

5.4.8 In the previous Economic Case, we also considered a high value of time scenario where we considered what might happen to the business case if we were to take account of some of the evidence in the original survey data around distance weighting for the commuting and leisure categories. We have repeated this test here, however, now using the new values of time. The results for this value of time test are shown for the full network in Figure 20.

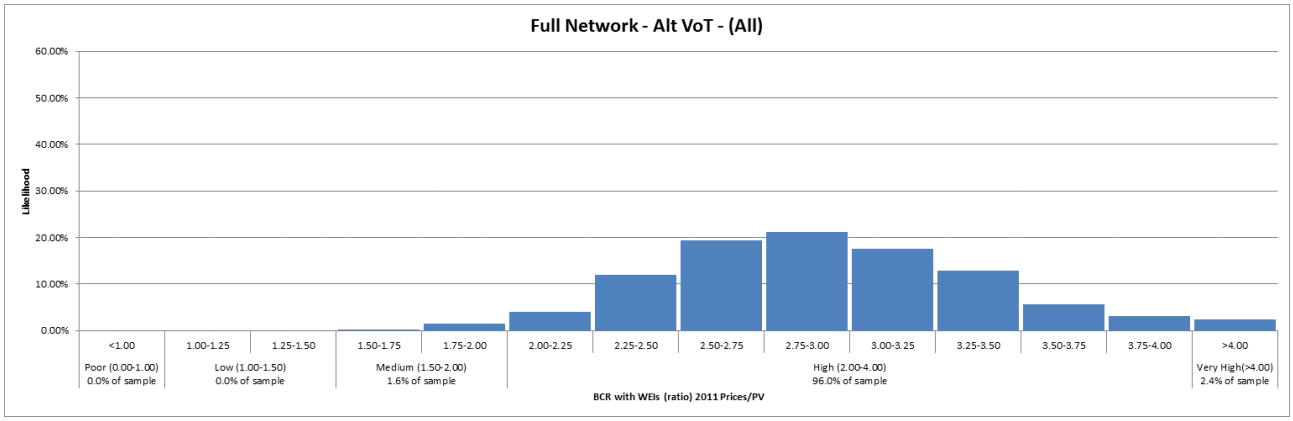


Figure 20: Value of time – full distance segmentation – full network with Phase 2a

5.4.9 This shows an increase in the BCR with the scheme now providing an average BCR of 2.9, and a 98% chance of providing at least a high value for money scheme. The impact on the incremental case for Phase 2a is a corresponding increase in BCR, with the Phase 2a scheme now providing an 89% chance of providing at least a medium value for money scheme.

5.5 Operating costs

5.5.1 The overall method of operating costs remains similar to the previous version of the economic case with a range of optimism bias applied to the elements of the operating cost assessments. The average level continues to range between 10% and 41%, with an average of 21%. To test and understand the potential impact on the value for money of the scheme of alternative operating cost optimism bias assumptions, we have looked at an optimistic assumption of all elements of operating cost having an optimism bias of 10%, and a pessimistic assessment with optimism bias set to 41%. Figure 21 shows how even with the more pessimistic optimism bias assumptions, there is a 99% chance of the full network returning a medium to high value for money.

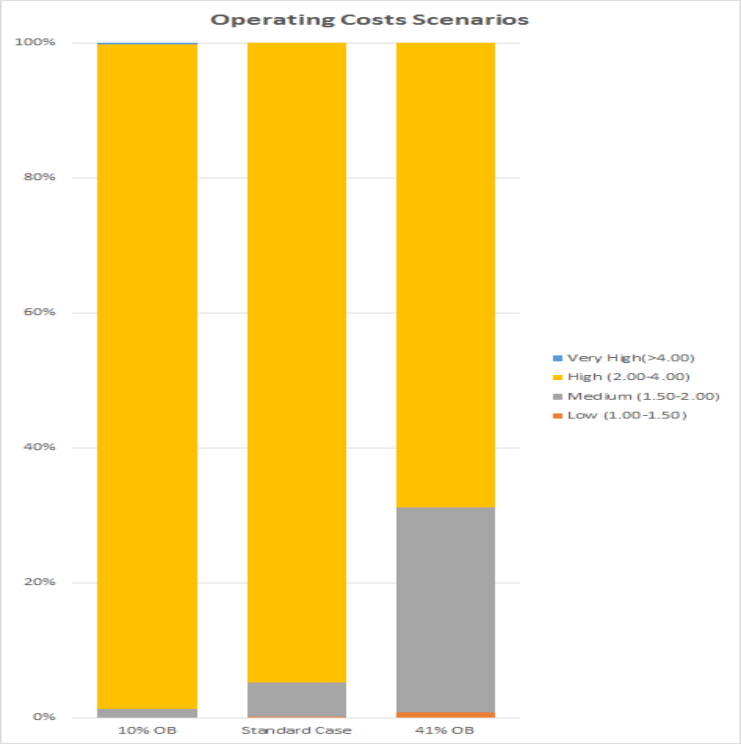


Figure 21: Variations in operating cost optimism bias of the full network including the acceleration of Phase 2a

5.6 Conclusions

5.6.1 This chapter shows that variations in the key assumptions does have an impact on the overall case for the full network and for Phase 2a. However across all of the variations examined, there is a very low chance of the scheme becoming poor value for money. In particular, the demand cap within the standard case exerts a strong influence on the appraisal of the value for money of the HS2 scheme. Whilst there is a lack of evidence on any specific assumption on when the demand for long-distance rail might saturate, it does show that the standard assumptions could well be conservative and the upside potential is greater than the downside risks to the scheme.

5.6.2 We can also see that future changes to the value of time in guidance will have a limited though positive impact on the scheme, with the use of a higher value of time based on distance (for all journey purposes) increasing the value for money of the scheme.

5.6.3 Finally, changes in the optimism bias assumption on operating costs can also have an impact on the scheme, with the high-optimism bias assumptions providing primarily medium to high value for money.

6 Extending our appraisal

6.1 Introduction

6.1.1 The WebTAG approach has been developed and refined over several years to provide a common basis for the comparison of transport schemes. In order to provide that common basis, some simplifying assumptions and approximations have been used within the guidance to ensure that the amount of effort required to complete an assessment is proportionate to the impact of the decision at hand.

6.1.2 HS2 is a unique proposal in many respects. It is both national in scale, and yet it strongly impacts on existing transport networks at a local level. It offers large step-changes in journey time, accessibility far larger than the majority of transport schemes, and it is likely to have significant impacts on behaviour, with implications for future land-use patterns, particularly around its stations. The large changes in journey time and accessibility create new opportunities for significant changes to the geographic distribution of economic activity across the country.

6.1.3 Economic activity is unevenly distributed in Britain. Like any other country, our cities make a disproportionate contribution to economic output, and there is significant variation in productivity, which in London and the South East is considerably higher than anywhere else. There are a number of reasons why activity and prosperity are not evenly distributed – some rooted in history, and competing forces of agglomeration (which tends to concentrate activity in dense, productive locations), and the cost of delivering a good or service (which tends to disperse activity so that it is produced closer to where it is consumed). HS2 could affect the balance of these forces and alter the geographical distribution of economic activity across Britain.

6.1.4 Our standard economic appraisal adopts simplifying assumptions, such as fixed land use, which means it is unlikely to capture these impacts on economic geography. In addition to this, because the approach takes a national perspective in the presentation of net benefits, it is limited in its ability to explain the more local or regional implications of the scheme.

6.2 The limits to the standard approach to calculating benefits

6.2.1 As discussed in the October 2013 Economic Case, the very large reductions in journey times brought about by HS2 have the potential to affect the appraisal calculus used to estimate benefits. Specifically, these large reductions may be stretching the limits of some of the appraisal calculi that are used to estimate the transport user benefits. Whilst we expect that these issues are by no means unique to the appraisal of HS2 – they are likely to be an issue for other transport interventions as well – the significant changes brought about by the HS2 scheme mean that they are more evident.

6.2.2 One of the fundamental elements of the standard WebTAG approach is the calculation of changes in measures of 'consumer surplus' for transport users. 'Consumer surplus' is, in essence, a measure of the amount of enjoyment that is taken from consuming a commodity, over and above the amount that someone paid for it.

In transport terms this is the sum total of the difference between how much a transport user is willing to pay for an option (measured in terms of money and journey time) and the amount that the user would actually have to pay.

6.2.3 In WebTAG transport appraisal, the change in this total is calculated with a mathematical relationship that is commonly referred to as the 'rule of a half'. The full rationales for the use of the 'consumer surplus' and 'rule of a half' approaches are set out in WebTAG guidance.

6.2.4 The 'rule of a half' is an approximation, which is expected, under certain conditions, to result in the mis-estimation of benefits. These circumstances include (a) large changes in demand or journey times, and (b) change in land-use patterns in response to a scheme.

6.3 Non-linearities in demand relationships

6.3.1 Under the first of these conditions, mis-estimation of benefits can result from the reliance of the 'rule of a half' on an approximation when calculating consumer surplus. In essence, the 'rule of a half' approach relies upon a linear approximation of the relationships between journey times and the levels of demand for the different options facing transport users. In circumstances where changes in demand or journey times are very small, the assumption that the relationship is linear has minimal impact on results. If changes in journey times or demand are larger, then any non-linearity in the relationships can lead to mis-estimation of the size of the change in consumer surplus.

6.3.2 Figure 22 illustrates the effect. The rule of a half calculations are attempting to measure the solid blue area between points ABT_1T_0. However the non-linearity of the demand curve leads – in this instance – to an overestimation of the change in consumer surplus equivalent to the hatched area on the chart.

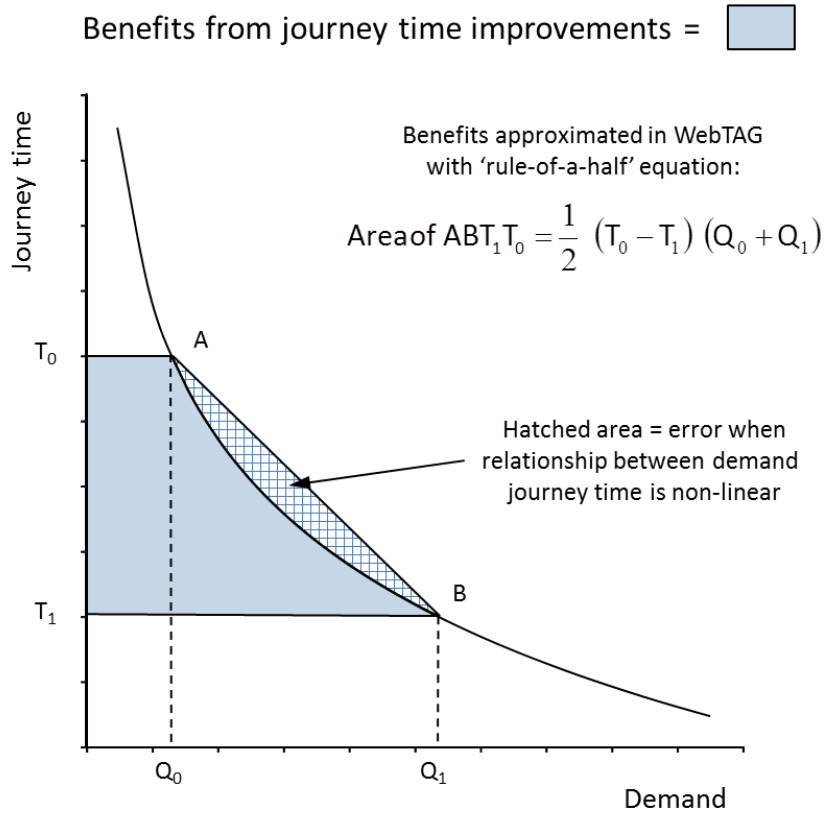


Figure 22: The potential for mis-estimation of benefits from the rule of a half

6.3.3 The sign and size of the mis-estimation depends on a number of different factors including the mathematical formulation of the relationship between demand and journey time, and the size of the changes in journey times themselves. Our demand model has been implemented using S-curve shaped relationships between demand and journey time. As a result, the linear approximation will sometimes overestimate and sometimes underestimate the size of changes in consumer surplus. This is illustrated with the diagrams in Figure 23.

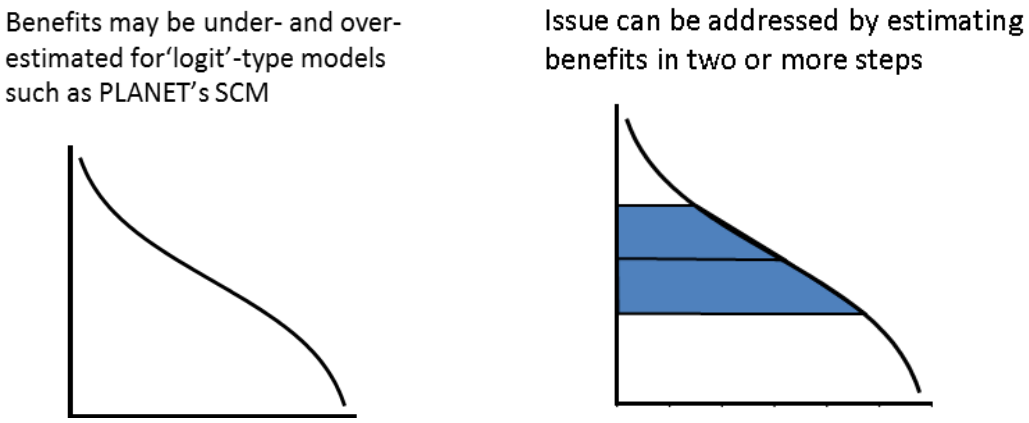


Figure 23: Illustration of staged approach to calculating benefits

6.3.4 We have conducted a series of tests to determine whether and how our results might have been affected by such non-linearities. The tests involve running the model several times, with journey-time changes introduced in stages, in order to reveal any non-linearities in the demand relationships. This process of introducing the journey times in stages is known as numerical integration.

6.3.5 The results from this numerical integration show that, for the full network (including opening of Phase 2a in 2027), there is a 15% difference in benefits calculated with the linear approximation[8]. The results show that for Phase 2a as an increment to Phase One, there is a 6% difference[9], with the WebTAG linear approximation yielding larger results than the staged approach.

6.3.6 In the interests of maintaining comparability of results with the alternatives, and other transport spending proposals, we have not adopted this alternative technique for our core analysis. However, we recommend that this variation in benefits between the two methods – along with the limitations imposed by land-use constraints (see below) – are borne in mind when considering the results.

6.4 The impact of fixed land-use patterns

6.4.1 Another limitation of the use of the rule of a half relates to the treatment of land-use change. The rule of a half is known to produce inaccurate results when used in circumstances where land-use has been allowed to change within the transport modelling framework.

6.4.2 However, it is expected that the scheme will trigger significant development in the areas immediately around HS2 stations as they would become considerably more attractive places to locate as a business.

6.4.3 Any increase in the employment density around the station is likely to result in higher levels of HS2 and rail patronage, and higher levels of benefits and revenues as a result.

[8] In the October 2013 Economic Case the difference was 13%. Whilst of similar magnitude it is not directly comparable as the definition of the full network at the time did not include the proposal to open the section from the West Midlands to Crewe from 2027.
[9] The October 2013 Economic Case did not report a similar result as it predated proposals to open the West Midlands to Crewe section in 2027.

These have not been captured in this analysis and therefore would at least partially offset, and could potentially outweigh, the difference between the rule of a half and the alternative numerical integration method.

6.4.4 On this basis, and also the need to ensure comparability of results, we have not deviated from the WebTAG guidance, and have continued to use the standard rule of a half approximation for the calculation of consumer surplus. This may result in the under- or overestimation of benefits, and we will conduct further analysis to better understand the balance of the two effects.

6.5 Wider economic impacts

6.5.1 The conventional approach to transport appraisal methodology primarily considers the direct benefits to transport users when assessing the value for money of a scheme. 'Wider economic impacts' refers to those economic impacts of transport that are additional to the direct transport user benefits.

6.5.2 If only direct user impacts are appraised, then there is a risk that the appraisal may miss some of the economic impacts of a scheme, especially in large transformative transport investments like HS2. The WebTAG guidance notes in relation to wider economic impacts, that "Analysis has shown that these impacts can be large, and can therefore be an important part of the overall appraisal of a transport scheme."[10]

Standard approach to wider economic impacts

6.5.3 This Economic Case has followed the current guidance for estimating wider economic impacts as outlined in WebTAG Guidance (Unit A2.1), with these results reported in (£m 2011 PV)

6.5.4 Table 5 below, and discussed in both Appendix 4 and Appendix 5.

6.5.5 The three types of wider economic impacts outlined in the DfT guidance can be summarised as follows:

- **Agglomeration** arising from increased connectivity. The introduction of HS2 and associated released capacity on the classic rail network will reduce the costs of travel between areas, creating opportunities for more intense and productive interactions between and among businesses and workers.
- **Imperfect competition** (increased output due to reduced costs). Companies operating in imperfectly competitive industries will be able to increase their production as a result of lower transport costs.
- **Increased labour force participation**. Transport changes can affect the individual incentives to work and therefore affect the overall level of labour supply.

[10] DfT, WebTag Guidance – A2.1 Wider Impacts, page 1.

6.5.6 The total benefit value for wider economic impacts is estimated for the full network (with acceleration to Crewe), to be £14.2 billion (in 2011 PV terms). This represents 20 per cent of total scheme benefits. As shown in Table 5, more than half of these (£9.5 billion) arise from agglomeration economies. The incremental case is estimated to deliver wider economic benefits of £366 million (16% of total benefits for the incremental scheme).

	Phase 2a (Increment)		**Full network (Including Phase 2a)**	
Disaggregated benefit	**Benefit value (£m)**	**Percentage of total**	**Benefit value (£m)**	**Percentage of total**
Agglomeration (businesses closer together)	£196	9%	£9,519	13%
Imperfect competition (increased output due to reduced costs)	£155	7%	£4,318	6%
Increased labour force participation	£15	1%	£381	1%
Total	**£366**	**16%**	**£14,218**	**20%**

(£m 2011 PV)

Table 5: Wider economic impacts

Appendix 1 – Modelling and appraisal approach

PLANET modelling, inputs and assumptions

Our modelling approach utilises the PFM, a detailed description of which is provided in *PLANET framework model (PFM V5.2) – Model Description.* Its main aim is to provide forecasts of demand to drive the appraisal of HS2.

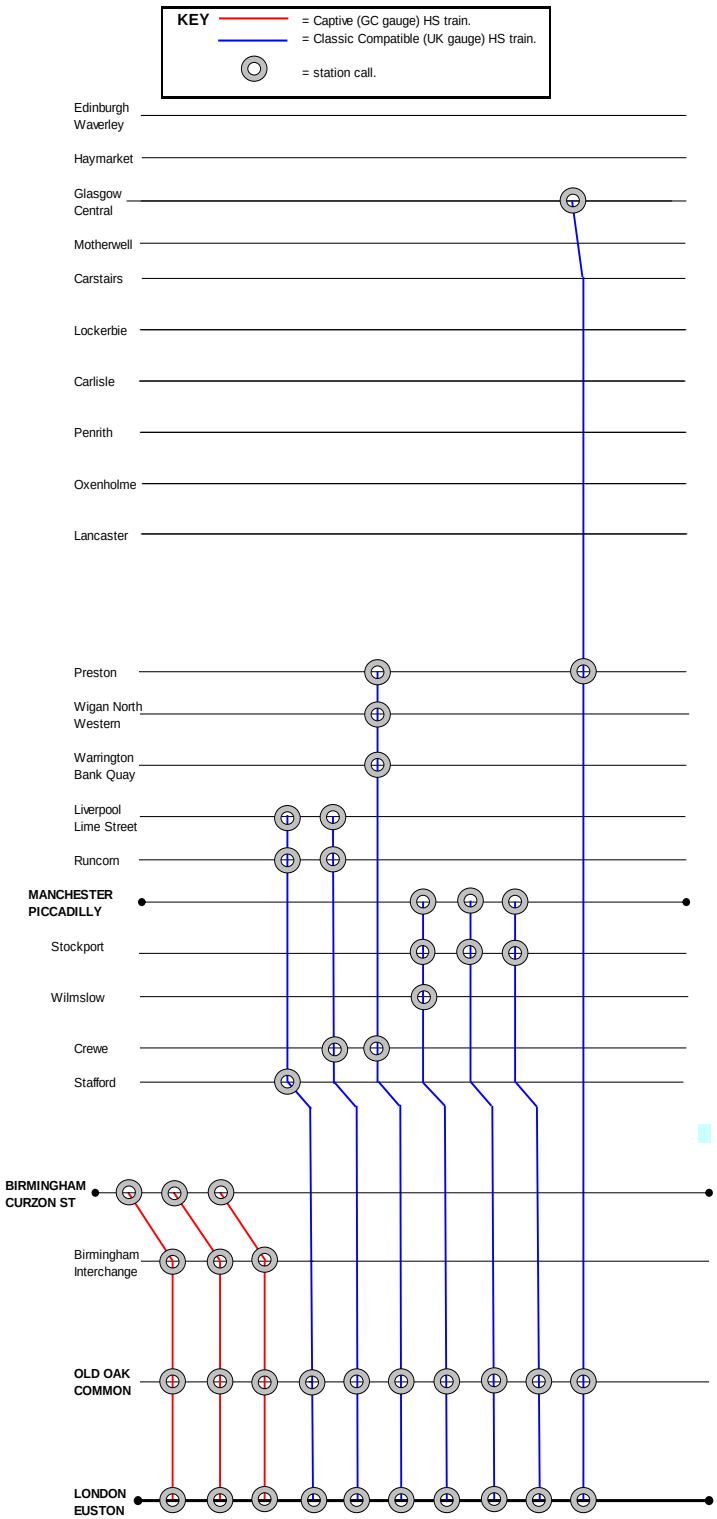
A series of model developments that builds upon PFM V4.3 have taken place since September 2013 that has resulted in PFM V5.2. This incremental approach has been fully documented and published in the report *Model Development Report: PLANET Framework Model Version 5.2.*

In order to understand the impacts of these incremental changes, HS2 Ltd has undertaken analysis on the changes to the benefits and revenues on each incremental version. This analysis has been documented and published in the report *Summary of Key Changes to the Economic Case since October 2013.*

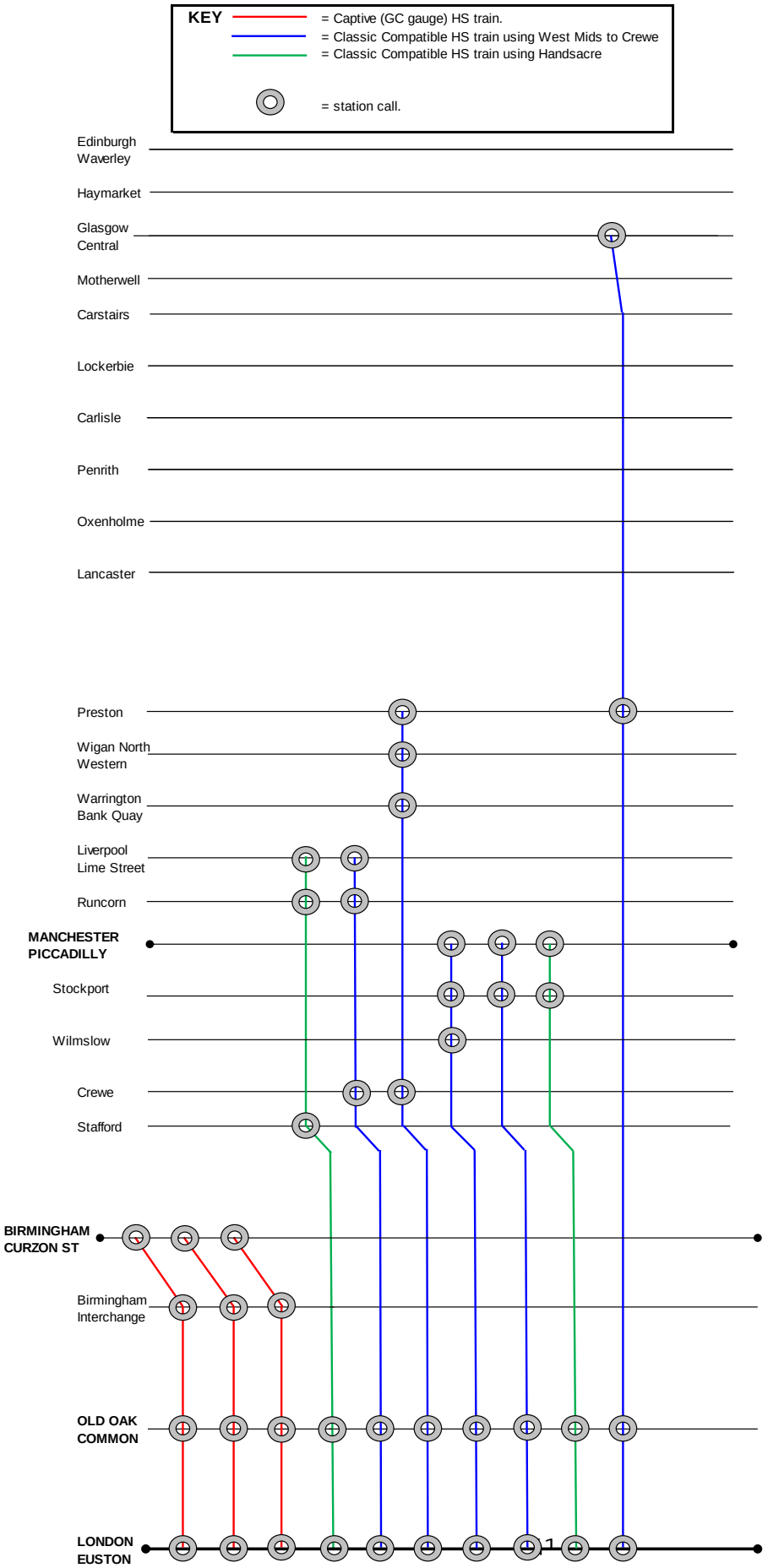
HS2 Ltd has updated its demand forecasts and input assumptions to reflect industry guidance and recommendations at the time of model development. These updates are fully described within the three documents: *Atkins Model Development report, PFMv4.3 to PFMv5.2; Updating the Exogenous Forecasts and Assumptions report;* and *PLANET Framework Model Version 5.2*, which are published alongside this report.

Appendix 2 – Scheme service pattern

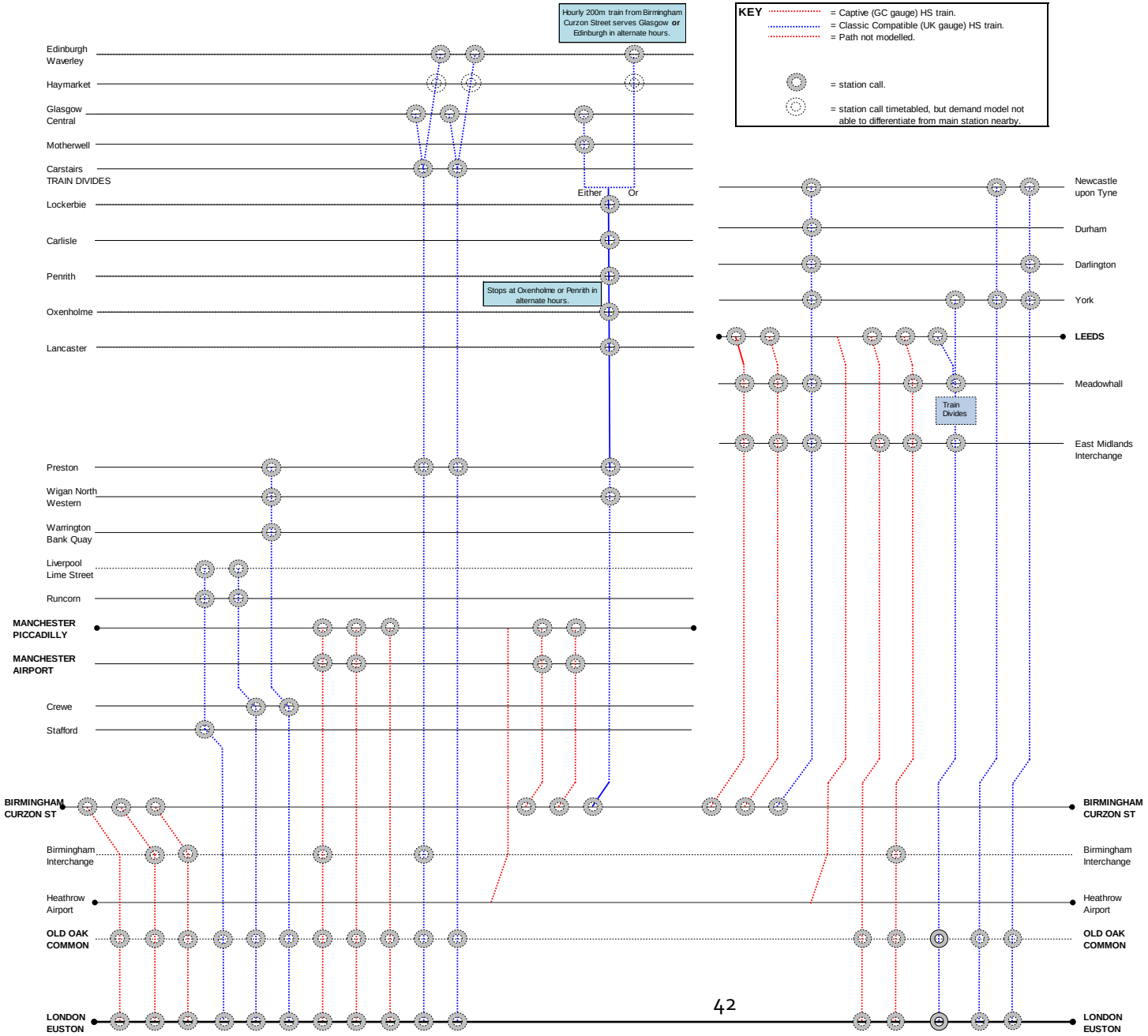
HS2 Phase 1 HS service pattern for demand modelling.



HS2 Phase 2A HS service pattern for demand modelling.



HS2 Phase 2 HS service pattern for demand modelling.



Appendix 3 – Cost assumptions: Phase 2a

Overview

Costs are calculated in two primary groups outlined below, and then combined with revenue estimates to give the net cost to Government. Costs have been calculated in 2011 prices to remain consistent with the rest of the economic analysis:

- capital costs – including construction costs, rolling stock and depot costs and infrastructure renewal costs; and
- operating costs – including operation and maintenance of trains and track, train crew and station staff for HS2, and any operating cost savings from changes to the classic network.

Construction costs

The 2013 Spending Review set out a funding envelope of £50.1bn (2011 prices) for the HS2 programme. In the 2015 Spending Review Treasury restated the long-term funding envelope at £55.7bn in 2015 prices. This budget is for delivery of the full HS2 scheme.

Contingency for Phase Two (and Phase 2a) is based on optimism bias. The approach taken in developing the appropriate level of optimism bias is in line with Supplementary Green Book Guidance on Optimism Bias. The Phase Two scheme has been assessed on an asset by asset basis to evaluate the complexity, innovation and uniqueness of elements. This has resulted in costs being divided into the categories set out in the guidance of standard civil engineering, non-standard civil engineering, standard buildings and non-standard buildings. Lower and upper bounds for optimism bias are provided in the guidance for each of these categories. Mitigation factors have then been applied to the upper bound for each category based on a contributory factors assessment. The aggregate position is an optimism bias of 40% on Phase Two base costs.

The accelerated full network includes additional indirect costs as compared to the standard full network due to the need for a separate hybrid Bill. It is also reprofiled to reflect the accelerated build of Phase 2a, and change in profile for the remainder of Phase Two as a result of the need for a second hybrid Bill.

In the Economic Case, all construction costs are discounted to a present value and converted to market prices and sunk costs are excluded in line with WebTAG.

The reference case in the Economic Case assumes construction costs increase over time in line with general price inflation, i.e. the GDP deflator. In recognition of the fact that infrastructure projects are subject to industry-specific inflation factors which have historically been very different to general price inflation, higher rates of construction cost inflation up to the year 2020/21 have been considered as a sensitivity test (see section 4.6). The inflation assumptions applied each year for this sensitivity are based on a project-specific inflation factor for the years up to 2020/21 and thereafter revert to the GDP deflator of 2.2%. The project-specific inflation factor is comprised of indices for different asset types acknowledging the higher rates of inflation on some assets relative to others. However, given the uncertainties inherent in long-term

inflation forecasting, particularly with the cyclical nature of the infrastructure sector, the GDP deflator is considered to be an appropriate assumption for the period from 2021/22 onwards.

Rolling stock and depot costs

It is currently assumed that two types of HS2 train will be in operation. Captive trains for use on HS2 track, and classic compatible trains which are designed to be capable of using both high speed track and the current rail network. Trains are planned to be 200m sets which can be used to form 200m or 400m services.

The number of 200m trainsets required for each phase, and the base cost of purchase are outlined in Table 7. In addition to the per-trainset cost, non-recurring costs are added to cover design and other project costs, as well as an allocation to cover spares, maintenance tooling and simulators.

	Base cost per 200m trainset	**Trainsets required for Phase One**	**Total trainsets required for full network**
Captive fleet	£20.75 million	16	70
Classic-compatible fleet	£21.25 million	45	95

(2011 prices)

Table 6: Breakdown of rolling stock costs

Rolling stock and depot costs include the costs of one depot for Phase One and two depots for Phase Two. Efficiency Challenge Programme and Value Engineering reductions have been applied to these estimates.

A quantified risk assessment (QRA) has been conducted on rolling stock and depot costs. The simulation produces a range of possible total costs which are presented as a cumulative frequency distribution, or s-curve. The s-curve shows the probability that a given cost will not be exceeded. The Economic Case analysis uses the P50 from the QRA. For Phase One, this represents a 20% increase to total rolling stock and depot base costs, and for trainsets and depots procured for Phase Two this represents a 14% increase. Risk is lower in Phase Two because in many cases, the mitigation applied in Phase One will inform the Phase Two solution The full network appraisal uses the sum of Phase One and Phase Two rolling stock and depot costs.

For the appraisal of the incremental impact of Phase 2a, no additional rolling stock or depot costs are included above those for Phase One. This is on the basis that the same trains are expected to be able to provide the modified Phase One TSS that provides quicker times on five hourly services. Likewise the appraisal of the full network including Phase 2a, uses the same rolling stock and depot costs as estimated for the full network.

It is assumed that rolling stock needs replacing after 35 years of operation, and a portion of depot costs are incurred at that point to account for renewal. Costs are discounted to a present value and converted to market prices.

Infrastructure renewals

Since the Economic Case appraises schemes for 60 years from opening, estimates are included to reflect the need to repair infrastructure over this time. Painting, cleaning and general maintenance of the infrastructure will be covered by operating costs, but larger expenditures such as repairs and replacements will require capital expenditure. Renewal estimates are based on assumptions of how frequently different types of assets would require capital spend, information on the cost of these assets in the base construction cost and adjustments to reflect how the cost may be different in an operational environment. The renewal of depots included under rolling stock and depot costs use the same process. The stream of renewal costs is discounted to a present value and converted to market prices.

Operating costs

The HS2 Operating Cost Model is used to appraise the capital, renewal, rolling stock and operating costs of the railway infrastructure and trains required for the HS2 project (including savings to services on the existing National Rail network that will be replaced or amended following the introduction of HS2 passenger service). Capital, renewal and rolling stock costs are inputs to the model, whilst operating costs are calculated within it. The main items of operating costs calculated are:

- rolling stock maintenance;
- infrastructure operations and maintenance;
- HS2 staff costs;
- traction electricity;
- Network Rail charges;
- HS2 train operator overheads and administration;
- HS2 station costs; and
- savings to existing National Rail operators.

Table 7 shows the breakdown of operating costs for Phase 2a and the full network (including Phase 2a). For the breakdown of operating costs for Phase 2a it should be noted that:

- HS2 will incur additional infrastructure maintenance costs in order to maintain the new high speed route between the West Midlands and Crewe;
- HS2 will benefit from some reduction in rolling stock maintenance due to the new high-speed route between the West Midlands and Crewe being slightly shorter than the current classic network between the same two points;
- HS2 will benefit from some reduction in Network Rail track access charges (from rerouting some services from the classic network to the new high speed section between the West Midlands and Crewe.

Item	Phase 2a (Increment) (£m)	Full network (Including Phase 2a) (£m)	Includes
Rolling stock maintenance	-16	9,715	Clearing, repairing and servicing the trains.
Infrastructure maintenance	287	2,842	Inspecting and repairing the infrastructure, and infrastructure manager head office.
Electrical consumption	70	5,746	Cost of electricity used by the trains and electrification asset usage charge.
Staff, offices and stations	-12	11,185	Station staff, station maintenance and utilities, train crew, TOC overheads and administration, including head office staff.
Other	-218	1,341	Variable track access charge, capacity charge, station access charge and rolling stock insurance.
Testing and commissioning	2	549	
Classic line savings	8	-8,514	Staff, electricity, diesel, lease costs, maintenance and other.
Total	121	22,864	**All costs net of classic line savings**

(2011 prices present value including optimism bias)

Table 7: Breakdown of operating costs

Appendix 4 – Calculation of the BCR

To generate a BCR for the scheme we need estimates of benefits, costs and revenues.

Description of benefits

As described in the introduction to the document, the estimation of the BCR is undertaken using a social cost benefit analysis. The benefits that are estimated therefore include both direct effects for rail passengers and indirect effects on the wider population.

The benefits for HS2 that are used in the economic appraisal are calculated using different methods. The types of benefits that are assessed and their method of calculation are shown in Table 8; the majority come from PFM. The benefits are then grouped into three primary groups as shown.

Grouped benefit	Disaggregated benefit	Description of benefit	Calculated using
Transport user benefits	Improved access/egress	The access/egress leg in the model is the part of a journey between the origin (house/work etc) and the rail station initially used. Changes in the service patterns can mean that stations are more (or less) attractive, which can lead to changes in benefits.	PFM
	Reductions in crowding	There is a reduction in the level of crowding for journeys, which means passengers will experience a more pleasant journey.	PFM
	Improvements in interchange	The introduction of HS2 and associated released capacity will change how often people change trains across the network, in some cases more interchanges, in some cases fewer.	PFM
	Reductions in waiting	The introduction of HS2 and associated released capacity will provide increases in frequency to a number of destinations, which means that passengers will spend less time waiting for the train.	PFM
	Reductions in walking	Some parts of the journeys made by passengers include walking between stations. This represents the benefits from whether passengers will need to make more or less of these walks.	PFM
	Reductions in train journey times	The journey times between a large number of destinations are reduced as a result of the addition of HS2.	PFM

	Greater reliability on the HS2 network	HS2 will be a highly reliable service, passengers are therefore much more likely to be on time.	PFM
	Benefits to road users	The introduction of HS2 and associated released capacity takes vehicles off the road. There will be benefits for the remaining drivers who now encounter less traffic and enjoy faster journey times.	PFM
Wider economic impacts	Agglomeration benefits	The introduction of HS2 and associated released capacity will reduce the costs of travel between areas and businesses, which will lead to greater business interaction.	Wider Impacts in Transport Appraisal model
	Imperfect competition	Companies will be able to increase their production as a result of lower transport costs.	Wider Impacts in Transport Appraisal model
	Increased labour force participation	Transport changes can affect the individual incentives to work and therefore affect the overall level of labour supply.	Wider Impacts in Transport Appraisal model
Other impacts	Reduction of car noise	The introduction of HS2 and associated released capacity takes cars off the road, so there will less noise caused by cars.	PFM
	Carbon	The introduction of HS2 and associated released capacity will reduce the total distance cars and diesel trains travel each year, which will reduce the carbon emissions they produce.	Spreadsheet model
	Reduction in car accidents	The introduction of HS2 and associated released capacity reduces the total number of cars on the road; there will fewer car accidents.	PFM
	Noise from HS2 trains	HS2 trains will create noise and this will have a negative impact on areas close to the track.	Spreadsheet Model
Tax impacts	Loss to government of indirect tax	As there will be fewer passengers travelling by car or other means, there will be a reduction in the level of tax generated as a result.	PFM

Table 8: Grouped and disaggregated benefits, what they are, and where they are calculated

The estimates of benefits are then combined to provide an estimate of net benefits:

Net benefits = Transport user benefits + WEIs + Other impacts + Tax impacts

Costs and revenue

As set out in Appendix 3, costs are estimated for three primary groups: construction, rolling stock and operating costs. Operating costs includes both the costs of operating HS2 trains, and savings from changes to services on the classic network. The costs of renewals are also included.

Revenue is estimated using changes in passenger kms from the PFM model, again incorporating changes from both HS2 and classic line passengers.

These estimates of cost and revenue are then combined to give a net cost to Government:

Net cost to Government = Construction cost + Rolling stock cost + Operating cost + Renewals - Revenue

Calculation of the BCR

All the estimates of the benefits and costs are then combined in the following equation to produce an estimate of the BCR.

BCR = Net benefits - Net cost to Government

Appendix 5 – Transport impacts: Phase 2a

Benefits breakdown

The breakdown of estimated benefits for the standard case is shown in Table 9.

		Phase 2a (Increment)		Full network (incl Phase 2a)	
Grouped benefit	**Disaggregated benefit**	**Benefit value (£m)**	**Percentage of total**	**Benefit value (£m)**	**Percentage of total**
Transport user benefits	Improved access	-£5	0%	£1,004	1%
	Reduction in crowding	-£579	-26%	£6,883	9%
	Improvements in interchange	-£102	-5%	£3,877	5%
	Reductions in waiting	-£104	-5%	£7,867	11%
	Reductions in walking	£7	0%	£1,288	2%
	Reductions in train journey time	£2,614	117%	£32,033	44%
	Greater reliability on the HS2 network	£140	6%	£7,515	10%
	Benefits to road users	£7	0%	£954	1%
	Total	**£1,978**	**89%**	**£61,421**	**84%**
Wider economic impacts	Agglomeration (businesses closer together)	£196	9%	£9,519	13%
	Imperfect competition (increased output	£155	7%	£4,318	6%
	Increased labour force participation	£15	1%	£381	1%
	Total	**£366**	**16%**	**£14,218**	**20%**
Other Impacts	Reduction of car noise	£0	0%	£15	0%
	Carbon	£2	0%	£103	0%
	Reduction in car accidents	£3	0%	£186	0%
	Noise from HS2 trains	-£8	0%	-£133	0%
	Infrastructure	£0	0%	£15	0%
	Total	**-£3**	**0%**	**£186**	**0%**
	Loss to government of Indirect tax	-£121	-5%	-£3,039	-4%
	Total	***£2,221**	**100%**	**£72,786**	**100%**

* Total does not equal sum of figures in table as figures are summed before rounding.

Table 9: Total net benefits including wider economic impacts for standard case

Regional benefits

Using the standard case, Table 10 shows the distribution of benefits according to where a trip starts. The figures are the proportions from our modelled year of 2037.

Region	**Phase 2a (Increment)**	**Full network (Including Phase 2a)**
London	43%	36%
South East	3%	3%
West Midlands	2%	14%
North West	39%	17%
East Midlands	1%	7%
Yorkshire and Humber	1%	11%
North East	0%	4%
Scotland	5%	5%
Other (East England, South West, Wales)	5%	4%
Total	**100%**	**100%**

(value in brackets are in £millions)

Table 10: Regional distribution of transport user benefits

Appendix 6 – Scenario results

This section reports detailed single point BCR estimates.

Standard case

The standard case (otherwise referred to as 'reference case') scenario uses all the WebTAG standard assumptions, shown in Table 11.

	BCR Components		Phase 2a (Increment) (£billion)	Full network (including Phase 2a) (£billion)
1	Transport user benefits	Business	1.5	43.2
		Other	0.4	18.2
2	Other quantifiable benefits		0.0	0.2
3	Loss to Government of indirect taxes		-0.1	-3.0
4	Net transport benefits = (1) + (2) + (3)		1.9	58.6
5	Wider economic impacts (WEIs)		0.4	14.2
6	Net benefits including WEIs = (4) + (5)		2.2	72.8
7	Capital costs		2.7	39.0
8	Operating costs		0.1	22.9
9	Total costs = (7) + (8)		2.8	61.9
10	Revenues		1.4	33.1
11	Net costs to Government = (9) - (10)		1.4	28.8
12	**BCR without WEIs (ratio) = (4)/(11)**		**1.3**	**2.0**
13	**BCR with WEIs (ratio) = (6)/(11)**		**1.6**	**2.5**

(2011 PV)

Table 11: Economic analysis results for the standard case scenario

Higher levels of demand – demand cap 20% higher

This scenario shows the impact of increasing the demand reached in the cap year by 20%, shown in Table 12.

	BCR Components		Phase 2a (Increment) (£billion)	Full network (Including Phase 2a) (£billion)
1	Transport user benefits	Business	1.7	52.5
		Other	0.5	22.0
2	Other quantifiable benefits		0.0	0.2
3	Loss to Government of indirect taxes		-0.1	-3.5
4	Net transport benefits = (1) + (2) + (3)		2.0	71.2
5	Wider economic impacts (WEIs)		0.4	15.1
6	Net benefits including WEIs = (4) + (5)		2.4	86.3
7	Capital costs		2.7	39.0
8	Operating costs		0.1	22.9
9	Total costs = (7) + (8)		2.8	61.9
10	Revenues		1.5	38.7
11	Net costs to Government = (9) – (10)		1.3	23.1
12	**BCR without WEIs (ratio) = (4)/(11)**		**1.5**	**3.1**
13	**BCR with WEIs (ratio) = (6)/(11)**		**1.8**	**3.8**

(2011 PV)

Table 12: Economic analysis results for the higher levels of demand scenario

Alternative values of time

This scenario examines the results using DfT's recent re-estimating of values of time, shown in Table 13.

	BCR components		Phase 2a (Increment) (£billion)	Full network (Including Phase 2a) (£billion)
1	Transport user benefits	Business	1.7	47.0
		Other	0.4	17.1
2	Other quantifiable benefits		0.0	0.2
3	Loss to Government of indirect taxes		-0.1	-3.0
4	Net transport benefits = (1) + (2) + (3)		2.0	61.3
5	Wider economic impacts (WEIs)		0.4	14.6
6	Net benefits including WEIs = (4) + (5)		2.3	75.9
7	Capital costs		2.7	39.0
8	Operating costs		0.1	22.9
9	Total costs = (7) + (8)		2.8	61.9
10	Revenues		1.4	33.0
11	Net costs to Government = (9) - (10)		1.4	28.9
12	**BCR without WEIs (ratio) = (4)/(11)**		**1.4**	**2.1**
13	**BCR with WEIs (ratio) = (6)/(11)**		**1.6**	**2.6**

(2011 PV)

Table 13: Economic analysis results for the alternative values of time scenario

Appendix 7 – Estimated journey times

Table 14 and Table 15 set out some of the journey times used in the Economic Case modelling for the HS2 services for Phase 2a and the full network. These journey times have been updated since those previously used, to align with more recently undertaken journey time modelling. This more detailed modelling provides a more accurate set of information, in line with the route the journey times have been assessed over, in this case the consulted Phase Two line of route.

These times have the potential to change in the future subject to changes to the Phase Two line of route as a result of the Phase Two consultation, if the route diverges from the consulted line of route.

Origin	Destination	Phase 2a journey time	Full network journey time
London	Crewe	55	54
London	Manchester Airport	N/A	63
London	Manchester Piccadilly	87	67
London	Preston	88	77
London	Liverpool	92	92
London	Glasgow	222	218
London	Edinburgh	N/A	219
Birmingham Curzon Street	Manchester Piccadilly	N/A	40
Birmingham Curzon Street	Edinburgh	N/A	190
Birmingham Curzon Street	Glasgow	N/A	198
Birmingham Interchange	Glasgow	N/A	185
Birmingham Interchange	Manchester Piccadilly	N/A	37

Table 14: HS2 journey times for the western leg as used in the economic case modelling for Phase 2a and the full network

Origin	Destination	Full network journey time
London	East Midlands Hub	51
London	Sheffield Meadowhall	68
London	Leeds	81

Origin	Destination	Full network journey time
London	York	84
London	Newcastle	137
Birmingham Curzon Street	East Midlands Hub	19
Birmingham Curzon Street	Sheffield Meadowhall	36
Birmingham Curzon Street	Leeds	53
Birmingham Interchange	East Midlands Hub	16
East Midlands Hub	Sheffield Meadowhall	15
Sheffield Meadowhall	Leeds	15
Sheffield Meadowhall	Newcastle	84
Sheffield Meadowhall	York	23

Table 15: HS2 journey times for the eastern leg as used in the economic case modelling for the full network

Appendix 8 – Glossary

Definitions	Acronym	
Appraisal period	-	The assumed useful life of the assets for analysis.
Benefit cost ratio	BCR	The ratio of project benefits to project costs.
Capital costs/capital expenditure	CAPEX	The cost of acquiring the physical assets for HS2, including construction, land purchases and rolling stock.
Cost benefit analysis	CBA	The process of calculating and comparing the benefits and costs of a project, usually to generate the BCR.
Consumer price index	CPI	A measure of inflation, currently adopted as the government's official measure of price increases.
Demand cap level	-	The level of long-distance demand at which demand growth is assumed to halt.
Demand cap year	-	The year in which the demand cap is reached.
'Do-Minimum'	DM	The set of train services and demand which are assumed to be in place if HS2 did not happen – the base case – against which the 'Do-Something' is assessed.
'Do-Something'	DS	The transport intervention being considered – here, the HS2 scheme.
Department for Transport	DfT	The government department responsible for the English (and some of the Scottish) transport network.
East Coast Main Line	ECML	The existing rail route connecting London King's Cross, Peterborough, Doncaster, Wakefield, Leeds, York, Darlington, Newcastle, Edinburgh and Aberdeen.
Elasticity	-	The responsiveness of a change in X as a result of a change in Y
Full network	-	The extent of the HS2 network currently being planned for construction.
Gross domestic product	GDP	The market value of all officially recognised final goods and services produced in the UK within a given period.
Gross wage rate	-	The money you earn based on your hourly pay, before any taxes or other deductions have been taken out.
Green Book	-	HM Treasury's guidance for public sector bodies on how to appraise proposals before committing funds to a policy, programme or project.
High speed rail	HSR	A railway that can operate at speeds of over 150mph.
Hybrid Bill	-	A proposal for new legislation that will provide the powers to build HS2.

Definitions	Acronym	
National Audit Office	NAO	The body responsible for auditing central government accounts and reporting on value for money issues.
National Air Passenger Allocation Model	NAPALM	A model used to forecast airport capacity constraints and the distribution of passengers between airports.
National Rail Travel Survey	NRTS	A survey of passenger trips on the national rail system in Great Britain on weekdays outside school holidays.
National Transport Survey	NTS	The primary source of data on passenger travel patterns in Great Britain.
National Passenger Survey	NPS	A network-wide survey of customer satisfaction with rail travel.
Optimism bias	OB	A financial allocation to compensate for the systematic tendency for appraisers to be over-optimistic about key project parameters.
Office for Budget Responsibility	OBR	An independent body that analyses the UK's public finances.
Office for National Statistics	ONS	The UK's largest independent producer of official statistics.
Operating Costs/Operating Expenditure	OPEX	The costs associated with running the railway, including the maintenance of the track and trains and staff costs.
PLANET Framework Model	PFM	The suite of models used by HS2 to analyse the impact of HS2 on rail travel in the UK.
Passenger Demand Forecasting Handbook	PDFH	A summary of over 20 years of research on rail demand forecasting, service quality and fares.
Phase One	-	The section of HS2 between London and the West Midlands with a connection via the West Coast Main Line at conventional speeds to the North West and Scotland. Phase One includes stations at London Euston, Old Oak Common (West London), Birmingham Interchange (near the National Exhibition Centre and Birmingham Airport) and Curzon Street.
Phase Two	-	The section of HS2 that extends beyond the West Midlands to Manchester and Leeds with connections to conventional railway lines via the West Coast and East Coast Main Lines. Phase Two includes stations at Manchester Airport, Manchester Piccadilly, East Midlands Hub (between Nottingham and Derby), Sheffield Meadowhall and Leeds.
West Midlands to Crewe (Phase 2a)	-	The section of HS2 between the West Midlands (Fradley) and Crewe.
Quantified risk assessment	QRA	A formal method of calculating the quantity of individual risks.
Real terms	-	The financial value, after removing the effects of inflation.
Released capacity	-	The availability on the classic network created by the introduction of HS2.

Definitions	Acronym	
Retail Price Index	RPI	An alternative measure of inflation that was previously adopted by the government as the official measure of price increases.
Service specification	-	The train service assumptions used in our modelling.
Standard case	-	Our scenario which most rigidly applies the assumptions in the DfT's WebTAG guidance.
Strategic Outline Business Case	SOBC	
Sunk cost	-	A cost that has already been incurred and cannot be recovered.
Train operating companies	TOC	A company that holds an operating contract for a rail franchise.
Value of time	VoT	The implicit value people place on time
Web Based Transport Analysis Guidance	WebTAG	The DfT's guidance that provides guidelines on how to conduct transport studies.
West Coast Main Line	WCML	The existing rail route connecting London Euston, Birmingham, Manchester, Liverpool, Glasgow and Edinburgh. It is the busiest mixed-traffic railway route in Europe.
Wider economic impacts	WEIs	The agglomeration, imperfect competition and Increased Labour force participation benefits.
Willingness to pay	WTP	The maximum value a consumer is willing to pay for a good or service.