

# THE ECONOMIC CASE FOR HS<sub>2</sub>

Summary of key changes to the Economic  
Case since August 2012

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Case since August 2012

October 2013



Department  
for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

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# 1 Introduction

- 1.1.1 This report provides a summary of the key changes made to the analysis that supports the assessment of the Economic Case for HS2 since August 2012, and the effect of these on the appraisal outputs.
- 1.1.2 The last update to the Economic Case, which was published in August 2012<sup>1</sup>, provided point-estimate benefit-cost ratios (BCRs) of 1.7 for Phase One of HS2, and 2.5 for the Full Network.
- 1.1.3 As with any scheme, the Economic Case for HS2 will evolve over time and be influenced by many factors including:
- the design of the scheme;
  - external factors such as economic or population forecasts;
  - forecasts of HS2 passenger demand, benefits and revenue; and
  - the guidance on forecasting and appraisal of transport schemes.
- 1.1.4 Much has changed in the period since August 2012. We have undertaken a comprehensive model development programme and further refined our economic appraisal tools. The design of the scheme has been further developed and we have re-estimated the costs of the scheme. There have also been developments in modelling and appraisal practice that have been incorporated into the Department for Transport's WebTAG<sup>2</sup> appraisal guidance.
- 1.1.5 We have incorporated all of these changes into the analysis supporting the Economic Case, and this document provides an analysis of the impact that they have had on the point-estimate BCRs of HS2.
- 1.1.6 Care needs to be taken when interpreting the results of this analysis in two respects.
- Firstly, there is a high degree of interaction between the effect of the changes, and each step in itself needs to be viewed in the context of the changes that have been made earlier in the sequence of the analysis.
  - Secondly, the size of the change is also dependent on a number of other inputs and assumptions in the modelling and appraisal process. Alternative assumptions, such as those used in the risk analysis presented in the Economic Case, would of course lead to different results for this step-through analysis.
- 1.1.7 The aim of this document is to help readers understand the effect that individual changes in our analysis and modelling have had on the Economic Case for HS2.
- 1.1.8 This document is one of a series that provides explanation and analysis of the evidence which underpins the appraisal of HS2, including the PLANET Framework

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<sup>1</sup> <http://www.hs2.org.uk/sites/default/files/inserts/Updated%20economic%20case%20for%20HS2.pdf>

<sup>2</sup> WebTAG is the Department for Transport's guidance on appraising all transport schemes - <http://www.dft.gov.uk/webtag/>

Model Description Report, Assumptions Report, and Risk Analysis Technical Documentation.

## 1.2 Summary of the changes to the Economic Case

- 1.2.1 Since we published the last estimates of the Economic Case for HS2, we have conducted a comprehensive programme of work to improve the methodologies, underlying assumptions and evidence base used by the economic models to assess the scheme. Additionally we have responded to changing external factors, such as GDP forecasts, and internal factors, such as more detailed development of the design.
- 1.2.2 The current Economic Case has been assessed using a newly developed version of the PLANET Framework Model (PFM) known as version 4.3<sup>3</sup> which has updated and refined many elements of the demand forecasting process.
- 1.2.3 The key changes that have been made to the appraisal of HS2 since the BCR was last reported in August 2012 can be summarised as:
- we have revised our cost estimates of building HS2 to take account of changes in the design of the scheme and new cost estimates (see Chapter 2);
  - we have updated our forecasts of the growth in travel by taking account of the latest evidence on the growth of the UK economy and other drivers of transport demand, and in the case of rail, by following new guidance on the relationship between these drivers and rail growth (see Chapter 3);
  - we have updated our appraisal methodology to draw on the very latest guidance and valuation of benefits contained in WebTAG, and taken advantage of the review and update of HS2's models to improve consistency both within the model and with WebTAG (see Chapter 4);
  - we have refined our modelling approach; building on the latest evidence on the choices and trade-offs which transport users make in their travel decisions. We have also taken this opportunity to improve consistency of parameters within the model and with WebTAG guidance (see Chapter 5).
  - we have updated our evidence on current travel patterns across the UK and their implications for future demand (see Chapter 6);
  - we have updated our without scheme or 'Do Minimum' network assumptions relating to committed transport investment that will happen regardless of HS2, and against which the HS2 scheme is compared (see Chapter 7);
  - we have changed the timetable assumptions for the operation of both HS2 and revised classic line services using capacity released on the existing network. These assumptions remain as modelling assumptions and are not a future service specification (see Chapter 8); and

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<sup>3</sup> The methodology and assumptions used by PFMv4.3 are separately reported.

## Summary of key changes to the Economic Case since August 2012

- our operating cost model has been updated to draw on more detailed and up to date evidence on the costs operating both HS2 and classic line trains (see Chapter 9).

1.2.4 Each of these refinements has impacted the BCR in different ways. The overall effect of these changes is shown in Table 1. The BCR in August 2012 for Phase One was 1.7 with Wider Economic Impacts and 2.5 for the Full Network. The table shows that the standard assessment of the BCR in the current Economic case is broadly unchanged.

Table 1: Overall change in quantified costs and benefits of HS2 (£bn 2011 present value prices) as presented in August 2012 and October 2013 Economic Case

Item (£bn 2011 present value prices)		Phase One			Full Network		
		Aug-12	Oct-13	Change	Aug-12	Oct-13	Change
1	Transport User Benefits						
	Business	12.6	16.9	4.4	34.3	40.5	6.2
	Other	7.2	7.7	0.5	16.7	19.3	2.6
2	Other quantifiable benefits	0.6	0.4	-0.2	1.0	0.8	-0.3
3	Loss to Government of Indirect Taxes	-1.6	-1.2	0.4	-3.8	-2.9	0.9
4	Net Transport Benefits (PVB)	18.8	23.8	5.0	48.2	57.7	9.5
5	Wider economic impacts (WEIs)	4.8	4.3	-0.5	15.4	13.3	-2.1
6	Net benefits including WEIs = (4) + (5)	23.6	28.1	4.5	63.6	71.0	7.4
7	Capital Cost	18.8	21.8	3.0	36.4	40.5	4.0
8	Operating Costs	8.2	8.2	0.0	22.3	22.1	-0.1
9	Total costs = (7) + (8)	26.9	29.9	3.0	58.7	62.6	3.9
10	Revenues	13.2	13.2	0.1	32.9	31.1	-1.8
11	Net costs to Government = (9) – (10)	13.8	16.7	2.9	25.7	31.5	5.8
12	BCR without WEIs (ratio) = (4)/(11)	1.4	1.4	0.1	1.9	1.8	0.0
13	BCR with WEIs (ratio) = (6)/(11)	1.7	1.7	0.0	2.5	2.3	-0.2

Note that the figures may not add due to rounding

The following chapters of the report provide further information on these refinements and the impact they have had on the Economic Case. The implications for costs, benefits and expected revenues for each phase are set out, with the change in BCR being calculated for each step.



## 2 Updated construction costs

### 2.1 Introduction

2.1.1 Construction costs have been updated for both Phase One and the Full Network. This reflects both changes in the design and scope of the scheme and improvements to the processes used to build the cost estimates.

2.1.2 The two phases of the scheme are at different stages of the design and development process. There is a difference in design maturity and the process behind building the estimate reflects this.

### 2.2 Change in Phase One costs

2.2.1 Extensive design development work undertaken over the past 18 months has utilised more accurate survey work, refinement of the design, and has included elements such as road diversions that had not been designed before. There has also been development of plans identifying how the railway will be constructed and how environmental impact mitigation measures will be implemented.

2.2.2 The estimates of Phase One construction costs which informed the August 2012 Economic Update were based on large-scale route alignment drawings and generic design assumptions, and 250 rates (e.g. cost per km for tunnels, cuttings and embankments).

2.2.3 Since then, the development work has delivered more than 5,000 plans, sections, schedules and specifications, allowing the production of a bottom-up estimate of project costs that is appropriately detailed and robust. The estimates are now specific to each of the design components and comprise more than 4,000 unit rates and allowances.

2.2.4 As well as conducting a review of the way in which the cost estimates are derived, we have also made design changes, which have affected our estimates. These changes include:

- increased tunnelling in the Northolt corridor;
- increased tunnelling in the Bromford corridor;
- addition of the cut and cover (Green Tunnels);
- increased number of roads and bridges;
- increased earthworks, retaining walls and culverts;
- increased certainty of designs at stations;
- increased scope of the power supply systems;
- increased scope of on network works;

- growth in indirect costs; and
- scope transfers from Phase Two.

## 2.3 Change in Full Network costs

- 2.3.1 The design of the extensions to Leeds and Manchester are at an earlier stage of development than Phase One, and so the design is still based on large-scale route alignment drawings and 250 rates. The construction cost estimates also include allowances for ground surveys, environmental mitigation, rail possession/isolation/safety management and TOC compensation.
- 2.3.2 There have been some improvements to the accuracy of Phase Two cost estimates driven by the lessons learned from Phase One, such as the revision to land and property cost estimates.
- 2.3.3 However, the cost changes resulting from refining the scheme design and changing the project route have been more significant. The key changes include:
- excluding the construction of the station previously planned for Heathrow Airport;
  - including construction of a station at Manchester Airport and choosing the M1 route option between Toton and Meadowhall on the leg to Leeds;
  - redesign of the tunnel at Madeley from a single-bore tunnel to twin-bore;
  - including maintenance sidings at regular intervals of the route to provide a means of stabling maintenance trains and to provide stabling for defective trains;
  - revising the route to minimise the impact on businesses and residential properties around Meadowhall; and
  - revising the route to minimise the impact on the site of the proposed East Midlands Strategic Rail Freight Interchange.

## 2.4 Impact of updated construction costs

- 2.4.1 Since August 2012 the total cost of construction has increased overall, leading to a downward impact on the BCR. The increase in cost estimate has been driven by a larger amount of tunnelling than previously planned, as well as other route revisions.

## Summary of key changes to the Economic Case since August 2012

Table 2: Change in quantified costs and benefits following updated construction costs

Item		Phase One		Full Network	
		Change (£bn 2011 present value prices)	% Change	Change (£bn 2011 present value prices)	% Change
1	Transport User Benefits				
	Business	0.0	0%	-0.1	0%
	Other	0.0	0%	0.0	0%
2	Other quantifiable benefits	0.0	0%	0.0	-3%
3	Loss to Government of Indirect Taxes	0.0	0%	0.0	0%
4	Net Transport Benefits (PVB)	0.0	0%	-0.2	0%
5	Wider economic impacts (WEIs)	0.0	0%	0.0	0%
6	Net benefits including WEIs = (4) + (5)	0.0	0%	-0.2	0%
7	Capital Cost	2.7	14%	4.5	12%
8	Operating Costs	0.0	0%	0.0	0%
9	Total costs = (7) + (8)	2.7	10%	4.5	8%
10	Revenues	0.0	0%	-0.1	0%
11	Net costs to Government = (9) – (10)	2.7	20%	4.5	18%
12	BCR without WEIs (ratio) = (4)/(11)	-0.2	-16%	-0.3	-15%
13	BCR with WEIs (ratio) = (6)/(11)	-0.3	-16%	-0.4	-15%

## 3 Updated forecasts of demand and economic growth

### 3.1 Summary of key changes

3.1.1 We have updated our forecasts of the growth in travel on rail, air and highway in accordance with the latest Department for Transport's WebTAG guidance. We have also taken account of the latest evidence on the growth of the UK economy and other drivers of transport demand.

- The methodology used to forecast rail demand now applies Passenger Demand Forecasting Handbook version 5.0 (PDFH 5.0) elasticities for all variables other than fares (which continue to be based on PDFH 4.1.). This is in line with the changes to WebTAG guidance<sup>4</sup>;
- Forecasts of drivers of demand for all modes have been updated. GDP growth forecasts have been updated in line with the data published by the Office for Budget Responsibility (OBR) in July 2012. Fares growth is assumed to be slower than in previous forecasts for the period 2012-14 (increasing by RPI +1% rather than RPI+3%), while other drivers of demand such as population and employment and the cost and time of travelling by other modes have also been updated in line with Department for Transport (DfT) guidance;
- Air forecasts have been updated using data from DfT's National Air Passenger Allocation Model (NAPALM); and

3.1.2 We have also updated the GDP growth assumptions that feed into the forecasts for the growth in values of time used in the appraisal in line with those that feed into the forecasts of demand.

### 3.2 Impact on demand

3.2.1 Growth in rail passenger demand is assumed to continue until a 'cap' is reached<sup>5</sup>. As with previous analyses of the Economic Case, we define the cap at a level of demand for all rail trips over 100 miles. This same level has been adopted here for the sake of consistency. The impact of adopting the PDFH 5.0 growth relationships is to slow the average growth rate of trips over 100 miles; with the greatest reductions seen on very long distance trips. However, the cap itself is still defined at the same absolute level of demand.

3.2.2 In isolation, this slower growth from the adoption of PDFH 5.0 would in result the cap being reached at a later year. However the slower growth is counteracted by the impact of updating the drivers of demand. Lower growth in rail fares and higher forecasts of the cost of travel on other modes, particularly bus and coach, result in faster growth in rail travel demand. This roughly cancels out the impact of applying PDFH 5.0 assumptions, such that on average growth rates of trips over 100 miles are

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<sup>4</sup> [http://www.dft.gov.uk/webtag/documents/expert/pdf/u3\\_15\\_4-rail-passenge-demand-forecasting-120723.pdf](http://www.dft.gov.uk/webtag/documents/expert/pdf/u3_15_4-rail-passenge-demand-forecasting-120723.pdf)

<sup>5</sup> The definition of the cap is reported in the accompanying assumptions report.

comparable to previous estimates. The end result is that the cap is now reached one year earlier than in the August 2012 forecasts, in 2036.

3.2.3 However, applying PDFH 5.0 assumptions also changes the distribution of demand across the country. The impact of this change increases with the distance of the trip, with the biggest reductions in the PDFH relationship between economic growth and demand growth being for trips over 250 miles. This change in relative growth rates of different trip distances leads to a change in the mix of trips in the cap year.

3.2.4 Table 3 shows the change in the distribution of trips without HS2 resulting from the updated forecasts. While there are a number of changes that affect the distribution of demand, the impact of the applying PDFH 5.0 assumptions can be seen in the table. The definition of the demand cap means that while the average number of trips greater than 100 miles remains the same<sup>6</sup>, the number of trips of over 150 miles in the cap year falls, while the number of trips between 100 and 150 miles slightly increases. The effect is also noticeable for trips under 100 miles where there are modest increases in demand.

Table 3: Change in the number of trips forecast by PLANET Long Distance (PLD)<sup>7</sup> in the cap year (without HS2) as a result of updating the forecasts

Distance	Change in the number of trips without HS2 in the cap year as a result of updating the forecasts
0-50	16%
50-100	15%
100-150	2%
150-200	-2%
200-250	-6%
250+	-4%

3.2.5 The level of highway and air demand falls in the cap year. Lower GDP forecasts and other revisions to the air forecasting approach adopted by DfT's latest air model means that highway and air demand grows slightly slower than in the previous forecasts. Combined with a slightly earlier cap year this leads to a reduction in forecast demand for these modes.

### 3.3 Impact on benefit-cost ratio (BCR)

3.3.1 The result of these changes is a mix of positive and negative impacts on the Economic Case:

- Demand for rail trips of under 150 miles increases compared to previous forecasts, resulting in greater crowding relief and more passengers enjoying

<sup>6</sup> Small variations in demand occur because the cap is defined as the 'year in which a given level of demand for trips over 100 miles would be reached', and not a fixed level of demand. Hence small variations occur depending on whether this level of demand is reached at the start or end of the cap year.

<sup>7</sup> PLD is one module of the PFM Framework as described in the model description report.

the benefits of HS2 and revised classic line services;

- Although there is less demand for longer distance trips of over 150 miles, the loss of benefits on these routes is not sufficient to offset the greater demand from shorter distance trips; and
- Slightly faster demand growth means that the benefits of HS2 occur earlier and are less discounted than if they had occurred later.

3.3.2 Overall there is an increase in benefits for both Phase One and the Full Network, as the increase in benefits on shorter distance routes outweighs the loss of benefits from trips over 150 miles and lower values of time. There is an increase in benefits between London and the West Midlands – which, at around 100 miles, is forecast to see greater demand in the cap year – while there is lower demand between London and the North West and Scotland. For the Full Network there is less demand forecast on longer distance routes between London and Yorkshire and Humberside and the North East.

3.3.3 Revenues also increase for both Phase One and the Full Network. Although fares on average are now lower in the cap year (due to changes in the fares growth assumptions growth and an earlier cap year), this is more than offset by the increase in the number of passengers using the rail network. The amount of new rail demand generated by HS2 (which determines additional fare revenue) increases by almost 8% in Phase One and 5% for the Full Network.

## Summary of key changes to the Economic Case since August 2012

Table 4: Change in quantified costs and benefits following updated demand and GDP growth

Item		Phase One		Full Network	
		Change (£bn 2011 present value prices)	% Change	Change (£bn 2011 present value prices)	% Change
1	Transport User Benefits				
	Business	0.4	3%	-0.6	-2%
	Other	1.0	15%	1.9	11%
2	Other quantifiable benefits	0.1	9%	0.0	0%
3	Loss to Government of Indirect Taxes	-0.1	7%	-0.1	2%
4	Net Transport Benefits (PVB)	1.4	8%	1.2	3%
5	Wider economic impacts (WEIs)	0.4	9%	3.1	20%
6	Net benefits including WEIs = (4) + (5)	1.9	8%	4.3	7%
7	Capital Cost	0.0	0%	0.0	0%
8	Operating Costs	0.0	0%	0.0	0%
9	Total costs = (7) + (8)	0.0	0%	0.0	0%
10	Revenues	0.5	4%	-0.3	-1%
11	Net costs to Government = (9) – (10)	-0.5	-3%	0.3	1%
12	BCR without WEIs (ratio) = (4)/(11)	0.1	11%	0.0	1%
13	BCR with WEIs (ratio) = (6)/(11)	0.2	11%	0.1	6%

## 4 Updated appraisal methodology and values

### 4.1 Summary of key changes

4.1.1 The appraisal of HS2 has been updated to improve consistency with WebTAG and implement the latest guidance and values recommended by the Department for Transport (DfT).

4.1.2 Since the production of the previous Economic Case, the following appraisal changes have been made to the WebTAG guidance and incorporated into the appraisal of HS2:

- Values of Time have been updated by DfT in draft WebTAG guidance which significantly reduces the value of time for business passengers and slightly increase values for other passengers;
- The methodology for calculating growth in values of time has also been updated. Non-work values of time now grow at the same rate as GDP per capita (compared to a previous elasticity of 0.8), and growth is no longer adjusted to reflect changes in discount rates over time; and
- Marginal External Cost of Congestion<sup>8</sup> values have been updated to reflect the latest WebTAG guidance.

4.1.3 As well as incorporating changes to the guidance, the appraisal process within the PLANET Framework Model has also been revised in order to improve consistency with the WebTAG guidance:

- The approach to estimating boarding and interchange penalties has been improved and is now more explicitly consistent with guidance<sup>9</sup>. The appraisal now applies a fixed 30 minute penalty for each time a passenger boards a train (including when interchanging between trains);
- Business values of time are now applied to boarding and interchange penalties and crowding impacts for business passengers. Previously commuting values of time were used in the appraisal of these impacts. This change followed a clarification from DfT on the interpretation of WebTAG and places the analysis on a more consistent footing with other rail appraisals;
- The method by which the model calculates the economic benefits of changes in demand and journey times has been changed to be more consistent with WebTAG. The calculation of benefits is now carried out at the most disaggregate level possible before summation;
- Forecasts of revenue growth have been updated to be consistent with the same GDP deflator measure of inflation as used across the rest of the appraisal.

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<sup>8</sup> <http://www.dft.gov.uk/webtag/documents/expert/unit3.9.5.php>

<sup>9</sup> [http://www.dft.gov.uk/webtag/documents/expert/pdf/u3\\_13\\_1-guidance-on-rail-appraisal-120723.pdf](http://www.dft.gov.uk/webtag/documents/expert/pdf/u3_13_1-guidance-on-rail-appraisal-120723.pdf)



- New estimates of the impact of HS2 on carbon emissions, noise of HS2 trains and the benefits of the HS2/HS1 link have been included; and
- The calculation of Wider Economic Impacts has been updated to reflect changes in the appraisal methodology and to improve the conversion of AM peak data in PLANET South, Midlands and North to all day benefits.

## 4.2 Impact of changes

- 4.2.1 These changes result in both positive and negative impacts, although overall these changes increase both benefits and revenues as shown in Table 5.
- 4.2.2 The latest WebTAG assumptions on value of time result in net reductions in benefits. Business values of time are around a third lower than previous estimates, although the impact of this is partially offset by higher values for non-work time and revisions to the parameters used to forecast future values of time. The change in approach to estimating boarding and interchange penalties to bring the appraisal more into line with PDFH 5.0 also has a negative impact.
- 4.2.3 Against these changes there are more positive impacts as a result of the changes in weightings applied to crowding values, and changes to the appraisal methodology. Changes to assumptions on the growth in value of time also boost benefits, particularly for non-work passengers. This is because non-work values of time are now assumed to grow at the same rate as GDP (rather than slightly slower), increasing the value of time for non-work trips in future years.
- 4.2.4 Applying business rather than commuting values of time to changes in crowding and boarding penalties for business passengers has increased the value of these benefits. The August 2012 commuting values of time are lower than the current business values of time, even after taking account of the latest assumptions in draft WebTAG guidance. The result is that the value of crowding relief and interchange benefits for business passengers increases.
- 4.2.5 Undertaking the appraisal calculus at the most disaggregated level in the model also results in an increase in benefits.
- 4.2.6 Overall benefits increase by 10% in Phase One and 18% for the Full Network. Most of this is the result of an increase in the value of crowding and boarding benefits, with crowding benefits increasing by over two thirds in Phase One as a result of the change in business values of time applied to this impact.
- 4.2.7 Revenues increase by £3.3bn in Phase One and £8.7bn for the Full Network as a result of changes in the GDP deflator used in calculating fares and revenues in the appraisal. Fares are assumed to grow by the Retail Prices Index (RPI) plus 1% per year until 2036 which is when demand is capped. The measure of inflation used within the appraisal is based on the GDP deflator, the previous definition of which was broadly consistent with the RPI measures.
- 4.2.8 In 2011, the Office of National Statistics revised the definition of the GDP deflator to be more consistent with a Consumer Prices Index (CPI) metric. When measured against this measure of inflation, this means that fares – which are assumed to grow

Summary of key changes to the Economic Case since August 2012

at RPI+1% - will grow by more than 1% in real terms per annum. This results in an increase in the real terms value of fares in the appraisal.

Table 5 Change in quantified costs and benefits following changes to the appraisal approach and values

Item		Phase One		Full Network		
		Change (£bn 2011 present value prices)	% Change	Change (£bn 2011 present value prices)	% Change	
1	Transport User Benefits	Business	0.3	2%	1.3	4%
	Other	2.0	24%	5.5	30%	
2	Other quantifiable benefits	-0.1	-13%	0.3	30%	
3	Loss to Government of Indirect Taxes	-0.2	13%	-0.6	15%	
4	Net Transport Benefits (PVB)	2.0	10%	6.5	13%	
5	Wider economic impacts (WEIs)	-1.9	-37%	-7.2	-39%	
6	Net benefits including WEIs = (4) + (5)	0.1	0%	-0.7	-1%	
7	Capital Cost	0.0	0%	0.0	0%	
8	Operating Costs	0.0	0%	0.0	0%	
9	Total costs = (7) + (8)	0.0	0%	0.0	0%	
10	Revenues	3.3	24%	8.2	25%	
11	Net costs to Government = (9) – (10)	-3.3	-21%	-8.2	-27%	
12	BCR without WEIs (ratio) = (4)/(11)	0.5	39%	0.9	55%	
13	BCR with WEIs (ratio) = (6)/(11)	0.4	27%	0.8	35%	

## 5 Revisions to modelling approach

### 5.1 Summary of key changes

5.1.1 Following a review of version 3 of the PLANET Framework Model (PFM) used to produce the August 2012 Economic Case, a new version of the model has been developed known as version 4.3. This incorporates a major programme of work to enhance its evidence base, transparency and consistency, the details of which are reported separately.

5.1.2 The main changes include:

- building on the latest evidence from the National Travel Survey and guidance in WebTAG, to update the demand model parameters which determine how passengers will react to the new journey opportunities resulting from HS2. The Station Choice Model within PFM has also been recalibrated to better reflect observed behaviour;
- improving the assignment process by which the model determines which trains passengers choose to travel on. This process now takes account of differences in journey time and crowding as well as frequency;
- implementing revised WebTAG guidance on the way passengers value crowding on trains (using information set out in PDFH 5.0);
- improving the treatment of local trips at the extremes of the rail network where sparse zoning and networks in PLD can have spurious impacts;
- improving the interaction between all day demand in the Long Distance Module with the peak demand in the regional modules; and
- improvements in understanding the accessibility of stations that ensures we are consistent in our assumptions on the provision of local transport schemes with organisations such as Transport for London.

### 5.2 Impact of changes

5.2.1 Table 6 shows that overall these changes reduce benefits and revenues. There is a significant reduction in benefits which is mainly driven by the adoption of PDFH 5.0 crowding parameters in the model. These parameters generally assume passengers place less value on travelling in less crowded conditions. This means that the value of the reduction in crowding that passengers experience as a result of HS2 and the value from re-use of released capacity is lower.

5.2.2 As well as reducing benefits, the adoption of PDFH 5.0 crowding values also leads to lower revenues. The lower crowding values imply that people perceive the benefit of HS2 to them as individuals is lower, making them less inclined to switch modes or make new rail journeys as a result of the scheme. It is these new rail journeys which drive revenues, so a reduction in rail journeys results in a reduction in revenues from HS2.

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5.2.3 The recalibration of the demand model has resulted in us forecasting that less of the demand for HS2 will transfer from other (non-rail) modes. Although this is partially offset by increases in the number of new or more frequent trips, the net effect is to reduce the net rail revenue generated by the introduction of HS2.

5.2.4 The net impact of all the changes to the PFM modelling approach results in reductions in benefits of 23% in Phase One and 17% for the Full Network. The underlying drivers of these reductions are the same, with reductions in crowding benefits accounting for a significant proportion of the overall change in benefits.

Table 6: Change in quantified costs and benefits following a revised PFM model

Item		Phase One		Full Network	
		Change (£bn 2011 present value prices)	% Change	Change (£bn 2011 present value prices)	% Change
1	Transport User Benefits				
	Business	-3.6	-27%	-6.9	-20%
	Other	-2.1	-20%	-3.5	-14%
2	Other quantifiable benefits	-0.1	-25%	-0.5	-36%
3	Loss to Government of Indirect Taxes	0.6	-31%	1.3	-30%
4	Net Transport Benefits (PVB)	-5.2	-23%	-9.5	-17%
5	Wider economic impacts (WEIs)	-0.4	-11%	-1.7	-15%
6	Net benefits including WEIs = (4) + (5)	-5.6	-22%	-11.2	-17%
7	Capital Cost	0.0	0%	0.0	0%
8	Operating Costs	0.0	0%	0.0	0%
9	Total costs = (7) + (8)	0.0	0%	0.0	0%
10	Revenues	-5.0	-29%	-11.5	-28%
11	Net costs to Government = (9) – (10)	5.0	40%	11.5	51%
12	BCR without WEIs (ratio) = (4)/(11)	-0.8	-45%	-1.1	-45%
13	BCR with WEIs (ratio) = (6)/(11)	-0.9	-44%	-1.3	-45%

## 6 Improved estimates of current transport demand

- 6.1.1 To produce better forecasts of future demand patterns, we have updated our assumptions on existing demand patterns (known as base year matrices). In particular, we have focused our research on better understanding the journey purpose of current rail passengers and whether they are categorised as business, leisure or commuting.
- 6.1.2 Our previous approach for determining this journey purpose made use of the National Rail Travel Survey (NRTS)<sup>10</sup> to derive a relationship between the type of ticket that was sold and the purpose of the journey. This was previously based on a single national average and meant our assumptions on journey purpose showed little variation between different places in the country.
- 6.1.3 Analysis of other data sources such as the National Passenger Survey (NPS)<sup>11</sup> has shown that while the journey purpose mix has remained stable since the NRTS was undertaken, the relationship between ticket type and journey purpose has changed, in part due to the greater availability of discounted tickets.
- 6.1.4 In this updated economic analysis we have therefore avoided the use of a ticket type relationship, and instead used the NRTS to directly estimate the journey purposes mix for different flows. This means that the journey purpose mix is now entirely consistent with NRTS; and shows the same regional variation. It also means our journey purpose assumptions are consistent with PDFH 5.0 which is based on the same NRTS data, and which has been adopted by the Department for Transport in its WebTAG<sup>12</sup> guidance.
- 6.1.5 These changes also affect the relationship between average weekday demand – which is used within the demand model – and annual demand and benefits. Therefore, the ‘annualisation factors’ used to convert estimated daily benefits to annual benefits in the appraisal have also been updated.
- 6.1.6 In addition to these revisions to estimates of current rail demand, we have also improved our understanding of how people currently make long-distance highway trips. We have incorporated new evidence available from the DfT’s Long-distance Model and National Travel Survey to provide a more robust starting point for our forecasts.

### 6.2 Impact of changes

- 6.2.1 A key result of the improvements in estimates of current rail journey purpose is that there is more variation in the proportion of business passengers across different regions. Figure 1 illustrates the change in the proportions of weekday passengers (not weekend travel) from London to a selection of destinations. The numbers are

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<sup>10</sup>The National Rail Travel Survey is based on records of over 2.7 million trips

[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/73094/national-rail-travel-survey-overview-report.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/73094/national-rail-travel-survey-overview-report.pdf)

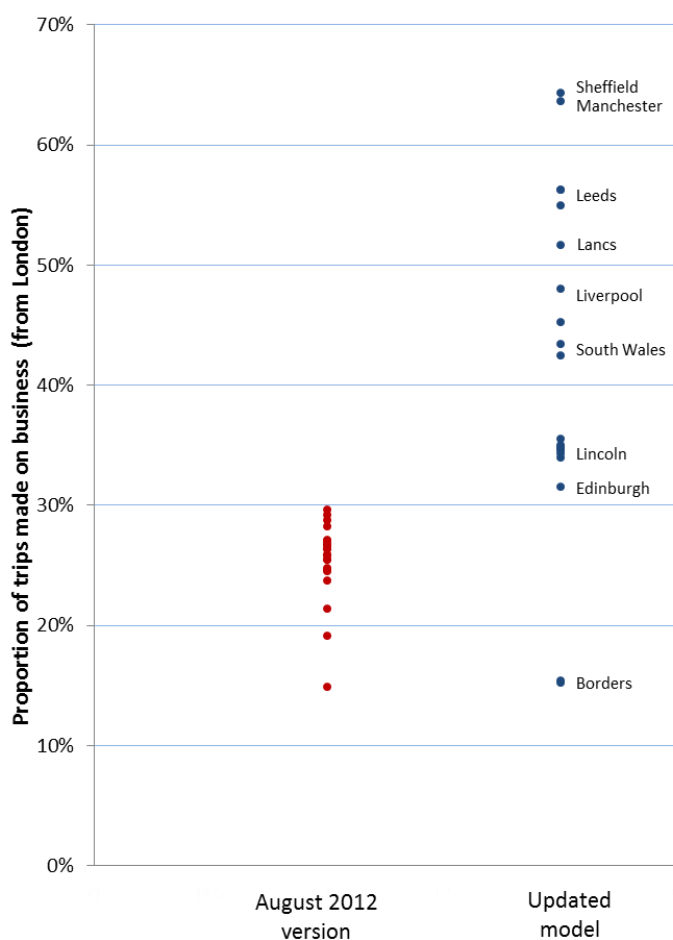
<sup>11</sup> <http://www.passengerfocus.org.uk/research/national-passenger-survey-introduction>

<sup>12</sup> <http://www.dft.gov.uk/webtag/documents/expert/pdf/unit3.15.4d.pdf>

generally higher than those actually used in the appraisal of HS2 due to the use of annualisation factors to multiply different journey purposes to annual totals.

- 6.2.2 However it is clear that there is significant variation in the proportion of business travellers by destination, reflecting both the nature of the destination – with large cities and conurbations attracting a significantly higher proportion of business trips – and the degree of competition with other modes for business travellers.

Figure 1: Change in proportion of weekday business rail travel by flow (excluding weekend travel)



- 6.2.3 Estimates of the proportion of business passengers on the routes served by HS2 are generally higher than previous estimates. As a result, while there is little change in the total number of passengers using HS2, a larger proportion of passengers who benefit from HS2 are forecast to be business passengers; increasing benefits for business passengers and reducing benefits for other passengers. Since business values of time are higher than for other passengers, this results in an increase in total benefits.
- 6.2.4 Revenues increase for the same reason, although the increase is rather smaller than for benefits as the difference between business and leisure fares is smaller than the difference in value of time.
- 6.2.5 Table 7 shows that total benefit for Phase One increases by almost one-third. Slight differences in the relative importance of crowding compared to other benefits, and variation in the proportion of business passengers on different routes results in a

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slightly smaller proportional impact for the Full Network, where overall benefits increase by 25%.

Table 7: Change in quantified costs and benefits following a revised base year matrices

Item		Phase One		Full Network		
		Change (£bn 2011 present value prices)	% Change	Change (£bn 2011 present value prices)	% Change	
1	Transport User Benefits	Business	7.0	72%	14.6	52%
		Other	-1.7	-21%	-3.1	-15%
2	Other quantifiable benefits	0.0	-5%	0.0	-4%	
3	Loss to Government of Indirect Taxes	0.1	-7%	0.0	-1%	
4	Net Transport Benefits (PVB)	5.4	32%	11.6	25%	
5	Wider economic impacts (WEIs)	0.7	24%	1.3	14%	
6	Net benefits including WEIs = (4) + (5)	6.1	30%	12.9	23%	
7	Capital Cost	0.0	0%	0.0	0%	
8	Operating Costs	0.0	0%	0.0	0%	
9	Total costs = (7) + (8)	0.0	0%	0.0	0%	
10	Revenues	1.9	15%	4.5	15%	
11	Net costs to Government = (9) – (10)	-1.9	-11%	-4.5	-13%	
12	BCR without WEIs (ratio) = (4)/(11)	0.5	47%	0.6	44%	
13	BCR with WEIs (ratio) = (6)/(11)	0.5	46%	0.7	42%	

## 7 Updated 'Do Minimum' networks

7.1.1 We have made significant updates to the representation of future rail services in the 'Do Minimum' (or 'without HS2' case). The update draws on advice provided by the Department for Transport on potential future investment on rail, and the implications of this on rail journey times and capacity.

7.1.2 In summary, the 'Do Minimum' has been updated to include<sup>13</sup>:

- Incorporation of electrification of the Midland Main Line from St Pancras involving increased capacity and faster journey times to the East Midlands;
- Incorporation of Intercity Express Rolling Stock on the East Coast Main Line resulting in increased capacity and faster journey times;
- Improvements to the West Coast Main Line including additional train paths, faster running speeds and infrastructure improvements. These changes result in additional services, increased capacity and faster journey times;
- Incorporation of the Northern Hub scheme to provide faster and more frequent services across the north of England; and
- Inclusion of the East-West Rail scheme between Oxford and Milton Keynes which will facilitate new local services and faster cross-country services.

### 7.2 Impact of changes

7.2.1 For Phase One the most significant impacts of these changes are on the journey times and capacity of WCML and London Midland services which improve for many locations north of Birmingham. There are slight reductions in capacity to Birmingham itself as some high capacity rolling stock is redistributed to other destinations on the WCML.

7.2.2 The implications of new Do Minimum assumptions for the Full Network are more significant, with the electrification of the Midland Mainline providing some significant time savings to Nottingham and Sheffield which reduces the time savings offered by HS2. Additional capacity further reduces benefits as crowding levels without HS2 fall.

7.2.3 The improvements in the rail network in the Do Minimum mean that HS2 offers comparatively less additional capacity and time savings than in previous forecasts, particularly between London and the North West, East Midlands, Yorkshire and Humberside, and Scotland. Whilst there are slightly more benefits to the West Midlands (which has less capacity without HS2 than in previous forecasts), this does not offset the impacts elsewhere and so overall benefits fall. This also means that expected increases in revenues are smaller, particularly for longer distance trips.

7.2.4 Overall therefore the improved services in the 'Do Minimum' mean that the benefits of the both Phase One and Phase Two fall.

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<sup>13</sup> Full details are provided in the separate Assumptions Report



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Table 8: Change in quantified costs and benefits following revised do minimum

Item		Phase One		Full Network	
		Change (£bn 2011 present value prices)	% Change	Change (£bn 2011 present value prices)	% Change
1	Transport User Benefits				
	Business	-0.8	-5%	-1.9	-4%
	Other	-0.5	-8%	-0.5	-3%
2	Other quantifiable benefits	0.0	-3%	0.0	-3%
3	Loss to Government of Indirect Taxes	0.1	-10%	0.2	-7%
4	Net Transport Benefits (PVB)	-1.3	-6%	-2.1	-4%
5	Wider economic impacts (WEIs)	0.2	7%	0.7	6%
6	Net benefits including WEIs = (4) + (5)	-1.0	-4%	-1.4	-2%
7	Capital Cost	0.0	0%	0.0	0%
8	Operating Costs	-0.4	-4%	4.2	19%
9	Total costs = (7) + (8)	-0.4	-1%	4.2	7%
10	Revenues	-1.2	-9%	-2.1	-6%
11	Net costs to Government = (9) – (10)	0.9	6%	6.3	21%
12	BCR without WEIs (ratio) = (4)/(11)	-0.2	-11%	-0.4	-21%
13	BCR with WEIs (ratio) = (6)/(11)	-0.1	-9%	-0.5	-19%

## 8 Revised HS2 and released capacity timetables

- 8.1.1 The assumptions on how both future HS2 and classic line services might operate once HS2 is opened have also been revised.
- 8.1.2 The revised service specification used in the assessment of the Economic Case is for illustrative purposes only and is not a future proposed service specification. Further discussion of how future services might be operated is provided in the separate Strategic Case Document.
- 8.1.3 The main changes to HS2 services in Phase One are:
- removal of additional peak services to Birmingham;
  - changes in routing and intermediate stopping patterns for Liverpool services; leading to faster journey times;
  - removal of stops on Scotland services to provide a better balance of demand and capacity and enhance journey times to Scotland; and
  - additional stops on Preston services to capture stations which are affected by the removal of stops on Liverpool and Scotland services.
- 8.1.4 For the Full Network, the main changes are:
- separation of Birmingham/Liverpool service (which previously split at Birmingham Interchange) into two services, providing faster journey times to Liverpool and Birmingham
  - splitting of one train per hour at Meadowhall to allow an additional train to York
  - provision of additional stops for Preston, Toton and York on some services
  - changes to journey time, with slight reductions in journey times to some locations in the North West, but increases in journey time to Scotland.
- 8.1.5 Assumptions on the re-use of capacity freed up on the classic network by HS2 have also been substantially updated. The modelled service pattern on the WCML has been revised to provide better services to shorter distance passengers and commuters along the line. This applies to both Phase One and the Full Network, with some further revisions to services north of Birmingham being introduced in the Full Network.
- 8.1.6 It is important to note that the HS2 and released capacity timetable assumptions in PFMv4.3 represent one possible set of assumptions for business case modelling purposes. They have been developed for modelling purposes and they do not represent any kind of commitment as to what will be implemented when the railway opens in 2026.

## 8.2 Impact of changes

- 8.2.1 Table 9 shows that the revised service patterns increase net transport benefits by 13%. Much of this is related to the revised assumptions on classic line services. The Phase One released capacity specification provides significant improvements to many shorter distance passengers and commuters all along the WCML. These passengers would see additional benefits of over £3bn.
- 8.2.2 The impact on HS2 and long distance passengers is smaller compared to the changes from released capacity. There are benefits between London and some areas of the North West and Scotland, while other areas see slightly lower benefits. This is particularly true in the West Midlands where peak services have been removed from Phase One to provide greater continuity with the Full Network service pattern.
- 8.2.3 The Full Network also sees the benefits of the improved use of released capacity around the West Midlands and along the southern section of the WCML as the same improvements are applied in both Phase One and the Full Network.
- 8.2.4 Overall benefits increase for both Phase One and the Full Network, with revenues also growing. Costs also fall, further enhancing the BCR which increases by 0.5 for both Phase One and the Full Network.

Table 9: Change in quantified costs and benefits following revised HS2 and released capacity timetables

Item		Phase One		Full Network	
		Change (£bn 2011 present value prices)	% Change	Change (£bn 2011 present value prices)	% Change
1	Business	1.0	6%	-0.2	0%
	Other	1.7	29%	2.1	12%
2	Other quantifiable benefits	0.0	4%	0.0	1%
3	Loss to Government of Indirect Taxes	-0.1	8%	0.0	0%
4	Net Transport Benefits (PVB)	2.7	13%	1.9	3%
5	Wider economic impacts (WEIs)	0.4	10%	1.7	15%
6	Net benefits including WEIs = (4) + (5)	3.1	12%	3.7	5%
7	Capital Cost	0.2	1%	0.5	1%
8	Operating Costs	-2.3	-29%	-6.5	-25%
9	Total costs = (7) + (8)	-2.1	-7%	-6.0	-9%
10	Revenues	0.6	5%	-0.5	-2%
11	Net costs to Government = (9) – (10)	-2.7	-16%	-5.5	-15%
12	BCR without WEIs (ratio) = (4)/(11)	0.4	35%	0.4	22%
13	BCR with WEIs (ratio) = (6)/(11)	0.5	34%	0.5	25%

## 9 Updates to cost methodology

- 9.1.1 All operating cost inputs and assumptions have been subjected to a comprehensive review to verify whether they are the most appropriate data to use. The inputs have been updated in line with new or more detailed data where appropriate.
- 9.1.2 The most significant changes to the base data include:
- Revised assumptions on train electricity consumption. Detailed modelling of the energy consumption of HS2's reference train using an industry standard tool has significantly changed the estimate of the amount of energy consumed by HS2 trains; and,
  - Revised assumptions on Train Operating Companies (TOC) overheads and administration costs. We have used significantly more detailed data based on current TOC overheads and administration expenditure to better estimate these costs for HS2.
- 9.1.3 In light of more detailed information, we have also added two new cost items to the model – the cost of HS2 services' impact on the classic line stations that they call at, and the cost of running an infrastructure manager head office.
- 9.1.4 We have also reviewed the application of optimism bias to our cost estimates. Previously, we applied a 41% uplift to all non-lease cost estimates, and 18% for lease cost estimates in line with the DfT's approach to risk on operating costs within WebTAG.
- 9.1.5 In consultation with DfT, we have now moved to a model where the level of optimism bias we apply to each cost line is dependent on the maturity of that individual estimate. Each cost operating cost line now has a tailored rate between 10% and 41%.
- 9.1.6 We no longer apply optimism bias to our estimate of costs savings on the classic line. It was decided that applying percentage uplift on savings goes against the purpose of optimism bias, which is to increase overall costs in order to counteract the tendency to be optimistic about future costs.

### 9.2 Impact of changes

- 9.2.1 The updates to the cost methodology overall have increased total costs, leading to a downward impact on the BCR. However, the new approach has generated both positive and negative changes. For example, the refinement of rolling stock purchase prices and better modelling of HS2 train energy consumption have pushed down costs. On the other hand, better evidence for TOC overhead estimates, as well as the addition of new costs, have increased costs.
- 9.2.2 Several of the changes which increase costs are effectively fixed costs which add the same amount to the estimated cost of operating both Phase One and the Full Network. As a result the proportional size of the increase in costs is larger in Phase One than in the Full Network.

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9.2.3 Moreover, where there have been changes in variable cost elements such as energy consumption, the scale of the change has differed by stock type, or the track type. This means that, for example, significant reduction in the energy consumption on the captive network has a larger reducing effect on the costs of the Full Network, as compared with Phase One.

Table 10: Change in quantified costs and benefits following updates to cost methodology

Item		Phase One		Full Network	
		Change (£bn 2011 present value prices)	% Change	Change (£bn 2011 present value prices)	% Change
1	Transport User Benefits				
	Business	0.0	0%	0.0	0%
	Other	0.0	0%	0.0	0%
2	Other quantifiable benefits	0.0	0%	0.0	0%
3	Loss to Government of Indirect Taxes	0.0	0%	0.0	0%
4	Net Transport Benefits (PVB)	0.0	0%	0.0	0%
5	Wider economic impacts (WEIs)	0.0	0%	0.0	0%
6	Net benefits including WEIs = (4) + (5)	0.0	0%	0.0	0%
7	Capital Cost	0.1	0%	-0.9	-2%
8	Operating Costs	2.6	47%	2.2	11%
9	Total costs = (7) + (8)	2.7	10%	1.3	2%
10	Revenues	0.0	0%	0.0	0%
11	Net costs to Government = (9) – (10)	2.7	19%	1.3	4%
12	BCR without WEIs (ratio) = (4)/(11)	-0.3	-16%	-0.1	-4%
13	BCR with WEIs (ratio) = (6)/(11)	-0.3	-16%	-0.1	-4%

## 10 Summary

### 10.1 Summary of results

- 10.1.1 Since we published the last estimates of the Economic Case for HS2, we have conducted a comprehensive programme of work to improve the methodologies, underlying assumptions and evidence base used by the economic models to assess the scheme. Additionally we have responded to changing external factors, such as GDP forecasts, and internal factors, such as more detailed development of the design.
- 10.1.2 Overall benefits for Phase One have increased by over 25%, while revenues are broadly unchanged. Despite the fact that business values of time in draft WebTAG guidance are around one third lower than in previous appraisals, business benefits are forecast to make up a larger proportion of benefits. This is partly because a larger proportion of HS2 passengers are now forecast to be travelling on business, but also because the value of some benefits has increased.
- 10.1.3 While there is little overall change in the BCR in October 2013 compared to August 2012, this is the net result of a number of much larger positive and negative changes. Changes to the scheme costs and changes to the demand model itself – particularly new crowding values and estimates of the amount of mode shift – reduce the BCR. However this is offset by changes in the appraisal methodology and assumptions, new evidence on current demand and journey purposes, and improvements in assumptions on HS2 and released capacity service patterns.
- 10.1.4 The analysis in this document has focused on a single point BCR to facilitate comparison across the steps and changes that have been presented. In the Economic Case, in line with advice from the National Audit Office (NAO) and other stakeholders, we have moved away from simply presenting our results as a single point estimate of the BCR. By presenting the risks and uncertainties around the case we are better able to demonstrate the key factors and assumptions that our analysis is sensitive to and more clearly address the risks that are being considered.