



Economy: Wider Economic Impacts Assessment

July 2015

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

Web: www.gov.uk/government/organisations/airports-commission

Email: airports.enquiries@airports.gsi.gov.uk

© Crown copyright 2015, except where otherwise stated

Copyright in the typographical arrangement rests with the Crown.

You may re-use this information (not including logos or third-party material) free of charge in any format or medium, under the terms of the Open Government Licence. To view this licence, visit www.nationalarchives.gov.uk/doc/open-government-licence/ or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or e-mail: psi@nationalarchives.gsi.gov.uk.

Where we have identified any third-party copyright information you will need to obtain permission from the copyright holders concerned.

ISBN: 978-1-84864-161-7

Contents

1. Introduction	2
2. Background	4
3. Methodology	10
Increased productivity through trade	11
Increased productivity through creating strengthening agglomerations and clusters	13
Tax revenue resulting from more productive jobs	19
Increased output in imperfectly competitive markets	19
4. Analysis of Results	21
Assessment of Need	23
Sensitivity testing scheme performance under the alternative demand scenarios	30
Gatwick: Gatwick Airport Second Runway	30
Heathrow: Heathrow Airport Northwest Runway & Heathrow Airport	
Extended Northern Runway	33
Carbon-capped analysis	37
Demand reduction approach	38
5. Conclusions	42

1. Introduction

- 1.1** In order to assess the economic impacts of each of its shortlisted schemes, the Commission has undertaken a thorough and broad assessment, ranging from empirical analysis using econometric techniques of partial and general equilibrium modelling and an extensive literature review. This report details the new analysis that was undertaken in response to consultation, to consider the wider economic impacts of airport expansion from a welfare perspective.
- 1.2** The Commission’s consultation¹ included an assessment of the welfare impacts using a ‘bottom-up’ approach looking at the direct impacts on passengers, producers, government and other users. This approach was consistent with current guidance outlined in DfT’s WebTAG² and the HM Treasury Green Book³. The welfare assessment for the consultation only monetised the direct impacts on the passengers and users, leaving the economic impacts on the wider economy non-monetised.
- 1.3** In order to consider wider economic impacts, the Commission undertook a new approach to monetise these using a Spatial Computable General Equilibrium (S-CGE) model. This approach considered the impact from a gross domestic product (GDP), gross value added (GVA) perspective at a macroeconomic level and could not, as a result, be considered additional to the direct welfare passenger and user benefits mentioned above (See – Strategic Fit: GVA/GDP Report⁴).
- 1.4** Following consultation, the Commission has completed a monetised assessment of the wider economic benefits from a welfare perspective. This has allowed the Commission to estimate the overall welfare impacts associated with expansion for each of the three shortlisted schemes. This now forms the basis on which the Economic Case has been monetised. The work was built upon a literature review completed by Steer Davies Gleave (SDG) that was published in the *Interim Report*. The S-CGE GDP/GVA work has subsequently now been presented in the Strategic

1 The primary aim of the consultation was to test the evidence base the Commission has assembled, understand stakeholders’ views as to the accuracy, relevance and breadth of the assignments it has undertaken and seek views on the potential conclusions that might be drawn from them. The consultation received and analysed around 72,000 submissions from airport operations, airlines, industry bodies, local councils, environmental and other pressure groups and private individuals.

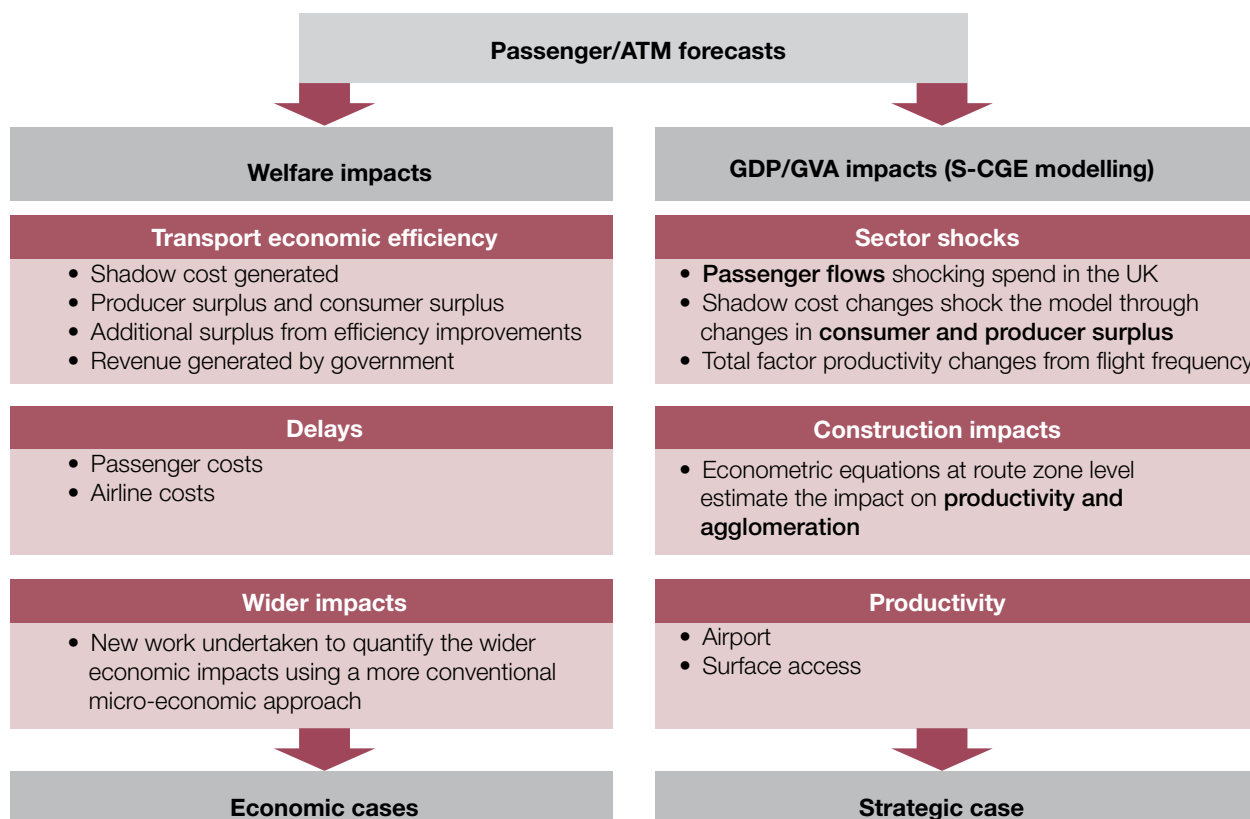
2 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275125/webtag-tag-unit-a1-1-cost-benefit-analysis.pdf

3 <https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government>

4 Strategic Fit: GVA/GDP Report

Case⁵. **Figure 1** demonstrates how the economic impacts feed through into the Economic and Strategic Cases, and highlights how the two approaches can be thought of e.g. welfare base impacts and GDP/GVA impacts.

Figure 1: Overview of economic impacts in the Strategic and Economic Cases⁶



1.5 This document sets out a summary of the analysis, methods and conclusions of the Wider Economic Impact work the Commission has undertaken since consultation. The assessment has used concepts, and methodology where possible, from the Department for Transport's (DfT) Web-based Transport Appraisal Guidance (WebTAG) but due to the nature of the impacts identified, such as the international nature of aviation, it has built upon these analyses with new approaches that are highlighted where used.

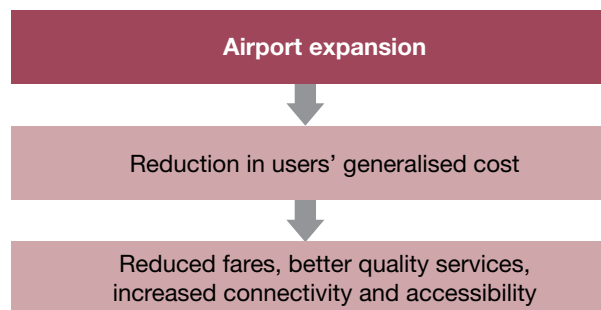
5 The full report is available within the *Business and Sustainability Assessment* on the Airports Commission website

6 The full report is available within the *Business and Sustainability Assessment* on the Airports Commission website

2. Background

- 2.1** A standard aviation transport appraisal considers the impacts of a scheme or policy on users, providers and government revenue. The Commission’s assessment uses a welfare approach that draws upon concepts from the DfT’s WebTAG.
- 2.2** As shown in **Figure 2**, the investment in airport expansion has direct impacts on passengers and other users of aviation, and on those who provide such services (e.g. airlines) and government revenue. The direct impacts from the airport expansion are seen to feed through via a decrease in the users’ generalised cost of air travel. The change in generalised cost of air travel could be interpreted in a number of ways, though most commonly it is considered as a removal of scarcity rents charged by the provider or alternatively as an increase in quality or accessibility of air travel.
- 2.3** The change in the generalised costs flows through to existing airport users via a transfer of surplus from producers; new airport users are now able to access their preferred airport; and through wider efficiency gains in the system.

Figure 2: Economic impacts of airport expansion



- 2.4** These impacts are considered in more detail in the *Economy: Transport Economic Efficiency Impacts*⁷ (2015).
- 2.5** The literature review undertaken by SDG⁸ for the Commission demonstrated that there could be significant further benefits, beyond those captured in the direct benefits, that investment in airport capacity can have on the wider economy. The DfT’s WebTAG also recognises wider economic impacts in WebTAG Unit 3.5.14 (and WebTAG unit A2.1) commonly associated with transport investment, which

7 Transport economic efficiency impacts Updated Economy:

<https://www.gov.uk/government/publications/additional-airport-capacity-economy-impact-analysis>

8 SDG literature review – <https://www.gov.uk/government/publications/airports-commission-interim-report>

they characterise under the following three headings⁹ with the following quoted definitions:

1 Agglomeration & clustering

The term “agglomeration” refers to the concentration of economic activity over an area. Agglomeration impacts arise because firms derive productivity benefits from being close to one another and from being located in large labour markets.

Greater productivity in agglomerations arises from the fact that firms have access to larger product, input and labour markets. Knowledge and technology spillovers are also important aspects of agglomeration effects.

Transport can alter the accessibility of firms in an area to other firms and workers, thereby affecting the level of agglomeration. Indeed, the introduction of an airport and associated connectivity (for example, through long-haul flights) would fundamentally change the ability of businesses to connect globally with countries such as China.

2 Output change in imperfectly competitive markets

A reduction in transport costs (to business and/or freight) allows firms to profitably increase output of the goods or services that require use of transport in their production.

A transport intervention that leads to increased output of goods and services will deliver a welfare gain as consumers’ willingness to pay for the increased output will exceed the cost of producing it.

3 Tax revenues arising from labour market impacts (labour supply impacts and the movement of labour to more or less productive jobs)

Changes in transport provision and costs can affect labour market decisions. Two main types of labour market impacts have been identified. These are referred to as “labour supply” impacts, and “moves to more or less productive jobs” impacts.

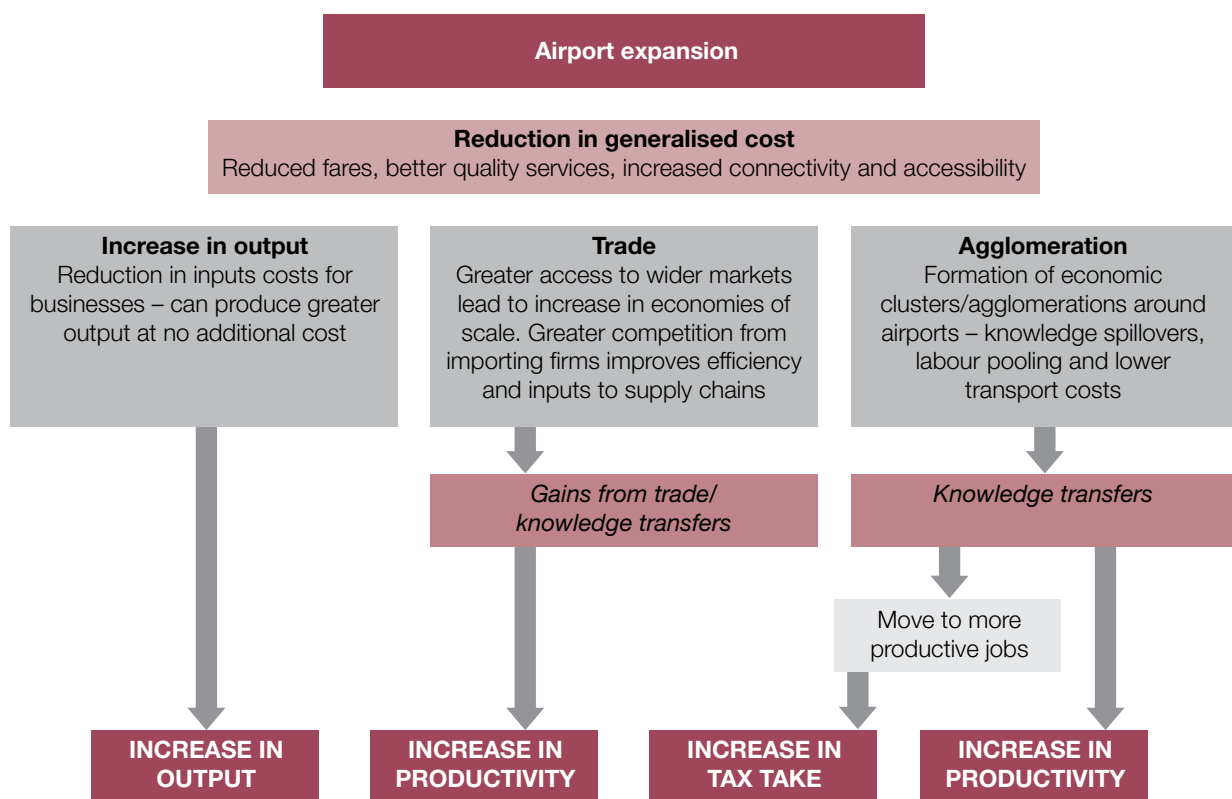
The labour supply impact is essentially computed by looking at how the estimated change in transport costs affects the incentives for an individual to work, therefore affecting the overall level of labour supplied, the additional value added to the economy and the resulting tax revenue to the government.

9 WebTAG Wider Impacts Tag Unit A2.1 (and Tag Unit 3.5.14) – http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/427091/webtag-tag-unit-a2-1-wider-impacts.pdf

As well as affecting incentives to supply labour, transport costs are likely to affect the overall costs and benefits to an individual from working in different locations and the benefits to business of operating and employing people in different locations. This demonstrates the move to more or less productive jobs.

2.6 WebTAG considers wider economic impacts from a broader transport perspective and therefore its methodology and range of impacts are not always appropriate to use in the context of aviation. As a result of this, the Commission has developed its own framework for aviation, based upon concepts in WebTAG and the wider literature in order to analyse the wider economic impacts, as detailed in **Figure 3**.

Figure 3: Economic impacts of airport expansion



2.7 **Figure 3** demonstrates how the impact of airport expansion flows through the chain of impacts to reach the outputs of increased productivity and output and a higher tax take. These steps are detailed below and highlight how WebTAG concepts have been modified to be applied in an aviation concept.

2.8 **Agglomeration** – the increase in connectivity and lower generalised costs benefit businesses connected to the airport. The increase in connectivity can translate to a larger number of destinations or a greater number of flights to current destinations which allow a greater opportunity for business to access connections abroad, while the lower generalised costs reduce the costs for these businesses to get to these

connections. As a result, these businesses connected with the airport will move closer to the airport to enjoy these benefits, along with stimulating opportunities for businesses already operating around the airport. These opportunities attract firms in similar industries to locate around the airports and encourages their supply chains and skilled labour to do so. These movements result in economic clusters forming around airports resulting in knowledge and technology transfers and thereby, an increase in productivity.

- 2.9 Increase in tax from productive labour** – firms become more productive as a result of the benefits of agglomeration with knowledge transfer, labour pooling and lower transport costs due to proximity. As a result, they attract more labour, who seek jobs in line with their skills. Workers anticipate higher wages in return for their higher marginal productivity. Higher wages generate government revenue from the increased income tax.
- 2.10 Increase in output in imperfectly competitive markets** – in the Commission’s direct benefit appraisal, it is assumed that markets are perfectly competitive and the cost of production equals the price. It is more likely that some firms operate in an imperfectly competitive market. With airport expansion, there is a fall in the cost of production due to lower transport costs. This allows the cost per unit to fall and firms are able to increase production and reduce the price they offer to consumers while still keeping their profit margins. Research into price-cost margins suggests a 10% additional business output benefit on the business output benefits captured in traditional appraisal¹⁰.
- 2.11 The increase in international trade** brought about by an increase in aviation connectivity is considered to have a significant productivity impact that is not included in WebTAG. As stated previously, aviation schemes provide international connectivity that would not be encompassed in standard transport analysis as it isn’t usually applicable to standard transport schemes.
- 2.12** Research (Frankel & Romer (1999), Alcalá & Ciccone (2004), Wagner (2012), and Smeets & Warzynski (2011))¹¹ suggests that improvements in aviation connectivity between countries encourages more trade between those countries.
- **Imports** – it is often assumed that imports would be thought of as a negative impact as it is considered to be foreign firms benefiting rather than domestic. Imports, however, demonstrate gains from trade through channels such as

10 WebTAG guidance – <http://webarchive.nationalarchives.gov.uk/20110503194640/http://www.dft.gov.uk/pgr/economics/rdg/webia/webmethodology/>

11 More details in the SDG literature review are available here – <https://www.gov.uk/government/publications/airports-commission-interim-report> Economics analysis: Consultants reports

generating knowledge transfers and access to technology where these firms would bring new practises and skills to the UK, that could allow firms to become more productive through these technological advances. Imports from other countries that increase competition in the market could also increase productivity, however it could potentially see the removal of inefficient firms from the market too. UK supply chains gain access to a larger range of inputs potentially at a lower input costs due to a more efficient use of resources and hence productivity. Finally, productivity gains could also feed through from increased variety and quality of goods and services.

- **Exports** – gains from trade for exports feed through with increased access to new markets, which become available with the increased connectivity from airport expansion. This allows firms greater access to a larger number of markets providing the potential to enjoy greater economies of scale¹². Exports have big multiplier effects, as a result of knowledge transfers feeding through to the occurrence of knowledge based industries with specialisation, producing higher value goods and attracting skilled workers and, importantly, firms enjoying access to higher value markets.

2.13 The SDG literature review also found there to be impacts of aviation on migration, tourism and foreign direct investment (FDI). The Commission found, however, that these were difficult to isolate or were potentially insignificant, as detailed below. The Commission has only included impacts that it feels are additional, but exclusion of these impacts can potentially result in an underestimate of the wider economic benefits as these impacts are still channels through which benefit could be gained.

- Migration is not included in the model as research from the SDG literature review has shown there are a considerable number of push (e.g. political decisions at home) and pull factors (e.g. relatively better economic conditions in the new destination)¹³, which are difficult to isolate from aviation connectivity. While distance instinctively would seem to affect migration, other links have greater impacts¹⁴. In order to test this, as part of the evidence published for the *Interim Report*¹⁵, the Commission conducted its own econometric analysis, and when controlling for other factors, found the migration variable to be insignificant. As a result of no strong evidence, the Commission has excluded it from its analysis.

12 Economies of scale is the concept of a larger market increases production which reduces per unit cost.

13 Lee (1966) "A theory of migration" Demography 3.1

14 Bijak, Kupiszewski & Kicinger (2004), "International Migration Scenarios for 27 European Countries, 2002-2052", CDFMR. Schwartz (1973), "Interpreting the effect of distance on migration" The Journal of Political Economy.

15 PwC Econometrics – <https://www.gov.uk/government/publications/airports-commission-interim-report>

- Tourism – the SDG literature review demonstrated that tourism impacts were considered to have an impact on the economy through aviation¹⁶, because of the inbound and outbound split. However, the net effect of tourism on the economy is predicted to be relatively small, particularly in a partial equilibrium context, where second and third round effects are not estimated. For the purposes for this approach we have assumed that the tourism sector can be considered to be relatively competitive and unlikely to be subject to large productivity or agglomeration impacts. The impact of inbound and outbound passenger spend has been considered from a macroeconomic GDP/GVA perspective in the S-CGE modelling, which considers a more dynamic movement of labour across sectors and supply chains. The S-CGE modelling considered inbound and outbound splits¹⁷ and found that in many cases there were net positive impacts, and therefore not including tourism could represent an underestimate of the wider economic benefits estimated as part of this study.
- FDI, while considered to have a significant impact, was difficult to include for two main reasons. Firstly, there were input issues with very peaky FDI data, such that it created an unbalanced picture and as a consequence was difficult to find a statistically robust time series result to estimate the relationship between seat capacity, passenger numbers and FDI. Secondly, the FDI impacts would be difficult to separate from the other effects and could risk double counting benefits. By including trade, the model has taken account of the additional knowledge transfer brought about from the greater access to international markets. This concept would technically apply in increasing FDI, and perhaps to a larger extent due to the longer-term nature of FDI investment compared to trade. Increased investment into firms may also cause additional feed through effects that would be difficult to isolate, particularly from trade. For example, if a firm decided to invest in a local production facility, this would increase trade but it would be captured twice through the increase in trade and the FDI flows. The Commission has therefore chosen to exclude FDI and thus the impacts of international connectivity capture are likely to be an underestimate.

16 Forsyth, P (2006). "Estimating the costs and benefits of regional airport subsidies: A computable general equilibrium approach." German Aviation Research Society Workshop, Amsterdam

17 Further details of this impact can be found in the consultation PwC *Wider Economic Impacts report*

3. Methodology

3.1 The following sections are intended to demonstrate how the impacts outlined above have been calculated. In order to gauge these impacts, the Commission has drawn on literature reviews and concepts from traditional appraisal methods to focus on:

- increasing productivity through trade;
- increasing productivity through the formation of agglomerations and strengthening existing agglomerations;
- impact on government’s tax revenue from people moving to higher paid jobs; and
- increasing output by exposing domestic firms to more competition.

3.2 The methodology used to estimate these impacts is conceptually based on the wider economic impacts guidance in WebTAG but, as stated previously, it has been adapted to be suitable for the aviation context. It also includes further impacts highlighted by SDG, who estimated the wider economic impacts of having a constrained airport system¹⁸.

3.3 As per standard Green Book guidance and consistent with other parts of the economic case, all impacts have been calculated against the do minimum for a 60 year appraisal period from the start of the scheme – which is 2025 for Gatwick and 2026 for both Heathrow schemes. In addition, impacts have been discounted using Green Book discount rates of 3.5% for the first 30 years and 3.0% for the following years.

3.4 In order to ensure uniformity with the data from the WebTAG wider impacts dataset¹⁹ and other areas of appraisal, all impacts have been calculated for 2020, 2030, 2040 and 2050 and interpolated for the years in between. The effects are assumed to remain flat each year after 2050.

18 Wider economic impacts – Research Final –
<http://www.gov.uk/government/publications/airports-commission-interim-report>

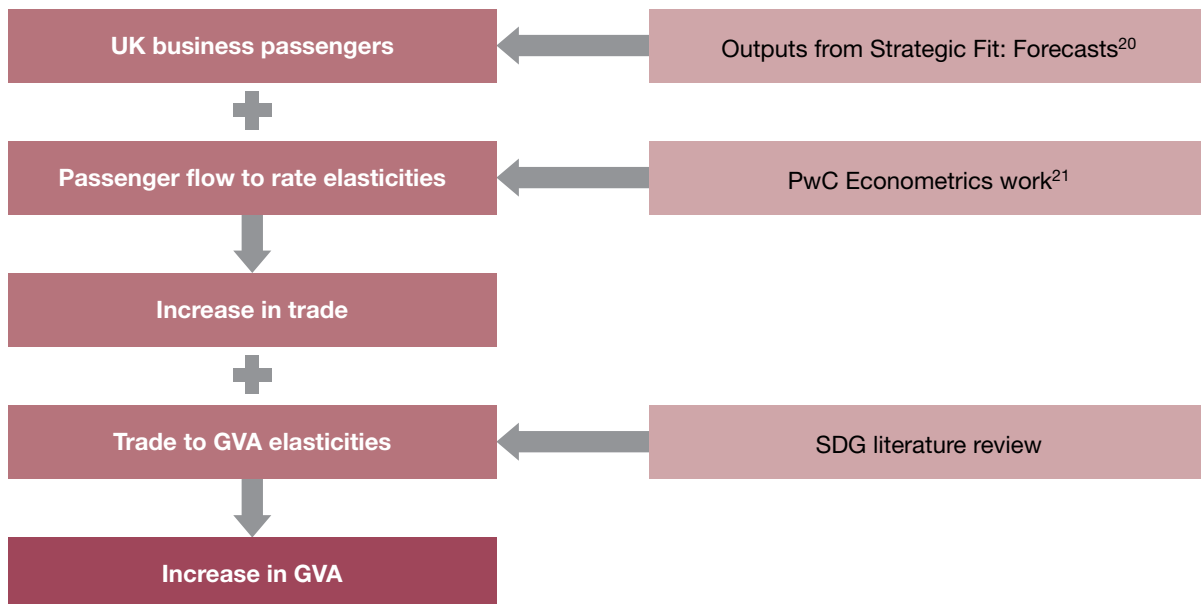
19 Wider economic dataset –
<https://www.gov.uk/government/publications/webtag-economic-impacts-worksheets>

Increased productivity through trade

3.5 Standard WebTAG guidance is predominantly designed for domestic road and rail schemes, and doesn't include international impacts. But airport expansion provides increased connectivity in the form of better access to foreign markets and thus drives and facilitates trade between the UK and the rest of the world. Exports to other countries encourage knowledge and technology transfers from international firms and also allows British firms to exploit economies of scale by selling to larger international markets. In addition to the knowledge transfers, imports from other countries also increase the level of competition in the market, on the one hand possibly leading to the loss of inefficient firms, but on the other leading to more efficient use of resources and access to a large range of inputs to UK supply chains, further improving efficiency. Other gains from an increase in trade could also feed through in terms of productivity gains from increased variety and quality of goods and services. These effects result in an increase in the overall level of productivity in trade-related sectors of the economy, which has been captured in the trade impacts as highlighted previously.

The methodology used to capture the trade benefits is represented in **Figure 4** below²⁰.

Figure 4: Flow of trade benefits in this modelling



20 Strategic Fit: Forecasts – <https://www.gov.uk/government/publications/additional-airport-capacity-strategic-fit-analysis>

- 3.6** In order to calculate the increase in productivity from trade, outputs of the Airports Commission’s version of DfT’s National Air Passenger Allocation Model (NAPAM)²¹ is used to get the total number of business passengers to each global destination from all UK airports, in the do minimum without expansion and the do something with expansion cases. These outputs available for 48 destinations in the DfT Aviation model are aggregated up to 24 global destinations in order to match the publicly-available trade data. This approach is different to WebTAG in that productivity impacts are typically fed through from a change in generalised costs rather than a change in passenger numbers.
- 3.7** The model has used the elasticities estimated by PwC in their econometrics²² work (*Econometric analysis to develop evidence on the links between aviation and the economy*), which are modelled to see the impact of increased passenger flow on the imports and exports of goods and services between groups of countries. These elasticities are split by world regions – Europe, North America, Asia and others, as shown in **Table 1**.

Table 1: Trade Elasticities by world region

Trade elasticities	Asia	Europe	North America	Others
Exports of goods	0.293	0.256	0.237	0.269
Export of services	0.297	0.248	0.257	0.293
Import of goods	-0.006	0.034	-0.078	-0.071
Import of services	0.000	0.000	0.000	0.000

- 3.8** Applying the elasticities to the additional business passengers in the do something expansion option, the model has estimated the effects of expansion on trade over the baseline 2011 trade data published by the Organisation for Economic Cooperation and Development (OECD)²³ on goods and by the Office for National Statistics (ONS)²⁴ on services.
- 3.9** It is worth noting that these elasticities are based on all passengers, and they have been applied to estimate the impacts of business passengers alone. However, literature suggests that the greatest impact of air connectivity on trade is through business passengers. It is therefore expected that the coefficients would be

21 PwC Econometrics analysis – Economic analysis:
<https://www.gov.uk/government/publications/airports-commission-interim-report>

22 ibid

23 OECD data: https://stats.oecd.org/Index.aspx?DataSetCode=BTDIXE_I4

24 ONS data: <http://www.ons.gov.uk/ons/search/index.html?newquery=%22International+Trade+in+Services+Reference+Tables%2C+2011%22>

somewhat higher when the relationships are estimated with business passengers alone. Hence, the trade impacts are potentially an underestimate.

- 3.10** Finally, in order to capture the effects of any change in trade on productivity, the elasticity of 0.1 has been used for consumer services, manufacturing and producer services found in the literature for the impacts of trade on GVA feeding through from productivity increase. The elasticity used is middle of the range of elasticity of 5% found in Frankel and Romer (1999)²⁵ and 12% found in Alcalá and Ciccone (2004)²⁶. These elasticities are applied to the GVA of the trading sectors of the economy to estimate the additional impact of airport expansion through increases in the number of business passengers and their effect on trade, on the GVA of the trading sectors.

Increased productivity through creating strengthening agglomerations and clusters

- 3.11** The change in connectivity offered by airport expansion attracts businesses, which benefit from the better international links as well as their supply chains to cluster around the airports. This leads to the creation of agglomerations around the airports, leading to productivity increases in these sectors through knowledge and technology spillovers as well as access to larger input markets and labour markets. These changes in productivity have been captured in the agglomeration effects.
- 3.12** The methodology used to estimate the increase in productivity through agglomeration around airports is slightly different for the largest ten UK airports²⁷ and all other 22 airports in the UK, due to the high sensitivity of the forecasts available for the other airports.
- 3.13** For the largest ten UK airports, the Commission has defined the ‘catchment areas’ around them as local authorities (LAs) within a 45 minutes total travel time to the airport by rail or road (taking the travel time from the centre point of each authority), where the effects are largely expected to be felt, as shown in **Figure 5**. These travel times are derived from the same dataset as the DfT Aviation model²⁸. The 45 minutes travel zone was chosen as the average commute time to the airport²⁹, while also minimising the overlap of catchment areas between different airports (especially London airports) which could have led to double-counting benefits.

25 Alcalá et al (2004), “Trade and Productivity”, The Quarterly Journal of Economics 119.2.

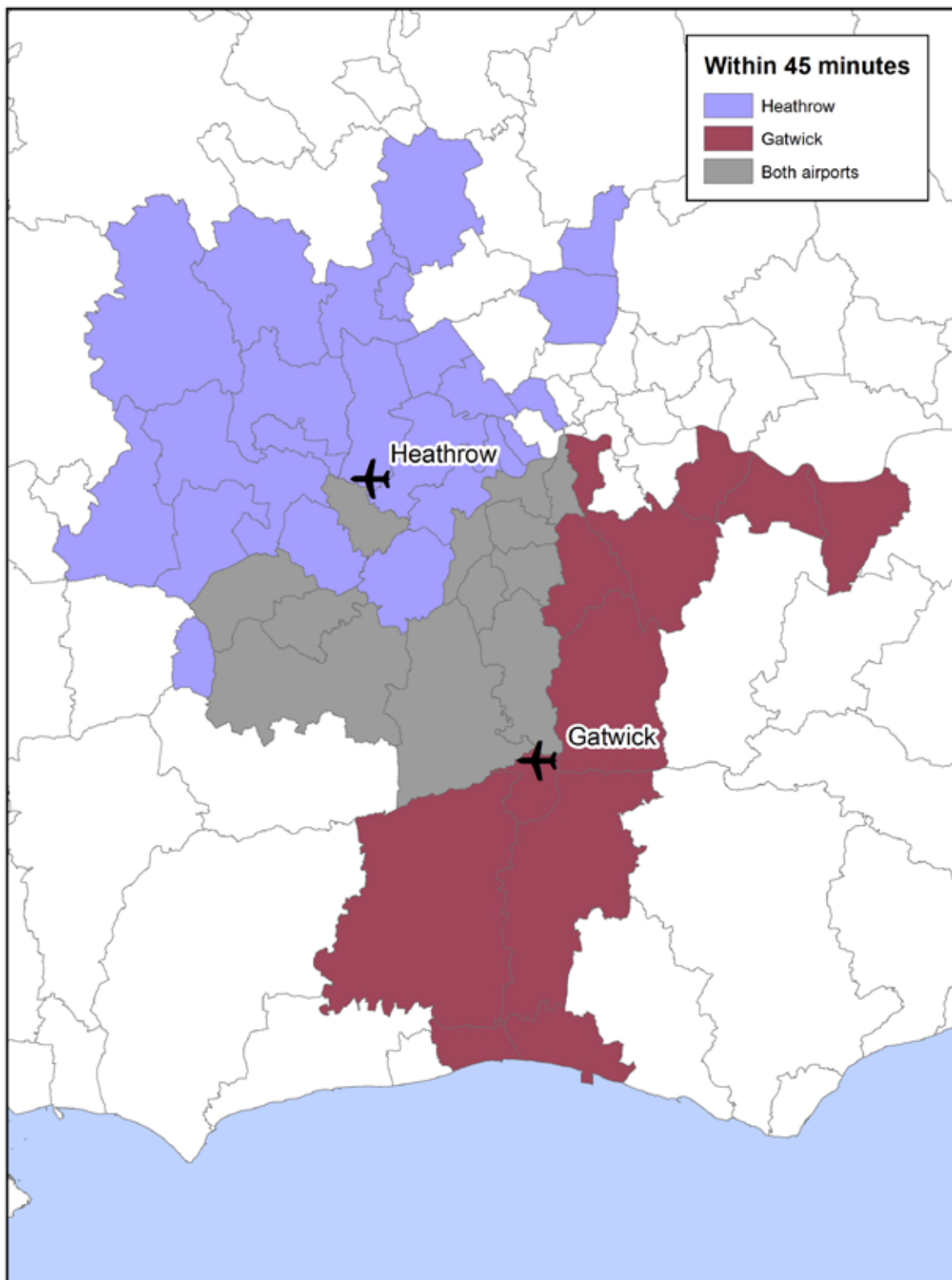
26 Frankel and Romer (1999), “Does trade cause growth?” American Economic Review.

27 These comprise Heathrow, Gatwick, Manchester, Stansted, Luton, Edinburgh, Birmingham, Glasgow, Bristol and Liverpool.

28 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223839/aviation-forecasts.pdf

29 Average commute time was close to the South East average of 47 minutes, above the UK average of 41 minutes – Randstead Financial and Professional (2013).

Figure 5: Map of local authorities within a 45 minute catchment area for Heathrow and Gatwick Airports



© Crown Copyright and database rights 2015. Ordnance Survey Licence Number 100039241
Department for Transport gisu1516j030

Source: Ordnance Survey data and Department for Transport (2015)

3.14 One criticism that could be applied to the model is the rigidity of the catchment area. There is the possibility that in order to reduce the risk of overlapping the catchment areas of the London airports, the methodology has omitted important high end sectors such as the City of London that may significantly be affected by the expansion of either airport. The catchment areas may therefore miss the change in attractiveness of London for high end economic activity due to the expansion. As previously stated, however, a key aim of the Commission was to ensure that the impacts were completely additional and therefore overlapping catchments would have increased the risk of this occurring.

3.15 The definition of agglomeration effects are those that are driven by the change in effective density for the relevant sectors (consumer³⁰ and producer services³¹ in this case). It is a measure of the accessibility of an area to jobs in all the destination areas.

3.16 According to WebTAG³², the effective density in area j for sector s is:

$$\text{Effective density}_{j,s} = \frac{\text{Employment}_j}{(\text{Generalised cost}_j \text{ to } j)^{\text{Decay rate for } s}} + \frac{\text{Employment}_i}{(\text{Generalised cost}_j \text{ to } i)^{\text{Decay rate for } s}} + \dots$$

Where, j, i are the LAs; and s is a sector of the economy.

3.17 From the equation above, the effective density of each local authority (LA) changes because of the change in employment in the LAs, since the generalised costs for surface transport remain the same.

3.18 The generalised cost for travel between various LAs is sourced from the DfT Aviation Model and is based on the 2026 surface transport baseline, which includes all committed surface access schemes, including HS2 Phase 1. The decay rates used for the four sectors of the economy are from the WebTAG wider impacts guidance, and are shown in **Table 2**.

Table 2: Decay parameters

	Manufacturing	Construction	Consumer services	Producer services
Decay Parameters	1.097	1.562	1.818	1.746

Source: WebTAG unit 3.5.14

30 Consumer services are final outputs sold to the consumer e.g. retail.

31 Producer services are intermediate inputs to further production activities that are sold to other firms e.g. transport distribution.

32 WebTAG 3.5.14 – http://www.transportworks.org/sites/default/files/assets/evidence_base_documents/DfT%20WEBs%20Guidance%20-%20expert.pdf

3.19 The employment for each LA in the do minimum comes from the WebTAG wider impacts dataset³³. In order to estimate the change in employment from the expansion, the elasticity of 0.1 between change in passenger numbers and employment has been used. This elasticity is middle of the range found in Brueckner (2003), Percoco (2010) and Sheard (2012) who found that a 10% increase in passengers boarding at US airports leads to a 0.5%-1.5% increase in service employment. As such, only the producer services and consumer services sectors can be expected to be affected based on SDG’s literature review, as mentioned previously. The elasticities are applied to the forecast change in passenger numbers at each airport from the DfT Aviation Model to get the additional do something employment in the catchment area. Since these effects are calculated for the catchment area as a whole, these additional jobs are expected to be split between the LAs in the same proportion as they were in the do minimum. It is important to note that it is assumed that there is no net additional employment in the UK and that all these additional jobs in the do something are being displaced from outside the catchment area. The benefit is therefore derived from higher productivity, and higher paid jobs.

3.20 The elasticity used to calculate the movement of employment purely concentrates on the percentage increase in passengers and relates that to the change of employment, but did not highlight the type of passenger at each airport or the importance of the airport itself to the surrounding businesses. As a result of this, an additional measure was added to this change in employment in order to demonstrate the proportion of UK business passengers each airport accounted for in relation to the whole UK system. This proportion fluctuated to reflect the differences under different demand scenarios and under each scheme according to the passenger forecasts.

3.21 Using the employment and the previously stated decayed generalised costs, the change in effective densities between the do minimum and do something has been calculated for each LA for each sector. The agglomeration elasticities from WebTAG (shown in **Table 3** below) are then utilised in order to calculate the increase in productivity in the affected sectors due to the change in effective density at each LA. These agglomeration elasticities are based on the Centre for Transport Studies paper by Graham, Gibbons and Martin (2009)³⁴.

33 Wider Economics dataset –

<https://www.gov.uk/government/publications/webtag-economic-impacts-worksheets>

34 Graham et al (2009) “Transport Investment and the distance decay of agglomeration benefits” Report to the Department for Transport.

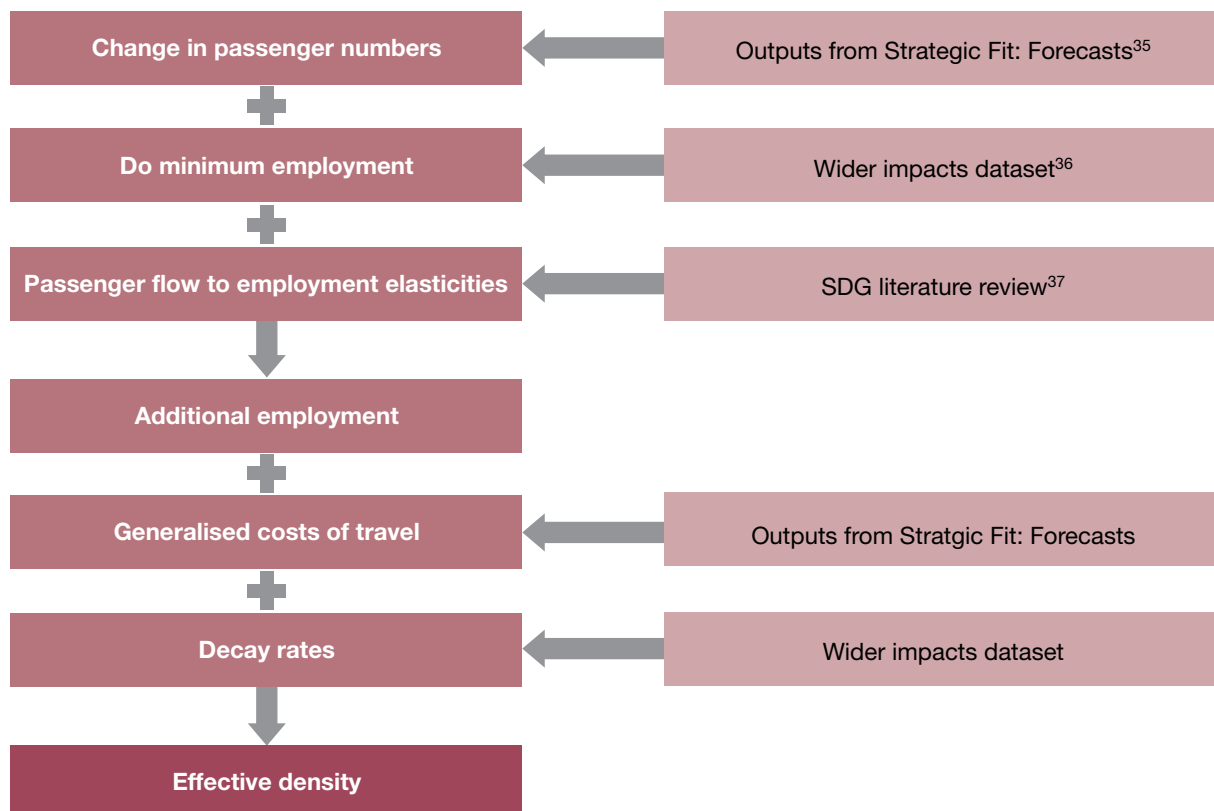
Table 3: Agglomeration elasticities

	Manufacturing	Construction	Consumer services	Producer services
Agglomeration Elasticity	0.021	0.034	0.024	0.083

3.22 The change in productivity is monetised using the GDP per worker in the sector in the LA, from the WebTAG wider impacts dataset.

3.23 The full methodology is demonstrated in **Figure 6**, where the flow through from the change in passenger numbers to the change in effective densities (agglomeration) is demonstrated

Figure 6: Flowchart depicting methodology for agglomeration benefits at the largest 10 UK airports



35 Wider Economic Impacts dataset https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/427091/webtag-tag-unit-a2-1-wider-impacts.pdf

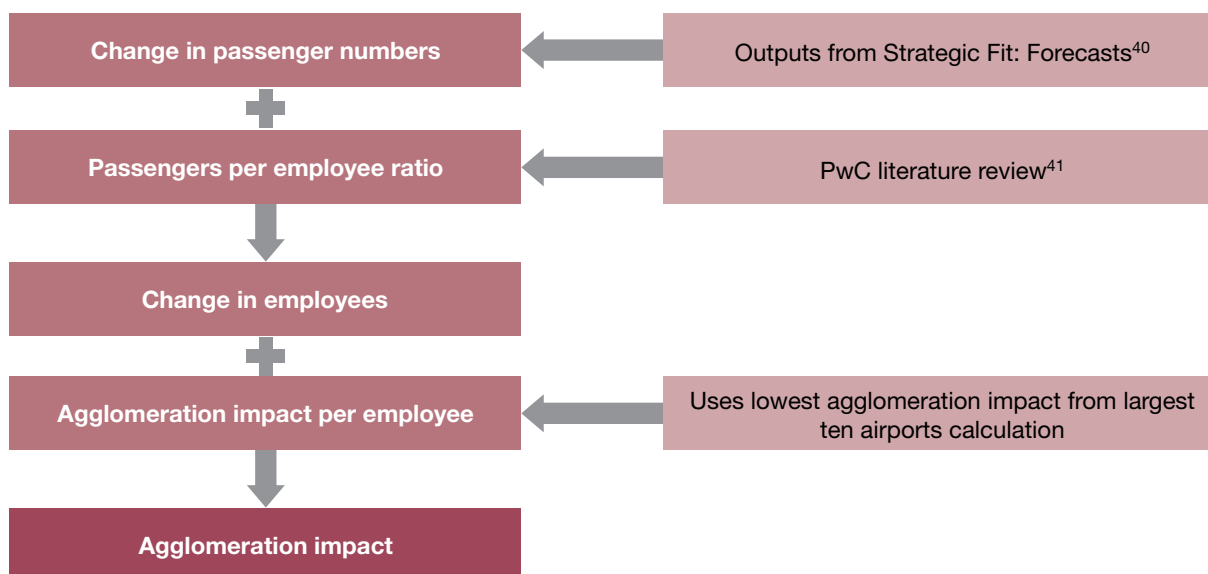
36 Strategic Fit: Forecasts https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223839/aviation-forecasts.pdf

37 Wider Economic Impacts dataset https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/427091/webtag-tag-unit-a2-1-wider-impacts.pdf

38 SDG literature review – interim report <https://www.gov.uk/government/publications/airports-commission-interim-report>

3.24 As stated previously, due to the sensitivity of the forecasts, those airports outside of the largest ten have been calculated using an alternative methodology (see **Figure 7**). The agglomeration impact per employee across all other UK airports has been assumed to be 80%³⁹ of the lowest agglomeration impact per employee within the catchment areas of the largest ten airports. This is used and applied to the total change in employees at the other airports to get the total agglomeration impact at these airports. The change in employees is calculated using the net change in passengers at all other UK airports and an average airport ratio of 1,200 passengers per employee sourced from the literature review conducted by PwC literature review for the AC’s National Consultation⁴⁰. This is potentially an overestimate as the main airports within the literature review were hub airports, which typically have a lower passenger to employee ratio.

Figure 7: Flowchart depicting methodology for agglomeration benefits at other UK airports



39 80% is considered a relatively high proportion, as the total business flights from those airports outside of the largest 10 airports account for approximately 10% of all business flights in the UK.

40 Local Economy PwC literature review: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/371811/3-local-economy--local-economy-literature-review.pdf

41 Strategic Fit: Forecasts
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223839/aviation-forecasts.pdf

42 ibid

Tax revenue resulting from more productive jobs

- 3.25** The changes in productivity arising from the agglomeration effects in particular sectors increases the returns to labour in these sectors and attracts some workers to move to better suited more productive jobs in the clusters surrounding the airports. The increase in productivity of the workers translates into higher wages in a competitive market and thereby increases the taxes paid by these workers. This is an additional wider economic impact that is not captured in the direct benefits to producers and consumers.
- 3.26** In order to estimate the tax impact on government from the move to more productive jobs, WebTAG methodology has been used. The employment in the catchment areas around each of the largest ten UK airports is taken from that calculated in the methodology used for the agglomeration impacts.
- 3.27** The employment in each catchment area has been multiplied with the relative productivity adjusted wages in the LAs around the airport from the Wider Impacts Dataset to get the total earnings in the area in the do minimum and the do something cases.
- 3.28** Since it has assumed no net additional employment, all the additional employment in the do something is assumed to come from outside the catchment areas. Thus, the expected earnings of these employees in the do minimum, assumed to be the average wage outside the catchment area for that sector, is netted off.
- 3.29** Assuming a 30% average tax rate, similar to WebTAG⁴³, the net additional tax paid in the do something by these employees is calculated to ascertain the additional tax take.

Increased output in imperfectly competitive markets

- 3.30** The expansion also results in a reduction in the cost of production for firms that use air transport as an input and thus allows them to profitably increase the level of output they produce. These benefits for firms that operate in perfectly competitive markets are captured in the direct benefits to business users. However, since the calculations for direct benefits assumes perfect competition, similar effects for firms in imperfectly competitive markets are missed out.

43 Wider Impacts Tag Unit A2.1 (2014) Pg.9 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/370532/webtag-tag-unit-a2-1-wider-impacts.pdf

3.31 Imperfect markets demonstrate where the firms are producing at a lower cost of production than the price the product is sold at. The reduction of the costs of inputs i.e. transportation costs for these firms, reduces their costs of production and therefore allows them to increase production for the same cost of inputs. In order to model this, these impacts are calculated to be 10% of direct UK business output benefits⁴⁴ from increased transport economic efficiency and reduced delays, as per WebTAG guidance. The 10% additional business output benefit is based on DfT research on price-cost margins and elasticity of demand.

44 WebTAG guidance based upon <http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/pgr/economics/rdg/webia/webmethodology/sportwidereconomicbenefi3137.pdf>

4. Analysis of Results

- 4.1** The results for each scheme are displayed in the sections below for imports, exports, agglomeration, tax revenue resulting from more productive jobs and business output benefits. All the figures quoted are £millions present value (PV) in 2014 prices unless stated otherwise.
- 4.2** The impacts of airport expansion were tested for five possible scenarios of future demand, which are outlined in **Table 4**. These demand scenarios compare forecasted passengers, and under a do minimum i.e. no expansion to forecasted passengers, and under a do something scenario i.e. expansion through one of the three schemes. The scenarios have been tested under a carbon-traded forecast, which 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 after 2030.

Table 4: Description of demand scenarios

Assessment of need (AoN)	This scenario is consistent with the forecasts underpinning the Commission’s assessment of need. Future demand is primarily determined by past trends and the central projections published by sources such as the Office for Budgetary Responsibility, OECD and IMF.
Global growth (GG)	This scenario sees higher global growth in demand for air travel in the future. It adopts higher passenger demand from all world regions, coupled with lower operating costs and assumes any actions to manage carbon emissions from aviation (see below) are taken at the global level.
Relative decline of Europe (RDE)	This scenario sees higher relative growth of passenger demand in emerging economies in the future compared to the growth in the developed world. It adopts higher passenger demand from newly industrialised and developing countries, a strengthened position of Far and Middle Eastern aviation hubs and airlines, and assumes any actions to manage carbon emissions from aviation are taken at the global level.

Low-Cost is king (LCK)	This scenario sees the low cost carriers strengthening their position in the short-haul market and capturing a substantial share of the long-haul market. As with global growth, it also sees higher passenger demand from all world regions, lower operating costs, and assumes any actions to manage carbon emissions from aviation are taken at the global level.
Global fragmentation (GF)	This scenario sees economies close themselves off by adopting more conditional and interventionist national policies. As a result, there is a decline in passenger demand from all world regions, coupled with higher operating costs and no global carbon agreement is reached, leading to the UK introducing unilateral measures on carbon emissions from aviation.

- 4.3** The *assessment of need* scenario has been reported as the starting point as it presents the middle of the range and is based upon verifiable historic relationships in the growth and allocation of demand and, in particular, its use of central projections of economic and population growth, oil prices and other drivers. The other scenarios are presented as sensitivities for low and high demand scenarios, compared to the appropriate do minimum baseline.
- 4.4** The Commission has also tested another carbon case in order to demonstrate the effects of keeping the level of aviation demand consistent with the Committee on Climate Change’s (CCC) current assessment of how UK climate change targets can be more effectively met. A demand reducing option has been used in this report, which is where demand is set to a level where overall UK aviation emissions with expansion would not exceed the CCC’s planning assumption of 37.5MtCO₂.
- 4.5** The passenger forecasts for each of these scenarios significantly impact the results and the assumptions in each of them are key to understanding the differences in the impacts between schemes. More details of these impacts are set out under the scheme results. A full detailed discussion of each impact has only been completed for *assessment of need* to avoid repetition of discussion of methodology. For the other scenarios, the differences have been highlighted for each scheme.
- 4.6** A further carbon case has also been considered, which uses a carbon policy approach where an indicative set of policies that could enable aviation emissions for each shortlisted scheme to be restricted to a level consistent with the planning assumption. The impacts of this approach are contained in a separate report published alongside this report, called *Economy: Carbon Policy Sensitivity Test*.

Assessment of Need

4.7 **Table 5** below demonstrates the results for each scheme under the *assessment of need* scenario in the carbon-traded case.

Table 5: Assessment of Need results, present value

Assessment of Need (£millions)	Imports	Exports	Net agglomeration	Tax Wedge	Business Output Benefits	Total
GAL	1,108	5,193	580	148	1,108	8,136
HAL	1,269	6,070	1,666	1,102	1,360	11,466
HUB	1,089	5,212	1,504	1,015	1,168	9,988

Source: Airports Commission analysis

Trade

4.8 Import and export benefits together demonstrate the gains from trade and are separated in the results in order to demonstrate the proportions they make up.

4.9 The export impacts for each scheme are the most significant impact for all schemes generating over £5 billion in benefits (PV, 2014 prices). Imports present a similarly important impact with around £1 billion per scheme (PV, 2014 prices).

4.10 Aside from physically facilitating trade through freight and connecting business passengers to their clients, aviation allows additional impacts through gains from trade along with the transfer of knowledge between markets. With airport expansion, exporters now have greater access to foreign markets, which allows greater economies of scale but also the ability to learn from foreign companies. Similarly importing companies, while generating increased competition and improving efficiency, provide knowledge of new techniques, skills etc. It is also significant to consider that trade may be one of many factors that increases connections. This being said, if other drivers are causing a greater number of connections, these additional connections could continue to open up trade routes resulting in the trade benefit regardless of whether it is the original driver.

4.11 It is important to establish that air freight is not included in this model, and this could present an underestimate for both schemes. Excluding air freight affects Heathrow Airport to a greater extent as it is the UK hub for air freight with 72%⁴⁵ of air freight by value being shipped through Heathrow Airport. This has the potential to cause an

45 HMRC – <https://www.uktradeinfo.com/Statistics/BuildYourOwnTables/Pages/Home.aspx>

underestimate in the trade impacts as belly-hold freight is an important facilitator of trade and could not be picked up in the model.

- 4.12** The trade destinations are heavily Europe-focused as these make up the largest proportion of destination regions for passengers in the DfT Aviation Model. With capacity constrained airports, short-haul routes are often the first to fall out of the system as the cost of constraint has been applied evenly to all aircraft, and this cost is a larger percentage of the fare than long-haul. Short-haul passengers are more sensitive to price changes and as a result fewer people are willing to pay the higher fares as these costs increase, resulting in short-haul being replaced by long-haul. Therefore, with reduced capacity constraints under expansion, an increase in flights to these short-haul destinations is seen, that were previously crowded out.
- 4.13** One area of consideration when assessing the trade interactions is that there are routes, which are well developed in terms of knowledge share. For example, the UK has a very established trading relationship with Europe and so is considered well integrated. However, long-haul routes to areas such as the Far East may be considered potential untapped markets in terms of ability to sell goods and services, expand into new markets, along with knowledge transfers. This could therefore be more valuable. When the trade impacts are considered, therefore, it is important to note that these high value long-haul flights take up a smaller proportion of the change in flights overall. This multiplier effect may not apply to the same extent with more established long-haul. As with flights from Europe, however, other gains from trade will remain present.

Gatwick

- 4.14** With a Gatwick Airport Second Runway scheme, the initial impact takes a long time to build up as passenger numbers take a longer time to increase at Gatwick Airport is less constrained prior to expansion. Similarly, the overall UK business passengers increase very slowly as the expansion at Gatwick Airport is predominantly used by leisure passengers. However, with overall passenger numbers increasing significantly by 2050, this generates substantial trade impacts. Gatwick Airport has a significant number of European flight routes, therefore the additional capacity increases passengers on these routes further, which in turn increases trade.
- 4.15** Although business passengers are increasing, the ability of flights to operate is substantially influenced by the leisure passengers, which are the high proportion of flights. Therefore, with an increase in flights to European locations, trade impacts are increased as the increase in flight frequency attracts more business passengers.

Heathrow

- 4.16** With a Heathrow Airport Northwest Runway scheme and a Heathrow Airport Extended Runway scheme, the additional runway provides a significant increase in passengers initially due to the current capacity constraint, which facilitates higher exports (and imports). However, Heathrow Airport experiences runway constraints very soon after expansion under both schemes due to pre-existing capacity demand pressures, resulting in smaller increases of gains from trade from 2030 onwards. As capacity fills, short-haul flights are increasingly replaced with long-haul flights, where passengers are more willing to absorb the additional capacity cost. A Heathrow Airport Extended Runway scheme reaches maximum capacity faster as it generates less capacity therefore the lack of growth occurs earlier than the than the Heathrow Airport Northwest Runway scheme, and results in lower trade benefits.
- 4.17** However the model has limitations in terms of picking up the value of these flights and as long-haul flights remain a smaller proportion of the network, the percentage increase is not significant in terms of influencing the results. This can be seen as a potentially conservative approach for Heathrow Airport where due to more pronounced capacity constraints, long-haul flights become a more significant proportion of their flights over time. Furthermore long-haul flights may be more valuable to trade as they provide a faster connection to areas that previously may not have been viable business connections if the routes were not as frequent. Similarly, while Europe is a primary trade partner, it is also important to note that trade can be generated through other modes. The model does not account for these factors.

Agglomeration

- 4.18** The impact of increased connectivity and lower transport costs attracts businesses to the area around the airport. These movements result in economic clusters being formed around airports, which also result in knowledge, technology transfers and labour pooling and thereby, an increase in productivity. The agglomeration benefits are calculated for the consumer and producer services industries which are the sectors that aviation is seen to effect (See Methodology for full details).
- 4.19** Under expansion at Heathrow Airport, the Heathrow Airport Northwest Runway scheme produces benefits of £1.7 billion (PV, 2014 prices) and the Heathrow Airport Extended Northern Runway produced benefits of £1.5 billion (PV, 2014 prices). Under a Gatwick Airport Second Additional Runway scheme, £0.6 billion (PV, 2014 prices) benefits is generated.

4.20 The agglomeration results include two impacts. This includes the impacts around the largest ten UK airports and those from smaller airports, which use a simplified methodology. Both methodologies are fully detailed in the previous section. The latter method should be considered with caution as it does not use the fully methodology of changing generalised costs around these airport but uses a proxy of the smallest agglomeration benefits generated with the full methodology. However these impacts are much smaller and do not significantly impact the overall benefits. The agglomeration impact of all UK airports, with the two different methodologies highlighted, are demonstrated in **Table 6**.

Table 6: Agglomeration results breakdown, present value

Assessment of Need (£millions)	Agglomeration at largest 10 UK airports	Agglomeration at other UK airports
GAL	596	-16
HAL	1,102	-27
HUB	1,529	-25

Source: Airports Commission analysis

Gatwick

4.21 An expansion of Gatwick Airport with a Gatwick Airport Second Additional Runway scheme demonstrates agglomeration benefits of £580 million (PV, 2014 prices). Gatwick Airport is historically a leisure passenger airport (85% of passengers are leisure passengers), therefore, although there are businesses located around the airport, there is less reliance on the airport in terms of business location. This is taken account of in the weighting which measures the impact in relation to the proportion of UK business passengers the airport represents.

4.22 The increase in business passengers at Gatwick Airport has a gradual profile as while capacity is beginning to be constrained, there is no build up of pent up demand. However this also means that less passengers are diverted from other airports as Gatwick Airport is slower to offer additional connectivity. As business passengers increase, the impacts of agglomeration become more pronounced with businesses attracted to the area around the airport to enjoy the lower travel cost. The clustering generates productivity benefits with labour attracted to the more productive jobs, moving from lower wages to higher wages offered.

4.23 However, as Gatwick Airport increases the number of business passengers, this begins to reduce the number of business passengers at other airports. Even with this increase, Gatwick Airport does not have the majority share of business

passengers in the UK system, which means that losing business passengers around other airports has a negative effect on the overall agglomeration benefits. For example, Gatwick Airport has a similar position to other UK airports such as Birmingham Airport and Luton Airport in weighting for business passengers so as passengers start to be attracted away from these airports. However, the positive effects at Gatwick Airport still outweigh the loss of business passenger and associated movement of labour away from these other areas as expansion generates incentive for labour to move to the area around Gatwick Airport.

Heathrow

4.24 An expansion of Heathrow Airport with a Heathrow Airport Northwest Runway or a Heathrow Airport Extended Northern Runway scheme demonstrates significant agglomeration benefits of £1.1 billion (Heathrow Airport Extended Northern Runway) to £1.5 billion (Heathrow Airport Northwest Runway) (PV, 2014 prices). The area around Heathrow Airport currently demonstrates strong clustering effects with a high proportion of business headquarters located within the area emphasising the dependence of the businesses such as GlaxoSmithKline and Apple on the airport. This is demonstrated by the high proportion of UK business passengers currently at Heathrow, more than any other UK airport that has been reflected in the weighting process. Heathrow is very close to London, which is a centre for consumer and producer services industries that rely on aviation links. However it is important to note the limitations in the model. The catchment area is only 45 minutes to avoid catchment area overlap meaning that many areas of London such as the City of London are not included in the effects. This is potentially a limitation as these areas contain many industries within the sectors with strong links to aviation. These are picked up in greater detail in the Strategic Case.

4.25 The current capacity constraints are a limitation for businesses as the cost of transport is higher and connectivity is lower. Therefore the expansion stimulates very strong passenger number growth with the removal of these restrictions, from which businesses will benefit. This demonstrates a significant agglomeration impact as it builds upon the current well-established business activity around the airport which, upon expansion, continues to build with businesses increasing production. Similarly labour is attracted to the area, due to jobs more aligned with their skills and higher wages. With employment moving towards the catchment area, an increase in wages is seen (weighted GDP per average) for workers as they move into these more productive jobs. With the current business presence around the airport, wages are already higher than average, therefore people moving into these higher paid jobs generate significant tax revenues, as detailed in the next section.

4.26 As demonstrated by passenger forecasts feeding through to the agglomeration at other airports, the expansion of Heathrow Airport does to some degree attract flights away from other airports as people have access to the airport they want to fly from. There are exceptions such as Edinburgh Airport, Liverpool Airport and Manchester Airport, where the number of flights increase (more detail in *Strategic Fit: Forecasts* report). However, the greater agglomeration benefits around Heathrow Airport outweigh these effects.

Tax revenue resulting from more productive jobs

4.27 With airport expansion, the clustering of businesses around the airports attracts workers to jobs that suit their skillset. In order to motivate workers to move, it is assumed that wages must be higher. If workers are earning more, they will pay higher tax and as a result, the tax take is higher. This generates higher government tax revenues.

Gatwick

4.28 The tax take from the movement of labour to more productive jobs under a Gatwick expansion generates £148 million (PV, 2014 prices). The wages in the consumer and producer service sector are also higher on average than other sectors. As workers are attracted to the more productive jobs in these sectors in the catchment area, they gain these higher wages, generating tax revenue.

4.29 In the methodology, the largest ten UK airports are considered, permitting consideration of the impact of a change in passenger numbers at these airports. With the expansion at Gatwick Airport, passenger numbers fall at other airports. As Gatwick Airport expands, people are attracted from around these airports to the area around Gatwick Airport. When passengers are being drawn from airports such as Heathrow Airport and Birmingham Airport, the wage differential in these areas is fairly low, despite the expansion at Gatwick. However there is still a net positive gain from the expansion as demonstrated by £148 million benefit.

Heathrow

4.30 Under a Heathrow expansion, the tax take from the movement of labour to more productive jobs generates £1.1 billion (PV, 2014 prices) is generated under a Heathrow Airport Northwest Runway, and under an Extended Northern Runway scheme at Heathrow, £1.01 billion is generated (PV, 2014 prices). The wage (weighted GDP per worker) around Heathrow Airport is high relative to the rest of the UK. In this assessment, the largest ten UK airports are considered, this allows the impact of a change in passenger numbers at these airports to be considered.

With a Heathrow Airport expansion, passengers are drawn from these other airports, meaning employment is negatively impacted around these areas. However the value of Heathrow Airport in terms of employment generation and higher wages in the area is higher than these negative impacts, resulting in a substantial net gain. The wages in the consumer and producer service sectors are also higher on average than other sectors. As workers are attracted to the more productive jobs in these sectors in the catchment area, they gain these higher wages, generating large tax revenues.

Business Output Benefits

4.31 The business output benefits are a cumulative figure of the additional business output benefit of delays and traditional business output benefits. The splits are demonstrated in **Table 7** in order to demonstrate their proportions of total business output benefits.

Table 7: Business output benefits breakdown, present value

Assessment of Need (£millions)	Business Output Benefits	Delay Benefits
GAL	1,045	62
HAL	1,339	20
HUB	1,154	14

Source: Airports Commission analysis

Gatwick Airport

4.32 £1.11 billion business output benefits are generated under a Gatwick Airport Second Runway scheme. The business output benefits reflect the profile of the passenger numbers. Under a Gatwick Airport expansion, capacity isn't fully constrained so passenger numbers take a while to build. In this respect, delay benefits are very high as the airport remains below full capacity for a long time, which means there is more capacity for coping with delays. There is a gradual increase in passengers as the airport opens. However, business output benefits are present for a long time as the airport has capacity past 2045. Businesses can therefore enjoy the lower transport costs (as shadow costs haven't built up), which results in increased profitable output as demonstrated by the benefit generated.

Heathrow Airport

4.33 £1.36 billion business output benefits are generated under a Heathrow Airport Northwest Runway scheme and £1.17 billion under a Heathrow Airport Extended

Northern Runway scheme. The business output benefits reflect the profile of the passenger numbers. The initial boost in passenger numbers due to the capacity constraint being removed generates high business output benefits. This feeds through to businesses in that their transport costs fall, which allows them to profitably increase the level of output they produce. Delay reductions have a similar impact. However, for both Heathrow Airport schemes, capacity becomes constrained very quickly so the benefits fall as the airport fills up. Similarly delays begin to build as capacity becomes constrained in 2030 and fully capacity constrained in 2035. As a result, businesses begin to feel the effect of shadow costs increasing and it is therefore assumed that they will not continue to increase output. The Heathrow Airport Extended Northern Runway scheme fills up quickly because the possible additional capacity is lower.

Sensitivity testing scheme performance under the alternative demand scenarios

Gatwick: Gatwick Airport Second Runway

4.34 **Table 8** below demonstrates the results for the Gatwick Airport Second Runway scheme for each of the scenarios with a carbon-traded policy.

Table 8: Gatwick Airport Second Runway results, present value

Gatwick Airport Limited (£millions)	Imports	Exports	Net Agglomeration	Tax Take	Business Output Benefits	Total
AoN	1,108	5,193	580	148	1,108	8,136
GG	2,452	12,072	756	239	2,611	18,130
RDE	1,482	7,234	381	153	845	10,095
LCK	2,078	10,600	786	303	2,249	16,015
GF	823	3,755	471	74	760	5,884

Source: Airports Commission analysis

Global Growth

4.35 The *global growth* scenario demonstrates a significant pick up in GDP growth domestically and globally, increased trade and falling oil prices, along with some aviation industry shifts such as the introduction of hub operations at Gatwick (moving an alliance such as SkyTeam from Heathrow Airport to hub at Gatwick Airport). Under a Gatwick Airport Second Runway, the passenger numbers increase

for a longer period of time as capacity does not start to fill until 2037. The results generates £18 billion benefits (PV, 2014 prices) under a Gatwick Airport Expansion.

- 4.36** There is a large increase in passenger numbers under the *global growth* scenario for Gatwick. The increase in business passengers, due to the assumed high GDP growth, drives trade results as it indicates that increased exchanges between businesses are being facilitated with more destinations available and more flights on current routes.
- 4.37** For similar reasons, business output benefits are high as transport costs become a smaller proportion of operating costs meaning it is profitable for firms to increase output. Delay benefits are reduced as the increase in passenger numbers results in capacity constraints occurring by 2037, so delays begin to build up.
- 4.38** Agglomeration and tax benefits are high relative to other scenarios, due to the increased level of demand driven by background assumptions of increased GDP. This results in a higher number of business passengers, which feeds through into greater business activity around the airport.

Relative Decline of Europe

- 4.39** Wider economic benefits of £10 billion are produced under this scenario under a Gatwick Airport Second Runway. A strong proportion of this is generated through trade. It is assumed that Middle Eastern hubs and Amsterdam Airport become more attractive and a Middle Eastern airline purchases a controlling stake at Gatwick Airport in order to use it as a feeder for its long-haul flights. Removing capacity constraints in the system increases this short-haul traffic and improves European links. As business flights increase to Europe, trade benefits increase as this is a key trading partner. Business benefits are lower however, as the demand is not present to build up substantial consumer surplus benefits.
- 4.40** Agglomeration and tax benefits are low relative to other scenarios, particularly agglomeration. This stems from the effect around other airports. Passengers are drawn from other airports, meaning that the mechanism of employment in respect to passengers draws employment away from other airports as the valuable business flights disappear. Moving passengers away from Heathrow Airport causes a very strong counter effect as many businesses around the airport rely on the business flights and wages are high around the airport regardless of expansion, so the loss of this high wage pushes tax effects down. In real terms, there could potentially be the relocation of some businesses to Gatwick Airport from Heathrow Airport, which reduces the high productivity impacts around Heathrow Airport.

Overall, it is counteracted by the benefits generated from the relocation to employment around Gatwick.

Low Cost is King

- 4.41** The *low cost is king* scenario assumptions are similar to that in *global growth* including a significant pick up in GDP growth domestically and globally, increased trade and falling oil prices. In order to demonstrate this at Gatwick Airport, long-haul flights from Heathrow Airport are seeded at Gatwick Airport and as a result it becomes more attractive, effectively acting as a hub. Low-cost carriers are reclassified in order to act like feeder traffic for the hub. With these assumptions, demand is very strong and the passenger numbers increase substantially, and the airport fills up fastest in this scenario (2033). The results generates £16 billion benefits (PV, 2014 prices) under a Gatwick Airport Second Runway scheme.
- 4.42** Although the assumptions trigger the highest demand, trade benefits are not boosted to the level of the *global growth* scenario as capacity constraints occur earlier and shadow costs begin to build up quickly, preventing some passengers from flying or switching to other airports. This has a detrimental effect with fewer UK business passengers entering the system, and therefore there are lower benefits associated with trade. For similar reasons, business output benefits are not quite as high. Delay benefits are significantly reduced as the huge demand results in capacity constraints occurring fastest in this scenario.
- 4.43** Agglomeration and tax benefits are highest relative to other scenarios as a result of the large increase in passengers stimulated by the high demand scenario. Although under a London Gatwick Second Runway scheme, Gatwick Airport gains a greater number of business passengers, its proportion of the UK share is the second largest which, as a result, means the loss at other airports is significantly outweighed. The high agglomeration benefits also indicate a strong movement towards more productive jobs that generating high tax benefits.

Global Fragmentation

- 4.44** Under *global fragmentation*, both UK and world GDP growth fall which reduces attractiveness for hub airports. Oil prices are also assumed to rise, increasing costs for airlines and passengers. As a result, Gatwick Airport loses thinner routes as they become unviable.

4.45 As a result of these assumptions, the benefits generated under this scenario are the lowest of the range at £6.2 billion. Passenger numbers still increase but slowly due to overall dampened demand. As a result of this, trade is relatively lower than other scenarios. Agglomeration remains higher than *relative decline of Europe* as Gatwick does not draw flights away from other airports to the same extent.

Heathrow: Heathrow Airport Northwest Runway & Heathrow Airport Extended Northern Runway

4.46 The analysis for the Heathrow schemes are very similar as the same characteristics apply to each airport. The differences are noted, and are driven by a lower maximum passenger capacity under the extended northern runway scheme.

Heathrow Northwest Runway

4.47 **Table 9** below demonstrates the results for the Heathrow Airport Northwest Runway scheme for each of the scenarios with a carbon-traded policy.

Table 9: Heathrow Airport Northwest Runway results, present value

Heathrow Airport Limited (£millions)	Imports	Exports	Net Agglomeration	Tax Wedge	Business Output Benefits	Total
AoN	1,269	6,070	1,666	1,102	1,360	11,466
GG	1,906	9,687	1,523	1,085	2,793	16,995
RDE	1,151	5,604	1,443	995	1,461	10,654
LCK	1,852	9,446	1,583	1,125	2,872	16,878
GF	1,126	5,386	1,583	881	1,057	10,033

Source: Airports Commission analysis

Heathrow Extended Northern Runway

4.48 **Table 10** below demonstrates the results for the Heathrow Airport Extended Northern Runway scheme for each of the scenarios with a carbon-traded policy.

Table 10: Heathrow Airport Extended Northern Runway results, present value

Heathrow Hub (£millions)	Imports	Exports	Net Agglomeration	Tax Wedge	Business Output Benefits	Total
AoN	1,089	5,212	1,504	1,015	1,168	9,988
GG	1,616	8,272	1,523	1,051	2,367	14,829
RDE	982	4,825	1,285	920	1,268	9,279
LCK	1,607	8,263	1,337	950	2,545	14,701
GF	960	4,602	1,491	836	911	8,800

Source: Airports Commission analysis

Global Growth

4.49 The *global growth* scenario demonstrates an overall pick up of the GDP growth domestically and globally, increased trade and falling oil prices. The role of hubs is enhanced to increase international to international passenger demand. Aside from this background set of assumptions, no additional changes are made to Heathrow Airport as it is assumed that background demand will pick up the slots.

4.50 Trade impacts are strongest under this scenario, generating £11.6 billion benefits (PV, 2014 prices) under a Heathrow Airport Northwest Runway scheme and £9.9 billion (PV, 2014 prices) under a Heathrow Airport Extended Northern Runway scheme. This is due to the excess demand in the system, which provides a large increase in passengers to the system when the runway opens which, in turn, results in larger benefits. Under constraints, short-haul flights are crowded out as the costs of congestion are a relatively higher share compared to long-haul flights. As Europe is a key trade destination, these destinations see a large increase when the cost is removed. However, the boost is fairly short lived as the airport is full by 2031. As a result, benefits do not continue to increase at the same rate as the airport fills. It is important to note that long-haul flights begin to replace short-haul flights, but as they still represent a smaller portion of the system, the percentage increase isn't significantly picked up by the model. As the model doesn't "value" these flights and treats the percentage change in passenger numbers as the link to understanding where an increase in trade would occur, this is potentially an underestimate. Indeed, long-haul flights to places such as Asia and North America are considered to generate larger trade benefits but they represent a much smaller percentage of the overall UK passenger number increase.

- 4.51** Delay benefits are significantly reduced as the huge demand results in capacity constraints occurring fastest in this scenario meaning business benefits are significantly reduced.
- 4.52** With the increase in passengers at Heathrow Airport, the agglomeration benefits are substantial. An increase in UK business passengers results in businesses associated with the airport continuing to expand their presence there. This happens alongside new companies that use the airport, locating around it to take advantage of the substantial increase in connectivity and lower transport costs associated with this expansion. Tax benefits are also high for this reason, as people move to take up more productive jobs.
- 4.53** The significant increase in Heathrow Airport flights reduces business flights at other airports as many business travellers now get their airport of preference as capacity increases. However as Heathrow Airport has the largest proportion of business passengers compared to that of other airports, the weighting system in the methodology takes account of the worth of these business flights and the benefits at Heathrow Airport far outweigh the losses at the other airports. However, the effects are reduced similarly to that of trade because the boost is short lived.

Relative Decline of Europe

- 4.54** Under this scenario, the background assumptions involve high GDP growth in developing areas such as Newly Industrialised Countries (NIC's) and Least Developed Countries (LDC's). This results in an increase in trade between Europe and these areas. Many European hubs become less attractive as Middle Eastern hubs become the key intermediate point between these trade routes. It is assumed that a Middle Eastern or Asian airline purchases a controlling stake in International Airlines Group (British Airways' parent company), and that results in Heathrow providing feeder services to Middle Eastern hubs such as Dubai. As result, long-haul services fall and a smaller route network is offered. Low-cost carriers are "unbanned" and some routes prove viable.
- 4.55** The benefits from trade under both Heathrow Airport schemes are significant as the overall number of business passengers increases. However, they are less substantial than under the other scenarios due to the impacts felt through a smaller route network and a loss of long-haul flights. There is a boost from the increase in short-haul flights (mainly LCCs) to Europe compared to the do minimum under expansion so there is a boost to trade on these routes. However, while passenger numbers do consistently increase capacity constraints begin to build up before

2030 and passenger growth stabilises and shadow costs begin to creep in, reducing incentives for businesses to trade, as the cost increases.

4.56 Agglomeration is relatively low due to the nature of the movement of business passengers. While Heathrow Airport loses long-haul routes to other hubs, short-haul flights enter into Heathrow Airport that would have been previously kept out by high shadow costs. These short-haul flights are pulled from other UK airports and reduce potential airport related employment around those airports. The lower demand in the system also reduces the overall number of passengers in the system, including those coming into Heathrow Airport, resulting in lower agglomeration benefits than other scenarios. Similarly, the airport becomes constrained again very quickly with this influx of short-haul flights so the benefits at Heathrow Airport do not outweigh the loss to other airports to the same extent as in other scenarios. However, the airport still pulls people towards higher paid jobs, which results in tax benefits remaining high.

Low Cost is King

4.57 The impacts under this scenario are very similar to that of *global growth*. The key assumption difference is that low-cost airlines are now able to operate at Heathrow Airport under the capacity expansion.

4.58 Trade impacts are strongest under this scenario, generating £11.3 billion benefits (PV, 2014 prices) under a Heathrow Airport Northwest Runway scheme and £9.88 billion (PV, 2014 prices) under a Heathrow Airport Extended Northern Runway scheme. Before expansion, Heathrow Airport is at capacity and shadow costs have increased over many years due to excess demand. As a result, there is a large rise in passengers to the system upon expansion that results in substantial benefits. Trade benefits from this expanded number of routes – particularly to Europe via the introduction of low-cost carriers. However, the boost is fairly short lived as the airport is constrained again by 2031. As result, benefits do not continue to increase at the same rate over the course of the period.

4.59 Delay benefits are significantly reduced as the huge demand results in capacity constraints occurring faster in this scenario. Business benefits are very high under this scenario as the removal of capacity constraints allows the frequency benefits to build along with the reduction in shadow costs. This feeds through to businesses in the form of reduced transport costs.

4.60 There is an extensive increase in passengers at Heathrow Airport and as a result agglomeration benefits are substantial. Increasing UK business passengers results in businesses associated with the airport continuing to expand their presence, along

with new companies locating around it to take advantage of the substantial increase in connectivity and lower transport costs. However, the benefits are lower than other scenarios as the introduction of low-cost flights at Heathrow Airport pulls flights from other UK airports, where low-cost flights are a substantial part of their operations.

Global Fragmentation

- 4.61** Under *global fragmentation*, both UK and world GDP growth falls which reduces attractiveness for hub airports. Oil prices are also assumed to rise, increasing costs for airlines.
- 4.62** As a result of these assumptions, the benefits generated under this scenario are £10 billion in a Heathrow Airport Northwest Runway scheme and £8.3 billion under an Heathrow Airport Extended Northern Runway Scheme. Passenger numbers still increase but much more slowly due to overall dampened demand in this scenario. As a result of this, trade is relatively lower than other scenarios.
- 4.63** Agglomeration remains higher than *relative decline of Europe* as it does not draw flights away from other airports to the same extent. Due to the methodology regarding the impacts around all the largest ten UK airports, the reduced removal of flights from other airports means that the net gain in agglomeration is higher. However, when the weighting of the proportion of UK business passengers is considered, the movement of employment is lower as businesses are relatively less incentivised to move to the areas around Heathrow Airport as a result of the economic conditions in this low demand scenario. As a result of this, fewer people are moving into the high productivity and high wage areas around Heathrow Airport, which results in lower tax benefits.
- 4.64** Business user benefits are substantially affected because frequency benefits do not build up as there is less demand in the system. However delays benefit as the airport takes the longest to fill up under this scenario showing a stronger positive result.

Carbon-capped analysis

- 4.65** In order to understand the implications of the CCC's planning assumption for future aviation demand, the Commission developed the 'carbon-capped' approach to forecasting. This approach treats carbon emissions as a constraint, rather than as an output of the model. The forecasts showed underlying demand growth consistent with the planning assumption of 67% over 2005 levels by 2050. The Commission sought to incorporate the 'carbon-capped' approach into its

assessment of the three shortlisted schemes for new runway capacity. However, incorporating the planning assumption into the transport economic efficiency analysis, which is an input to the wider economic impact appraisal, presented a number of technical challenges, which are set out in *Economy: Transport Economic Efficiency Impacts*.

4.66 Therefore, for the purpose of transport economic efficiency and wider economic impact appraisal in which demand is reduced to a level consistent with the proposed CCC planning assumption, the Commission has adopted the demand reduction approach.

4.67 The methodology used to calculate the forecasts for the demand reduction test is fully detailed in the *Strategic Fit: Forecasts*. The wider economic impacts of this approach are contained below. The wider economic impacts of the carbon policy sensitivity test are contained in a separate report as stated previously.

Demand reduction approach

4.68 For this approach, a set of forecasts have been prepared in which underlying demand is reduced to a level at which overall UK aviation emissions with expansion would not exceed 37.5 MtCO₂ (and hence lower emissions are seen in the ‘do minimum’ forecast). Whilst conceptually this would be consistent with UK aviation being subject to some form of international trading scheme, no trading or purchase of offsets has been included to allow UK aviation emissions to rise above 37.5MtCO₂. Further details of this approach are contained in *Economy: Transport Economic Efficiency Impacts and Strategic Fit: Forecasts*⁴⁶.

4.69 The demand reduction sensitivity tests have been run for two scenarios; *assessment of need* and the high demand scenario *low cost is king*. *Low cost is king* has been included as a “stress test” where the most abatement of carbon is required. The methodology used to calculate the forecasts for these tests is fully detailed in the *Strategic Fit: Forecasts* document.

46 Strategic Fit: Forecasts – https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374660/AC05-forecasts.pdf

Assessment of Need

Table 11: Demand reduction assessment of need results, present value

Assessment of Need (£millions)	Imports	Exports	Net Agglomeration	Tax Wedge	Business Output Benefits	Total
GAL	785	3,689	290	23	682	5,469
HAL	756	3,629	1,579	936	786	7,686
HUB	644	3,089	1,320	812	694	6,558

Source: Airports Commission analysis

Gatwick Airport

4.70 In this test, the demand reduction scenario results in much lower increases in passenger numbers, although expansion still sees overall passenger numbers rise. As a result, trade numbers increase as the UK business passenger numbers rise, however it is a significantly lower benefit compared to carbon-traded. If fewer business passengers are able to fly, trade effects from expanded capacity are lower as fewer benefits from trade are being realised. Gatwick Airport is relatively higher due to the prominence of short-haul at the airport.

4.71 Business user benefits remain as the shadow costs remain low due to the airport not becoming constrained again.

4.72 Agglomeration remains lower as the increase in flights under a Gatwick Airport Second Runway scheme is significant but not completely offset by the fall in flights at other airports, most significantly Heathrow Airport. With the loss of flights at Heathrow Airport, there is a substantial impact as there is currently a strong business presence around the airport. As a result, people are drawn away as businesses that rely on the airport lose flights. Movement to Gatwick Airport does promote agglomeration effects but it does not have the business presence and higher wages that Heathrow Airport does so it does not generate such strong effects. As a result, the tax revenue resulting from more productive jobs also remains low.

Heathrow Airport

4.73 The demand reduction scenario results in lower passenger number increases. However, capacity constraints at Heathrow Airport are still removed and there is still excess demand in the system which results in a boost in the passenger numbers upon expansion. As a result benefits from trade increase as the UK business

passenger numbers rise. It is a significantly lower benefit compared to the carbon-traded case. If fewer business passengers are able to fly, trade effects from expanded capacity are lower as fewer benefits from trade are being realised.

4.74 Agglomeration remains high as increasing business flights at Heathrow Airport increases its proportion of UK business passengers. This strongly increases the impacts as there is a greater pull for businesses to move to Heathrow Airport if flights from other UK airports are being removed to meet the carbon restrictions. The business presence around Heathrow Airport is already strong so continuing to increase access to business flights would further encourage firms to cluster. As a result, the tax revenue resulting from more productive jobs also increases as the clustering develops high productivity jobs to which labour is attracted due to its assumed higher wage.

Scenario sensitivity tests

The demand reduction scenario has also been tested for a high demand scenario as completed in the *Transport Economic Efficiency* report. The following results show the impacts of a *low cost is king* scenario.

Table 12: Demand reduction low cost is king results, present value

Low Cost is King (£millions)	Imports	Exports	Net Agglomeration	Tax Wedge	Business Output Benefits	Total
LGW 2R	873	4,268	730	304	313	6,487
LHR NWR	566	2,785	1,214	995	528	6,088
LHR ENR	482	2,383	1,061	895	430	5,251

Source: Airports Commission analysis

Gatwick Airport

4.75 Passenger number increases are much lower due to the demand cap. There is capacity already in the system, which results in overall passenger numbers increasing slowly over time.

4.76 Under this scenario, there is a demand for low-cost flights, which are typically short-haul. As a result, trade benefits are relatively high as short-haul flights to Europe continue to grow as passengers continue to increase (more slowly) over time, which allows benefits to build, with the increasing routes. Growth is much slower, however, because demand is capped. This generates over £5 billion benefits (PV, 2014 prices).

4.77 Agglomeration also builds because Gatwick Airport gains a substantial boost in business passengers over time. Growth develops slowly so the number of passengers diverted from other airports is smaller over time. As a result, benefits build at Gatwick Airport as capacity remains so flights can continue to increase and business become attracted to Gatwick Airport with lower costs and increased connectivity that stimulates clustering. Tax revenue resulting from more productive jobs are also higher as the increased clustering strongly boosts the number of people in higher productivity jobs – attracted by the increased number of jobs (high wage) around the airport.

Heathrow Airport

4.78 Capacity constraints at Heathrow are still removed and there is still pent up demand in the system which results in a boost in the passenger numbers upon expansion. The key assumption difference is that low-cost airlines are now able to operate at Heathrow Airport under the capacity expansion.

4.79 Trade impacts are weaker with the carbon restrictions, generating £3.4 billion benefits (PV, 2014 prices) under a Heathrow Airport Northwest Runway scheme and £2.9 billion (PV, 2014 prices) under a Heathrow Airport Extended Northern Runway scheme. The boost comes from capacity constraints being removed, however the overall passenger numbers are not increasing dramatically and there is an overall fall in the number of routes available as the short-haul begins to be replaced with valuable long-haul destinations, reducing the European flights where a large proportion of the trade flights feed through.

4.80 Agglomeration remains substantially high as more business flights increase Heathrow Airport's proportion of UK business passengers. This strongly increases the impacts as there is greater pull for businesses to move to the area around Heathrow Airport if flights from other UK airports are being removed to meet the carbon restrictions. However, under this scenario, flights from other airports reduce under a Heathrow expansion as they are predominantly low-cost carriers which now move to Heathrow Airport.

5. Conclusions

- 5.1** The wider economic impacts assessment considers four key impacts; gains from trade, benefits from agglomerations forming, additional tax from the movement to more productive jobs and the benefit from additional business output resulting from reduced transport costs and reduced delays.
- 5.2** The result of the expansion upon these impacts generates substantial benefits, with the highest benefit of £11.5 billion (PV, 2014 prices) generated under a Heathrow Airport Northwest Runway scheme (*assessment of need, carbon-traded*), as demonstrated in **Table 13**. The breakdown of results demonstrates key differences for each scheme.

Table 13: Assessment of need results, present value

Assessment of Need (£millions)	Imports	Exports	Net agglomeration	Tax Wedge	Business Output Benefits	Total
GAL	1,108	5,193	580	148	1,108	8,136
HAL	1,269	6,070	1,666	1,102	1,360	11,466
HUB	1,089	5,212	1,504	1,015	1,168	9,988

Source: Airports Commission analysis

- 5.3** Benefits from trade are fairly similar across the three schemes as they are largely driven by the number of additional business passengers in the system under each scheme. However, they are also influenced to a degree by the destinations served under each scheme, which do differ. Across all options, short-haul flights dominate overall business passenger numbers and therefore represent a high proportion of the trade benefits presented. While levels of trade are high between Europe and the UK, and this is forecast to increase, they are already well integrated and gains from trade in the future will be limited when compared to some other less well connected and integrated economies.
- 5.4** Long-haul flights to fast growing and developing economies are a much smaller proportion of flights overall, and therefore do not represent a large increase, in percentage terms, given differences between the schemes. As a result, the full value of these additional flights are potentially underestimated. These once underserved additional high value long-haul flights, represent an opportunity to develop new

frequent global connections, open new markets and generate more significant knowledge transfers, as they are less extensively integrated with the UK. Heathrow Airport sees a higher number of these high value long-haul flights than Gatwick Airport, however, this effect is lost to some extent in the analysis undertaken.

- 5.5** Agglomeration benefits are substantially higher under the Heathrow Airport Northwest Runway scheme. This is due to the business presence already in existence around Heathrow Airport and its proximity to London and therefore the higher GDP per worker within the area and region.
- 5.6** It is interesting to put the results into the context of other transport schemes. The benefits for Heathrow Airport Northwest Runway represent around 16% of the total benefits to the scheme. Compared to other transport assessments, this is a much smaller percentage, indeed Crossrail estimated wider economic impacts to be around a quarter of the overall final benefit of the scheme (PV, 60 year appraisal period)⁴⁷ using a WebTAG methodology. As the methodology used for this assessment has been adapted and developed to be aviation specific, there are differences in the impacts assessed, which make it difficult to compare scale in this way. The Commission has also undertaken some S-CGE work with PwC to estimate the impact on UK GDP; again the approach, methodology and assumptions differ; so generate a different scale of benefit and should not therefore be directly compared.
- 5.7** Overall the analysis undertaken in this paper suggests that a Heathrow Airport Northwest Runway scheme demonstrates the highest benefits of £11.5 billion (PV, 2014 prices) under a carbon-traded assessment of need scenario. For Heathrow Airport Extended Northern Runway the benefits are slightly lower at £10 billion (PV, 2014 prices) and then under Gatwick Airport Second Runway scheme they are £8.1 billion (PV, 2014 prices). These results vary when the different demand scenarios and carbon cases considered by the Commission are tested.

47 Business Case for Crossrail (2005) – <http://www.crossrail.co.uk/benefits/wider-economic-benefits/>

