International Transport Forum

Impacts of Expanding Airport Capacity on Competition and Connectivity

The case of Gatwick and Heathrow

Country-Specific Policy Analysis

OECD

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THE INTERNATIONAL TRANSPORT FORUM

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SEO Economic Research carries out independent applied economic research on behalf of the public and private sectors. SEO Economic Research is affiliated to the University of Amsterdam, giving it access to the latest scientific research tools. Operating on a not-for-profit basis, SEO continually invests in the intellectual capital of its staff by arranging for them to pursue graduate studies, publish scientific papers and participate in academic networks and conferences.

Table of Contents

Figures

Tables

Executive Summary

The UK Airports Commission has short-listed three options for expanding airport capacity in the UK. One option concerns expansion of Gatwick with an additional runway. The other options concern expansion of runway capacity at Heathrow. The impacts of expansion on passenger and air freight user welfare do not only depend on the macro-economic and aviation industry future, as defined by the aviation scenarios already developed by the Airports Commission, but also on the airline responses that can be expected as capacity comes on stream. This report assesses quantitatively the competition, scarcity and connectivity impacts of different airline responses to expanding runway capacity at Gatwick or Heathrow.

Airlines may react in different ways to expansion of capacity at Gatwick or Heathrow. The way macro-economic conditions change, how business models develop over time and how new aircraft (such as the Boeing 787 and Airbus A350) have an impact on the industry will affect the likelihood of potential airline responses unfolding. An additional runway at Gatwick would most likely see airlines responding either with development of Gatwick into a low-cost gateway or by expanding conventional point-to-point services at Gatwick. Additional runway capacity at Heathrow could be expected to be taken up predominantly by hub operations but in some circumstances could see growth focused on an increase in point-to-point services at the airport.

These two pairs of airline responses can be considered as representative of the range of outcomes for capacity expansion at Gatwick or Heathrow. The four responses combined with the most relevant aviation demand scenarios developed by the Airports Commission are assessed in this report for the impact on socio-economic welfare. The four airline response-scenario combinations ('airline response outcomes' for short) are as follows.

Heathrow expansion

- Airline response outcome 1: 'Hub-carrier growth at Heathrow, point-to-point growth at Gatwick' combined with the Airports Commission 'Assessment of Need' scenario.

- Airline response outcome 2: 'Point-to-point growth at Heathrow and Gatwick, Heathrow remains the network hub' combined with the Airports Commission scenario 'Low-cost is King'.

Gatwick expansion

- Airline response outcome 3: 'Partnerships: Gatwick becomes a low-cost gateway, Heathrow remains the network hub' combined with the Airports Commission scenario 'Low-cost is King'.

- Airline response outcome 4: 'Gatwick point-to-point growth, Heathrow remains the network hub' combined with the Airports Commission scenario 'Relative Decline of Europe'.

We estimate the airline response outcomes in terms of connectivity gains, competition gains and gains due to a reduction in scarcity rents to the benefit of passengers, all in comparison to a 'do minimum' scenario without any expansion of capacity in the London airports system.

Approach

The analysis of the airline response outcomes takes a medium-term perspective, examining impacts in the year 2030. This choice is deliberate. Formulation of airline responses beyond 2030 would significantly reduce credibility as uncertainty regarding future business models, financial performance of the airline industry, cost levels and the survival of individual carriers becomes increasingly large. The choice of the year of analysis does have implications for the results. Growth in demand is delayed under the Relative Decline of Europe scenario and this results in benefits to passengers from capacity expansion accruing mainly after 2035 under airline response outcome 4.

The airline response-aviation scenario combinations are evaluated in terms of passenger welfare impacts related to connectivity gains (more flights and destinations), changes in competition levels (lower fares) and reduction in airline scarcity rents (lower fares), compared to the do minimum scenario.

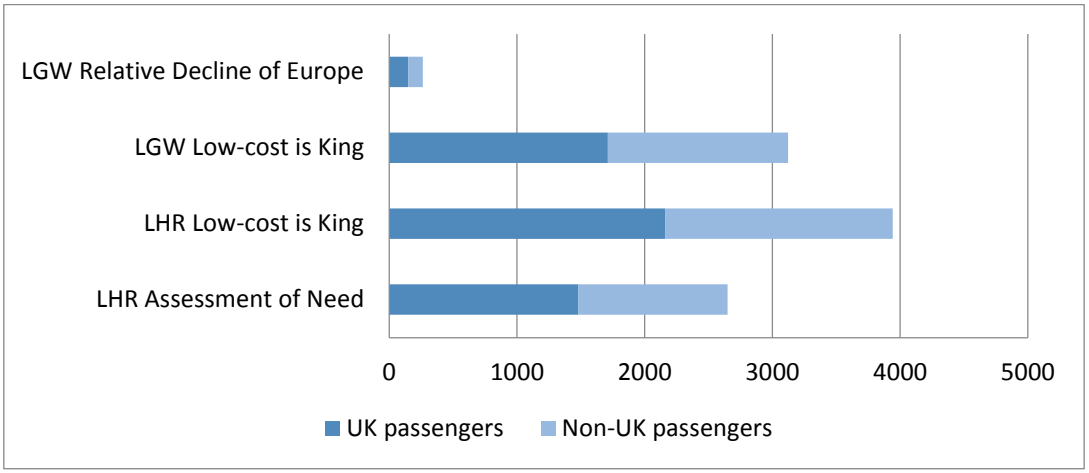
The system currently employed for allocating slots for take-off and landing in London airports, with most slots allocated free of charge to incumbent airlines, means that rents accrue mainly to airlines. Airline scarcity rents arise when potential demand exceeds the physical airport capacity to accommodate airline seat supply, as is currently the case at Gatwick and Heathrow. Airline rents accrue as air ticket prices increase to balance supply and demand and clear the market. Ticket prices are higher than they would be if all demand was accommodated. Airport expansion will reduce airline scarcity rents, reflected in lower airfares and lower airline revenues.

The welfare gains assessed arise mainly from the lower travel costs for UK and non-UK residents that result from runway capacity expansion at either Gatwick or Heathrow and the airline responses that unfold. The SEO Netcost model is used to estimate the effects for the year 2030 for the four airline responses outcomes.

Results

We find that reductions in airline scarcity rents make up the majority of the consumer welfare gains. All tested airline responses, including expansion of the hub operation at Heathrow, produce benefits for passengers from competition. Welfare benefits for passengers in 2030 for each of the airline response outcomes are summarised in figure 1.1.

Figure 1. **Total Passenger Benefits in 2030 (million GBP)**



Source: SEO Netcost

The outcomes are not directly comparable as they reflect different scenarios for the overall development of aviation and the global economy and are strongly affected by differences in the pattern of GDP growth assumed. It should be noted that beyond 2030 the point-to-point airline response in the Relative Decline of Europe scenario following Gatwick expansion would be expected to begin to generate more substantial welfare gains.

Based on our assessment, we conclude the following main points.

1. For each of the airline responses expansion of Gatwick and Heathrow produces welfare benefits for passengers.

2. The reduction in airline scarcity rents is the most important element of the consumer welfare impacts of airport expansion for all airline response outcomes.

3. All tested airline responses produce benefits from competition, including those with an expanded hub operation at Heathrow, and all produce connectivity benefits.

4. Around 55% of total welfare benefits accrue to UK residents in all airline responses. In the OD market, leisure traffic accounts for about three quarters of the consumer welfare gains.

5. Total consumer benefits are highest in the scenario assuming point-to-point traffic growth at Heathrow (airline response 2) and low-cost gateway development at Gatwick (airline response 3).

6. The lowest total consumer benefits are found in airline response 4, which assumes point-to-point growth at an expanded Gatwick in the Relative Decline of Europe scenario.

7. An important factor in explaining the differences between airline responses is the fact that different demand growth rates are used, depending on the Airports Commission scenario that applies for each airline response. Until 2030, growth in the Low-cost is King scenario is higher than in the Assessment of Need scenario or the Relative Decline of Europe scenario. This difference between the demand scenarios leads to higher overall welfare gains in airline responses 2 and 3 (which both

assume a Low-cost is King scenario) compared to the Assessment of Need (airline response 1) and Relative Decline of Europe scenarios (airline response 4).

8. The effects quantified relate to direct welfare benefits for passengers. Changes in surface transport access conditions and the consequences of expansion in allowing passengers to switch to a more convenient airport in terms of access are not included. Similarly, wider economic effects from improved connectivity of the London area have not been quantified.

1. Introduction

UK Airports Commission has short-listed three options for expanding airport capacity in the UK. One option concerns expansion of Gatwick with an additional runway. The other options concern expansion of runway capacity at Heathrow. The impacts of expansion on consumer welfare do not only depend on the macro-economic and aviation industry future, as defined by the aviation scenarios already developed by the Airports Commission, but also on the airline responses that can be expected as capacity comes on stream. This report assesses quantitatively the competition, scarcity and connectivity impacts of different airline responses to expanding runway capacity at Gatwick or Heathrow.

Background and objective of the study

In December 2013 the UK Airports Commission short-listed three options for airport expansion in the UK, two at Heathrow and one at Gatwick[1]. A report with the Commission's assessments of these options was published for national consultation in the autumn of 2014.

Against this background, the Airports Commission asked the International Transport Forum and SEO Economic Research to carry out a study to determine how each of the short-listed expansion options might impact on the competitive nature of the London and UK-wide airport system. In a first study (ITF 2014)[2], the factors that drive airline behaviour were identified. Probable airline responses were formulated under a range of demand scenarios for the overall development of international aviation, defined by the Airports Commission (Airports Commission 2014). The impacts on competition and connectivity were outlined.

The present report provides a quantitative assessment of the impact of the most likely airline responses to expansion of capacity at Gatwick or Heathrow on connectivity, competition and scarcity rents.

Our approach

Four combinations of aviation scenario and airline response to expanding airport capacity were selected for quantitative impact assessment from the 30 potential combinations examined in the earlier report, on the basis of their high likelihood. These four combinations are first described and the rationale for choosing this set of responses outlined. The modelling framework used to assess the impacts of the airline responses under alternative airport expansion options is then discussed. Key assumptions underlying the analysis are identified and finally the results of the impact analysis presented.

1 In September 2014, the Commission made the decision not to shortlist the Estuary option. More information on this can be found here: https://www.gov.uk/government/publications/inner-thames-estuary-airport-summary-and-decision.

2 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/383331/expanding-airport-capacity-competition-_connectivity.pdf>

The two Heathrow expansion proposals short-listed by the Airports Commission have been grouped together as one Heathrow expansion option for the purpose of this work. The alternatives have been grouped together as they are very similar in the context of this study: they share the same location, the same catchment area and provide the same peak-hour capacity. Only the terminal capacity is different, by 40 000 annual aircraft movements.

Note that surface access to the airports was excluded from the terms of reference for this study. Surface access is clearly an important factor in determining choice of airport and flight options. It can be factored into models of generalised travel cost but the focus for the current report is the response of airlines to expansion of airport capacity.

2. Airline Responses

Airlines may react in different ways to expansion of capacity at Gatwick or Heathrow. The way macroeconomic conditions change and how business models develop over time will affect the likelihood of potential airline responses unfolding. An additional runway at Gatwick would most likely see airlines responding either with development of Gatwick into a low-cost gateway or by expanding conventional point-to-point services at Gatwick. Additional runway capacity at Heathrow could be expected to be taken up predominantly by hub operations but in some circumstances could see growth focused on an increase in point-to-point services at the airport. These two pairs of airline responses can be considered as representative of the range of outcomes for capacity expansion at Gatwick or Heathrow. The four responses combined with the most relevant aviation demand scenarios developed by the Airports Commission will be used for the assessment in the chapters that follow.

Airline responses and their likelihood

Based on an analysis of the factors that drive airline behaviour and the characteristics of the London airports system, SEO identified six different sets of airline responses to expansion of airport capacity at Gatwick or Heathrow in the earlier analysis undertaken for the International Transport Forum and the Airports Commission (ITF 2014). The airline responses have a varying impact on the traffic structure in the London airport system as well as on connectivity, competition and reduction of airline scarcity rents to the benefit of passengers and air freight users. We refer to ITF (2014) for an in-depth discussion of each of the identified airline responses[3].

The way macroeconomic conditions develop over the long term will affect the likelihood of the airline responses examined unfolding. Airline business models evolve, macro-economic conditions change, new aircraft technology is introduced and air-side airport charge (aero-charge) levels change. Some of the airline responses are unlikely under some future aviation demand scenarios, as developed by the Airports Commission (Airports Commission 2014a). The six different sets of airline responses were therefore assessed on their likelihood in each of the aviation demand scenarios (ITF 2014). Based on this analysis, four combinations of airline responses and aviation demand scenarios were selected for the quantitative assessment in this study, as follows.

Heathrow expansion

- Airline response outcome 1 'Hub-carrier growth at Heathrow, point-to-point growth at Gatwick' combined with the Airports Commission 'Assessment of Need' scenario.
- Airline response outcome 2 'Point-to-point growth at Heathrow and Gatwick, Heathrow remains the network hub' combined with the Airports Commission scenario 'Low-cost is King'.

3 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/383331/expanding-airport-capacity-competition-_connectivity.pdf>

Gatwick expansion

- Airline response outcome 3 'Partnerships: Gatwick becomes a low-cost gateway, Heathrow remains the network hub' combined with the Airports Commission scenario 'Low-cost is King'.

- Airline response outcome 4 'Gatwick point-to-point growth, Heathrow remains the network hub' combined with the Airports Commission scenario 'Relative Decline of Europe'.

The response-scenario combinations ('airline responses outcomes' in short) chosen for each expansion option have the highest likelihood of realisation. As such, we can expect the future for an expanded Gatwick to lie between airline responses 3 and 4, while an expanded Heathrow would see an outcome between responses 1 and 2.

In the subsequent analysis we estimate the outcome of the airline responses in terms of connectivity gains, competition gains and gains due to a reduction in scarcity rents to the benefit of passengers, all in comparison to a scenario without any expansion of airport capacity. Each of the four airline responses in combination with the Airports Commission demand scenarios is examined in section: Description of the selected combinations of airline responses and aviation demand scenarios.

Medium-term impact analysis focusing on 2030.

The analysis of the airline response outcomes takes a medium-term perspective, examining impacts in the year 2030, while the aviation demand scenarios of the Airports Commission take a long-term perspective (through 2050). The choice of a medium-term perspective is deliberate: formulation of airline responses beyond 2030 would significantly reduce credibility as uncertainty regarding future business models, financial performance of the airline industry, cost levels and the survival of individual carriers becomes increasingly large.

The choice of the year of analysis does have implications for the results. Growth in demand is delayed under the Relative Decline of Europe scenario and this results in consumer welfare benefits from capacity expansion accruing mainly after 2035 under airline response 4 (see Airports Commission 2014b).

Table 2.1 **GDP growth rates in Airports Commission Scenarios**
(Annual growth rates through 2030)

Scenario	UK	World
Assessment of Need	2.5%	1.8% Western Europe 1.9% OECD 3.8% Newly Industrialised Countries 2.6% Less Developed Countries
Low-cost is King	3.0%	2.3% Western Europe 2.4% OECD 5.8% Newly Industrialised Countries 4.6% Less Developed Countries
Relative Decline of Europe	2.5%	1.8% Western Europe 1.9% OECD 5.8% Newly Industrialised Countries 4.6% Less Developed Countries

Source: Airports Commission.

Description of the selected combinations of airline responses and aviation demand scenarios.

Heathrow expansion

Airline response outcome 1: Hub-carrier growth at Heathrow, point-to-point growth at Gatwick in the Assessment of Need scenario.

This airline response outcome following expansion of Heathrow unfolds in the context of the scenario underpinning the Commission's assessment of need for additional runway capacity in the London area. In this scenario, future demand is primarily determined in relation to past trends and central data projections. The development of oil prices and GDP growth are key among the main economic variables taken into account.

The additional capacity at Heathrow enables the hub-carrier British Airways (and partners) to grow from today's constrained, sub-optimal hub-and-spoke system to an efficient fully developed hub operation using a wave-system for coordinating arrivals and departures. Larger, more clearly defined banks of arriving and departing flights will make it possible for many more transfer passengers to connect at Heathrow. Other non-home-based network carriers such as American Airlines and Emirates also increase flights from Heathrow to their own hubs, as do legacy point-to-point carriers such as Virgin Atlantic[4]. Low-cost remains focused at Gatwick and the other London airports.

The expected increase of inbound long-haul traffic and growth of leisure demand from Asia may provide opportunities for non-home based network carriers and long-haul low-cost carriers at Heathrow and at Gatwick.

Airport charges will increase because of the costs involved in expanding Heathrow. This increase will favour high capacity services into Heathrow and will discourage airlines from flying high frequency, low capacity services. For the hub-carrier this means that its feeder network into the UK and the rest of Europe will grow but potentially without the same degree of penetration to small cities as at Amsterdam or Frankfurt.

Airline response outcome 2 Point-to-point growth at Heathrow and Gatwick, Heathrow remains the network hub in the Low-cost is King scenario.

Airline response outcome 2 develops under the Low-cost is King aviation demand scenario. This scenario assumes a growing role for low-cost carriers as they enter long-haul markets and self-connecting becomes more common for passengers. By 2040, charter and low-cost carriers take 50% of the market. It also sees higher passenger demand from all world regions and lower operating costs. The importance of hubs and network carriers declines throughout the world while liberalization of aviation markets continues on a global scale. In this scenario low-cost carriers use new generation of aircraft such as the Boeing 787 and Airbus A350 to enter long-haul point-to-point markets, while they generally refrain from entering formal alliances.

The airline response assumes a saturating European low-cost, point-to-point market between secondary airports. Low-cost carriers search for premium traffic at primary airports, including Heathrow. Despite the increased airport charges at Heathrow, low-cost airlines establish a significant operational base at

4 The airline names mentioned are only indicative of the type of carrier that could respond to the expansion of London's airport capacity in the future.

Heathrow to target the premium market, while keeping up their operations at Gatwick. Additional slots are taken up by visiting network carriers and legacy point-to-point carriers.

Gatwick expansion

Airline response outcome 3 Partnerships – Gatwick becomes a low-cost "gateway", Heathrow remains the network hub in the Low-cost is King scenario.

Airline response outcome 3 evolves under the Low-cost is King scenario (like airline response 2), but assumes expansion of Gatwick. Legacy network carriers and/or low-cost carriers (of which some start to operate in the long-haul market) partner to facilitate passenger connectivity. This could take place either through a new alliance/codeshare formula or by an airport-led connection strategy. Low-cost airline services, both short and long-haul, grow at Gatwick. The expected increase in airport charges could move charges at Gatwick from the level of the other European gateways to the current aero-charges level of Heathrow (PWC 2014). As a result, lower yield low-cost airlines may decide to move part of their operations to airports such as Luton and Stansted.

Long-haul low-cost flourishes at Gatwick given the large local OD market and strong expected growth in the inbound long-haul leisure market, predominantly from Asia, as well as the potential for low-cost and some full-service feed. The introduction of new generation long-haul aircraft (Boeing 787 and Airbus A350) further contributes to the long-haul low-cost opportunities. Due to the nature of their business model, low-cost operators can be expected to avoid the complexity of a wave-system structure for arrivals and departures. Hence, the share of transfer traffic will remain limited and will not reach the levels of a typical hub airport. Non-Oneworld long-haul carriers increasingly focus network growth at Gatwick, benefiting from feed provided by low-cost carriers and availability of capacity. In particular, network carriers from Asia benefit from brand loyalty in their own home market as inbound London long-haul traffic is expected to grow faster than outbound traffic.

Airline response outcome 4 Gatwick point-to-point growth, Heathrow remains the network hub in the Relative Decline of Europe scenario.

Instead of developing Gatwick into a low-cost gateway following capacity expansion (where point-to-point traffic is mixed with connecting traffic), this airline response option assumes that low-cost carriers take up most of the capacity at Gatwick. However, they stick to a typical low-cost carrier business model without a deliberate strategy to stimulate connecting traffic and achieve additional route density and connectivity. The growth of low-cost carriers at Gatwick comprises partly "autonomous growth" and partly migration of flights from Stansted and Luton to Gatwick, given Gatwick's big catchment area for leisure traffic and increased availability of peak-time slots. But as aero-charges are expected to rise at Gatwick after expansion, lower yield traffic is likely to continue to use Stansted and Luton.

A number of low-cost, long-haul destinations are assumed to be developed, based on the growing inbound leisure market predominantly from Asia and the use of smaller, more fuel-efficient aircraft like the Boeing 787 and Airbus A350. Over time, an increasing share of the additional capacity at Gatwick will be used by carriers that currently operate at Heathrow but find more attractive options at Gatwick when capacity becomes available. This may free-up some capacity at Heathrow, which can be used by the hub carrier and other network carriers. Over time, as capacity shortages remain at Heathrow, the focus at Heathrow will be on high-capacity flights to popular long-haul destinations reflected in an increasing share of OD traffic. Crowding-out will take place with respect to short-haul flights and transfer passengers at Heathrow in the long run.

3. Methodology

The airline response-aviation scenario combinations are evaluated in terms of consumer welfare impacts related to connectivity gains, changes in competition levels and reduction in airline scarcity rents, compared to a scenario without any capacity expansion in the London airports system ('do minimum'). The SEO Netcost model is used to estimate these effects.

Principles of the approach

The impact of the selected airline response outcomes with expansion of Gatwick or Heathrow is assessed with SEO's generalised travel cost model, Netcost. Annex A provides a technical description of the model.

The 'Do minimum' scenario (base case)

Connectivity, competition and scarcity impacts in 2030 following airport capacity expansion at either Gatwick or Heathrow are compared to a 'do minimum' scenario. The 'do minimum' scenario assumes no new runway capacity in the future, but takes into account:

- maximum use of existing infrastructure;
- infrastructure schemes and changes to airport master-plans that are already in the planning pipeline and are to be delivered by 2020;
- incremental growth to full potential long-term capacity by 2030;
- terminal capacity increasing incrementally to service available runway capacity.

Growth rates per airport, destination region and airline category in the 'do minimum scenario' are derived from the Airports Commission 'carbon traded' constrained forecast. This forecast represents total potential demand for UK aviation, but assumes that existing constraints on UK airport capacity persist throughout the forecast period. The forecast assumes that carbon emissions from flights departing UK airports are traded at the European level until 2030 and then as part of a liberal global carbon market. Thus, the forecast assumes that any aviation emissions target can be met in part through buying credits from other sectors of the economy.

Airside airport charges

The regulatory framework for aero-charges is assumed to remain as it is today. Under the do minimum scenario they are unchanged. Under the expansion scenarios they rise to pay for the investment in runway capacity. The change in aero-charges is incorporated in the airline responses and their impact on airline choice is captured. In relation to welfare impacts increased charges will be absorbed first by airlines through a reduction in rents and competition will prevent airlines passing on much of the cost of

higher charges to passengers. To 2030 the assumption in the modelling is that increases in charges do not get passed on to passengers.

Estimation of benefits

Netcost estimates changes in benefits to passengers (consumer surplus) from changes in airport capacity and airline services. The calculation of these 'transport user benefits' is based on conventional consumer surplus theory where consumer surplus is defined as the benefit passengers enjoy in excess of the costs they perceive (Airports Commission 2014). The benefits reflect reductions in 'generalised travel costs' associated with the better air travel options that arise after expansion of capacity at Gatwick or Heathrow.

Many of those benefits ripple through the rest of the economy and benefit parties outside the aviation sector. Most of these secondary effects are captured by assessment of the direct benefits to passengers but some may be additional. Such "wider economic impacts" are not, however, included in our modelling framework.

Benefits to the users of aviation can be divided into the following three categories.

1. *Connectivity gains*

Connectivity benefits are estimated based on the relative frequency increase. The total passenger benefits are estimated by a utility function which depends on the frequency and generalised travel costs. The connectivity benefits consist of the frequency component from this utility function. A complete technical description is given in Annex A[5].

2. *Competition*

Capacity expansion facilitates market entry and is generally likely to reduce market concentration. Passengers benefit from the increasing downward pressure of competition on fares.

3. *Reduction in airline scarcity rents*

When potential demand exceeds the physical airport capacity to accommodate airline seat supply, airline rents accrue as air ticket prices increase to balance supply and demand and clear the market (Figure 3.1a). The system currently employed for allocating slots for take-off and landing in London airports, with most slots allocated free of charge to incumbent airlines, means that rents accrue mainly to airlines. In sufficiently competitive markets, airport expansion will reduce airline scarcity rents (figure 3.1), reflected in lower airfares and lower airline revenues than would otherwise (figure 3.1) arise (although not necessarily lower than today).

When capacity is added to either Heathrow or Gatwick, new airlines will enter the market and add new routes. Because of the increased contestability of the market, ticket prices will fall, reducing the economic rent for the airlines to the benefit of the consumer (Figure 3.1b). Benefits in terms of ticket prices are likely to be highest when capacity is expanded at the airport with the largest excess demand.

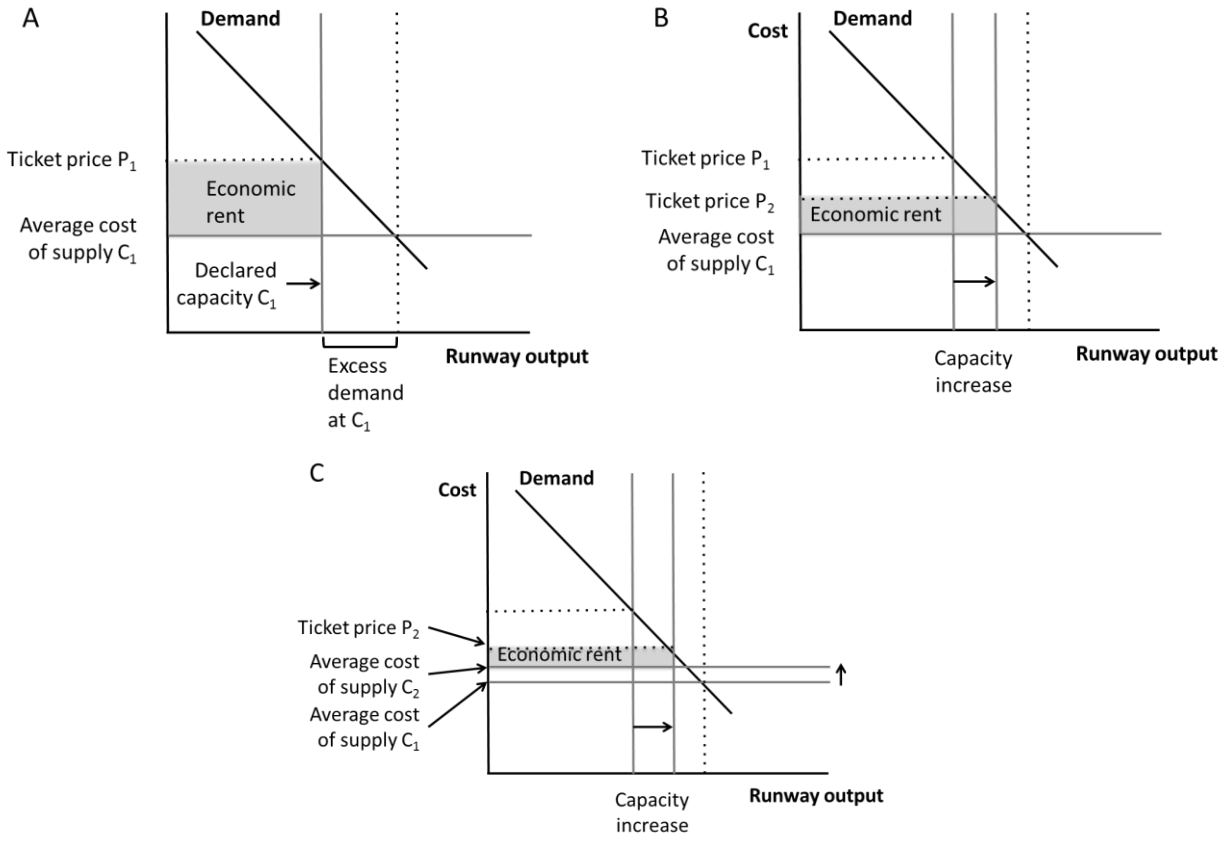
If airport charges rise as a result of capacity expansion, the average cost of supply will rise, further reducing the economic rents accruing to the airlines. As Starkie (1998, p. 115) states: 'Increasing the price [of charging landed aircraft] (Figure 3.1c) would have the effect of reducing the scarcity rent

5 Welfare gains from more direct routings have not been quantified separately, as the gains are expected to be relatively limited given the modest growth in new direct routes in 2030. Yet, as we calculate first total welfare gains based on the difference in network supply in the airline response with airport expansion compared to a constrained scenario, any improvements in the network are taken into account into the overall reductions in generalised travel cost.

enjoyed by the incumbent airline'. In other words, where there are airline scarcity rents, airfares are unlikely to increase simply because airline costs have increased through higher airport charges; instead scarcity rents (and thus fares and yields will fall). This effect is accentuated if capacity increases because competition would tend to drive fares down closer to a higher cost base. With sufficient airline competition increased airport charges will erode rents before they affect ticket prices.

For this study, we assume that the remaining airline rents after expansion are larger than the increases in aero-charges and that airline do not pass through any further cost increases in a highly competitive market, but choose to absorb them.

Figure 3.1. **Reduction of excess demand decreases ticket prices/ airline scarcity rents. Increase in charges further reduces the airline rents**



Source: ITF (2014) adapted from Starkie 1998.

In the do minimum scenario we have lower airport charges but persistent scarcity rents. In the expansion scenarios we have higher airport charges but lower scarcity rents. Explicit modelling of this relationship was beyond the scope of the present report.

Airports Commission demand forecasts

The Airports Commission's aviation demand forecasts provide an important basis for the impact analysis. The Airports Commission provided passenger forecasts for 2030 for five different scenarios: Assessment of Need, Global Growth, Relative Decline of Europe, Low-cost is King and Global

Fragmentation[6]. Three of these forecasts (Assessment of Need, Low-cost is King and Relative Decline of Europe) provide a basis for this analysis. Separate aviation demand forecasts are used for the unconstrained, constrained and airport expansion scenarios.

The unconstrained forecast represents total potential demand for UK aviation, in the absence of any constraints on airport capacity or a cap on aviation emissions. Hence there are no scarcity rents at any airport and passenger numbers grow in the range of 1-3 percent a year[7]. The unconstrained airport scenarios are used solely for the calculation of scarcity rents.

The constrained forecast represents the baseline case without capacity expansion at any airport. In this forecast the current airport capacity is fully utilised without building an extra runway. This forecast is also referred to as the 'do minimum' scenario. The constrained forecast is used to determine scarcity rents with respect to the unconstrained forecast.

The Heathrow or Gatwick expansion forecasts are used to determine the passenger benefits with respect to the constrained scenario. These benefits are determined by the decrease in scarcity rents obtained by the additional runway capacity.

The Airports Commission has developed two versions of the forecasts: carbon traded and carbon capped[8]. In this analysis the carbon traded version is used. It assumes that aviation continues to participate in existing emissions trading schemes such as the EU Emissions Trading System (ETS), so passengers face a carbon cost, but no specific emissions level is targeted.

Overview of the approach

Stepwise, the Netcost modelling framework was applied as follows.

1. Construction of unconstrained airline networks
2011 is the base year for the analysis. Using the growth figures in the applicable aviation scenario as defined by the Airports Commission carbon traded forecast, the base network of 2011 was projected to the year 2030 at the individual carrier-destination level by airport, taking into account any shifts of traffic between airports foreseen in the aviation scenarios. An unconstrained network was projected for each individual airline response–scenario combination. For airline response 1 the growth rates in the Airports Commission Assessment of Need scenario were used, for airline responses 2 and 3 the 'Low-cost is King' scenario was used and for airline response 4 the 'Relative Decline of Europe' scenario was used, projecting networks by destination region and London airport.

Part of the seat capacity growth to 2030 translates into higher frequencies on existing routes, part into higher frequencies on new routes and part of it is accommodated through the rising number of seats per flight (larger aircraft). Section 3.4 describes the procedure followed in order to breakdown the seat capacity growth into frequency growth, route growth and aircraft size growth.

6 A detailed description of these forecasts is given in : Airports Commission (November 2014), Strategic fit : forecasts. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374660/AC05-forecasts.pdf

7 Department for Transport (January 2013). UK Aviation Forecasts. https://www.gov.uk/government/publications/uk-aviation-forecasts-2013

8 Ibid, pp. 51-52.

2. Estimation of generalised travel costs in unconstrained airline networks
After the construction of the unconstrained airline networks for 2030, generalised travel costs and consumer welfare values were estimated using the SEO Netcost model. The ticket price model of Netcost uses flight time, frequency, competition level, type of connection (direct/indirect) and a dummy for low-cost carriers as independent variables to estimate average fare levels. The competition level depends on both direct flights and indirect alternatives via other hubs, although on short-haul indirect alternatives are less relevant. Connectivity effects depend mainly on frequency growth following capacity expansion.

Next, airline networks and passenger numbers were assigned to destination and airline groups at a suitable level of detail for the definition of the airline responses (see Annex B). The level of detail was chosen so that competition within an airline group at a single destination region is as small as possible.

3. Projection of constrained airline networks in a 'do minimum' scenario and in a scenario with capacity expansion
Similar to the methodology used in step 1, growth figures by destination region and London airport derived from the Airports Commission's aviation demand scenarios are used to construct a constrained network for each of the London airports. The constrained scenarios exist for both the 'do minimum' and expansion scenarios. Airline responses are developed for the expansion scenarios.

4. Estimation of generalised travel costs in constrained airline networks
Assuming constant load factors for the constrained scenarios, passenger numbers for each destination region, London airport and carrier can be derived[9]. A reduction in passenger numbers compared to the unconstrained network implies an increase in generalised costs. Generalised costs for the 'do minimum' and capacity expansion scenario are estimated using price elasticities taken from the literature (see Annex A).

5. Determination of airline scarcity rents
The differences in generalised costs between the 'do minimum' and capacity expansion scenarios equate to scarcity rents that accrue to the airlines in the form of higher ticket prices.

6. Distinction between OD and transfer passengers
Transfer passengers are highly price-sensitive and so substitution elasticities in the transfer market are much higher than elasticities in the origin-destination market. For the transfer market, a conservative substitution elasticity of -3 has been used[10], although at other hub airports these elasticities can average values of -4 to -7, with much higher values possible on individual OD markets (CPB 2011; Oum et al. 1993). This is an important notion as carriers focus on the higher yield OD-traffic when there is excess demand, with lower yield transfer traffic is gradually crowded out. This is the assumption in the constrained aviation demand scenarios. In balancing excess passenger demand with capacity in the constrained scenarios, relatively small increases in ticket prices result in large decreases in transfer

9 Note that it is possible that average load factors may further rise somewhat in the future, which could result in marginally smaller increases in aircraft size and flight frequency.

10 Some transfer markets at Heathrow face a lot of competition (e.g. New York Vienna) others low competition (e.g. New York Leeds). For around 80% of the connecting markets via Heathrow passengers have an alternative direct flight or hub to choose from (Lieshout and Burghouwt 2012). This is much higher than all the other European hubs except Zurich. So BA is extremely exposed to competition in the connecting market. This means that substitution elasticities in Heathrow's transfer markets are expected to be very high. Nevertheless, there may be reasons for passengers to travel with BA: loyalty programs play a part and there are still markets where the hub carrier is dominant and passengers do not have an alternative. Hence, as an average a moderate substitution elasticity of -3 (rather than -4 to -10) was retained.

passengers. To bring OD demand into line with available capacity ticket price increases need to be relatively high to achieve the same reduction in passenger demand, resulting in the bulk of airline scarcity rents.

7. Determining consumer welfare impacts

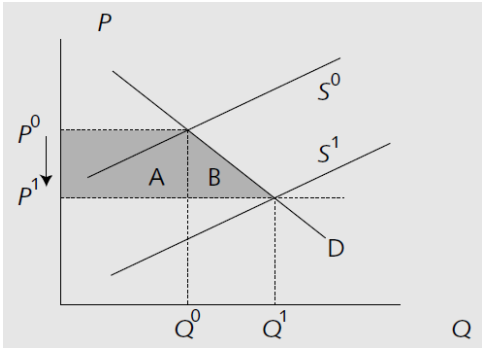
Benefits to passengers from the airline responses following capacity expansion at Gatwick or Heathrow are calculated by multiplying the expected reductions in generalised travel costs by the number of passengers in the expansion scenario/airline response and adding the benefit from reduction in excess demand[11] (difference in demand between constrained and unconstrained forecasts). The welfare benefits arising from reducing excess demand is treated using the 'rule of half'. Additional passengers 'pay' half of the change in generalised travels (see box).

Box 1. The Rule of Half

Two categories of passengers benefit from capacity expansion. The first category are passengers who would have travelled anyway in the absence of capacity expansion (i.e. in the constrained forecast), the others are 'new' passengers able to travel at the lower prices consequent to expansion of capacity. The first category benefits fully from the price decrease, the second category is treated using the 'rule of half'. This can be explained using the figure below. As a result of capacity expansion ticket prices are reduced from P^0 to P^1 and the number of passengers increases from Q^0 to Q^1. The consumer benefits differ between the categories as follows.

There are Q^0 passengers traveling in the constrained scenario. These passengers benefit from a price reduction of P^0-P^1. The benefits for this category are represented by the surface of rectangle A, which is equal to $Q^0*(P^0-P^1)$.

There are Q^1-Q^0 passengers not traveling in the constrained scenario. This is the previously denied demand as a result of capacity constraints. The willingness to pay of these passengers is less than P^0. The first entrant to the market has a willingness to pay of P^0, resulting in a consumer benefit of P^0-P^1. The willingness to pay for the last additional passenger is equal to P^1 hence the consumer benefit of this passenger equals 0. The benefits for this category are depicted by triangle B in the figure. The surface of this triangle equals $0.5*(Q^1-Q^0)*(P^0-P^1)$.



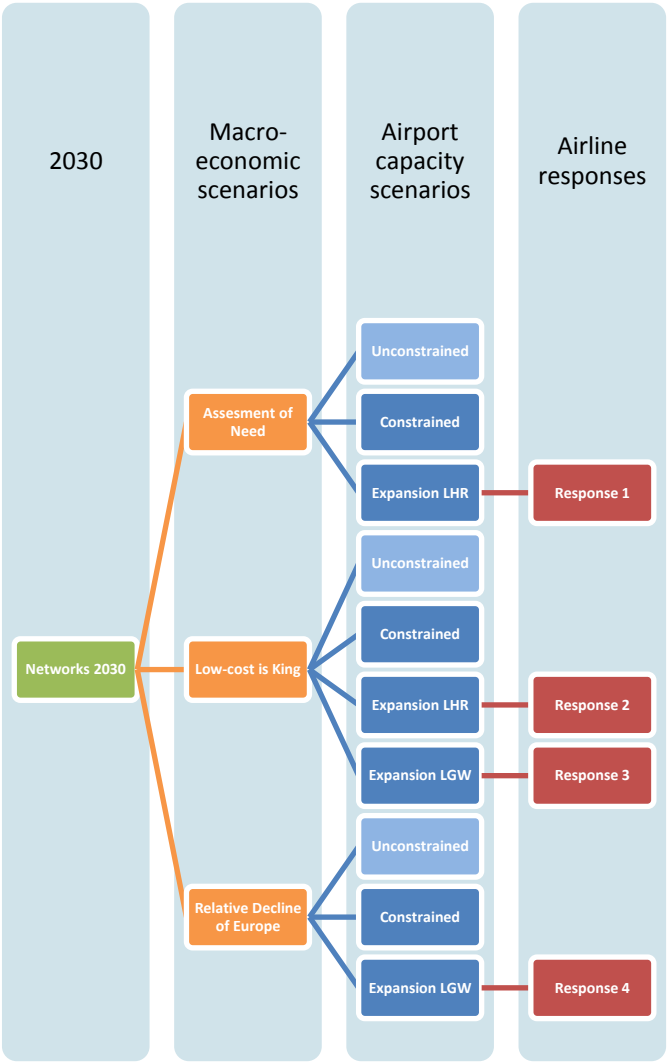
8. Break-down of effects

Consumer welfare is divided into competition, connectivity and scarcity components. The competition component depends on the change in Herfindahl-Hirschmann concentration index (the sum of squared market shares for each airline). The connectivity component is the change in generalised costs caused (mainly) by the increase in frequency of flights following capacity expansion. The remaining part of the welfare impact consists of the reduction in airline scarcity rents, which benefit the passenger in the form of lower ticket prices.

11 In this exercise the assumption was made that these potential passengers did not travel rather than travelled by one of the other London airports.

In sum, the Netcost approach calculates the reductions in generalised travel costs as a result of capacity expansion under the four airline response-scenario combinations and adds the welfare benefits of the previously denied demand.

Figure 3.2 **Combining the Airports Commission aviation demand scenarios with the airline responses**



Source: SEO

Growth rates in the Airports Commission's aviation demand scenarios

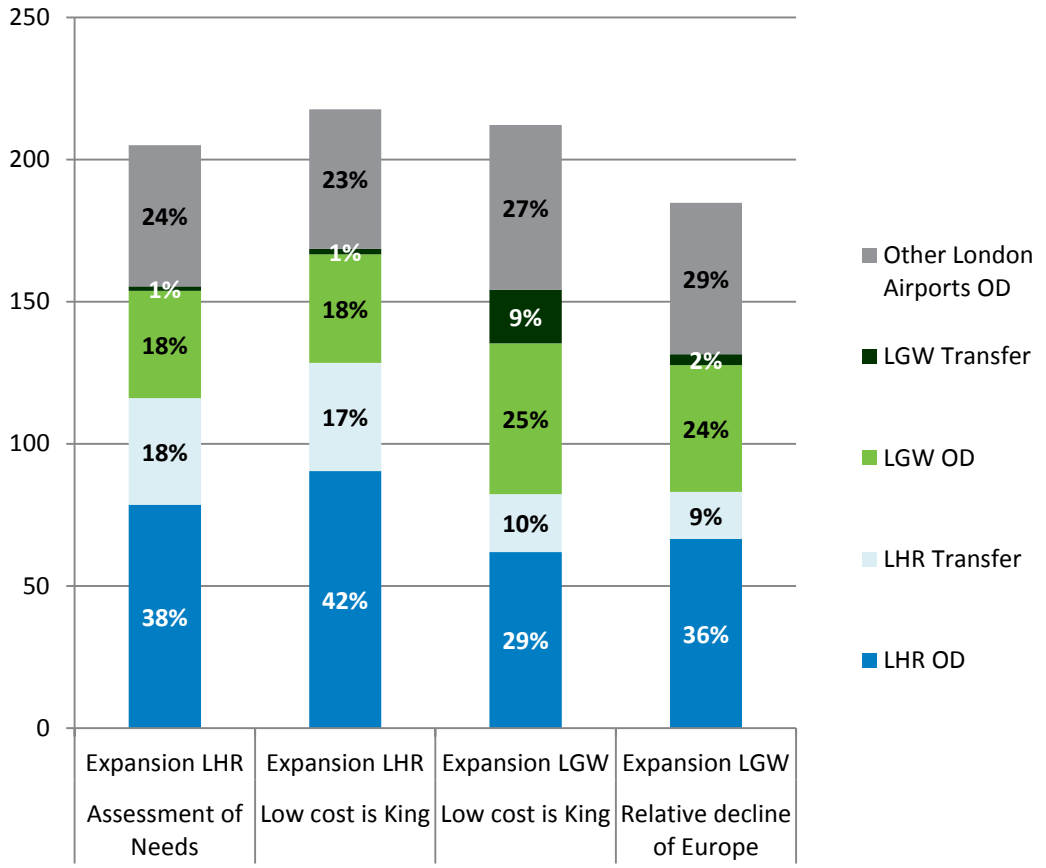
The Airports Commission has forecast the number of passengers per London airport, by destination region and for each scenario in 2030, as summarised in table 3.1. The growth rates applied in the various airline responses are crucial to understanding the analysis: the higher the growth rate, the larger the excess demand in a 'do minimum' scenario in 2030 and the larger the reductions in scarcity rents once capacity is added to the London airports system. In particular the low growth rates in the scenario Relative Decline of Europe in airline response 4 lead to much lower consumer welfare benefits in comparison to the other airline responses, where the scenarios Assessment of Need and Low-cost is King apply.

Table 3.1 **Overview annual growth rates in passenger traffic in the different aviation scenarios used in this study at the London airports (2011-2030)**

Capacity expansion option	Unconstrained	'Do minimum'	LGW expansion	LHR expansion
Assessment of Need	2,45%	1,65%		2,22%
Relative Decline of Europe	2,29%	1,62%	1,66%	
Low-cost is King	2,59%	1,84%	2,43%	2,49%

Source: Airports Commission.

Figure 3.4 **gives the breakdown of passenger numbers by airport following expansion of either Gatwick or Heathrow for the different aviation demand scenarios as defined by the Airports Commission.**



Source: Airports Commission's forecasts; elaboration SEO

Assumptions on network expansion: aircraft size versus frequencies

Growth in seat capacity at the London airports can take place through use of larger aircraft, service to more destinations and higher frequencies per route. For the extrapolation of the networks to 2030, we made assumptions on how seat capacity growth on markets already served directly translates into use of larger aircraft (more seats per flight) and more frequencies per route.

For this purpose, flights schedules for all airlines serving the five airports in London[12] as well as a sample of other major EU hub airports were obtained from OAG airline schedules data for the period 2004 to 2014. Next, we analysed to what extent seat capacity growth at these airports has taken place via increases in average aircraft size and via increases in frequencies. The annual growth rates derived are summarized in table 3.2.

Table 3.2 **On long-haul routes seat capacity increase is mainly delivered by increased frequency; on short-haul routes aircraft size is the main driver.**

	Frequency growth	Aircraft size growth
Long-haul	1,9%	0,1%
Short-haul	0,2%	1,7%

Source: OAG 2004-2014

From the historical analysis it follows that on average, network growth on long-haul markets can mostly be attributed to frequency increases, while the main driver for total annual seat expansion on short-haul routes has been the use of larger planes.

We have assumed that this development will continue through 2030 but expect convergence in the longer run. Therefore we assume a maximum aircraft size threshold in the Netcost model. That is, once the average aircraft size for short-haul routes has grown to 120 seats for aircraft landing at London city, or to 240 seats for planes landing at the other London airports, we assume this number to remain stable until 2030. Consequently, we model all additional growth in this market as a result of frequency increases. Table 3.3 summarizes the aircraft size thresholds used.

Table 3.3 **Assumptions on maximum aircraft size and frequency**

	Maximum aircraft size	
	Long-haul	Short-haul
LHR	600	240
LGW	600	240
LTN	250	240
STN	600	240
LCY	120	120
Low-cost	275	240

To a certain extent, we use a similar reasoning for frequencies. As concluded in the previous report (ITF, 2014), scheduled airlines that are able to achieve the largest frequency share on a route may benefit from a disproportionately large market share on that route. Similarly, airlines operating a route with a low share in frequency of service may experience a disproportionate drop in market share. This 'S-curve effect' triggers legacy airlines to increase frequencies and concentrate services at a single airport. The effect has especially proved to play a role on long-haul markets, where competition from low-cost carriers is generally limited or absent.

12 Southend was excluded from the analysis.

Following the S-curve logic, further increases at already high frequency levels will not result in substantial further increases in market share or additional market generation. Hence, market saturation can be a reason for airlines to develop new routes or additional frequencies at other airports on a parallel route. Although we did not put an explicit maximum as to how many daily frequencies could be offered to a certain destination, we did check and correct for any frequencies that appeared unrealistically high.

New destinations

To assess which new destinations might be served directly from one of the London airports, we relied on adjusted passenger booking data for 2010[13]. We analysed how many OD passengers travel indirectly to their final destination via another hub airport. OD demand on these indirect connections was extrapolated to 2030. Using minimum demand, capacity and frequency thresholds, we identified the destinations that might have enough demand potential for direct services to be added between now and 2030. These new destinations have been added to the unconstrained network, for which generalised travel costs have been calculated at the individual carrier-destination level.

As a level of service threshold, we assume a minimum required frequency of seven flights per week. In addition, we assume that a new direct connection will stimulate demand (market generation) based on IATA's demand stimulation curve depending on the level of existing demand in the market (Sismanidou et al., 2013). In addition, we assume that transfer passengers that now travel via other hubs will use the direct flight. For short-haul and long-haul flights, we assume a minimum required average load factor of 90% and a minimum weekly frequency of seven. As a rule of thumb, we assume that at least a daily frequency is needed for a competitive service. In reality, on some routes and for some airlines lower frequencies may apply. For long-haul, the minimum aircraft size threshold was set at 214 seats, equivalent to the capacity of a Boeing 787 aircraft. For short haul, a new direct flight has a minimum aircraft size of 160 seats.

Definition of the four airline responses

The four airline responses selected to estimate the impacts of airport capacity expansion on connectivity, competition and reduction of scarcity rents are described in Chapter 2 in qualitative terms[14]. For the impact assessment, the aviation scenarios developed by the Airports Commission and our projected networks for 2030 are used to model the airline responses with the Netcost model. The airline names mentioned are only indicative of the type of carrier that could respond to the expansion of London's airport capacity in the future.

13 The so-called MIDT (Marketing Information Data Tapes).

14 For an extensive discussion, refer to ITF (2014)

Table 3.4 **Assumptions for definition of airline responses in combination with the relevant aviation scenarios developed by the Airports Commission**

	Airline response 1: Hub-carrier growth at Heathrow, point-to-point growth at Gatwick	**Airline response 2: Point to point growth at Heathrow and Gatwick, Heathrow remains the network hub**	**Airline response 3: Partnerships: Gatwick becomes a low-cost gateway, Heathrow remains the network hub**	**Airline response 4: low-cost: Gatwick point-to point-growth, Heathrow remains the network hub**
Aviation scenario	Assessment of Need	Low-cost is King	Low-cost is King	Relative Decline of Europe
Airport scenario	Expansion of Heathrow	Expansion of Heathrow	Expansion of Gatwick	Expansion of Gatwick
Traffic shift between LHR and LGW	Oneworld traffic moves from LGW to LHR. Oneworld flights at LGW are replaced by higher frequencies of other carriers such that total seat capacity at both airports remains unchanged.	No traffic shift between airports	No traffic shift between airports	No traffic shift between airports
Traffic shift between airline groups	Low-cost point-to-point (PtP) traffic is moved from LHR to LGW. If insufficient to restore the seat capacity at LGW, non-Oneworld FSC traffic is relocated to LGW. A BA point-to-point subsidiary serves remaining Oneworld leisure traffic at LGW.	Oneworld loses market share at LHR to LCCs such as EasyJet and Vueling. In long haul markets Virgin and leisure carriers gain frequencies with respect to Oneworld.	Low-cost carriers such as Norwegian, EasyJet and Ryanair replace legacy carrier flights in both long haul and short haul markets at LGW.	Capacity increase at LGW is used by PtP carriers. Oneworld frequencies do not change with respect to the constrained growth scenario.
Transfer traffic	Transfer traffic at LHR increases. Transfer traffic at Gatwick almost entirely limited to 'self hubbing'. Oneworld at LHR: 60% transfer for long-haul, 50% for short-haul.	Share of transfer traffic remains stable for Oneworld: at LHR 50% for long-haul, 45% for short-haul. As share of Oneworld declines absolute number of transfer passengers decreases.	Transfer share of Oneworld remains the same. Low-cost carriers increasingly serve the connecting market with guided connections (average of 10% transfer on low-cost flights at Gatwick).	Transfer traffic at LGW almost entirely limited to 'self-hubbing'. Transfer share at LHR remains stable.
Aircraft size	No additional changes in aircraft size.	No additional changes in aircraft size.	Low-cost carriers carry more traffic in smaller long-haul aircraft such as 787 or A350.	Low-cost carriers carry more traffic in smaller long-haul aircraft such as 787 or A350.

Airline response 1 'Hub-carrier growth at Heathrow, point-to-point growth at Gatwick'

- The share transfer traffic within the network of British Airways (and partners) at Heathrow grows to 60% on long-haul and 50% on short-haul due to increased hubbing operations.
- Oneworld will move all of its long-haul operations from Gatwick to Heathrow. The additional capacity at Heathrow enables the hub-carrier British Airways (and partners) to grow from its current constrained, sub-optimal hub-and-spoke system to an efficient fully developed wave-system for coordinating arrivals and departures.
- Full service carriers currently serving Gatwick will also move their operations to Heathrow
- Other full service carriers that already serve Heathrow such as Emirates will increase flights to their own hubs. Legacy point-to-point carriers such as Virgin Atlantic will also grow at Heathrow.
- British Airways (and partners) will give up some of their slots at Gatwick to low-cost carriers in the interests of consolidation and maximising hub economies at Heathrow while keeping a significant part of their slots to be operated by the point-to-point subsidiaries in the airline group.

Airline response 2 'Point-to-point growth at Heathrow and Gatwick, Heathrow remains the network hub'

- The share of transfer passengers per airline group and per airport is in line with the Airports Commissions forecasts but for Heathrow lower than under airline response 1.
- Oneworld will move all of its long-haul operations from Gatwick to Heathrow. The additional capacity at Heathrow enables the hub-carrier British Airways (and partners) to grow from its current constrained, sub-optimal hub-and-spoke system to an efficient fully developed wave-system for coordinating arrivals and departures.
- Full service carriers currently serving Gatwick will also move their operations to Heathrow
- Other full service carriers that already serve Heathrow such as Emirates will increase flights to their own hubs. Legacy point-to-point carriers such as Virgin Atlantic increase flights at Heathrow.
- BA and partners will give up a large share of their slots at Gatwick to low-cost carriers.

Airline response 3 'Partnerships: Gatwick becomes a low-cost gateway, Heathrow remains the network hub'

- We assume that low-cost carriers operating from Gatwick will have a limited share of transfer passengers on their flights, much less than that of BA and its partners at Heathrow.
- BA and partners will keep the largest part of their long-haul operations at Heathrow, but will increase stand-alone point-to-point services from Gatwick.

- Long-haul low-cost and long-haul leisure services will increase from Gatwick. Airlines such as Norwegian long-haul and Air Asia X will gain market share in the long-haul market, partly driven by the growth of the inbound Asian leisure market and the use of smaller, more fuel-efficient long-haul aircraft (Boeing 787 and Airbus A350).

- Low-cost services from Stansted and Luton will increase. These will mainly be provided by low-cost airlines, such as Ryanair and Wizz Air, that do not focus on premium markets. Other low-cost carriers whose strategy would be to tap into premium markets, currently for example the case for EasyJet, will increasingly move services from Luton to Gatwick and gain market share in the business passenger market.

Airline response 4 'Gatwick point-to point growth, Heathrow remains the network hub'

- We assume that low-cost carriers at Gatwick will stick to the more traditional low-cost carrier business model, which means a continuing focus on point-to-point traffic.

- Point-to-point legacy carriers at Heathrow such as Virgin Atlantic move some of their operations to the expanded Gatwick. Any slots that become available at Heathrow are taken up by BA and partners at Heathrow.

- Because of lower local airline industry growth rates in the Relative Decline of Europe scenario, BA and partners consolidate operations at Heathrow. Available capacity at Gatwick is filled up with point-to-point carriers.

- Gatwick benefits from the introduction of the Boeing 787 and Airbus A350, which allows low-cost carriers to fly profitably on long-haul routes. As UK economic growth is modest in this scenario, connectivity gains through 2030 are limited despite strong growth in Asia and other parts of the world.

4. Results: Impact on Connectivity, Competition and Scarcity Rents

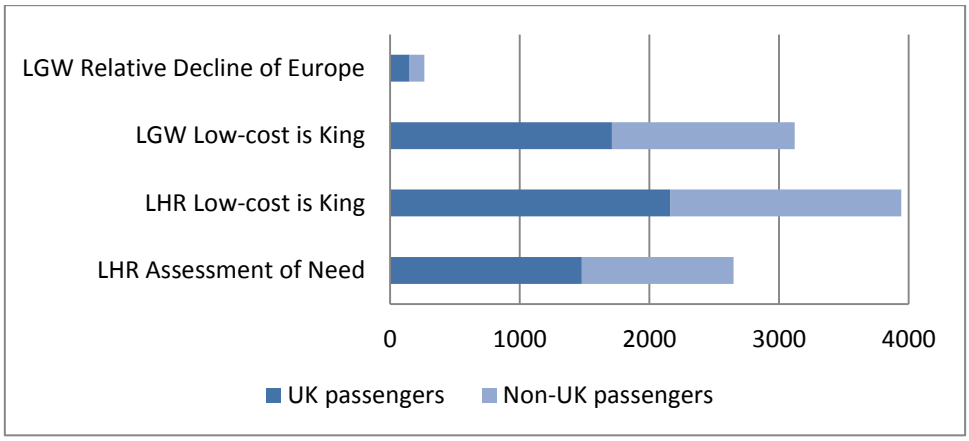
This chapter summarises our findings on the impacts of runway capacity expansion on connectivity, competition and reduction of airline scarcity rents, for four airline response outcomes following expansion at Gatwick or Heathrow. We find that reductions in airline scarcity rents make up the majority of the consumer welfare gains. All tested airline responses, including expansion of the hub operation at Heathrow, produce benefits for passengers from competition. The analysis has a medium-term perspective and does not look beyond the year 2030. It should be noted that beyond 2030 the point-to-point airline response in the Relative Decline of Europe scenario following Gatwick expansion would be expected to begin to generate substantial welfare gains.

Results of the quantitative impact assessment

Figures 4.1 to 4.3 and the Tables in 4.1 and 4.2 summarise the results of the impact assessment on connectivity, competition and reduction of airline scarcity rents. Before discussing the results, we note that:

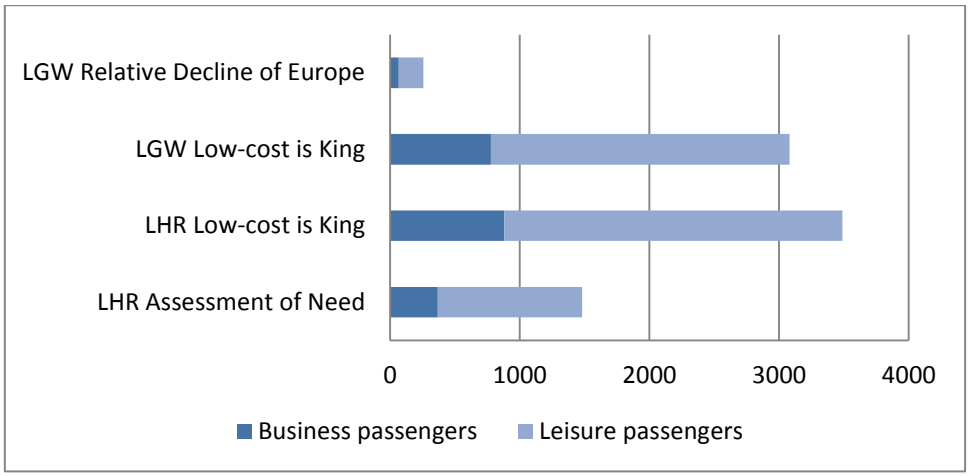
- All results are in comparison to the same 'do minimum' scenario.
- The airline response outcomes are not directly comparable as they reflect different scenarios for the overall development of aviation and the global economy.
- Benefits to passengers relate to the year 2030 only, therefore they need to be interpreted with caution. That is especially the case for airline response 4, which unfolds in the Relative Decline of Europe scenario, as in this particular scenario the demand profile at Gatwick indicates that welfare benefits would mainly accrue after 2035.

Figure 4.1 **Total Consumer Benefits in 2030 (million GBP)**



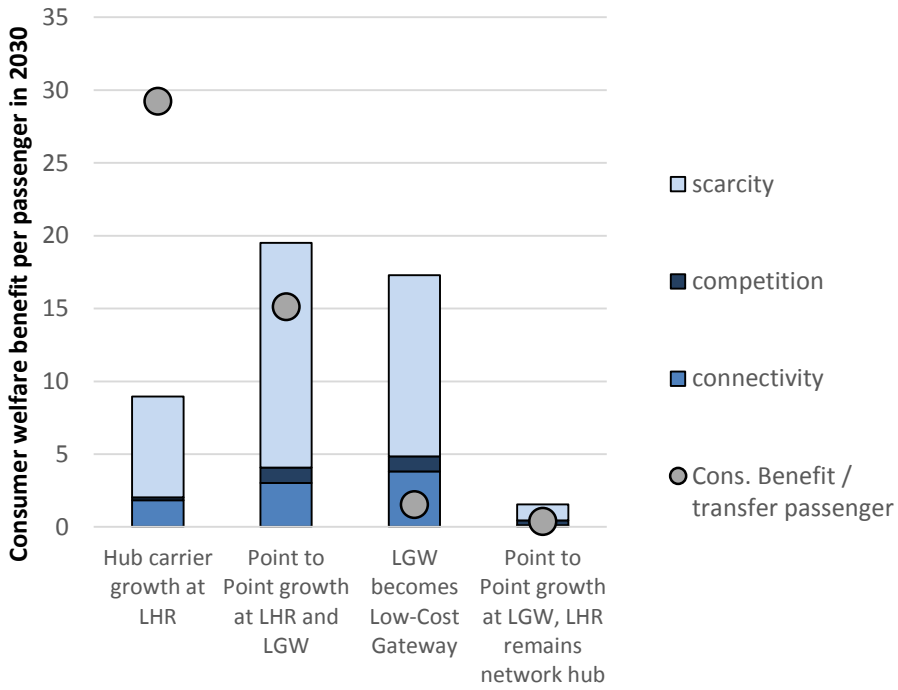
Source: SEO Netcost

Figure 4.2 **Business and Leisure Consumer Benefits in OD Markets in 2030**
(million GBP)



Source: SEO Netcost

Figure 4.3 **Consumer welfare impacts of airport expansion in 2030: Benefits to passengers travelling to and from the UK (bars) and to transfer passengers (dots)**
(GBP per passenger)



Source: SEO Netcost

The results of the impact assessment for each of the airline responses are summarised in Table 4.1, following Heathrow expansion, and Table 4.2, following Gatwick expansion. All results are presented in terms of consumer welfare benefits; the reduction in travel costs for passengers following airport

capacity expansion through more flights and lower fares, in comparison to the do minimum scenario in which capacity is not expanded.

Table 4.1 **Impact analysis results for Heathrow expansion for the year 2030 in GBP**
(reference = do minimum scenario/no capacity expansion)

	Heathrow Expansion					
	1. Assessment of Need Hub-carrier growth at LHR			**2. Low-cost is King** Point-to-point growth at LHR and LGW		
Benefit / OD passenger	**£ 8.96**			**£ 19.51**		
connectivity	£ 1.83			£ 3.01		
competition	£ 0.20			£ 1.06		
scarcity	£ 6.93			£ 15.44		
Benefit / transfer passenger	**£ 29.23**			**£ 15.13**		
		Constrained			**Unconstrained**	
Number of OD passengers (x 1000)	**168,218**	**162,518**		**187,914**	**169,803**	
LHR	85,187			103,193		
LGW	38,376			39,791		
LCY	4,561			5,414		
LTN	10,897			11,494		
STN	29,197			28,022		
Number of transfer passengers	**39,961**	**23,194**		**29,971**	**22,198**	
LHR	39,837			29,493		
LGW	124			478		
LCY	0			0		
LTN	0			0		
STN	0			0		
		UK	*non-UK*		*UK*	*non-UK*
Total benefit to passengers (mln GBP)	**2,649**	1,480	1,169	**3,943**	2,162	1,781
		Business	*Leisure*		*Business*	*Leisure*
Total benefit OD passengers (mln GBP)	**1,481**	367	1,114	**3,490**	882	2,608
OD passengers (connectivity) (mln GBP)	303			539		
OD passengers (competition) (mln GBP)	33			189		
OD passengers (scarcity) (mln GBP)	1,145			2,762		
Total benefit Transfer passengers (mln GBP)	**1,168**			**453**		

Source: SEO Netcost.

Table 4.2 **Impact analysis results for Gatwick expansion for the year 2030 in GBP**
(reference = do minimum scenario/no capacity expansion)

	Gatwick expansion					
	3. Low-cost is King LGW becomes low-cost gateway			**4. Relative Decline of Europe** Point-to-point growth at LGW, LHR remains network hub		
Benefit / OD passenger	**£ 17.28**			**£ 1.54**		
connectivity	£ 3.80			£ 0.12		
competition	£ 1.05			£ 0.33		
scarcity	£ 12.44			£ 1.09		
Benefit / transfer passenger	**£ 1.53**			**£ 0.38**		
		Constrained			**Constrained**	
Number of OD passengers (x 1000)	**186,652**	**169,803**		**167,028**	**165,093**	
LHR	65,895			70,466		
LGW	69,624			48,881		
LCY	6,778			6,497		
LTN	15,016			13,583		
STN	29,339			27,601		
Number of transfer passengers	**27,211**	**22,198**		**19,412**	**19,618**	
LHR	22,824			19,412		
LGW	4,387			0		
LCY	0			0		
LTN	0			0		
STN	0			0		
		UK	*non-UK*		*UK*	*non-UK*
Total benefit to passengers (mln GBP)	**3,122**	1,712	1,410	**264**	150	113
		Business	*Leisure*		*Business*	*Leisure*
Total benefit OD passengers (mln GBP)	**3,081**	779	2,302	**256**	66	191
OD passengers (connectivity) (mln GBP)	678			21		
OD passengers (competition) (mln GBP)	187			55		
OD passengers (scarcity) (mln GBP)	2,216			180		
Total benefit Transfer passengers (mln GBP)	**42**			**7**		

Source: SEO Netcost.

The first section of the table lists the consumer benefit per passenger. It shows the average benefit to the individual OD (origin-destination) passenger, broken down by the benefits generated by reductions in airline scarcity rents (and thus lower fares), benefits of improved connectivity (more frequencies and routes) and benefits of more competition (lower fares). So in the case of airline response 3 (Gatwick becomes a low-cost gateway under the Low-cost is King scenario), on average the individual O/D

passenger is 17 pounds better off with expansion of Gatwick. The majority of the welfare benefits per passenger are generated by a reduction in fares because of a reduction in airline scarcity rents (12 pounds), followed by a connectivity benefit of 4 pounds per passenger and a competition benefit through lower fares of 1 pound. The same welfare benefits per passenger are given for transfer passengers, totalling 1.5 pounds in case of airline response 3.

The second section presents the number of OD and transfer passengers at each of the London airports in 2030 for each airline response following capacity expansion. The section also lists the number of passengers in the London airports system if capacity is not expanded, the constrained case. The difference between the number of passengers with and without capacity expansion already gives an impression of the extent to which airline scarcity rents can be reduced by expanding airport capacity. The larger the difference, the higher the expected reductions in scarcity rents.

The third section presents total passenger welfare benefits, which include the total benefits of lower travel costs for existing passengers and the total benefits for previously denied passenger demand. In case of airline response 3, these benefits are over 3.1 billion pounds, benefiting a total of 186 000 OD passengers and 27 000 transfer passengers. Part of these benefits accrues to UK residents (1.7 billion pounds) and another part accrues to non-UK residents (1.4 billion pounds).

The final section breaks down the total passenger welfare benefits between OD passengers and transfer passengers. For the OD passengers, we have estimated the total benefits through lower fares resulting from a reduction in scarcity rents and from increased competition and through improved connectivity. In case of airline response 3, the majority of the total benefits go to the OD passengers and only a small portion to the transfer passenger. Again, a major part of the benefits result from reduced scarcity rents.

Based on the quantitative impact assessment, we conclude the following main points.

The reduction in airline scarcity rents is the most important element of the consumer welfare impacts of airport expansion for all airline responses. All tested airline responses produce benefits from competition, including those with an expanded hub operation at Heathrow.

Around 55% of total welfare benefits accrue to UK residents in all airline responses. In the OD (origin-destination) market, leisure traffic accounts for about three quarters of the consumer welfare gains. On a per passenger basis, transfer passengers benefit most in the airline responses to Heathrow expansion.

Total consumer benefits are highest in the scenario assuming point-to-point traffic growth at Heathrow (airline response 2) and low-cost gateway development at Gatwick (airline response 3), both of which are based on the Low-cost is King demand scenario for. The lowest total consumer benefits are found in airline response 4, which assumes point-to-point growth at an expanded Gatwick in the Relative Decline of Europe scenario.

An important factor in explaining the differences between airline responses is the fact that different demand growth rates are used, depending on the Airports Commission scenario that applies for each airline response (see table 3.1). Until 2030, growth in the Low-cost is King scenario is higher than in both the Assessment of Need scenario and the Relative Decline of Europe scenario. This difference in the aviation demand scenarios leads to higher overall welfare gains in airline responses 2 and 3 (which both assume a Low-cost is King scenario) compared to the Assessment of Need (airline response 1) and Relative Decline of Europe scenarios (airline response 4).

We note that the deliberate choice for 2030 as the year of analysis is the main explanation for the very low figures for airline response 4. According to the Airports Commission (2014b) benefits are expected to accrue after 2035 in the Relative Decline of Europe scenario.

An important consideration in the total welfare effects is the change in the amount of transfer passengers. Transfer passengers have a much higher price elasticity, given the many close substitutes available (direct flights, via other hubs) for a connection via Heathrow. As a result, welfare effects are much lower when carriers use the additional capacity to a considerable extent to carry transfer traffic. For OD passengers a price decrease of 10 percent leads to a 10 percent passenger increase on average. On the other hand, a 10 percent price decrease for transfer passengers leads to a 30 percent increase in passenger numbers. Hence, for transfer passengers the additional capacity fills up sooner with a smaller price decrease. The gains for transfer passengers accrue to non-UK residents to a considerable extent.

The difference between OD and transfer passengers in terms of benefits from airline scarcity rent reductions is most relevant for airline responses 1 and 3. In both responses, the number of transfer passengers is expected to increase significantly once capacity becomes available at Heathrow or Gatwick. In contrast, in airline response 2, not only growth rates are higher but capacity expansion most benefits the local OD passengers, resulting in larger welfare gains because of their much lower price elasticities.

The effects quantified only relate to direct welfare benefits for passengers. Changes in surface transport access conditions and the consequences of expansion in allowing passengers to switch to a more convenient airport in terms of access are not included. Similarly, wider economic effects from improved connectivity of the London area have not been quantified.

Annex A. Methodology Technical Description

The Netcost model serves as a basis for the methodology used for this study. This model uses OAG schedule data for all direct and indirect alternatives to determine generalised costs and market shares for individual markets. The Netcost model was first presented in Heemskerk and Veldhuis (2006a, 2006b) and developed by Veldhuis and Lieshout (2009).

For the purpose of this study, the Netcost model has been applied on a more aggregate level. We quantify consumer benefits for the London area depending on different airline responses. These responses incorporate traffic shifts between airports and carrier groups, which are adjusted at a regional level. Destination regions and carrier groups are defined such that we assume that destinations in one region are perfect substitutes and there is no competition between carriers of the same carrier group.

Welfare effects for the four airline responses are determined using a 5-step approach:

1. Construct unconstrained, constrained and expansion-option airline networks for 2030 based on OAG schedule data and passenger growth forecasts from the Airports Commission (2014a).

2. Determine generalised travel costs and consumer utility using the Netcost price model.

3. Calculate scarcity rents resulting in a demand increase or decrease to satisfy capacity constraints.

4. Include airline response scenarios by allocating frequencies over specific carriers.

5. Divide the welfare effects between connectivity, competition and scarcity components. Break-down results by UK/non-UK and OD/transfer passengers.

Construction of airline networks for 2030

Passenger forecasts provided by the Airports Commission were used to construct an airline network for each scenario. For each, an unconstrained, constrained and LHR/LGW expansion a network is determined. These networks are created by increasing the seat capacity offered in 2011 by annual passenger growth rates from the Airports Commission forecasts. In total, 10 airline networks were constructed: 3 for the Assessment of Need and Relative Decline of Europe scenarios and 4 for the Low-cost is King scenario (as this scenario is considered for both expansion options).

The Netcost model also requires a ‘beyond-network’ for 2030 to determine indirect travel alternatives to final destinations. This ‘beyond-network’ consists of all destinations that can be reached from London with a connection at an intermediate hub airport. Direct and indirect travel alternatives are used to determine the competition level in an OD market, which is an input variable for the fare model. Consider for example the route LHR-SIN. British Airways and Singapore Airlines provide direct connections from LHR. Besides this there are numerous indirect alternatives such as connections via Frankfurt or Dubai. For this reason we construct airline networks for 2030 for Frankfurt, Dubai and other ‘onward hubs’. We

project the 2011 network to 2030 by applying the average growth figures by destination region for all airports given in the Airports Commission forecasts.

Calculating generalised travel costs and consumer value

The Netcost fare model determines generalised travel costs for an individual route alternative based on travel time, competition level, carrier type and connection type. The fare model is estimated using Ordinary Least Squares (OLS) and is defined as:

$$\ln(fare) = \beta_0 + \beta_1 \cdot t_{nonstop} + \beta_2 \cdot t_{nonstop}^2 + \beta_3 \cdot \ln(f) + \beta_4 \cdot HHI + \beta_5 \cdot D_{LCC} + \beta_6 \cdot D_{indirect}$$

Where

$t_{nonstop}$= non-stop travel time

f= weekly frequency

HHI = Hirschmann-Herfindahl concentration index (sum of squared market shares)

D_{LCC}= Dummy variable, equals 1 if the flight is operated by a Low Cost Carrier
$D_{indirect}$= Dummy variable, equals 1 if the flight is an indirect flight.

As we only consider direct routes in this analysis all dummy variables for indirect routes are set to 0.

The fare model is estimated using passenger booking data for 2010 and is specified by the following parameter values:

t_nonstop	0.28873
t_nonstop ²	-0.00827
ln(freq)	0.03718
HHI	0.30101
D_LCC	-0.12801
D_indirect	-0.11753
β_0	3.95411
R^2	0.7663

All variables are significant at 99.5% confidence level

As this analysis is done at regional level we assume there are no additional costs incorporated for the route alternatives. Hence, the fare derived by the model defined above defines the generalised travel cost of a route alternative.

After the generalised travel costs (GC) are derived, a utility function is used to determine the Consumer Value (CV), having as base the frequency (f). A cost sensitivity parameter α is included. The consumer value for route alternative i (CV_i) is given by:

$$CV_i = f \cdot e^{-\alpha \cdot GC_i}$$

The total consumer value for the connection between London and one of the world regions is determined by adding up the consumer values for all independent route alternatives.

We consider the example of the route from LHR to North-East USA. Flights are offered by six different carrier groups flying from three London airports. We suppose the amount of passengers is determined by the seat capacity offered: load factors remain constant. The amount of OD-passengers is determined by the load factor multiplied by the seat capacity, minus the number of transfer passengers. The welfare effects for transfer passengers are calculated separately.

Region_dest	Airport_ori	Carrier_code	frequency	Ac. size	seats	Load factor	OD-passengers	Market share	Generalised costs (fare model)	Consumer value
NA3	**LCY**	3	1	32	**42**	**85%**	**35**	**0%**	299	0.01
NA3	**LGW**	12	0	162	**5**	**90%**	**5**	**0%**	275	0.00
NA3	**LHR**	1	87	240	**20929**	**85%**	**17790**	**17%**	333	0.63
NA3	**LHR**	2	146	235	**34222**	**85%**	**29089**	**28%**	349	0.80
NA3	**LHR**	3	386	271	**104558**	**85%**	**35550**	**34%**	336	2.58
NA3	**LHR**	4	5	281	**1468**	**85%**	**1248**	**1%**	303	0.06
NA3	**LHR**	5	88	293	**25920**	**85%**	**22032**	**21%**	325	0.70
Total NA3			**714**		**187145**		**105749**	**100%**		**4.79**

Before we can determine the scarcity rents in step 3 we need to adjust the generalised costs based on the market share by the number of OD passengers. The consumer value is redistributed according to the market shares. Adjusted generalised costs GC_i' are calculated by inverting the consumer value equation:

$$GC_i' = \frac{\ln(CV) - \ln(f)}{\alpha}$$

The generalised costs in the unconstrained (base) scenario are given by the multiplying the generalised costs and the market shares:

$$GC' = \sum_i GC_i' \cdot MS_i$$

These costs are required to determine the scarcity rents.

Calculating scarcity rents

As a result of capacity restrictions the seat capacity offered and resulting passenger numbers is lower in the Constrained scenario:

Region_dest	Airport_ori	Carrier_code	frequency	Ac. size	seats	Load factor	OD-passengers
NA3	LCY	3	1	32	42	85%	36
NA3	LGW	12	0	162	5	90%	5
NA3	LHR	1	69	237	16463	85%	13994
NA3	LHR	2	116	232	26920	85%	22882
NA3	LHR	3	307	268	82247	85%	34955
NA3	LHR	4	4	278	1155	85%	982
NA3	LHR	5	70	290	20389	85%	17331
Totaal NA3			569		147222		90184

The OD demand decreased from 105 794 to 90 184, a 15% decrease. Assuming a price elasticity of -1, this yields a GC increase of 17%: $0.85^{-1} = 1.17$. The adjusted generalised costs (GC') were equal to 328. Hence a price reduction of $56 is needed to realise the desired demand reduction.

	OD-Demand change	GC Change	GC'	Welfare effect
NA3	0.85	1.17	328	-56.55

The new generalised costs resulting from the calculation steps shown above can be used similarly to determine the welfare effect for a capacity expansion scenario. This leads to the following result for the Heathrow capacity expansion in the Assessment of Need scenario:

Region_dest	Airport_ori	Carrier_code	frequency	Ac. size	seats	Load factor	OD-passengers
NA3	LCY	3	1	32	41	85%	35
NA3	LGW	12	0	162	5	90%	5
NA3	LHR	1	83	240	19921	85%	16933
NA3	LHR	2	139	234	32574	85%	27688
NA3	LHR	3	368	270	99522	85%	35102
NA3	LHR	4	5	280	1398	85%	1188
NA3	LHR	5	84	293	24672	85%	17910
Totaal NA3			681		178132		98861

In the fourth step of the model airline responses are applied.

Seeding the airline responses

Airline response 1 under the Assessment of Need scenario assumes hub-carrier growth at Heathrow. The adjustments made for the US North-East region would be to assign some of the airline group 5 frequencies to Oneworld. In this case we would reduce airline group 5's frequencies back to 70, its level in the constrained case. Now all additional slot capacity at Heathrow is assigned to Oneworld.

As aircraft sizes differ for the various airline groups and total seat capacity remains unchanged for the airline responses, the total frequency might change. This leads to a change in welfare effects attributed to connectivity. Changes in market shares lead to a change in competition level.

Dividing welfare effects into connectivity, competition and scarcity components

In the third step we have determined a welfare effect of $-53 for the constrained scenario with respect to the unconstrained scenario. In a similar way we can determine that the welfare effect of the LHR expansion after incorporating the airline response equals $33. In this last step we divide this effect over a connectivity, competition and scarcity component.

Frequency:

After the airline response scenario is applied, the frequency in the LHR expansion scenario equals 683 flights per week. A 20% increase with respect to the frequency of 569 flights in the constrained case. The generalised cost change caused by this frequency increase can ΔGC_{freq} be calculated by:

$$\Delta GC_{freq} = -\ln\left(\frac{f_{expansion}}{f_{restr}}\right)/\alpha$$

$$\Delta GC_{freq} = -\frac{\ln\left(\frac{683}{569}\right)}{-0.015} = 12.16$$

Competition:

The competition level is determined by the HHI (sum of squared market shares). The HHI is an input variable in the Netcost fare model. The fare increase attributed by the model to an absolute HHI increase of 0.1 equals 0.0301%. Hence more market concentration yields a cost increase.

In the North-East US example the HHI changes from 0.31 to 0.30:

carrier	**1**	**2**	**3**	**4**	**5**
MS restr	16%	25%	39%	1%	19%
MS expansion	17%	28%	36%	1%	18%

As we can observe the competition effect is very small. The corresponding welfare effect resulting from the competition increase equals $1.00 per passenger.

Scarcity:

The remaining welfare effect can be attributed to scarcity. In this case, this equals $32.61 - $12.16 – $1.00 = $19.45

Price elasticity

In this study two price elasticity values are used, one for O&D passengers and one for transfer passengers. The values used are:

- O&D passengers: -1
- Transfer passengers: -3

These values were derived from various literature studies and earlier SEO studies. InterVistas finds values between -0.48 and -1.23 on a national level in a price elasticity study prepared for IATA[15]. Elasticities on intra-European routes as well as trans-Atlantic routes tend to be relatively high. These routes contain the majority of traffic from London airports.

Transfer passengers are more price elastic than O&D passengers (CPB 2011; Oum et al. 1993). For most transfer routes many alternatives via other hubs are available, which are close substitutes. Particularly for London there is fierce competition between transfer airports. More than 80 percent of the routes served via London is also served via another hub airport.

Annex B. Carrier and Route Categorisation

	Carrier group	Carrier group Name
Full service carriers	1	SkyTeam
	2	STAR
	3	oneworld
	4	independent full-service carriers
	5	Virgin Atlantic
	6	Regional carriers/full service PtP
Point-to-point	7	EasyJet
	8	Ryanair
	9	Norwegian
	10	Vueling
	11	other Point-to-point (Low-cost)
Leisure	12	leisure carriers

15 InterVistas (2007) - Estimating Air Travel Demand Elasticities

Continent	Region code	Region name	Region SPASM						
Europe	EU1	**UK/Ireland**	---	UK	Ireland				
	EU2	**Scandinavia**	516	Norway	Sweden	Finland	Denmark	Iceland	Faroes
	EU3	**North-West Europe**	---	Germany	Netherlands	Belgium	Luxembourg	Switzerland	Austria
	EU4	**France/Italy**	---	France	Italy				
	EU5	**Iberian peninsula**	514	Spain	Portugal				
	EU6	**South-East Europe**	---	Former Yugoslavia	Albania	Bulgaria	Greece	Romania	Turkey
	EU7	**North-East Europe**	518	Czech Rep.	Slovakia	Poland	Lithuania	Latvia	Estonia
				Hungary					
	EU8	**CIS**	518	Belarus	Ukraine	Moldova	Russia	Georgia	Armenia
				Turkmenistan	Uzbekistan	Tajikistan	Kyrgyzstan	Kazakhstan	Russia
				Azerbaijan					
Asia	AS1	**Middle-East**	523	UAE	Bahrain	Qatar	Oman	Yemen	Saudi Arabia
				Jordan	Lebanon	Kuwait	Syria	Iraq	Iran
				Israel	Afghanistan	Pakistan			
	AS2	**India**	524	India	Sri Lanka	Maldives			
	AS3	**China**	525	China	Mongolia	Nepal	Bhutan	Taiwan	Hong Kong
	AS4	**Korea/Japan**	525	North-Korea	South-Korea	Japan			
	AS5	**South-East Asia**	525	Bangladesh	Myanmar	Cambodia	Laos	Vietnam	Thailand
	AS6	**Australia/New Zealand**	526	Australia	New Zealand				
Africa	AF1	**North-Africa**	515	Morocco	Algeria	Libya	Tunesia		
	AF2	**East-Africa**	520	Egypt	Sudan	Eritrea	Ethiopia	Somalia	Kenya
				Burundi	CAR	Congo	Tanzania	Uganda	Rwanda
	AF3	**South-Africa**	521	Mozambique	Zimbabwe	Botswana	Namibia	S. Africa	Madagascar
				Angola	Zambia				
	AF4	**West-Africa**	519	Gabon	Cameroon	Nigeria	Benin	Togo	Niger
				Ivory Coast	Liberia	S. Leone	Guinea	Gambia	Senegal
				Burkina Faso	Ghana	C. Verde			
North-America	NA1	**East-Canada**	503	NS	NB	NL	QC	ON	
	NA2	**West-Canada**	502	BC	AL	SK	MB	YT	NT
	NA3	**USA-northeast**	513	Maine	Viriginia	Missouri	Minnesota		
	NA4	**USA-southeast**	513	N. Carolina	Florida	Texas			
	NA5	**USA-northwest**	512	Washington	Oregon	Colorado			
	NA6	**USA-southwest**	512	California	New Mexico				
Middle-America	MA1	**Middle-America**	522	Mexico	Panama				
	MA2	**Carribean**	522						
Latin-America	LA1	**Latin-America**	522	Peru	Ecuador	Colombia	Venezuela	Guyana	
			522	Argentina	Uruguay	Paraguay	Chile	Bolivia	Brazil

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International Transport Forum

Impacts of Expanding Airport Capacity on Competition and Connectivity

The case of Gatwick and Heathrow

The Airports Commission was set up by the Government of the United Kingdom in 2012 to take an independent look at the UK's future airport capacity needs. It has been tasked with setting out the nature, scale, and timing of steps needed to maintain the UK's status as an international hub for aviation, alongside recommendations for making better use of the UK's existing runway capacity by the end of 2013 and setting out recommendations on how to meet any need for additional airport capacity in the longer term by the summer of 2015.

In December 2013 the Commission published its Interim Report, which included a shortlist of three options for increasing the UK's aviation capacity in the long term: two at Heathrow and one at Gatwick. To determine which alternative would provide the largest benefits to passengers, freight businesses and the UK economy overall it is important to understand how airlines are likely to respond to increased runway capacity.

This report summarises a quantitative analysis of the likely responses from airlines in all segments of the market building on a companion report that identifies the main drivers of airline behaviour and considers the possible influence of changes to existing business models and the introduction of new types of aircraft, such as the Boeing Dreamliner and Airbus A350.

Four sets of airline responses are modelled, two following expansion of Gatwick and two following expansion of Heathrow, to test outcomes under a range of scenarios for the overall development of the global aviation market. The analysis quantifies impacts on connectivity and potential benefits to the consumer through airline competition and relieving congestion at airports and reducing the associated economic rents.

This report is part of the International Transport Forum's Country-Specific Policy Analysis (CSPA) series. These are topical studies on specific transport policy issues of concern to a country carried out by ITF on request.

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