Airports Commission

Discussion Paper 01: Aviation Demand Forecasting

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An independent commission appointed by Government

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1. Introduction

1.1 The Airports Commission was launched on 2 November 2012 to examine the nature, scale and timing of any requirement for additional capacity to maintain the UK's global hub status.

1.2 To make its assessment of the need for new capacity, and any options to meet that need, the Commission will require credible forecasts of demand for aviation in the UK and the international markets that UK airports serve. A number of organisations already have well-established aviation forecasts, of which those produced by the Department for Transport (DfT) are the most detailed and frequently-updated forecasts produced at a national level. The most recent version of the DfT forecasts was published on 29 January 2013.[1] and is discussed in more detail later in this document.

1.3 However, whilst the DfT forecasts might offer a reasonable starting point for our work, we are keen to explore how this approach might be enhanced and supplemented to ensure that it is as effective as possible in supporting our analysis. There are also some specific questions we will need to address which the current DfT model is not equipped to answer fully.

1.4 The Commission is particularly interested in:

- **Patterns of domestic and international demand for air travel, how these might change over time, and the implications for UK airports.** We will need to analyse carefully how demand for air travel may change in the future. Changes may stem from factors such as developments in the UK or global economy; policy changes such as carbon targets implemented on a national and/or international scale or changes in the cost of travel, for instance from increases in fuel prices. Understanding these will help us to understand what the implications are for airport capacity and whether there is a need for additional infrastructure.
- **The competitive landscape for air travel both within the UK and internationally and how this may develop in future.** For example, we will need to understand the impact that capacity constraints, and options to alleviate them, could have on the UK's share of the international transfer market and the range of destinations served by UK airports. This is central to the debate around the economics of hub airports, and the nature as well as the scale of any future capacity needs.

1 The Department for Transport's UK Aviation Forecasts (2013) can be found at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69925/uk-aviation-forecasts.pdf

The data annexes that support the forecasts can be found at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69858/data-annexes.xls

- **How to deal with uncertainty.** Many changes have been seen since the last detailed consideration was given to airport capacity, in the preparation of the previous Government's 2003 White Paper. Demand for aviation has not grown as rapidly as was then forecast, partly attributable to the recession. This underlines the need for any forecasting approach to be able to deal effectively with uncertainty.

1.5 This paper is structured around these three key themes.

1.6 **Chapter 2** considers the different approaches to forecasting, its use in facilitating decision making in the aviation industry and the role forecasting tools can play in helping us to address the range of issues that will play a part in our assessment of the evidence on the nature, scale and timing of the UK's future aviation capacity and connectivity needs.

1.7 **Chapter 3** focuses on the Department for Transport's approach to forecasting UK aviation demand. It sets out its assessments of the key drivers of demand and how these might change over time and describes its projections for future demand for air travel in the UK. The chapter also briefly reviews three other aviation demand forecasts produced by Eurocontrol, ICAO and Boeing.

1.8 **Chapter 4** examines the international aviation market and whether capacity constraints could have an impact on the UK's share of international transfer traffic. It explores the strengths and weakness of DfT's forecasting approach in relation to this issue.

1.9 **Chapter 5** considers the way in which we can approach uncertainty in our forecasting approach to ensure that any decisions we make are credible and can withstand a range of different future outcomes.

1.10 **Chapter 6** sets out a range of questions on which we would welcome evidence both in relation to the outputs of the recent DfT forecasts and to help us to ensure our forecasting approach is as effective as possible.

2. Demand forecasting and its value in aviation

2.1 In order for us to make a recommendation on the capacity and connectivity that the UK will need to maintain its status as a leading global aviation hub, we will need to make an assessment of future demand for air travel. Without such an assessment, it is impossible to reach an objective, quantified view of what additional runway or airport capacity might be required if we wish to accommodate growing numbers of air passengers, of what the implications of such growth might be – for example, in relation to the UK economy or the global climate – or of the potential effects of any policy or other measures on levels of demand.

2.2 Forecasting methodologies that use historical trends, and draw upon evidence as to how and why these have changed over time, can provide a useful tool for projecting how they may develop in future. For example, if past experience shows a link between factors such as population growth and Gross Domestic Product (GDP) increases and rising demand for electricity, and if the strength of those relationships can be measured, then the power industry can use that information to make an estimate of whether demand growth is expected to continue in future.

2.3 But the limits of such an approach must be borne in mind. Forecasters do not have a crystal ball and so they need to find ways to analyse the uncertainty in their assessments, and the possibility that patterns and trends that have been identified in the past may not continue in the future – for example, by looking at how sensitive their forecasts are to changes in particular variables.

2.4 In transport, the aim of forecasting is to determine how patterns of demand will change over time, reflecting external factors such as growth in incomes, changes in transport prices and demographic changes.[2] Forecasting is therefore a key tool for decision making and is used across industry and Government in both business planning and policy decision making.

Forecasting approaches

2.5 Forecasts are derived in a range of ways depending on both the time and data available and also on the questions the forecasts are trying to address. Methods of forecasting vary from simple 'naïve' forecasts, more complex 'causal' forecasts to judgement based forecasting.

2.6 'Naïve' forecasts rely entirely on the historic values of what is being projected. For example, a naïve forecast may make the assumption that 'the growth in passenger numbers in the next five years will be the same as the growth in passenger numbers in the last five years'. Naïve forecasts are too

2 TAG,http://www.dft.gov.uk/webtag/documents/expert/unit3.15.1php

simplistic to be able to build an understanding of what might be expected in the future in response to policy changes or alternative future scenarios. However, naïve forecasts are often able to respond quicker to changes in demand and are therefore sometimes used as benchmarks against which more sophisticated models can be compared.

2.7 To address some of the perceived weaknesses of this approach, more complex 'causal' forecasts are constructed by looking at past relationships between demand and variables such as GDP, population, travel costs, consumer spending, etc. By using historical data to build an understanding of how these relationships have functioned over time and how changes in one or more of the variables have affected the overall level of demand, it is possible to make assumptions about the potential future effects of such changes. In this way, a picture of future demand for travel can be developed on the basis of existing economic, fiscal and demographic forecasts, amongst others. This approach is the most common of the two used to forecast aviation demand.

2.8 In cases where there is limited or no data available, judgement based forecasting, using techniques such as the 'Delphi Method'[3] is applied. This approach involves experts in the field considering historical patterns to predict future trends and is often used in conjunction with both naïve and causal models to compare forecast trends. The Delphi method is considered especially useful for long term forecasting (20-30 years) and is effective in drawing on existing knowledge to identify areas of agreement and disagreement in forming the forecast. However, for complex themes the Delphi Method is not always considered appropriate as there is no way of testing different outcomes e.g. through scenario testing.

Uncertainty in forecasting

2.9 Forecasting is inherently uncertain. The factors that underpin forecasts of future demand for travel are hard to predict, and a wide range of outcomes could occur during the period being forecast.

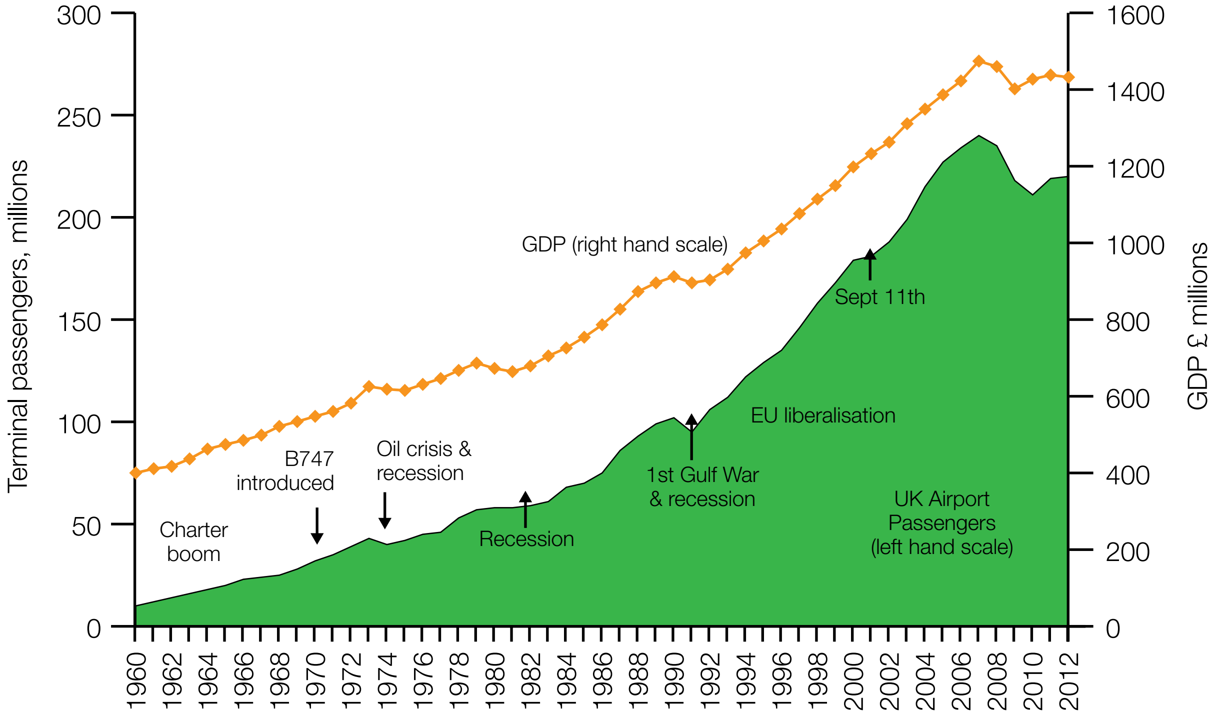
2.10 Economies evolve over time and are subject to intermittent, and sometimes large, unanticipated shifts. These changes may be driven by new legislation, switches in economic policy or political unrest.[4] Demographic changes can also be unpredictable, as can their effects. This makes forecasting with any accuracy difficult as whilst some short term fluctuations can be forecast, the impact of uncertainty across a number of the component variables of longer term forecasts is more difficult to predict.

2.11 In some cases, despite short term fluctuations, long term trends have re-established themselves, but this is not always the case. Figure 2.1 shows that deviations from the long term trend in air travel between 1950 and 2009 were driven by economic factors, such as recessions or oil price shocks, or by other international events, like military conflicts or terrorism. Despite these short term fluctuations, Figure 2.1 shows that the longer term trends eventually re-established themselves. However the drop in demand in 2007 as a result of the current recession has

3 http://www.unido.org/fileadmin/import/16959_DelphiMethod.pdf

4 Clements, Michael P. and Hendry, David F (2008) Economic forecasting in a changing world. Capitalism and Society Vol. 3 (No.2) Article 1

Figure 2.1: Terminal Passengers at UK airports and GDP, 1950 to 2012



1950 – 1960	1960 – 1970	1970 – 1980	1980 – 1990	1990 – 2000	2000 – 2012
Growth = 372%	Growth = 214%	Growth = 83%	Growth = 77%	Growth = 75%	Growth = 23%
Annual average = 17%	Annual average = 12%	Annual average = 6%	Annual average = 6%	Annual average = 6%	Annual av. = 2%

Source: CAA/ONS data.

led to a fall in UK passenger traffic and the latest DfT forecasts indicate slower growth projections than previously expected.

2.12 Conversely, some trends appear to reverse themselves completely. This can be seen in Figure 2.2 which shows that despite a clear downward trend in passenger rail journeys between 1946 and the late 1980s, the trend reversed itself from the early 1990s and continues to climb today.[5]

2.13 For these reasons, focusing solely on a single, central-point forecast would be a risky approach. While a central forecast may be produced, as is the case with the DfT forecasts, it is useful to model a range of potential outcomes alongside this (particularly over the long term) to test the robustness of decision making.

5 http://www.rail-reg.gov.uk/upload/pdf/rail-vfm-summary-report-may11.pdf

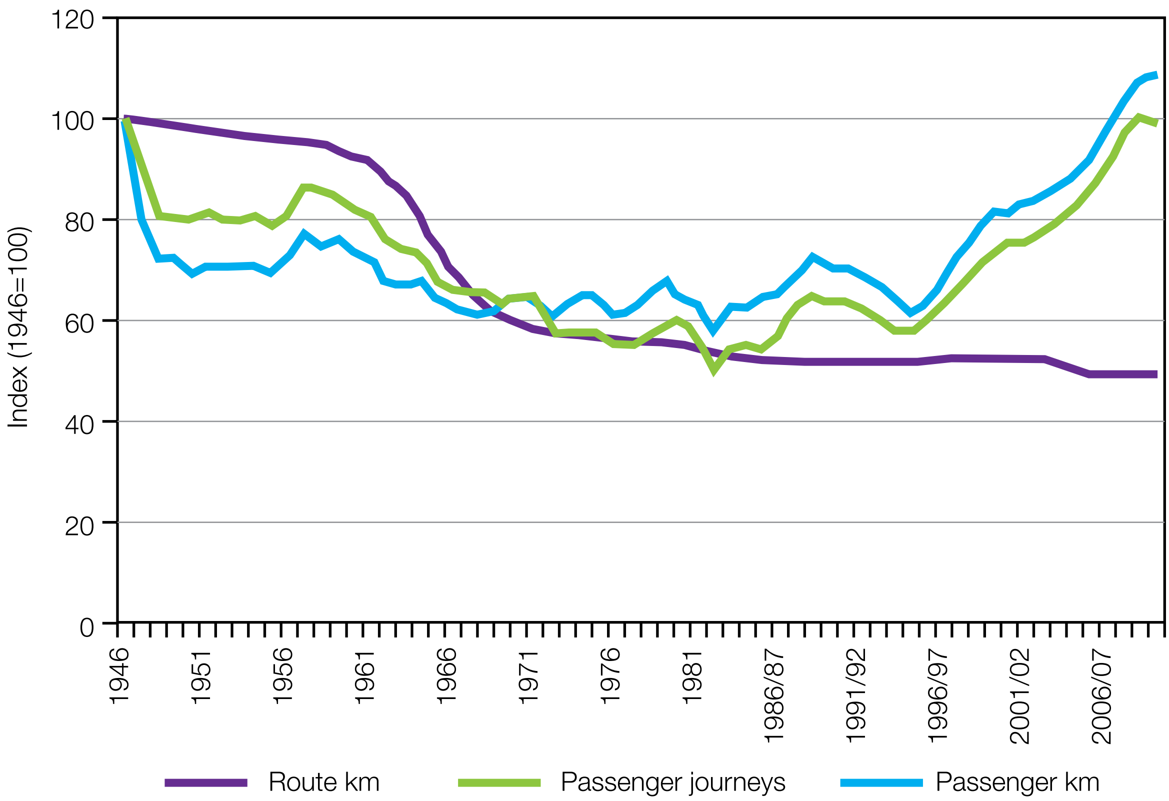
Chapter 5 of this paper discusses this issue in more detail, and sets out some of the approaches which have been developed to enable forecasters and policy-makers to identify and assess this uncertainty.

The role of demand forecasting

2.14 The aviation industry uses forecasting both to enable short term decisions such as whether to expect adverse weather conditions and how to respond, and to support longer term decisions in respect of future patterns in demand for air travel.

2.15 The use and scope of aviation forecasts can vary. For example, airlines use demand forecasting as a way of optimising the use of their planes by taking into account seasonal demand, whereas aircraft manufacturers have used forecasting to identify demand for

Figure 2.2: Change in passenger rail journeys 1946–2007



more fuel efficient aircraft, in response to rising fuel prices, or for larger aircraft to serve the most popular routes more efficiently.

2.16 Forecasts are also used across government to help inform policy decisions, however, the scope and emphasis of the analysis can differ substantially depending on the nature of the decisions being made.

2.17 The primary purpose of the Department for Transport (DfT) aviation forecasts is to inform long term strategic aviation policy in the UK. As such they cover a long time-horizon to 2050, focusing on the key drivers of demand and how they might change over this period at a national level. The model can also be used to forecast how national passenger demand will be distributed between the 31 largest airports in the UK. Demand is presented in both an unconstrained and constrained scenario to facilitate an understanding of how the market for passenger air travel will develop, whether current infrastructure is sufficient to accommodate this and the effects of any capacity constraints.

2.18 Previous policy questions that have been examined using the DfT model include the assessment of airport capacity options as part of the 2003 Air Transport White Paper process, an analysis of different options for reducing aviation carbon emissions in response to the Committee on Climate Change[6] and a review of the impacts of airport specific charges for HM Revenue & Customs.[7] This need for policy analysis means that the model incorporates a significant level of detail including both airport-level passenger and carbon emission projections.

6 https://www.gov.uk/government/publications/government-response-to-the-committee-on-climate-change-report-on-reducing-co2-emissions-from-uk-aviation-to-2050

7 http://www.hmrc.gov.uk/research/report188.pdf

Areas for exploration

2.19 The Commission's objective is to examine the nature, scale and timing of the steps needed to maintain the UK's global hub status; and to identify and evaluate how any need for additional capacity should be met in the short, medium and long term.

2.20 In order to meet these objectives, we will need to develop projections for UK and international demand for air travel, and to consider an appropriate range of potential demand scenarios, bearing in mind the uncertainty inherent in any such forecasting approach.

Forecasting aviation demand in the UK

2.21 Historically, the key drivers of long term growth in aviation demand in the UK have been rising GDP and a long term decline in the real cost of air fares.[8] We will need to consider how these drivers of demand may change in the future and how their impact varies across different parts of the aviation market. We will also need to consider how environmental challenges, such as the need to tackle greenhouse gas emissions, might shape future demand.

2.22 Forecasts of this kind will also support us in developing an understanding of how demand might respond to:

- Changes in the real cost of air fares, for example as a result of changes in oil prices;
- Changes in the fiscal or regulatory environment, for example initiatives to mitigate the effect of climate change;
- Technological and behavioural changes, for example the impact of improvements in videoconferencing on business travellers; and
- Future transport infrastructure plans such as the implications of HS2 for demand for domestic air travel.

2.23 **Chapter 3** discusses the approach taken by the Department for Transport to produce their UK aviation demand forecasts, including how they seek to understand how the key drivers of demand might change over time and what the projections for UK demand are in both an unconstrained and constrained model.

UK aviation demand and the international aviation market

2.24 To reach a view on the UK's aviation capacity and connectivity needs, the Commission will need to understand recent changes in industry behaviour, and how the industry may respond to prospective policy interventions. This includes changes to the competitive environment for UK airports, the emergence of new and growing international hubs over the past decade, and the growing international competition for transfer traffic.

2.25 In particular, we will need to consider:

- The impact that capacity constraints could have on the UK's share of international transfer traffic and the consequences this has for the range of destinations served by UK airports;
- The scope for a range of UK airports to attract increasing numbers international services, including long-haul and transfer traffic; and
- Whether prospective measures to increase capacity at particular

8 Department for Transport, UK Aviation Forecasts (2013) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69925/uk-aviation-forecasts.pdf

locations could enable the UK to maintain or grow its share of the international transfer market and the impact this would have on the range of destinations served.

2.26 We will also need to look at the potential rates of growth in both the leisure and business travel markets, as well as to and from different areas of the globe, to enable us to review the types of connectivity that might be needed in future and the scale and timing of any such requirements.

2.27 **Chapter 4** explores in detail how the Department for Transport's forecasts take account of competition between UK airports for international passenger air service. It looks at the degree to which its approach can help us in our consideration of these issues, but also at areas of potential weakness in the approach.

Dealing with uncertainty

2.28 Finally, we will need to ensure that our decision making approach is robust, including looking at how we interpret and test the forecasts that we use. All forecasts are subject to some degree of uncertainty, and we will need to ensure that our recommendations are credible in a range of possible future outcomes. Therefore we will need to come to a view as to how we wish to approach this uncertainty in our forecasting approach.

2.29 **Chapter 5** reviews and discusses the different methodologies for understanding the uncertainty and risk in forecasting and considers to what extent these can help us to ensure our approach to decision making is rigorous and weighs the different risks appropriately.

3. Department for Transport forecasts

Introduction

3.1 The Department for Transport has recently published updated forecasts of UK air passengers and UK aviation carbon dioxide (CO_2) emissions. These forecasts present a comprehensive estimate of how activity in UK airports and the associated CO_2 emissions are likely to change into the future. We currently expect to use this forecasting approach as the starting point for our own assessments of future aviation demand.

3.2 This chapter seeks to outline how DfT forecasts aviation demand, how its model has been developed and the outputs that can be derived.

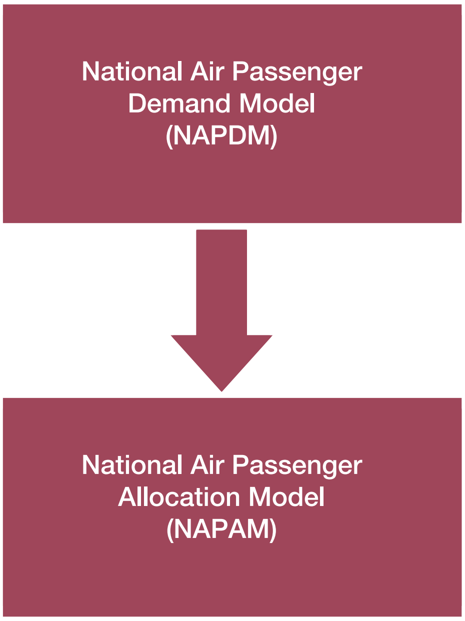
3.3 We would encourage submissions providing evidence and views as to how the DfT approach might be enhanced or supplemented to make it as effective as possible in supporting our work. Chapter 6 provides information as to how such submissions can be made.

3.4 The government has issued forecasts of UK air passengers in different forms for over 30 years. The last decade has seen a period of intensive development to the scope of outputs produced and approach used:

- In 2000, a national level forecast of future aviation demand derived using a set of econometric models was published.
- In 2002, DfT developed an allocation model to understand passengers' airport choice decisions and the impacts of capacity constraints. This was used to generate the forecasts for the South East and East of England Regional Air Services consultation (SERAS) in 2002. A model to estimate consumer benefits from major policy interventions was also created for SERAS.
- A number of significant developments were subsequently made prior to the publication of updated forecasts in the 2006 document, *The Future of Air Transport Progress Report*. These included: the development of the National Air Passenger Demand Model to allow national forecasts to be updated more rapidly as well as the development of an approach to projecting carbon emissions based on detailed fleet modelling.

3.5 Since then, while the overall approach has remained stable, these models have been subject to an ongoing process of incremental development and have been continually updated through the 2007, 2009, 2011 and 2013 versions of the UK air passenger demand and CO_2 forecasts. The DfT model now has two basic stages as set out in Figure 3.1 below. The first is the National Air Passenger Demand Model (NAPDM) which produces 'unconstrained' demand forecasts at a national level, and second is the National Air

Figure 3.1: The two stages of the DfT model



NAPDM produces forecasts of terminal passengers travelling from, to or through the UK, at a national level split across 19 different market segments. These projections are based on historical analysis of the key drivers of demand in each segment combined with assumptions about how these relationships might change in the future.

NAPAM allocates this national level demand across 31 of the largest UK airports based on a detailed geographic breakdown of passenger origins, surface access transport costs and service frequency modelling. Passenger decisions include the option of travelling direct or via a hub in either the UK or abroad.

This stage of the forecast can be produced on either an unconstrained basis, allowing all airports to expand as much as required to meet demand, or a constrained basis, incorporating the impact of capacity constraints on demand.

Passenger Allocation Model (NAPAM) which divides this demand between the 31 largest airports in the UK, taking into account capacity constraints.

3.6 The 'constrained' NAPAM forecast effectively provides a 'do minimum' baseline scenario against which potential changes in airport capacity can be assessed.

3.7 DfT's projections of numbers of passengers and Air Transport Movements[9] (ATMs) for each airport are used in a number of sub-models to provide additional outputs. For example, a detailed model of the UK's future fleet is used to project the level of CO_2 emissions from flights departing the UK on a route by route basis and a Transport User Benefits Model has been developed to assess the benefits to passengers of alternative policy options in a way that is consistent with the DfT appraisal guidance.

9 An Air Transport Movement is defined as a landing or take-off of an aircraft engaged on the transport of passengers, cargo or mail on commercial terms (i.e. it excludes 'air taxi' movements and empty positioning flights).

Data and input projections

3.8 The process used by DfT to identify relevant inputs to the model starts from analysis of historical data on a sector by sector basis. Passenger data is differentiated according to the purpose of travel (business vs. leisure), residence of passengers (UK or foreign) and five broad geographic zones using data from the Office of National Statistics' International Passenger Survey in conjunction with Civil Aviation Authority sources. The definition of these geographic zones is discussed in Chapter 4.

3.9 Time-series regression analysis is then used to identify which drivers have historically had the strongest relationship to passenger demand in each segment and to weigh the importance of one input over another. This analysis has demonstrated, for example, that measures of consumer expenditure and air fares are more strongly related to UK leisure travel demand whilst measures of GDP and trade are more strongly related to business demand.

Figure 3.2: Drivers that influence aviation demand

Drivers relating to economic activity are shown in green and drivers relating to air fares are shown in orange.

The most important drivers are shown in larger text.

3.10 The drivers identified by the DfT can be divided into two broad groups: those affecting the level of economic activity and those affecting air fares. Figure 3.2 visually demonstrates the importance of different drivers at an aggregated national level.

3.11 Producing a comprehensive forecast requires separate forecasts for each of these key drivers. A similar approach is used across government, for example, in order to produce its fiscal forecast, the Office of Budget Responsibility (OBR) works across a number of Government departments to pull together numerous forecasts covering revenue, spending and financial transactions. This includes working with HMRC and DWP who provide the forecasts for the major components of tax receipts and benefit expenditure reflecting their expertise in the area.

3.12 Table 3.1 summarises the sources used for each of the inputs to the DfT aviation forecasts outlined above. In the case of GDP, consumer expenditure, oil prices and carbon prices, inputs are sourced from other Government departments to

Table 3.1: Sources of inputs for National Forecasts

Input	Source
UK Consumer Expenditure	Office of Budget Responsibility
UK GDP	Office of Budget Responsibility
Foreign GDP	International Monetary Fund & Enerdata
Imports and exports	Projected in line with GDP assumptions
Oil Prices	DECC
Carbon Prices	DECC
Airline Costs	DfT projection
Load Factors	DfT Projection
Exchange Rates	Office of Budget Responsibility

Table 3.2: Long run price and income elasticities of UK terminal passenger demand[10]

Sector	Share of passenger demand in base	Elasticity of demand with respect to	
		Income	Air fares
UK Business	8%	1.2	-0.2
UK Leisure	45%	1.4	-0.7
Foreign Business	7%	1.0	-0.2
Foreign Leisure	14%	1.0	-0.6
International to international interliners	10%	0.5	-0.7
Domestic	15%	1.7	-0.5
Overall	100%	1.3	-0.6

Source: DfT Aviation Forecasts 2013

provide cross-departmental consistency in approaches used. However, where projections are not available from other government departments, the DfT seeks to use independent sources wherever possible.

3.13 We are interested in receiving views and evidence regarding these input sources, their appropriateness in supporting our work, and any alternative sources that might be considered.

3.14 These projections are combined with the relationships identified historically to project demand going forwards in each of the 19 market segments forecast. For example, the model derives long run elasticities of demand for air travel with respect to income and air fares for each of the 19 market segments. An elasticity of 1 means that a doubling of income would lead to a doubling of demand; a lower elasticity equates to a weaker relationship (e.g. a doubling of income leads to less than a doubling of demand) and a higher elasticity to a stronger relationship. A negative elasticity, such as between air fares and demand, means that as the one factor rises the other falls.

3.15 Table 3.2 summarises the elasticities used by DfT. It demonstrates the variability of air fare elasticities across different markets and shows that income is a strong driver in the domestic and UK markets in particular.

3.16 The exact relationship between air travel growth and the key drivers of demand such as income and air fares are likely to change over time. For example, in more developed countries, it is possible that decreases in travel costs have been driving recent demand growth whereas, in less developed economies, it is likely that economic growth has been, and will continue to be, a key determinant in stimulating new travellers to travel.[11]

3.17 The DfT model incorporates judgements about the degree to which the different parts of the aviation market are likely to mature over time, therefore becoming less responsive to further increases in income. The market segments are split

10 Income variables depend on the sector and the results are elasticities of terminal passengers to income or fares

11 GRAHAM, A. 2006. Have the major forces driving leisure airline traffic changed? *Journal of Air Transport Management,* 12**,** 14-20 and University of Westminster, 2010 DfT Air Transport – Market Maturity – Summary Report.

into the following three groups which are broadly based on how soon they are expected to show signs of market maturity:

1. domestic markets which are deemed to be the most mature;
2. business and leisure markets to and from western Europe and the non-European OECD countries, as well as leisure travel by UK passengers to newly industrialised and less developed countries. These have experienced rapid growth, but this is not expected to continue at the same pace in the future; and
3. business markets to and from newly industrialised and less developed countries as well as leisure travel to the UK by foreign passengers from these regions. These have experienced lower growth rates in recent years, but they are generally low income markets that are expected to experience rapid economic development over the forecast period. They are therefore deemed to be less mature.

3.18 When allocating national level demand to individual airports, DfT's NAPAM is aligned to Civil Aviation Authority passenger data.[12] In addition, a number of more detailed geographic inputs are used to help predict future patterns of passenger demand; these are outlined in Table 3.3.

The DfT CO_2 emissions model

3.19 Outputs from NAPAM, in conjunction with a detailed fleet mix model, are also used to generate DfT's forecast of the CO_2 emissions of aircraft departing UK airports. The approach taken is shown in Figure 3.3 below.

3.20 The starting point is a forecast of the number of Air Traffic Movements (ATMs) for each airport and route by 'seat-band'[13] of aircraft. These ATMs are fed into DfT's Fleet Mix Model (FMM) which forecasts the aircraft fleet mix at each airport and by route, in order to identify the number of seat kilometres by aircraft size and the distance flown on each airport route. This forecast is combined with the projected fuel efficiency of each aircraft type to estimate the annual fuel burned by flights departing each UK airport. A similar but simpler approach is applied to forecasting CO_2 emissions from freight aircraft.

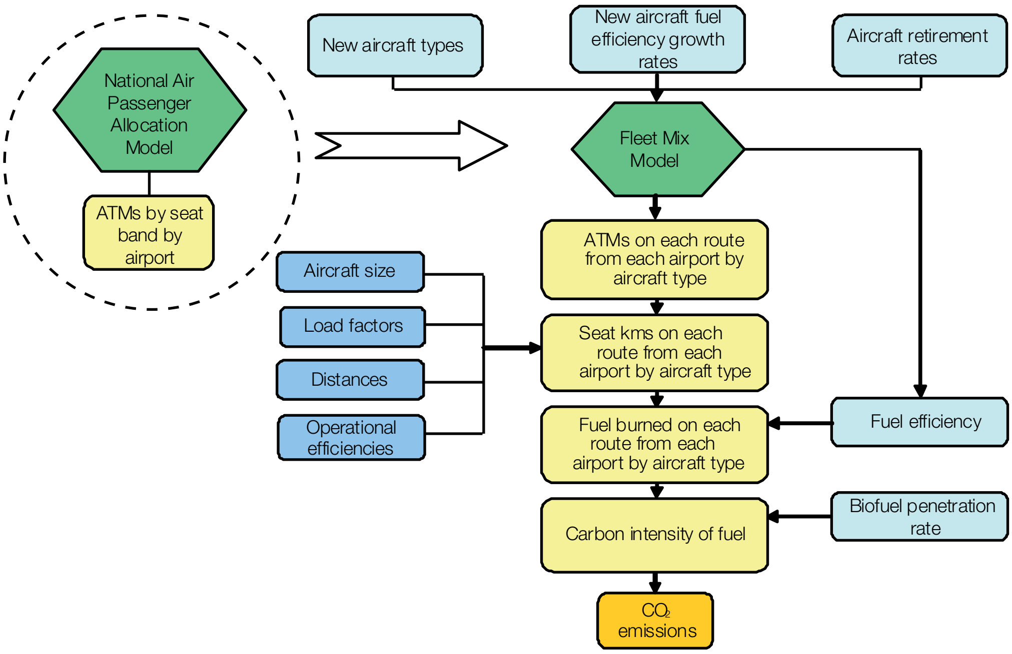
Table 3.3: Geographical inputs used to help predict future patterns of passenger demand

Input	Source
Current District Level Origins & Destinations of Passengers	Civil Aviation Authority Passenger Survey
District Level Projections of Income and Population	DfT Projections (National Trip End Model)
Surface Access Costs	DfT Projections (Long Distance Model)
Capacity Assumptions	DfT Assessment

12 Details of the performance of the model in replicating outturn data for 2011 are provided in Chapter 9 of the UK Aviation Forecasts, 2013 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69925/uk-aviation-forecasts.pdf

13 There are six 'bands' based on the seating capacity of the aircraft.

Figure 3.3: DfT approach to forecasting aviation CO_2[14]



Other available forecasts

3.21 While we believe the DfT forecasts to be the most comprehensive national-level forecasts, they are not the only forecasts of aviation demand that have been made. For example, other organisations such as Eurocontrol, Boeing and the International Civil Aviation Organisation (ICAO) have also produced aviation demand forecasts. The approaches used by ICAO and Boeing are discussed in more detail below, and the results considered on page 23–24.

3.22 Eurocontrol[15] publishes a seven year forecast annually which it refreshes at mid-year to support the capacity planning process in Europe. The latest published forecast covers the period from 2012 to 2018 and projects the annual numbers of Instrument Flight Rules (IFR) flight movements in Europe in a constrained model to reflect annual airport capacity.

3.23 The forecast is derived from historic air traffic trends and by a set of scenario assumptions based on economic growth, modal interactions, demographic change, airport capacity, events and trends such as the Olympics, EU Emissions Trading Scheme (EU ETS)/carbon pricing and airplane load factors.

3.24 In contrast to DfT and Eurocontrol's forecasts which are both derived from an econometric forecasting approach, ICAO's Forecast and Economic Support group (FESG)[16] produces global traffic and fleet forecasts using a judgement-based consensus approach. This considers forecasts produced by a range of sources including ICAO, Eurocontrol, the United States Federal Aviation Administration and industry (including organisations such as Airbus, Boeing and Rolls Royce amongst others), with the FESG forecasts derived

14 Department for Transport Aviation Forecasts (2013) pg 34, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69925/uk-aviation-forecasts.pdf

15 Eurocontrol Medium-term forecast, September 2012. Flight movements 2012–2018 http://www.eurocontrol.int/sites/default/files/content/documents/official-documents/forecasts/seven-year-flight-forecast-2012-2018-sep12.pdf

16 ICAO's FESG CAEP/8 Traffic and fleet forecasts (2008) http://media.wix.com/ugd/47767c_3492d579cbf7675023235bc2894d0876.pdf

following discussion and debate amongst the forecasting experts within the group.

3.25 The last forecasts produced by the FESG were published in 2008. Its traffic forecast was an unconstrained forecast covering a 20 year period from 2006 to 2026 and projecting passenger traffic growth rates within 23 major route groups. These were obtained from ICAO and the aviation industry. An additional ten year forecast to 2036 was also produced, which was not based on existing industry forecasts but which relied on professional judgement. The FESG also applies a consensus based approach to estimating the effects of market maturity.

3.26 The FESG's 2008 fleet forecast covered a 30 year period from 2006 to 2036 and was based on a corporate model produced by Airbus but with inputs and assumptions provided by the FESG.

Latest DfT projections

3.27 At a national level, the latest unconstrained DfT projection suggests that, if airports were to expand as required to meet demand, growth in UK air passengers is likely to be within the range of 1% and 3% per year, compared to a historical growth rates of 5% per annum over the last 40 years. This slow down in growth rates reflects the anticipation of market maturity across different passenger markets and a projected end to the long term decline in average fares seen in the last two decades. This long term decline in average fares has historically been driven by low oil prices and the widespread take-up of the low cost carrier strategy, which has reduced non-fuel costs. DfT projects that this trend will come to an end in future as a result of sustained high oil prices, a slow down and eventual stop in the rate of reduction for non-fuel costs, and an increasing cost of carbon for the aviation sector.

3.28 On the basis of these central projections, and in the absence of capacity constraints, the underlying trend of growth in UK air passenger demand is forecast to continue, rising from 219 million passengers per annum (mppa) in 2011 to 320mppa in 2030 and to 480mppa by 2050. The proportions of traffic travelling long-haul vs. short-haul and business vs. leisure remain broadly constant over the forecast period.

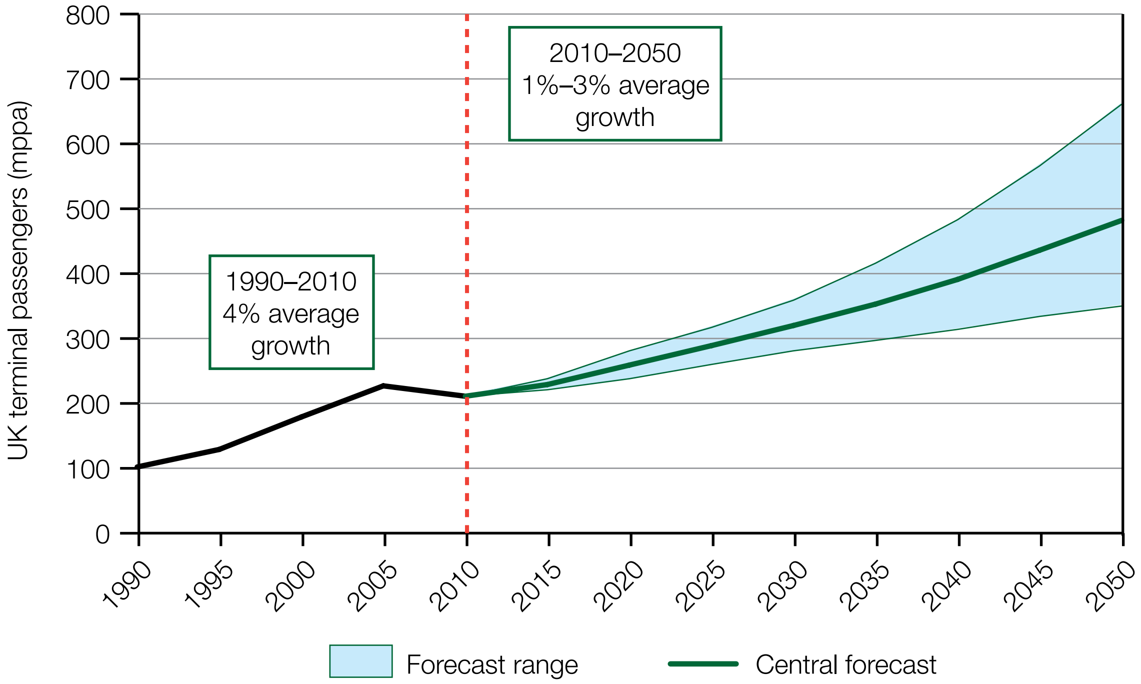
3.29 The central DfT forecast, together with the Department's projected range of high and low scenarios, are shown in Figure 3.4 opposite.

3.30 The represents a reduced rate of growth in demand for air travel compared to previous DfT forecasts. This can be seen in Table 3.4 below, which compares the outputs of its three most recent published UK air passenger demand and CO_2 forecasts.

Table 3.4: Change in the DfT unconstrained central projections for UK air passenger demand, mppa

	2009 projections	2011 projections	2013 projections
2010	260	211	211
2030	465	345	320
2050		520	480

Figure 3.4: DfT's projected range[17]



Source: DfT UK Aviation Forecasts, January 2013

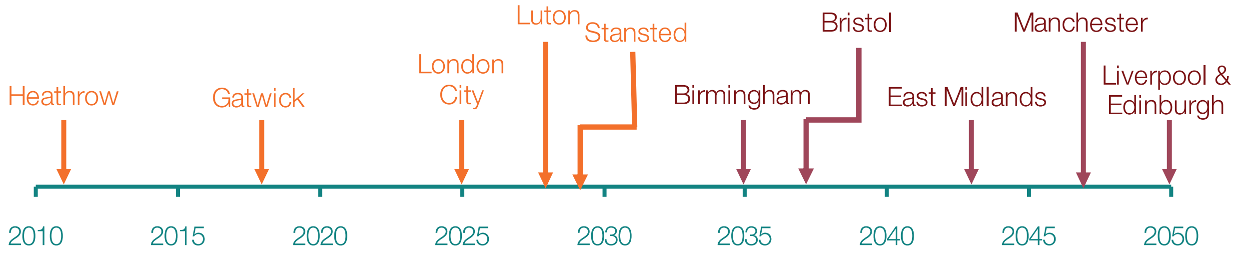
3.31 When capacity constraints at UK airports are taken into account, the central forecast is lowered by around 5 million passengers in 2030 and 35 million in 2050. At an airport level, the central forecasts as demonstrated in Figure 3.5 below project that the five largest airports in the South East of England are forecast to be full by 2030. However, the high and low demand scenarios underline the uncertainty around this conclusion. With the range of demand used they could be full as soon as 2025 (the high case) or take until around 2040 (the low case).

3.32 The DfT forecast uses 2008 as its baseline year but is aligned with outturn data at a national level up to and including 2012 which indicates that across the full range of input assumptions, Heathrow effectively reached capacity in 2011. The UK terminal passenger central forecast at Heathrow does however indicate a slight growth in passenger numbers throughout the forecast period attributable to an increase in the average number of passengers per flight as airlines focus on "thicker routes" in response to capacity constraints.

3.33 The DfT aviation forecasts also include a projection for CO_2 emissions from aircraft departing the UK. The 2013 central forecast projects an increase in emissions until 2030 when this trend is expected to slow in line with the effects of market maturity and airport constraints take effect. Table 3.5 below demonstrates that the London airports share of UK aviation CO_2 will diminish over the period of the forecast. This is because, as demonstrated in Figure 3.5 above, the London airports are predicted to be at capacity by 2030 and growth in ATMs would therefore only be possible at the regional airports. It is also assumed that the London airports – particularly Heathrow and Gatwick – would benefit from the new generations of aircraft that enter the fleet.

17 DfT UK Aviation Forecasts, January 2013 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69925/uk-aviation-forecasts.pdf

Figure 3.5: Central forecast at airport level



3.34 DfT's central projections for UK aviation emissions published in January 2009 showed emissions increasing from 37.5 Mt CO_2 in 2005 to around 58.4 Mt CO_2 by 2030, then remaining flat to 2050, whereas DfT's latest central forecasts of UK aviation CO_2 emissions project a slower increase.

3.35 On the basis of the 2009 projections, the Committee on Climate Change (CCC) deemed that UK aviation emissions would account for around 35% of total allowed UK greenhouse gas emissions in 2050 to meet an 80% emissions reduction target. The latest DfT projections would be expected to have implications for the CCC's conclusions, potentially meaning that aviation emissions would account for a lower proportion of the UK's total allowable greenhouse gas emissions in 2050.

Performance against historical trends

3.36 Figure 3.6 below shows that the DfT forecasting approach has performed well against outturn during periods of relative stability in the key drivers, such as the trend in economic growth, but less well in the face of major shocks – most notably, the impact of rising oil prices and the financial crisis in late 2008. The average error for the 2003 forecast was 1.6% in the years 2003 to 2007, but over 30% for the period 2007 to 2012.

Table 3.5: Airport CO_2 emissions and their share of the total UK departure CO_2

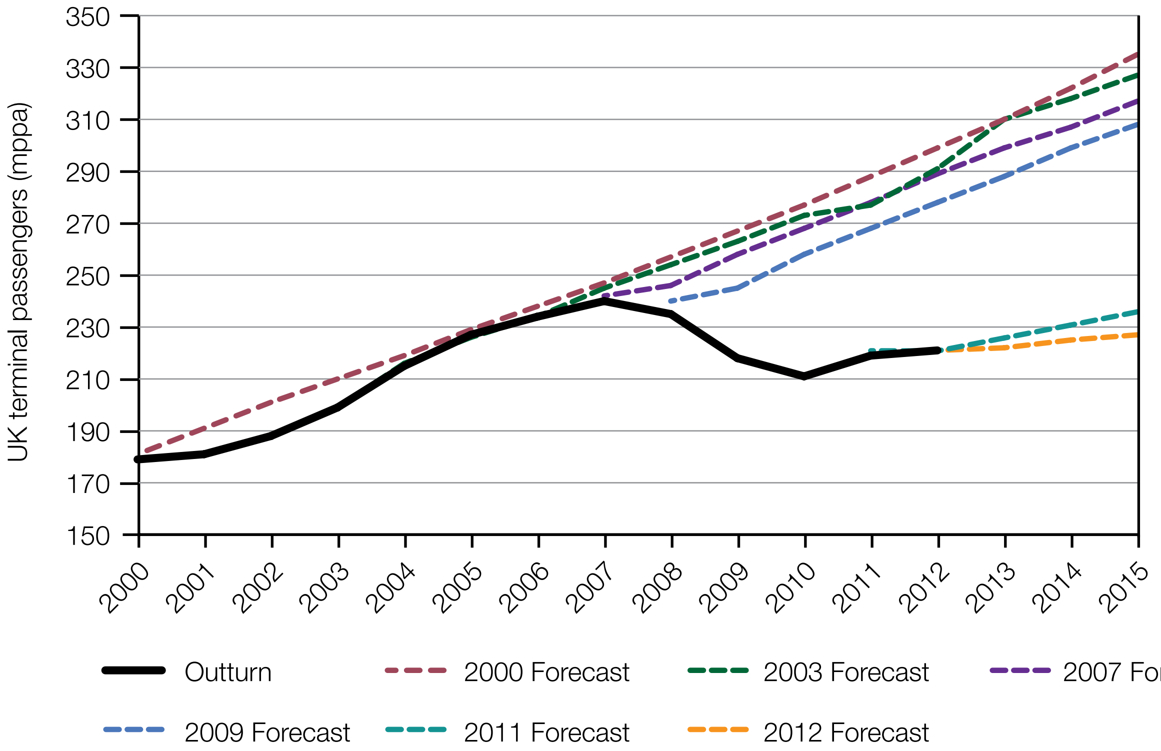
	Emissions million tonnes CO_2			Share of total UK departure CO_2		
	2010	2030	2050	2010	2030	2050
Heathrow	18.8	21.4	18.2	57%	49%	39%
Gatwick	3.9	4.7	4.3	12%	11%	9%
Stansted	1.1	3.5	1.9	3%	8%	4%
Luton	0.7	1.3	0.9	2%	3%	2%
London City	0.2	0.5	0.5	1%	1%	1%
London Total	**24.7**	**31.4**	**25.7**	**75%**	**72%**	**55%**
Other UK Airports	6.9	10.3	19.5	21%	24%	42%
Ground APU	0.4	0.5	0.7	1%	1%	2%
Freight	0.8	1.2	0.9	2%	3%	2%
Residual	0.1	0.1	0.1	0%	0%	0%
Total	**32.85**	**43.50**	**46.97**	**100%**	**100%**	**100%**

Source: Table 6.3 UK Aviation Forecasts, January 2013

3.37 The experience over this period highlights one of the major challenges in forecasting aviation demand – if projections of the key drivers are incorrect then the final forecast will be inaccurate. The last forecast before the decline in total passenger numbers became evident was published in 2009. This forecast was based on projections from HM Treasury that implied that UK GDP would be 11% higher and that oil prices would be 23% lower than they actually turned out to be in 2010. Figure 3.7 below demonstrates that if these inputs had been projected accurately then the forecast would likely have been lower than outturn rather than higher.

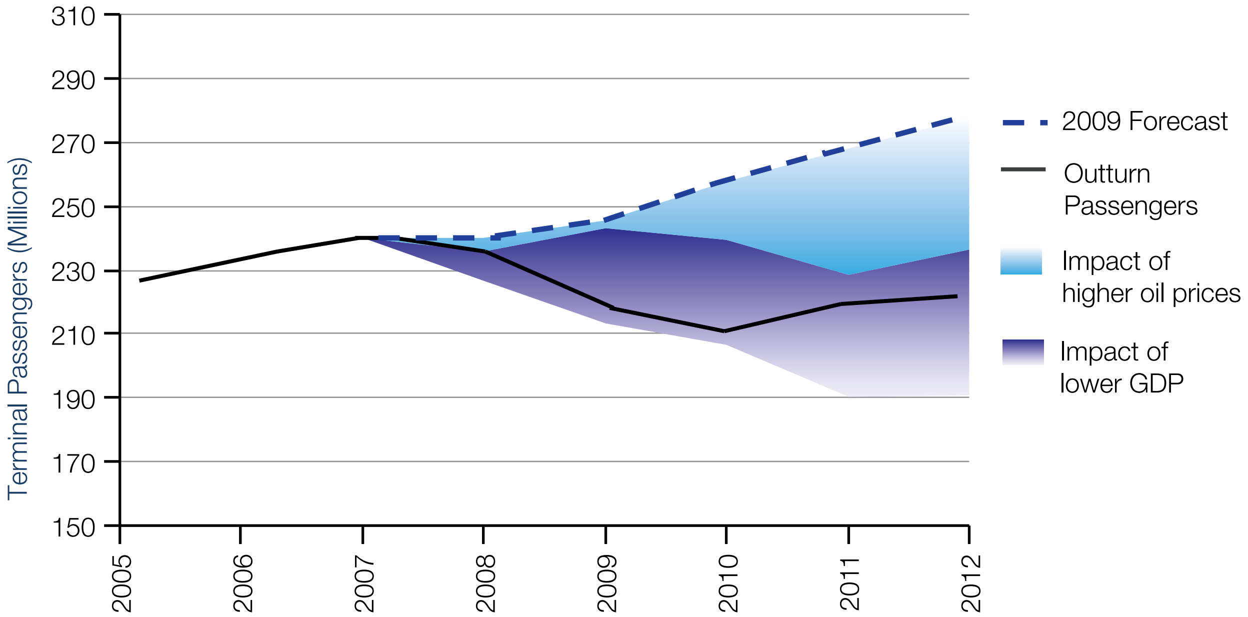
3.38 Since the majority of economic forecasts prior to 2008 predicted a continuing pattern of growth, it is unlikely that using alternative sources for central projections of inputs would have significantly improved the DfT aviation demand forecasts over this period.[18] Additionally, it is only possible to review the performance of forecast models where outturn data is available. This means that although the performance of the DfT forecasting models can be evaluated over the relatively near term, their quality in the longer term remains difficult to assess. However, this assessment does demonstrate the inherent uncertainty in forecasting the future for any sector that is so dependent on the state of the economy. This highlights the importance of understanding uncertainty in forecasting and of testing the robustness of policy recommendations against a range of outcomes. Chapter 4 considers the approaches forecasters can use to understand this uncertainty in more detail.

Figure 3.6: Historic DfT forecast performance



18 HM Treasury produced a comparison of 34 independent forecasts of the UK economy in 2008 and 2009 which demonstrated that only 5 of the 34 forecasts projected negative growth during 2009. http://www.hm-treasury.gov.uk/d/200809forcomp.pdf

Figure 3.7: Impact of variability of GDP and oil price inputs on the DfT's 2009 aviation demand forecast



Comparisons with other forecasts

3.39 As with the DfT forecast, other publicly available forecasts project an ongoing trend of growth in aviation demand, although the growth trends vary according to the inputs and assumptions used and in the scope of the forecast.

3.40 For example, Eurocontrol's forecast projects a 14% growth in flight movements in Europe between 2011 and 2018. The forecasts demonstrate very slow growth in the first two years with 0% growth in 2013 followed by growth stabilising at around 2.9% annually and then slowing in the last year of the forecast as airport capacity constraints become an issue.

3.41 In contrast, Boeing's long term forecast of air traffic volumes and airplane demand[19] covering the period 2012-2031 projects world passenger traffic growth of 5% annually and air cargo growth of 5.2% annually through to 2031. For Europe, Boeing forecast that passenger traffic growth will grow by 4.1% annually and air cargo will grow by 4.6% annually. ICAO's central case world traffic forecast also projects a relatively high annual growth rate of 4.9% over the forecast period (2006–2026).

3.42 It is unsurprising that global growth rates are higher than DfT's forecast of UK growth rates. This is due to the relative maturity of the UK and European markets especially in Western Europe, and the rapidly increasing demand for air travel in emerging and developing economies.

19 Boeing, Current Market Outlook, 2012 – 2031 http://www.boeing.com/commercial/cmo/pdf/Boeing_Current_Market_Outlook_2012.pdf

4. UK aviation demand and the international aviation market

4.1 In our interim report, the Commission will set out recommendations to the Government regarding the criteria that should underpin its overall objectives for aviation connectivity. To do this we will need to consider:

- the impact of capacity constraints on the UK's share of the international market, and how that share might grow in the absence of capacity constraints;
- the consequences capacity constraints might have on the range of destinations served by UK airports both individually and in aggregate; and
- the implications of changes in airport capacity in other countries (for example, Turkey's recent announcement of its intention to build a six runway hub airport) on the UK's competitive position in the global aviation market.

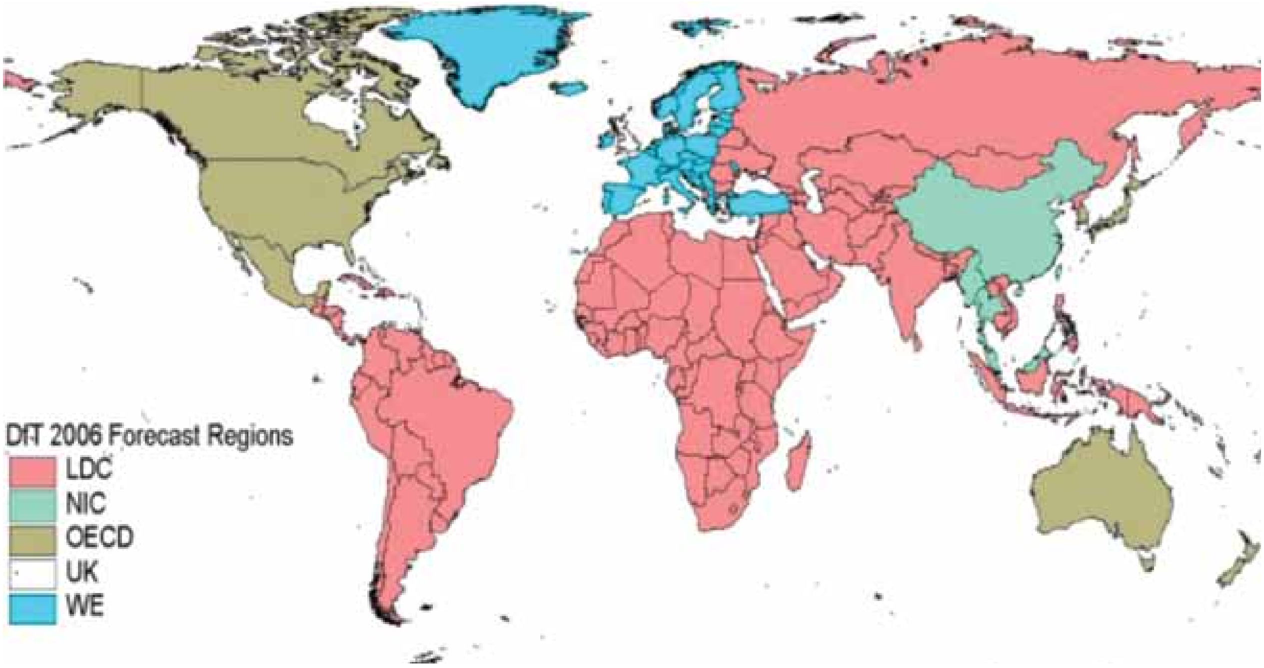
4.2 In considering international demand for air travel, the Department for Transport (DfT) National Air Passenger Demand (NAPDM) model disaggregates the overall market for passenger air travel into a number of sub-markets based on:

- origin and destination regions (see Figure 4.1 below);
- passenger's country of residence (UK or overseas);
- purpose of journey (business or leisure); and
- whether the passenger is a transfer passenger.

4.3 Each sub-market's contribution to total demand is calculated separately, taking into account the relative importance of various drivers of demand in different contexts. For example, GDP growth, market maturity, and the availability of alternative forms of transport vary significantly between the various global regions shown above. As a result, variations can also be seen in the rates of growth forecast for the different sub-markets, as set out in Table 4.1 below.

4.4 Although the differences between growth rates may appear small (ranging from 1.98 to 2.53%), they are sufficient over a long period to drive substantial variation between markets in the levels of growth achieved. It should be noted, however, that some of the fastest growth rates are seen in sub-markets which account for only a small proportion of total demand, so the impact on the aggregate level of demand will be limited.

Figure 4.1: Global regions[20] used in the National Air Passenger Demand Model



Key: LDC – Less Developed Countries, NIC – Newly Industrialised Countries, OECD – Organisation for Economic Co-operation and Development member states (excluding Western Europe), UK – The United Kingdom and WE – Western Europe.

4.5 As set out in Chapter 3, the National Air Passenger Allocation Model (NAPAM) is used to distribute total forecast demand between major UK airports, based on:

- Capacity assumptions;
- Local population projections;
- Regional economic forecasts;
- Service frequencies; and
- Surface access costs.

4.6 This part of the model operates on a more detailed geographic basis, applying the growth in demand from NAPDM to travel between the UK and 48 international destination zones.[21]

Table 4.1: Growth in terminal passengers in unconstrained forecasts*

	Domestic		Western Europe		Other OECD		Newly Industrialised Countries		Less Developed Countries	
	Business	Leisure	Business	Leisure	Business	Leisure	Business	Leisure	Business	Leisure
Average Growth 2010-2050	2.10%	2.08%	2.15%	2.06%	1.98%	2.11%	2.13%	2.27%	2.53%	2.07%
Proportion of Traffic in 2030	6.09%	5.76%	13.32%	50.25%	2.50%	8.49%	0.69%	2.36%	2.28%	8.27%

* Numbers are presented in this table to two decimal places to aid transparency of the results, however, this does not reflect a true assessment of the level of uncertainty around the forecasts. Transfer passengers are allocated to their final destination region.

20 The global regions were selected by the DfT by grouping countries with broadly similar economic and air passenger market characteristics.

21 The 48 international destination zones can be found on page 26 of the DfT UK Aviation Forecasts, 2013

This makes it possible for the model to estimate service frequencies and numbers of passengers, split by purpose of travel and origin, on a route-by-route basis.

4.7 NAPAM takes account of competition between UK airports for passenger air travel. However, hub airports in the UK also compete with overseas hubs, such as Amsterdam, Paris Charles de Gaulle, Frankfurt and Dubai for the transfer passenger market. This market comprises three main passenger groups:

1. **UK transfer passengers connecting via any hub.** Passengers whose journeys originate or terminate in the UK, who connect via a UK or non-UK hub airport.
2. **International transfer passengers connecting via a UK hub.** Passengers whose journeys originate and terminate outside the UK, who connect via a UK hub airport.
3. **International transfer passengers connecting via an overseas hub.** Passengers whose journeys originate and terminate outside the UK, who connect via a non-UK hub airport.

4.8 The first of these groups is captured in the DfT model, and is forecast using the key drivers for each market, as identified for NAPDM. The second group is also included and similarly forecast using projected economic growth outside the UK. However, the ability of this second group to choose between competing hubs is not fully modelled. The third group is not currently included in the model, although these passengers could potentially transfer via a UK hub if an appropriate and attractively-priced service was available. This is discussed in more detail below.

4.9 Nonetheless, the DfT forecasting approach may still provide a reasonable starting point for us to consider the impact of capacity constraints on the UK's share of the international market, and how that share might grow in the absence of capacity constraints. By comparing the projections of number of destinations served at major UK airports under the 'constrained' and 'unconstrained' version of the forecasts, it is possible to derive an implied number of routes being lost due to capacity constraints.

4.10 The results of this calculation for the latest version of the DfT forecast are shown in Table 4.2 below for routes served on a daily basis.

4.11 As can be seen, in the constrained version of the forecast, the number of destinations served increases at those airports with fewer capacity constraints, principally outside London, but contracts sharply at the most constrained airports, most notably Heathrow and Gatwick. These figures clearly show the uneven impact of capacity constraints across UK airports. Examining the specific routes lost and gained in more detail would then enable a fuller assessment to be made of the impacts on the UK's international connectivity.

4.12 The main weakness of the current DfT approach, however, is that it does not fully capture the international transfer passenger market (the second and third of the transfer passenger groups above). This means that the model as currently constructed only partially assesses the impact of capacity constraints on the UK's ability to maintain or grow its current share of the international transfer market but there are areas that could be strengthened.

4.13 In the current forecasting approach, it is assumed that the UK's share of international transfer traffic broadly follows recent trends and, at the point when a UK hub airport reaches capacity, it is assumed that some proportion of its international transfers will choose to make their connections outside the UK in future. However, the choice of international transfer passengers between different European hubs is not explicitly captured, for example the extent to which transfer passengers may respond to improving frequencies of service outside the UK.

4.14 Conversely, the exclusion of international transfers connecting outside the UK (the third transfer passenger group above) means that the DfT approach cannot currently model how a prospective increase in UK aviation capacity could enable the UK to grow its current share of the international transfer market, by attracting passengers who currently choose to connect via hubs outside the UK.

4.15 The Commission would welcome views on how the outputs currently produced by the DfT model can best be used to consider UK aviation demand in relation to the international market and how the model could be strengthened to address the issues identified above.

4.16 We would also welcome evidence and views on the implications of changes to route networks, both in aggregate and at specific airports, for example as set

Table 4.2: Implied route losses due to capacity constraints by 2050

	Unconstrained	Constrained	Difference
Heathrow	193	121	-72
Gatwick	106	83	-23
Stansted	79	68	-11
Luton	40	31	-9
London City	25	14	-11
Southend	1	4	+3
London*	**245**	**230**	**-26**
Manchester	83	105	+22
Birmingham	52	67	+15
Glasgow	10	12	+2
Edinburgh	30	31	+1
Newcastle	14	17	+3
Belfast International	15	16	+1
Bristol	35	41	+6
Liverpool	22	35	+13
East Midlands	14	54	+40
Other airports	56	79	+23

Source: DfT UK Aviation Forecasts, January 2013. Table shows routes served on a daily basis only.

* Total different modelled destinations served in London, and not the sum of London airport destinations.

out in Table 4.2 above. This might include evidence on the potential consequences for the UK's share of the international aviation market, but also on the implications for the local and regional economy where an airport sees a significant shift (either positive or negative) in its international connectivity.

5. Dealing with uncertainty

5.1 Whatever forecasting approach is used to estimate future patterns of demand for air travel, the results will inevitably be subject to significant uncertainty. An understanding of how this uncertainty could affect any decisions is therefore about as important as the forecast itself.

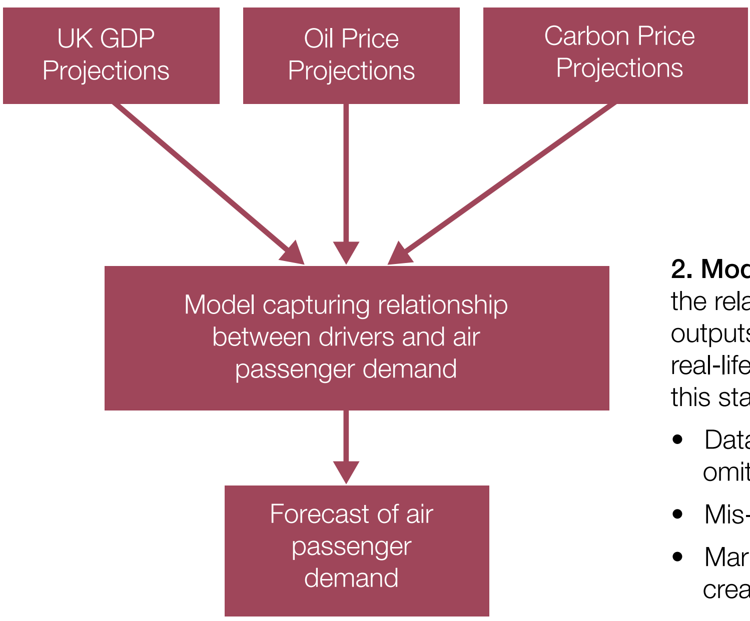
5.2 Uncertainty in forecasting can be broken down into that associated with model inputs and that associated with the structure and parameters of the model itself – Figure 5.1 illustrates how uncertainty affects forecasts of air passenger demand.

5.3 Given these uncertainties, forecasters can use a range of approaches to test the forecast model to understand how changes in the projections of the key variables will alter the model outcomes:

- **Sensitivity analysis –** is based on the identification of the key variables and testing the impact on the forecasts of changing individual variables one at a time. An air fares sensitivity, for example, might assess how much aviation demand would change if fares were 5% higher or lower.

- **Scenario testing –** this approach develops alternative views of the future to test the robustness of decisions. This could be done quantitatively by varying a number of inputs to a traditional forecast model at one time – effectively combining a number of sensitivity tests. It can also be done qualitatively by identifying key characteristics that could define the future and considering what the world might look like as these are

Figure 5.1: Uncertainties in air passenger demand forecasts



1. Input Uncertainty is derived from the fact that forecasts are made up of a range of projections of key variables all of which could be wrong and bring their own uncertainty to the model's outcomes.

2. Model Uncertainty reflects the fact that the relationship estimated between inputs and outputs is a simplified approximation of real-life. Sources of error and uncertainty at this stage include:

- Data limitations leading to uncertain or omitted variables;
- Mis-specification of relationships;
- Market developments after the model is created.

varied. Whilst a range of scenarios can be built, the most common approach is to start with a central 'most likely outcome' scenario and to create high and low growth scenarios around this.[22]

- **Probability analysis** – this term is used to describe a set of approaches that assess the likelihood of different outcomes occurring.[23] For example, a forecast of the probability that the target rate of inflation will be exceeded next year, or the probability that the economy will contract, may be much more informative for setting macroeconomic policy than simple point forecasts of the expected rates of inflation and output growth, especially in the absence of any indication of the degree of uncertainty to be attached to the point forecasts.[24]

5.4 Assessing which approach is most appropriate will depend on the nature of the decisions being taken. If conclusions are relatively insensitive to variations of individual inputs then either sensitivity analysis or scenario testing are simple, relatively transparent and fit for purpose. If, however, a decision is significantly affected by the level of the forecast then it becomes more important to understand how much weight to place on different scenarios by understanding the relative likelihood of different outcomes. In this situation a probability based approach is likely to be helpful, however, this comes at the cost of additional complexity and less transparency compared to simpler approaches.

22 'Forecasting the future: Stochastic outcome simulation and scenario testing' – Sholom Feldblum. https://www.casact.org/pubs/dpp/dpp95/95dpp151.pdf

23 The 'Monte Carlo Method' is one example of a probability analysis approach which samples the probability distribution of thousands of possible outcomes. These results are then analysed to attach probabilities to the different outputs occurring.

24 Combining probability forecasts, http://www2.warwick.ac.uk/fac/soc/economics/staff/academic/clements/wp/clements_harvey.pdf

Managing uncertainty in the DfT aviation forecasts

5.5 DfT recognises the inherent uncertainty in forecasting long periods into the future. It addresses this using two approaches to help users understand the levels of uncertainty around its forecasts:

- A series of sensitivity tests are presented that vary the most important input variables (economic growth, oil prices, air fares and market maturity).
- High and low scenarios around the central forecast are presented. These combine alternative projections for a number of input variables, for example, the low demand scenario combines the low GDP, low oil price and high market maturity sensitivities, along with changes to assumptions about some other variables.

5.6 Although in the near term the GDP sensitivity test is derived from the OBR's own assessment of the uncertainty around their forecast[25] there is no assessment of the likelihood of any of the other sensitivities or scenarios occurring. Furthermore, the latest forecasts only vary national level inputs rather than also considering how patterns of demand might change at the airport level if the model parameters were varied.

5.7 There is little publicly available information about the methodology used to assess uncertainty in relation to other aviation demand forecasts. Nonetheless,

25 Capturing a range of around 60% of possible outcomes around their central projection.

it appears that most forecasters undertake scenario testing in much the same way as DfT, producing three scenarios – a central ‘baseline scenario’ and low and high growth scenarios.

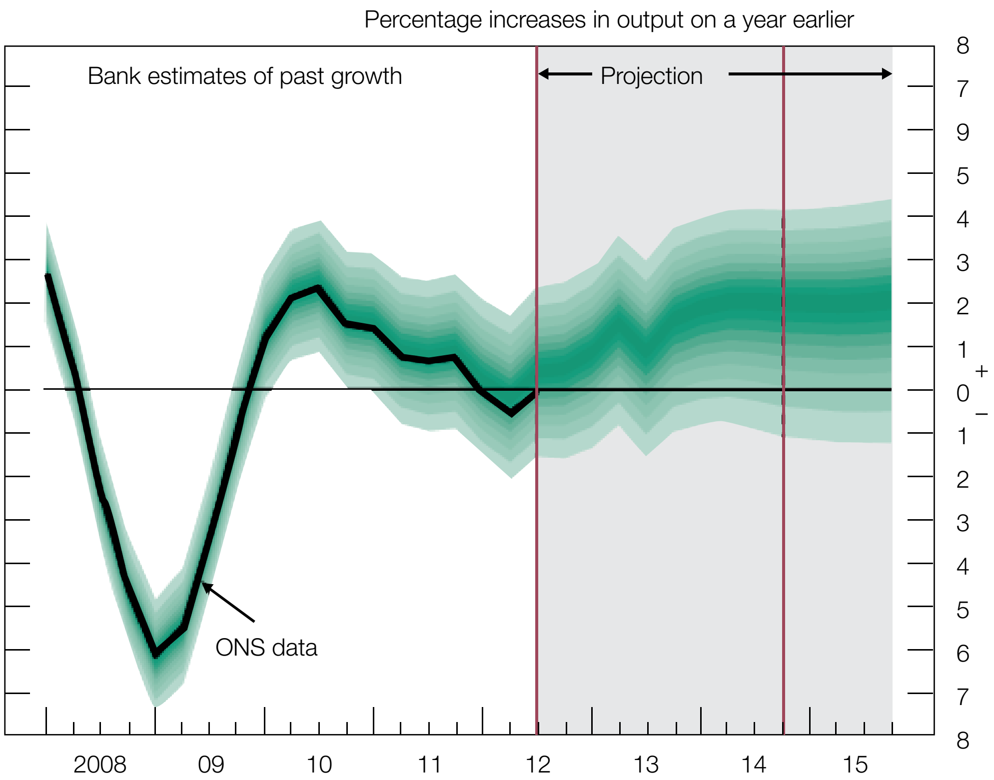
5.8 There are however instances in other fields where probability analysis is utilised to support policy making. For example, the Monetary Policy Committee at the Bank of England uses probability analysis to produce fan charts as a way of presenting the uncertainty surrounding their projections for the annual rate of CPI inflation and the four quarter growth rate of GDP. For example, Figure 5.1 shows projections of GDP growth where each shaded band represents a declining likelihood that outturn GDP will fall outside of the range.[26]

The results of DfT’s 2013 scenario testing

5.9 DfT’s 2013 unconstrained forecasts show a difference of 310 million terminal passengers per annum between their high and low scenarios in 2050. The range is based on combining a number of alternative assumptions for key input variables. These assumptions are combined so that for each scenario, some changes will increase demand whilst others have an offsetting decrease in demand – for example, the high demand scenario combines a high GDP assumption that increases demand with a high oil price assumption that acts to decrease demand through increased fares.

5.10 This approach avoids creating extreme scenarios, however, the choice of which

Figure 5.2: Bank of England GDP fan chart, Inflation Report, November 2012



26 These fan charts capture the MPC’s projected probability distributions of these values using a probability density function http://www.bankofengland.co.uk/publications/Documents/inflationreport/ir02mayfanbox.pdf; http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/qb980101.pdf

input assumptions to combine is somewhat arbitrary. It could be possible to justify different combinations of inputs to form alternative scenarios that could lead to alternative conclusions.

5.11 The Commission will need to consider whether the approach used by DfT to analyse forecasting uncertainty is appropriate or whether a different approach, potentially including probability based analysis, would allow us to better understand this issue. This is to ensure that our approach to decision making is robust whilst also weighing different risks appropriately.

6. Conclusion

6.1 This paper has discussed the approach and value of forecasting, has set out some of the issues the Commission will need to consider as we go about our work and has reviewed in detail the approach DfT has taken to producing its national forecasts. It has also compared the approach used by DfT and the outputs produced with those for some of the main alternative forecasts that are publicly available.

6.2 We currently expect to use the DfT approach to forecasting as the starting point for our own assessments of future demand. However, we recognise that there may be scope to further enhance this approach and that the DfT forecasts may not be able to provide information in all the areas that we may wish to consider.

6.3 The Commission's approach to forecasting will be shaped by its wider timetable particularly its requirement to produce an assessment of the nature, scale and time of the UK's need for airport capacity as part of its interim report at the end of 2013.

Questions

6.4 To inform those preparing submissions on demand forecasting, we have set out below a number of specific questions of interest. This should not be considered an exclusive list, however, and we would welcome submissions covering any other relevant topics or issues.

- To what extent do you consider that the DfT forecasts support or challenge the argument that additional capacity is needed?
- What impact do you consider capacity constraints will have on the frequency and number of destinations served by the UK?
- How effectively do the DfT forecasts capture the effect on UK aviation demand of trends in international aviation?
- How could the DfT model be strengthened, for example to improve its handling of the international passenger transfer market?
- What approach should the Commission take to forecasting the UK's share of the international aviation market and how this may change in different scenarios?
- How well do you consider that the DfT's aviation model replicates current patterns of demand? How could it be improved?

6.5 In addition, the following questions of interest focus on the forecast approach in more detail.

- Do you agree with the source of the input data and assumptions underpinning the DfT model?
- Do you agree with the choice of outputs modelled?

- Do you consider that the DfT modelling approach presents an accurate picture of current and future demand for air travel? If not, how could it be improved?
- Is the DfT model suitable to underpin an assessment of the UK's aviation connectivity and capacity needs?
- What alternative or complementary approaches could be used to assess the impact of international competition?
- What factors, if any, are missing from the DfT's modelling approach? How can these be more effectively analysed?
- Is the DfT model granular enough to underpin the Commission's assessment of future demand?
- Does the DfT approach to demand uncertainty capture a reasonable range of uncertainty? Could the approach be improved?
- Would a probability based approach to dealing with uncertainty help the Commission to test the robustness of the model's outputs?
- We have reviewed four alternative forecasts. Do you consider that there are others we should be looking at and why?

How to respond

6.6 Submissions of evidence should be no more than 15 pages long and should be emailed to demandforecasting@airports.gsi.gov.uk clearly marked as a response to the 'Aviation Demand Forecasting Discussion Paper'. Evidence will be reviewed thereafter by the Commission. If further information or clarification on your submission is required, the Airports Commission Secretariat will be in touch.

6.7 We are therefore inviting submissions and evidence by **15 March 2013** to inform the development of our approach to forecasting future patterns of demand for air travel.

6.8 In exceptional circumstances we will accept submissions in hard copy. If you need to submit them in hard copy form, please provide two copies to the Commission Secretariat at the following address:

Airports Commission
6th Floor
Sanctuary Buildings
20 Great Smith Street
London
SW1P 3BT

6.9 We regret that we are not able to receive faxed documents.

6.10 We are also expecting to hold public evidence sessions later this year to help us form our assessment of the need for additional capacity. These sessions are expected to be based on both this paper and the other thematic papers the Commission will be publishing for example on the arguments surrounding the concept of a hub airport, and on environmental issues, including noise and climate change. More information on the structure and scope of these sessions will be published on our website: https://www.gov.uk/government/organisations/airports-commission

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